Foreclosure Contagion and the Neighborhood Spillover Effects of Mortgage Defaults

Selection, Leverage and Default in the Mortgage Market,
with Christopher Hansman

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Research Agenda Identifies Determinants of Mortgage Default

- **Research Question:** What determines mortgage default?
- **Context:** ARM borrowers during Financial Crisis ‘08:
  - Hybrid 5/1 ARM Borrowers—pay initial rate for five years, before reset.
  - Option ARM Borrowers—low fixed payment, scheduled payment based on index.
- **Identification:** Interest Rate shocks from LIBOR/Treasury Divergence identify payment and balance shocks.
- **Key Results**
  - Payment shocks drive borrowers to default.
  - Defaults trigger other defaults among peers, who find it difficult to refi in presence of local foreclosure.
  - Shocks to borrower leverage *with no impact on current payments* also cause defaults.

*Results support double-trigger theory of mortgage default—combination of cash-flow shock and negative equity drive mortgage defaults.*
1. Foreclosure Contagion

Impact of Local Foreclosures on Neighbors
Deeds:
- Property-level administrative dataset on all housing transactions, including geocodes; 23m observations between 2000–2012.

BlackBox:
- Mortgage-level dataset with dynamic information (payment status, interest rate) on mortgage and static information (credit score, purpose) on borrower.
- Represents 90% of the private-label securitized market.

Equifax:
- Borrower-level data with dynamic credit information (credit score, payment status on various debts).
Contract Details Specifying How Market Interest Rates are Chosen Result in Interest Rate Variation

- Identify novel instruments resulting in different interest shocks to borrowers resetting the same month:
  - **Index:** Either LIBOR or Treasury. Loans with initial length of five years.

- Borrower awareness of precise contract terms and nature of ARM reset is limited (Bucks and Pence 2006—only 25% report a plausibly correct index).

- First Stage: This variation in interest rates predicts default rates among borrowers.

- Second Stage: Predicted defaults due to purely within-month interest rate variation induce payment responses among neighbors.

- Key assumption: Within month variation in interest rates of resetting ARMs, conditional on other observables, is uncorrelated with default behavior of neighbors except through channel of ARM default.
LIBOR–Treasury Values Similar Pre-Crisis; Spread Opens up

Interest Rate\(_t\) = Margin + Index\(_t\)

**Fixed**  
**Variable**

![Graph showing 1 Year Libor/Treasury Values (pp) from Jan 2003 to Jan 2010 with significant increase and decrease in the spread around Jun 2008.](image-url)
Spread Results in Sizable Rate Shocks to Borrowers

Distribution of Interest Rate Shocks

Density
Sample Consists of Resetting ARMs and Their Neighbors

- Subset of adjustable-rate mortgages with reliable information on interest rates paid upon reset.
- Universe of transacting borrowers within a 0.10 mi radius of the resetting loan.
- Neighborhoods in which there is one, and only one, resetting adjustable-rate mortgage. Results are robust to including areas with multiple resetters.
- Analyze borrower behavior in the period after reset among neighboring mortgages.
- All borrowers in sample are therefore exposed to a nearby resetting ARM; variation comes size of post-reset interest rate shock paid by ARM borrowers.
Illustration of Sample

Treasury Reset Jan 2009, $r = 3.90$

Treasury Reset July 2007, $r = 4.97$

LIBOR Reset Jan 2009, $r = 1.26$

LIBOR Reset July 2007, $r = 5.26$

- ARM
- Other Property
Illustration of Sample

Treasury Reset July 2007, $r = 4.97$

LIBOR Reset July 2007, $r = 5.26$

LIBOR Reset Jan 2009, $r = 3.90$

LIBOR Reset Jan 2009, $r = 1.26$

- ARM
- In Sample
- Not in Sample

0.10 mi
First Stage Predicts Foreclosure of Resetting Loan as Function of Interest Rate Variation

**First Stage:** Resetting mortgage $i$ in zipcode $s$ and month $t$:

$$D_{is,t \rightarrow t+12} = \mu_{st} + \beta' R_{ist} + \gamma' X_{ist} + \epsilon_{ist}$$

- $D_{ist}$ = Foreclosure start on house $i$ in zipcode $s$ in year following reset
- $\mu_{st}$ = Zip code, month fixed effects
- $R_{ist}$ = Size of post-reset shock
- $X_{ist}$ = Other borrower controls
- $\epsilon_{ist}$ = cluster at tract $\times$ year
- $\hat{D}_{ist}$ = Predicted default rate due to rate reset
Examine Neighbor Foreclosure Responses as Function of Resetting Loan Characteristics

- **Reduced Form**: Neighbor of resetting mortgage $i$ in zipcode $s$ and month $t$, responding as a function of reset characteristics:

  \[ D_{-i,s,t \rightarrow t+24} = \mu_{st} + \beta' R_{ist} + \gamma' X_{-i,st} + \epsilon_{-i,st} \]

- **Second Stage**, predicted foreclosure completions next two years among mortgages neighboring reseters, with instrumented local default due to rate reset:

  \[ D_{-i,s,t \rightarrow t+24} = \mu_{st} + \delta' \hat{D}_{ist} + \gamma' X_{-i,st} + \epsilon_{-i,st} \]
Estimate Strong Effects of Foreclosure Contagion

<table>
<thead>
<tr>
<th></th>
<th>First Stage</th>
<th>Reduced Form (ITT)</th>
<th>Second Stage (2SLS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Index Sample</strong></td>
<td>0.024</td>
<td>0.0012</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.0007)</td>
<td>(0.013)</td>
</tr>
<tr>
<td><strong>All Resets</strong></td>
<td>0.025</td>
<td>0.0005</td>
<td><strong>0.021</strong></td>
</tr>
<tr>
<td></td>
<td>(0.0013)</td>
<td>(0.00014)</td>
<td>(0.0049)</td>
</tr>
</tbody>
</table>

Dep Var is Foreclosure of: Resetter Neighbor Neighbor
Avg [0.08] [0.03] [0.03]
Ind Var: Int Rate Int Rate Predicted Default

Aggregating: each foreclosure causes additional 0.45 foreclosures in neighborhood
Sample: All loans within 0.10 miles of a resetting loan.
Foreclosure Spillover Effects Decay with Distance

Effects by Distance

Size of Spillover Effect by Distance

- 0
- 0.05
- 0.1
- 0.15

Distance in mi

95% CI Spillover Effect

- Spillover Effect
  - 95% CI
Neighbor Borrower Demand for Refinancing Does Not Go Up

Mortgage Inquiries

<table>
<thead>
<tr>
<th>Time from Foreclosure</th>
<th>Upper 95% CI</th>
<th>Lower 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mortgage Inquiry</td>
<td>Mortgage Inquiry</td>
</tr>
<tr>
<td></td>
<td>0.004</td>
<td>−0.004</td>
</tr>
<tr>
<td></td>
<td>0.002</td>
<td>−0.002</td>
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<tr>
<td></td>
<td>0.000</td>
<td>0</td>
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<tr>
<td></td>
<td>0.002</td>
<td>0.002</td>
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<td></td>
<td>0.004</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Graph showing the trend of mortgage inquiries over time from foreclosure with upper and lower 95% confidence intervals.
But Refinancing Volume Falls, Suggesting a Lender Response

<table>
<thead>
<tr>
<th></th>
<th>Refinancing (2SLS)</th>
<th>Refinancing (2SLS)</th>
<th>First-Stage F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index Sample</td>
<td>-0.078</td>
<td></td>
<td>1031</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Resets</td>
<td>-0.035</td>
<td>-0.063</td>
<td>173 (458 BBX)</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.009)</td>
<td></td>
</tr>
<tr>
<td>N(Clusters)</td>
<td>1.7m(26k)</td>
<td>4.4m(58k)</td>
<td></td>
</tr>
<tr>
<td>Sample</td>
<td>BBX</td>
<td>Deeds</td>
<td></td>
</tr>
<tr>
<td>Avg of Dep Var</td>
<td>[0.076]</td>
<td>[0.17]</td>
<td></td>
</tr>
</tbody>
</table>
Results Indicate Mortgage Contract Structure Exposed Borrowers to Default Risk

- Borrowers default due to LIBOR-Treasury variation inducing interest rate shocks.
- Estimate sizable spillover effects from foreclosures: each foreclosure contributes to an additional 0.45 foreclosures in neighborhood.
- Price channel is one mechanism, but appears unlikely to explain full effect.
- Refinancing channel is one important mechanism: point to important externalities on access to credit.
- Neighboring borrower responses also suggest role for peer effects; informational channel of learning of costs of default.
- Implications: Neighborhoods and social interactions matter for understanding information flows, propagation of shocks. Important amplification mechanism during financial crisis.
2. Separating Moral Hazard and Selection

Using LIBOR/Treasury Variation on Balances
Separating Information Asymmetries: Unpacking a Correlation

Borrowers with High Leverage Mortgages More Likely to Default
Why do borrowers with higher leverage default more often?

(1) *Moral Hazard*: Causal effect of leverage on default
   - Larger loans $\Rightarrow$ larger balances $\Rightarrow$ more defaults

(2) *Adverse Selection*: Unobservably risky borrowers take more leverage
   - Types that choose high leverage more likely to default (holding loan terms fixed)

Classic empirical challenge to separate:
   - Different leverage choice $\iff$ Different balance
Identifying Moral Hazard: Compare A and B

Identical Loans

Borrower A

Loan: $100,000

Borrower B
Disentangling Information Asymmetries: Ideal Experiments

Identifying Moral Hazard: Compare A and B

Identical Loans

Borrower A
Loan: $100,000
Borrower B

Exogenous Shock

Balance A: $110,000
Balance B: $105,000
Disentangling Information Asymmetries: Ideal Experiments

Adverse Selection: Compare C and D

Different Loans

Borrower C

Loan C: $100,000

Exogenous Shock

Balance: $105,000

Borrower D

Loan D: $95,000
Replicating Ideal Experiments

- Both ideal experiments feature exogenous variation in balances
  - *After* initial contract choice

- Unique features of option adjustable rate mortgages (Option ARM):
  1. Fixed (low) payment schedule for first 5 years
  2. Variable interest rates: typically LIBOR or Treasury indexed

- Substantial market prior to crisis (≈ 10% of originations in 2006)

- ⇒ Balance depends on the ex-post realization of a financial index
  1. Identical loans + different index realizations ⇒ different balances
  2. Larger loan + lower index realization ⇒ same balance
Index $\times$ Origination Month Creates Diff-in-Diff Style Variation
Reduced Form Implementation

\[ D_{it+1} = \alpha LTV_{it} + \gamma L_i + x_i' \beta + \varepsilon_{it} \]

\[ LTV_{it} = \delta Z_{it} + \eta L_i + x_i' \pi + u_{it} \]

- Moral Hazard: \( \alpha > 0 \), Adverse Selection: \( \gamma > 0 \)
  - \( L_i \): Origination leverage
  - \( LTV_{it} \): Current leverage
  - \( D_{it+1} \): default in one year (60 DPD)

- Estimate cross-sectionally at different loan ages \( t \) (baseline: 24 months into loan)
- \( x_i \) contains borrower/loan characteristics at origination and rich set of fixed effects
  - Most saturated: index type/zipcode/originator \( \times \) origination month
Leave-out IV Strategy

- Jackknife style instrument for $LTV_{it}$:

$$Z_{it} = \frac{1}{n_{I(i) \times m(i)} - 1} \left[ \left( \sum_{j=1}^{n_{I(i) \times m(i)}} LTV_{jt} \right) - LTV_{it} \right]$$

- Average leverage at $t$ for others with same index $I(i)$ and origination month $m(i)$
- Analogous to index $\times$ origination month fixed effects
- $I(i)$ and $m(i)$ fixed effects (at least) for cohort effects/index differences
  - Focus on interaction between index and origination month
## Separating Adverse Selection and Moral Hazard

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<tr>
<td></td>
<td>Baseline</td>
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<tr>
<td>Origination Leverage</td>
<td>1.066***</td>
</tr>
<tr>
<td></td>
<td>(0.073)</td>
</tr>
<tr>
<td>Current Leverage</td>
<td></td>
</tr>
<tr>
<td>Index Type FEs</td>
<td>Yes</td>
</tr>
<tr>
<td>Zipcode FEs</td>
<td>Yes</td>
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<tr>
<td>Credit/Loan Controls</td>
<td>Yes</td>
</tr>
<tr>
<td>Originator x Orig. Month FEs</td>
<td>Yes</td>
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<tr>
<td>Mean of Dep. Var.</td>
<td>0.44</td>
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<td>N</td>
<td>491,215</td>
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- **Baseline**: Borrowers with 10 point higher original LTV default ≈ 10pp/year more
- **Conditional on observables**
## Separating Adverse Selection and Moral Hazard

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<td>0.818***</td>
<td>0.655***</td>
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<td></td>
<td>(0.073)</td>
<td>(0.075)</td>
<td>(0.127)</td>
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<tr>
<td>Current Leverage</td>
<td></td>
<td>0.285***</td>
<td>0.473***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.028)</td>
<td>(0.171)</td>
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- Adverse selection accounts for ≈ 60 percent of association between leverage and default
- Moral hazard (causal effect of debt on default) ≈ 40 percent
Non-Linearity of Leverage and Default
Overview of Findings

- Strong correlation between loan size and default
  - Borrowers with 10 point higher original loan-to-value (LTV) default 10pp/year more conditional on observables
  - Holding payments fixed: Adverse Selection: \( \approx 60\% \), Moral Hazard: \( \approx 30\%-40\% \)

- Causal Estimation of Default even among borrowers who suffer rise in leverage but *no* immediate payment shock.
Results Point to Double-Trigger Model of Mortgage Default

- Combination of Life Event and negative equity trigger default.
- Causally identify role of Adverse Events by Interest Rate Shocks on ARMs based on Index.
- Negative Equity effects causally identified by exogenous shocks to balances among Option ARM.
- Precise trigger point varies across borrowers:
  - Borrowers quicker to default pick high-leverage contracts.
  - Borrowers change trigger based on availability of external financing and peer effects.