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

Data Represents a Novel Linkage of Three Datasets

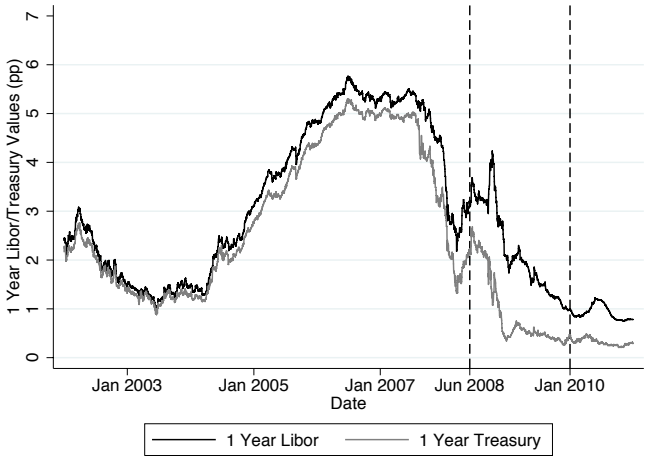
- **Deeds:**
  - Property-level administrative dataset on all housing transactions, including geocodes; 23m observations between 2000–2012.
- **BlackBox:**
  - Mortgage-level dataset with dynamic information (payment status, interest rate) on mortgage and static information (credit score, purpose) on 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

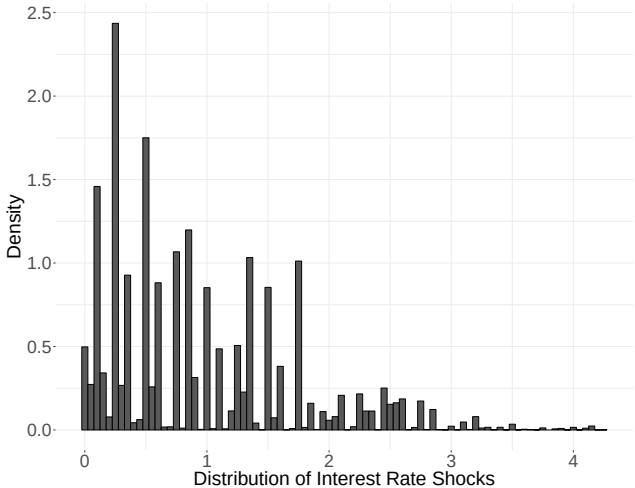
- Identify novel instruments resulting in different interest shocks to borrowers resetting the same month:
  - **Index:** Either LIBOR or Treasury. Loans with initial length of five years.
- Borrower awareness of precise contract terms and nature of ARM reset is limited (Bucks and Pence 2006—only 25% 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

$$\text{Interest Rate}_t = \underbrace{\text{Margin}}_{\textit{Fixed}} + \underbrace{\text{Index}_t}_{\textit{Variable}}$$



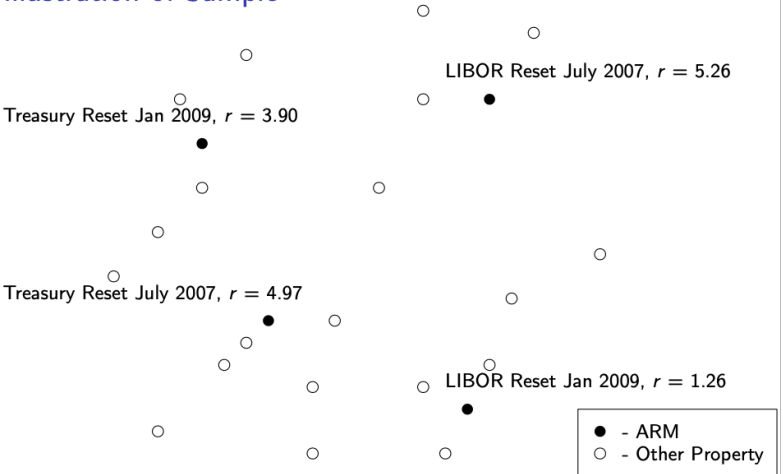
Spread Results in Sizable Rate Shocks to Borrowers



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



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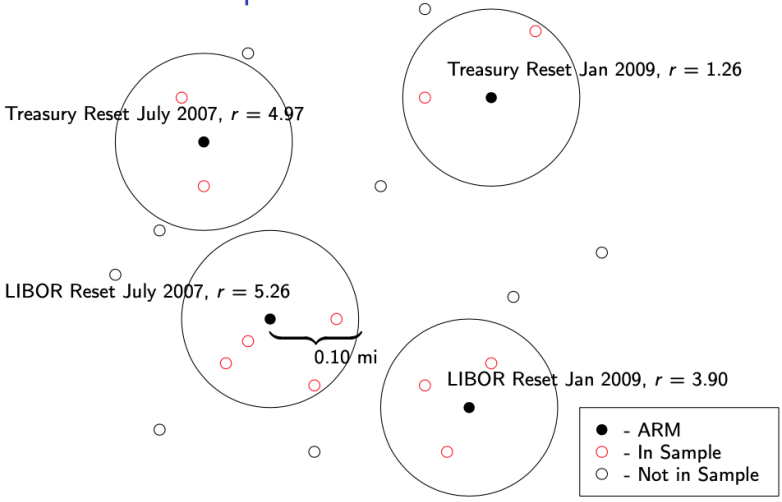


First Stage Predicts Foreclosure of Resetting Loan as Function of Interest Rate Variation

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

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

- D_{ist} = Foreclosure start on house i in zipcode s in year following reset
- μ_{st} = Zip code, month fixed effects
- R_{ist} = Size of post-reset shock
- X_{ist} = Other borrower controls
- ε_{ist} = cluster at tract $\times$ year
- $\hat{D}_{ist}$ = Predicted default rate due to rate reset

Graphical

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:

$$D_{-i,s,t\to t+24} = \mu_{st} + \beta' R_{ist} + \gamma' X_{-i,st} + \varepsilon_{-i,st}$$

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

$$D_{-i,s,t\to t+24} = \mu_{st} + \delta' \hat{D}_{ist} + \gamma' X_{-i,st} + \varepsilon_{-i,st}$$

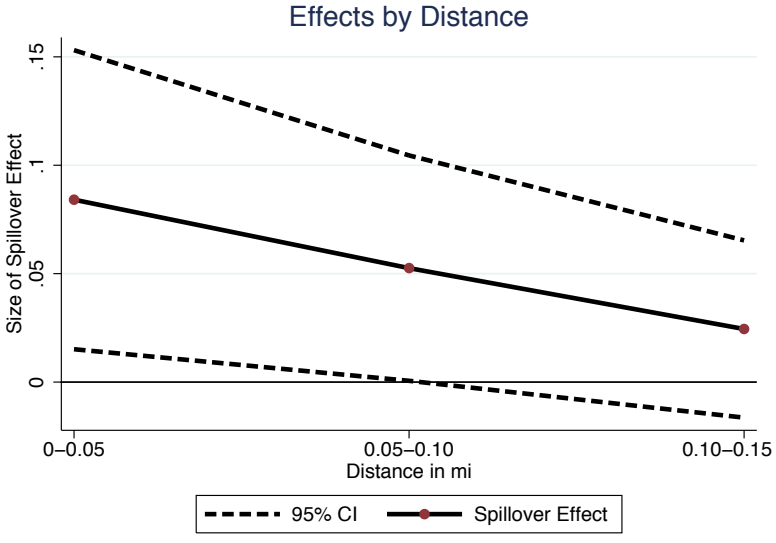
Estimate Strong Effects of Foreclosure Contagion

	First Stage	Reduced Form (ITT)	Second Stage (2SLS)
Index Sample	0.024	0.0012	0.050
	(0.003)	(0.0007)	(0.013)
All Resets	0.025	0.0005	**0.021**
	(0.0013)	(0.00014)	(0.0049)
Dep Var is Foreclosure of:	Resetter	Neighbor	Neighbor
Avg	[0.08]	[0.03]	[0.03]
Ind Var:	Int Rate	Int Rate	Predicted Default

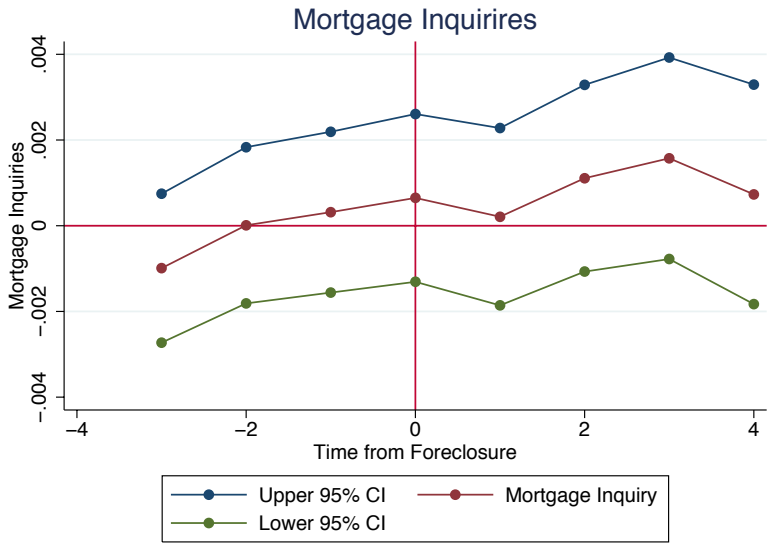
Aggregating: each foreclosure causes additional 0.45 foreclosures in neighborhood

Sample: All loans within 0.10 miles of a resetting loan.

Foreclosure Spillover Effects Decay with Distance



Neighbor Borrower Demand for Refinancing Does Not Go Up



But Refinancing Volume Falls, Suggesting a Lender Response

	Refinancing (2SLS)	Refinancing (2SLS)	First-Stage F
Index Sample		-0.078	1031
		(0.027)	
All Resets	-0.035	-0.063	173 (458 BBX)
	(0.01)	(0.009)	
N(Clusters)	1.7m(26k)	4.4m(58k)	
Sample	BBX	Deeds	
Avg of Dep Var	[0.076]	[0.17]	

Back

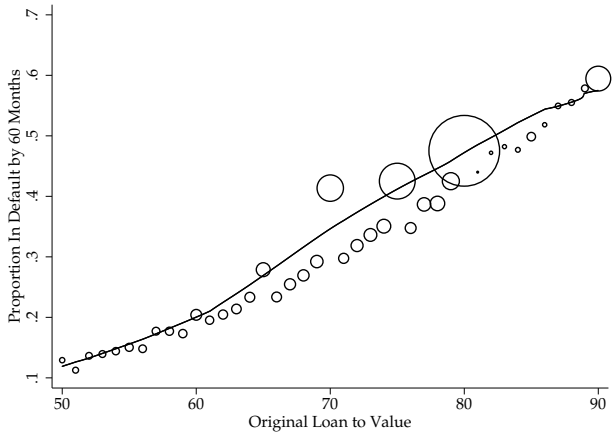
Results Indicate Mortgage Contract Structure Exposed Borrowers to Default Risk

- 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



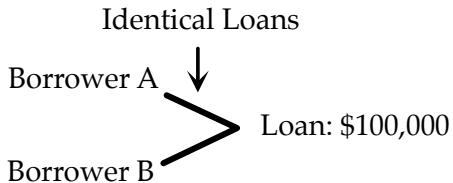
Borrowers with High Leverage Mortgages More Likely to Default

Separating Information Asymmetries: Unpacking a Correlation

- 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 $\Longleftrightarrow$ Different balance

Disentangling Information Asymmetries: Ideal Experiments

Identifying Moral Hazard: Compare A and B



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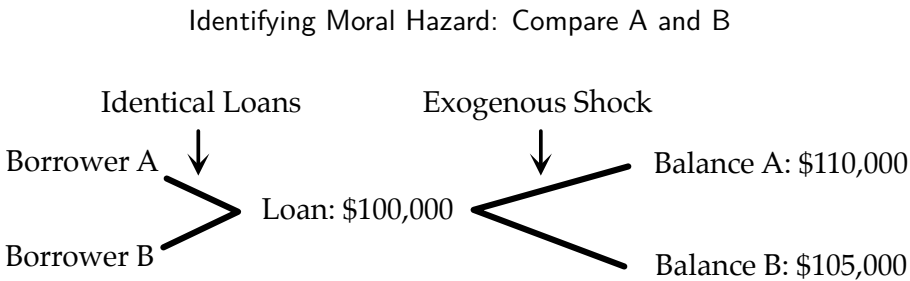
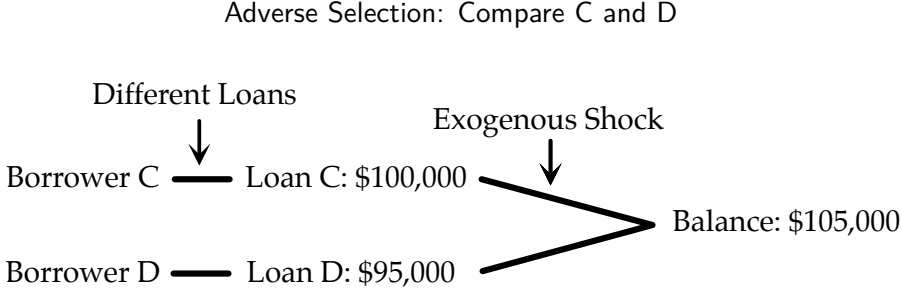


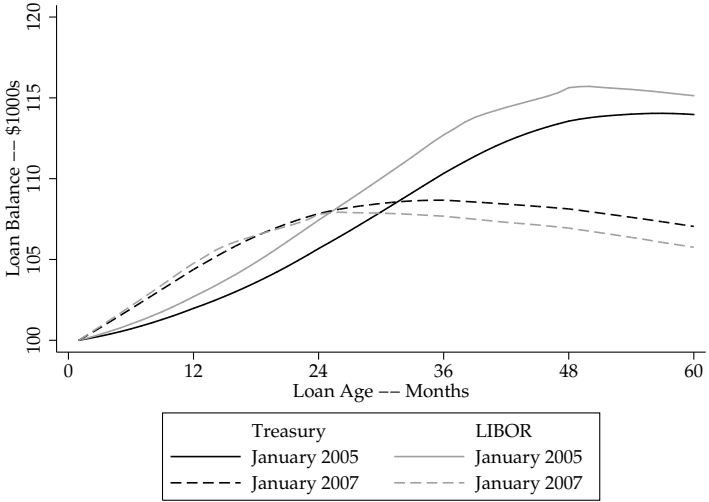
Disentangling Information Asymmetries: Ideal Experiments



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 ($\approx$ 10% of originations in 2006)
- $\Rightarrow$ Balance depends on the ex-post realization of a financial index
  1. Identical loans + different index realizations $\Rightarrow$ different balances
  2. Larger loan + lower index realization $\Rightarrow$ same balance

Index × *Origination Month* Creates Diff-in-Diff Style Variation



Reduced Form Implementation

$$D_{it+1} = \alpha LTV_{it} + \gamma L_i + \mathbf{x}_i'\beta + \varepsilon_{it}$$

$$LTV_{it} = \delta Z_{it} + \eta L_i + \mathbf{x}_i'\pi + u_{it}$$

- 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)
- $\mathbf{x_i}$ contains borrower/loan characteristics at origination and rich set of fixed effects
  - Most saturated: index type/zipcode/originator $\times$ origination month

Source of Adverse Selection | Full Model | Details of Option ARMs | Data Description | Balance and Summary Stats

Leave-out IV Strategy

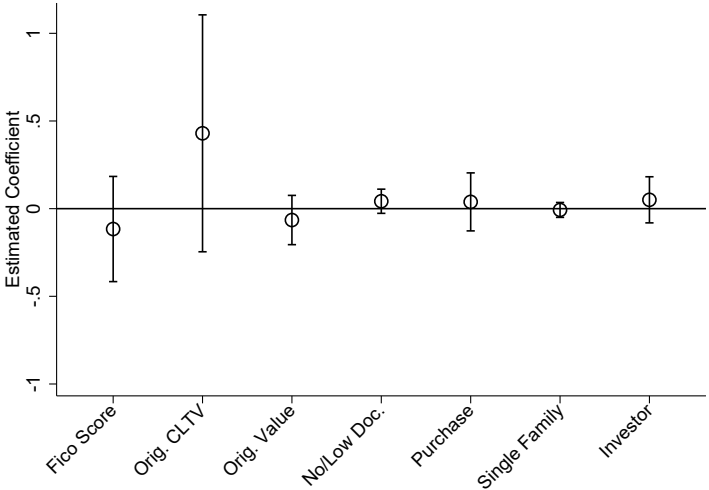
- Jackknife style instrument for LTV_{it}:

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

  - Average leverage at t for others with same index $I(i)$ and origination month $m(i)$
  - Analogous to index×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

Leave Out Instrument Uncorrelated with Observables at Origination



Separating Adverse Selection and Moral Hazard

	24 Months		
	Baseline	OLS	IV
Origination Leverage	1.066***		
	(0.073)		
Current Leverage			
Index Type FEs	Yes	Yes	Yes
Zipcode FEs	Yes	Yes	Yes
Credit/Loan Controls	Yes	Yes	Yes
Originator x Orig. Month FEs	Yes	Yes	Yes
Mean of Dep. Var.	0.44	0.44	0.44
N	491,215	491,215	491,215

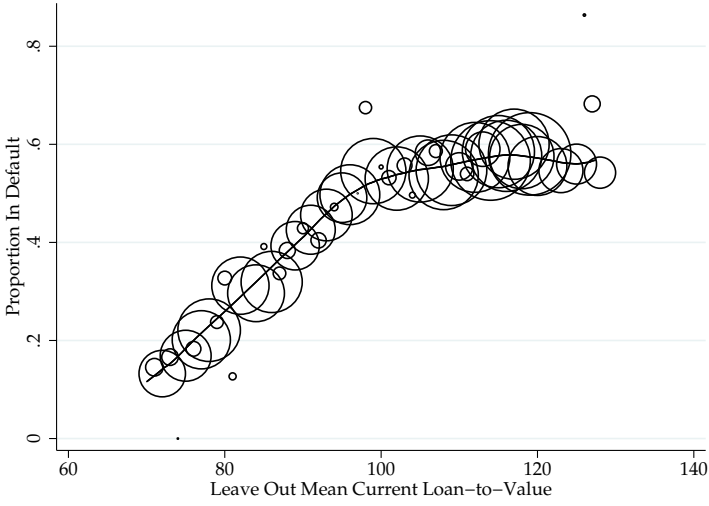
- Baseline: Borrowers with 10 point higher original LTV default $\approx$ 10pp/year more
  - **Conditional on observables**

Separating Adverse Selection and Moral Hazard

	24 Months		
	Baseline	OLS	IV
Origination Leverage	1.066***	0.818***	0.655***
	(0.073)	(0.075)	(0.127)
Current Leverage		0.285***	0.473***
		(0.028)	(0.171)
Index Type FEs	Yes	Yes	Yes
Zipcode FEs	Yes	Yes	Yes
Credit/Loan Controls	Yes	Yes	Yes
Originator x Orig. Month FEs	Yes	Yes	Yes
Mean of Dep. Var.	0.44	0.44	0.44
N	491,215	491,215	491,215

- Adverse selection accounts for $\approx$ 60 percent of association between leverage and default
  - Moral hazard (causal effect of debt on default) $\approx$ 40 percent

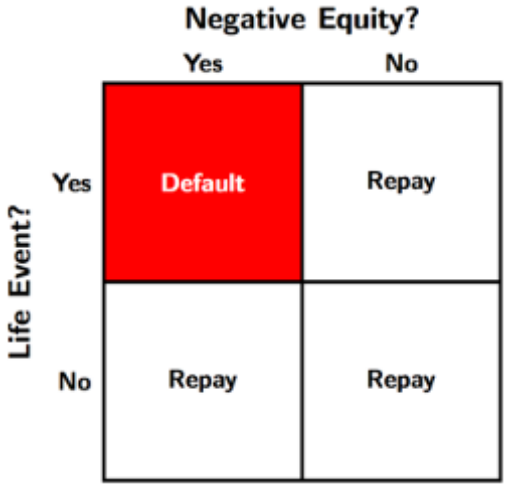
Non-Linearity of Leverage and Default



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: ≈60%, Moral Hazard: ≈ 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.