Funding Fragility in the Residential-Mortgage Market

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Introduction

Many authors have blamed the "originate-to-distribute" model of mortgage securitization for the crisis.

- Model had in use for many years pre-crisis with no ill-effects
- Many firms went bankrupt, *before* many loans defaulted

An important and as yet unstudied component of the U.S. mortgage market is its funding structure

- Pre-crisis, repo funding comprised about 60% of originations.
- Currently, repo funding comprises about 51% of originations.

Research objective: Develop an equilibrium model and derive empirically testable hypotheses to assess the potential market fragilities that underly repo-funded mortgage origination in the U.S.

- Private label channel more fragile than Government-Sponsored Entity

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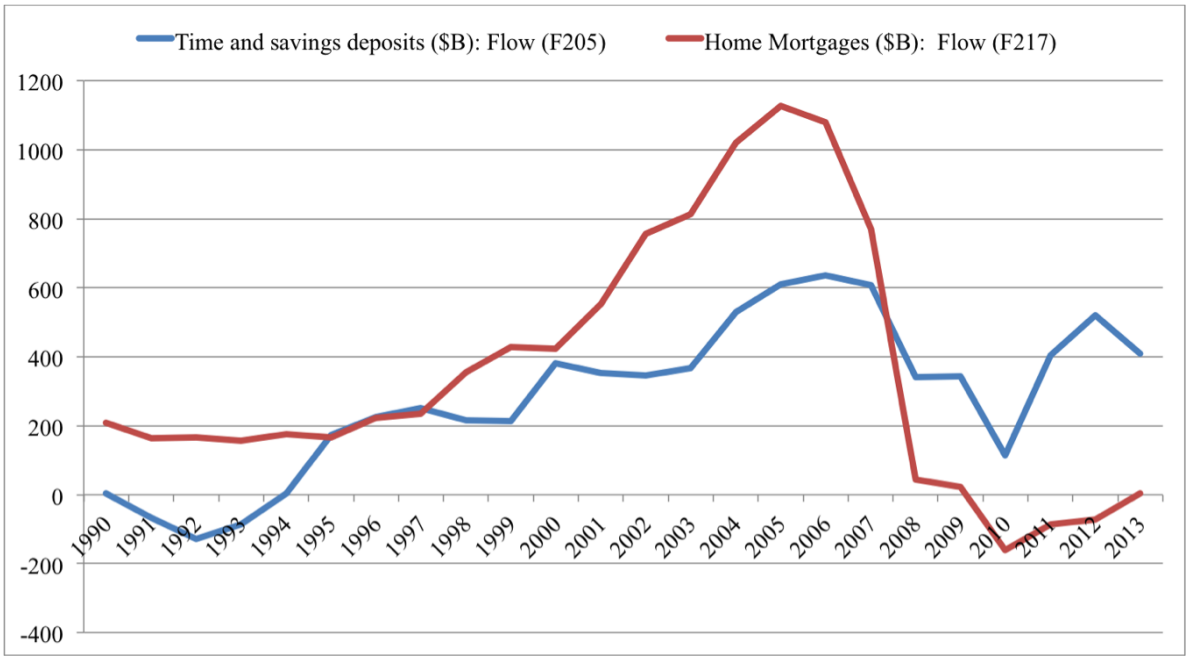
U.S. mortgage origination is uncorrelated with deposits



- U.S. mortgages are largely funded via a form of repo:
  - Repo contractual structures are typically defined under **Master Repurchase Agreements (MRAs)**.

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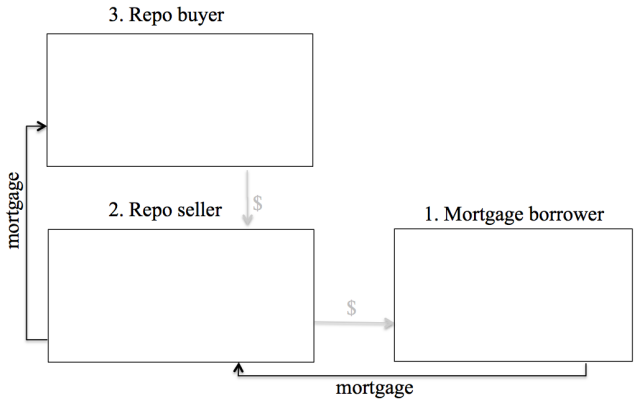
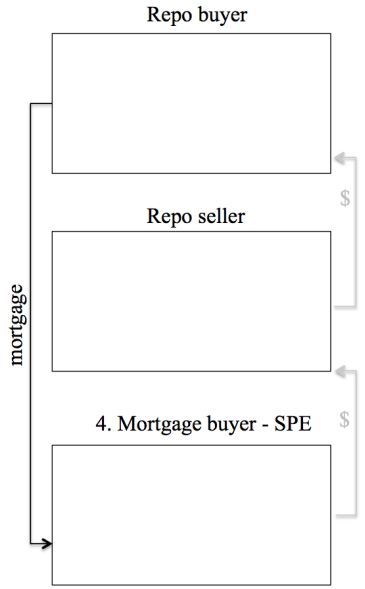
Stages of MRA funding



(a) Repo setup



(b) Repo unwind

1. Borrower obtains a mortgage from an originator;
2. Repo seller, the mortgage originator, obtains the funds from a draw on an MRA contract, funds the haircut, and holds repo liability;
3. Repo buyer funds the line and receives the mortgage note as collateral on the repo;
4. Repo seller sells mortgage (bailee letter) to an SPE investor and repays repo buyer.

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MRA: Summary of contract features

- Strict requirements on the required timing of securitization.
  - Risk of haircuts and dynamic margins.
- Strict capital and accounting covenants to maintain lines.
  - Significant roll-over risk on lines (short term maturities).
- **Exempt from automatic stay under BAPCPA 2005 (repo buyer holds perfected mortgage collateral).**
  - Upon the bankruptcy of the repo seller (the mortgage originator), the repo buyer (the warehouse lender) owns and may sell the repo collateral.
- Rep and warranty risk resides with the mortgage originator (the repo seller) who has no capital.

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Literature

- Funding fragility and runs in repo markets
  - **Structured product repo:** Gorton Metrick (2010), Gorton Metrick (2012), Dang Gorton Hölmstrom (2013), Krishnamurthy Nagel Orlov (2014)
  - **Structural features:** Martin Skeie von Thadden (2014)
  - **Fire sales:** Begalle Martin McAndrews McLaughlin (2015)
  - **Rehypothecation:** Bottazzi Luque Pascoa (2012)
  - **Asset risk:** Brunnermeier Pedersen (2009)
  - **Counterparty risk:** Dang Gorton Hölmstrom (2013), Weymuller (2013)
- To our knowledge, no prior literature on the functioning of the U.S. mortgage repo funding markets
  - Introduce metrics to monitor the liquidity of the securitization channels.
  - Use metrics to calibrate a model and assess structural differences between the PL and GSE channels

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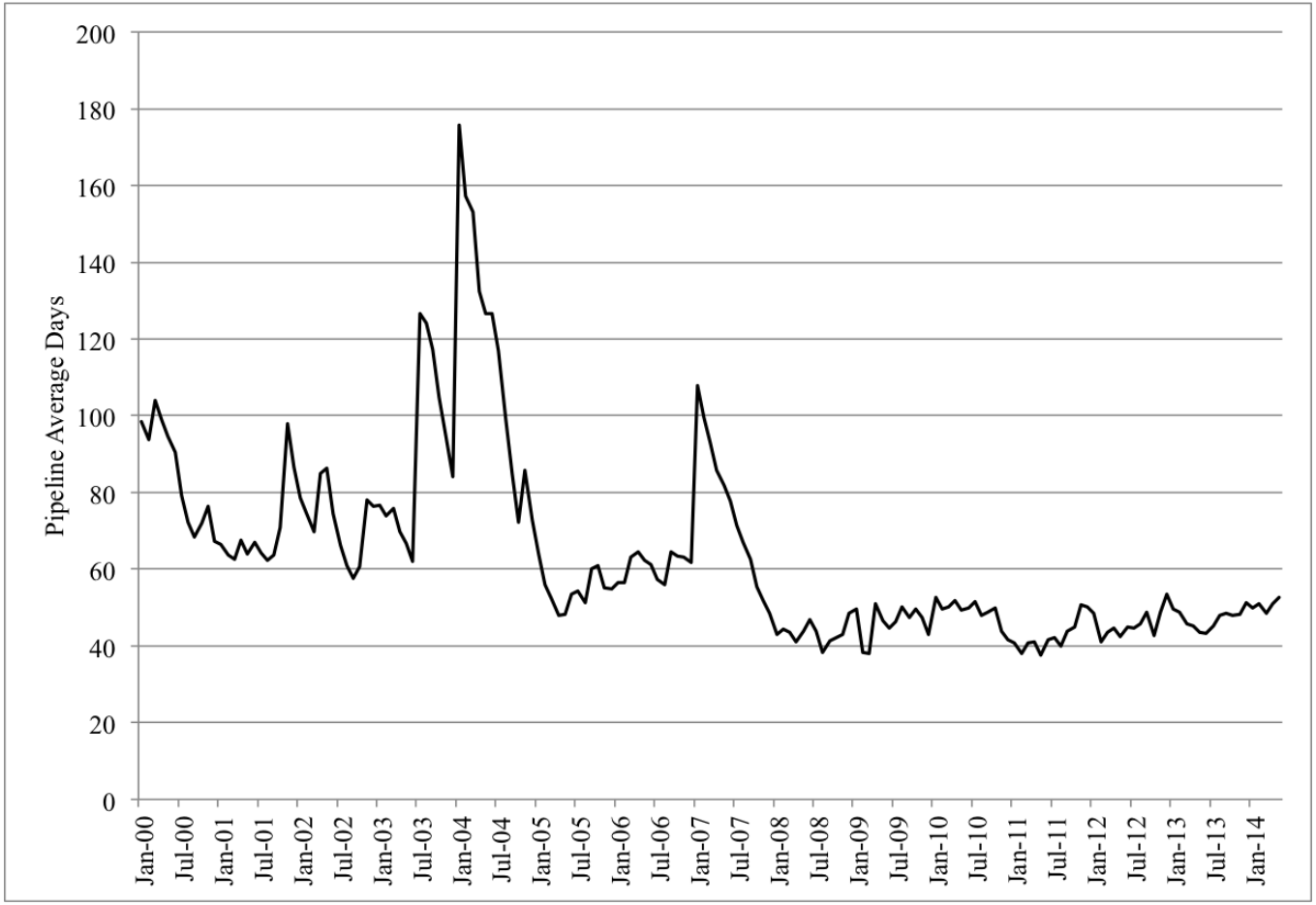
Average speed: GSE pipeline



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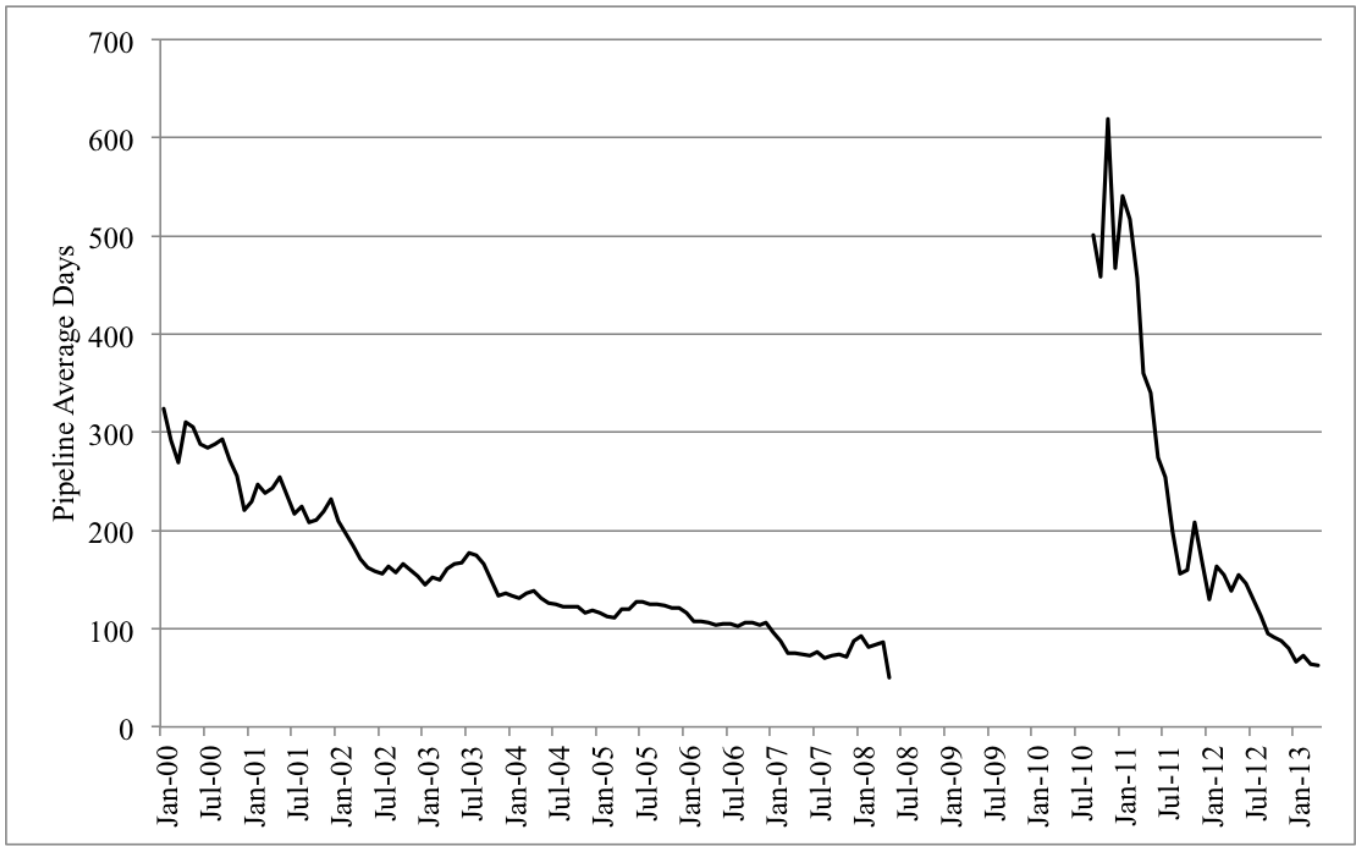
Average speed: private-label pipeline



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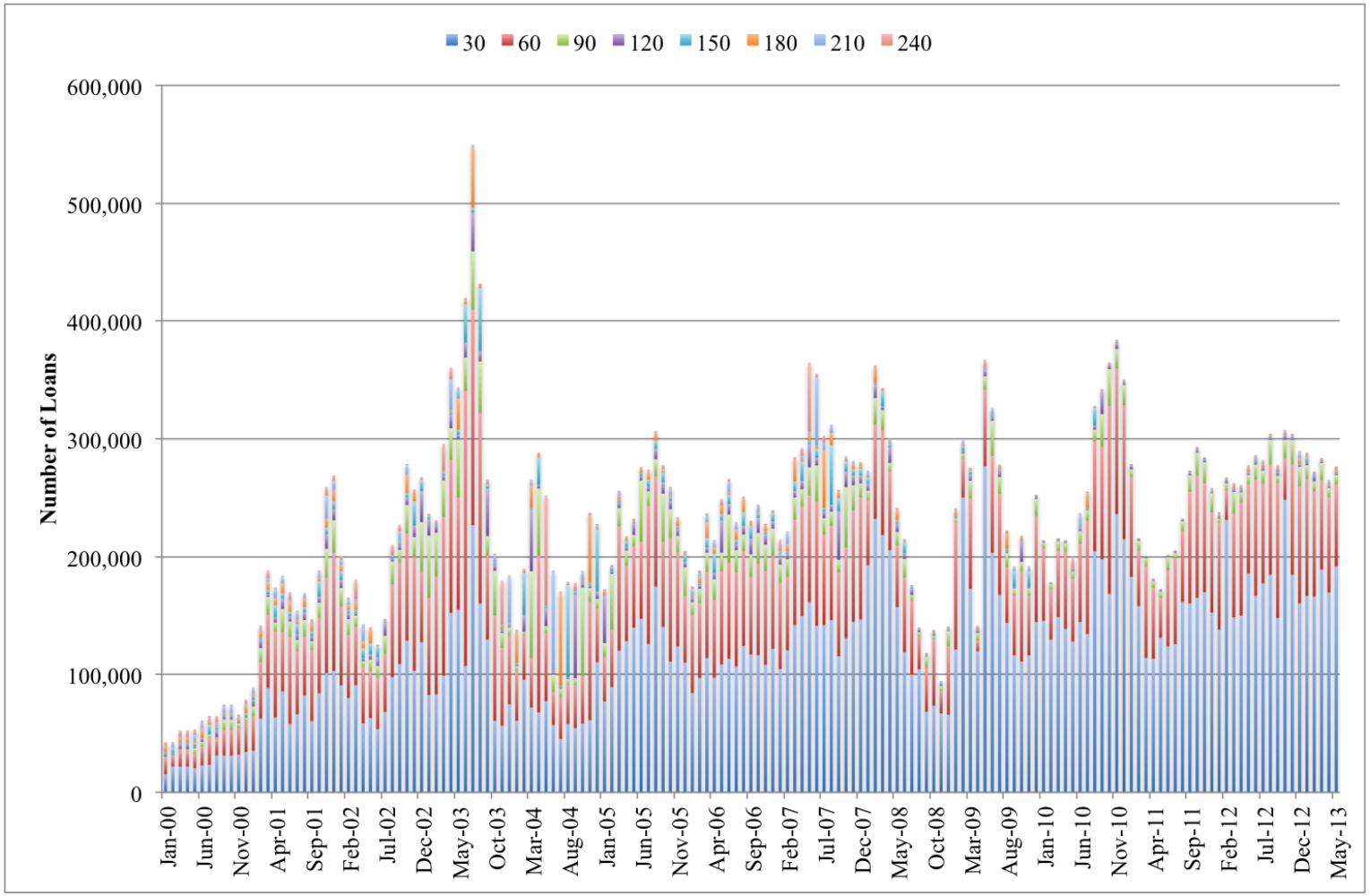
Distribution of speeds: GSE



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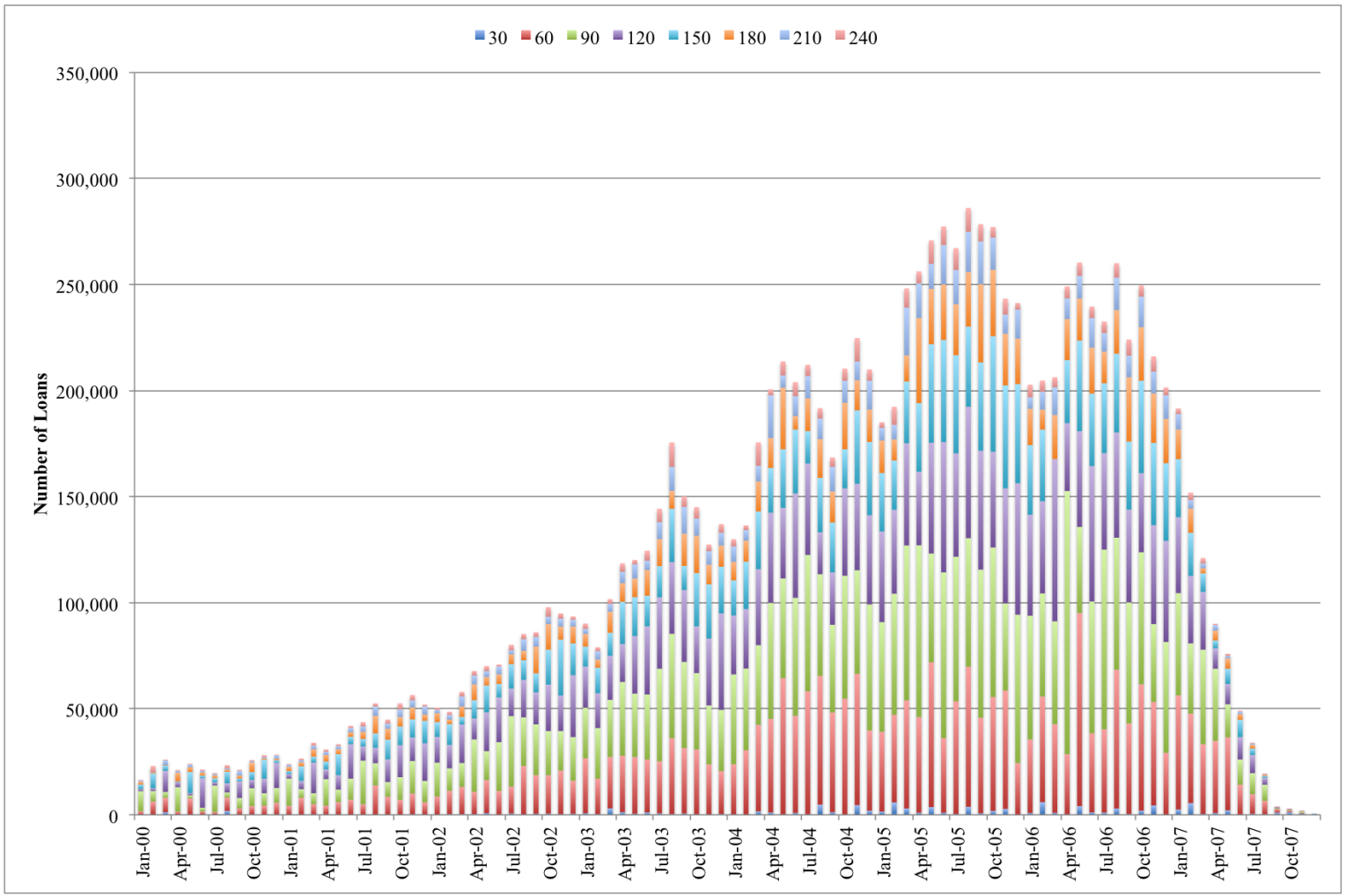
Distribution of speeds: private label



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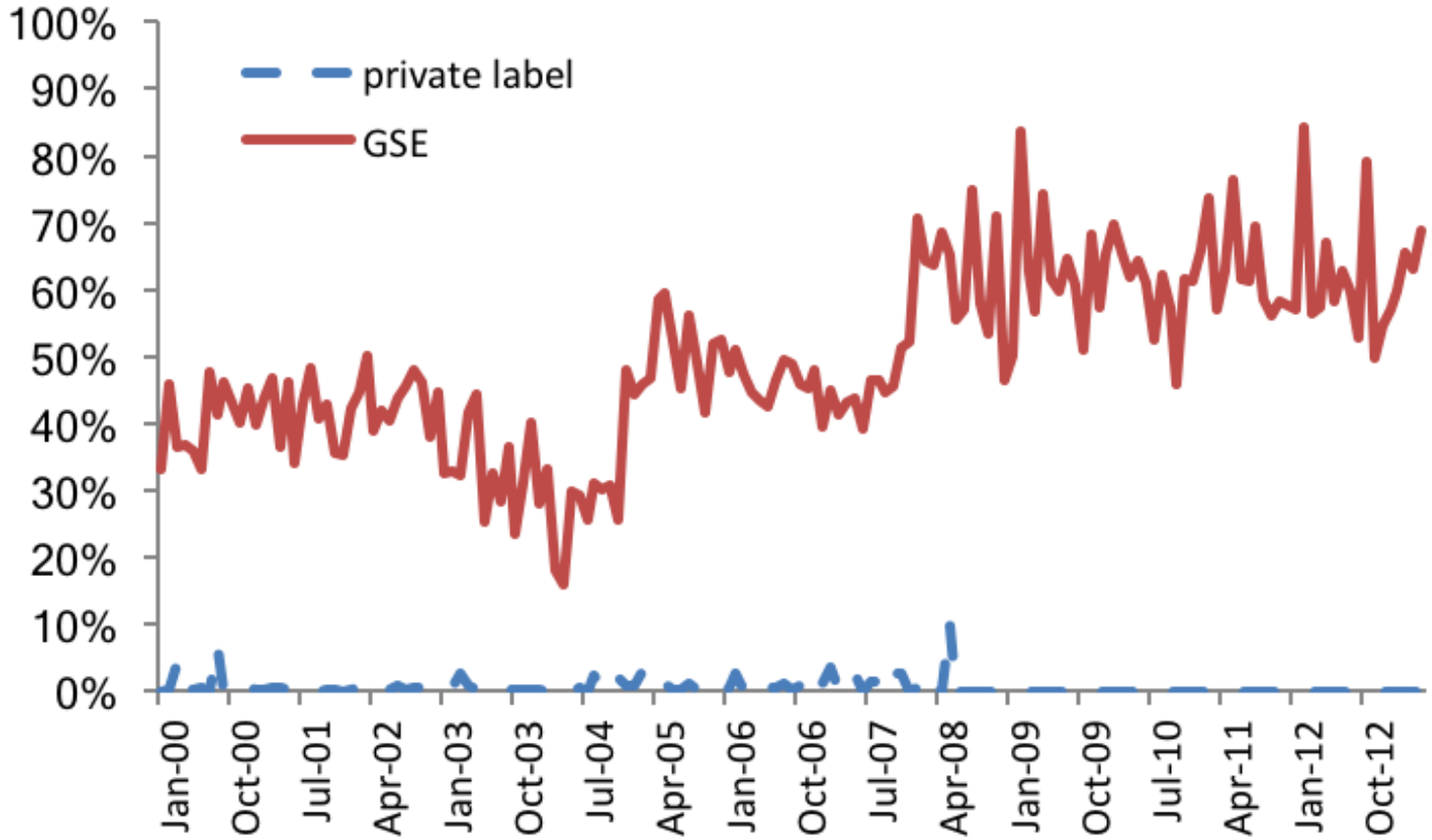
Securitization Hazards$_{GSE,PL}$ for newly originated mortgages



- *Securitization Hazard*$_{GSE,PL}$ = the ratio of loans securitized by $t+1$ ($t+30$ if measured in days) to the total count of loans originated at t.

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GSE securitization hazard affects TBA prices

	Fannie Mae Δp_t	Freddie Mac Δp_t	Private Label Δp_t
	(1)	(2)	(3)
Hazard_{30}	6.300***	6.354***	2.586***
	(3.25)	(3.29)	(12.91)
Dispersion in time distribution	0.00758	0.00753	
	(0.94)	(0.94)	
Treasury yield (10y)	-0.734**	-0.730**	-0.142***
	(-2.83)	(-2.83)	(-10.27)
Constant	1.129	1.088	-2.536***
	(0.66)	(0.64)	(-8.82)
Year fixed effects	Yes	Yes	Yes
Private label tranche fixed effects			Yes
Observations	115	115	170,055

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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Private Label securitization hazard affects PL AAA RMBS

	Thirty-day hazard		Sixty day hazard	
	(1)	(2)	(3)	(4)
	Δp_{lt}	Δp_{lt}	Δp_{lt}	Δp_{lt}
Securitization hazard at month t	1.271**		0.670***	
	(3.12)		(9.15)	
Dispersion in securitization time at month t	-0.0169***	-0.0140***	-0.0200***	-0.0204***
	(-19.70)	(-14.97)	(-21.70)	(-14.88)
Change in 3m LIBOR	-0.368***	-0.214***	-0.201***	0.118*
	(-7.57)	(-4.16)	(-3.86)	(1.99)
Ten-year constant maturity treasury yield	-0.327***	-0.365***	-0.362***	-0.504***
	(-23.90)	(-25.02)	(-25.59)	(-28.83)
year=2004 × hazard_30,PL		-5.084***		
		(-6.14)		
year=2005 × hazard_30,PL		-2.740***		
		(-4.34)		
year=2006 × hazard_30,PL		4.985***		
		(7.59)		
year=2007 × hazard_30,PL		6.151***		
		(8.32)		
year=2004 × hazard_60,PL				0.573***
				(5.67)
year=2005 × hazard_60,PL				0.491***
				(4.42)
year=2006 × hazard_60,PL				1.343***
				(14.80)
year=2007 × hazard_60,PL				0.656***
				(7.71)
Constant	2.496***	2.473***	2.697***	3.298***
	(24.68)	(23.17)	(26.23)	(26.23)
Bond fixed effects	Yes	Yes	Yes	Yes
Observations	86041	86041	86041	86041

t statistics in parentheses

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Mortgage price dynamics by channel

The mortgage asset is risky and its fundamental value, $v_{i,t}$, is stochastic.

$$\Delta v_{i,t+1} = \sigma_{i,t+1}\varepsilon_{i,t+1}, \qquad \text{where}$$
$$\sigma_{i,t+1} = \kappa_i + \theta_i|\Delta v_{i,t}|.$$

- $i = GSE, PL$,
- $\varepsilon_{i,t+1} \sim$ i.i.d. $N(0,1)$,
- κ_i = constant baseline volatility,
- θ_i = autocorrelation parameter.
- $\kappa_{GSE,PL}$ and $\theta_{GSE,PL}$ are empirically estimated parameters.

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Metrics for market liquidity

- Calibrate a model to the realized liquidity metrics for the GSE and PL channels
  - **Liquidity proxies:** The estimated *ex post* securitization hazards, $hazard_{GSE,PL}$.
  - **Measures of mortgage price dynamics:** volatility, $\kappa_{GSE,PL}$, and autocorrelation, $\theta_{GSE,PL}$.

- Differing market liquidity metrics determine whether repo haircuts are stabilizing or destabilizing over cycles.
  - **?** finds that haircuts can amplify market pro-cyclicality.
  - **?** emphasize the role of the repo buyers' asset value information in determining whether haircuts stabilize the market.
  - **Our model:** repo buyers can be uninformed about asset values and still face a fragile market due to the $hazard_{GSE,PL}$ and $\theta_{GSE,PL}$.

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Borrower and the Investor SPE by channel

- There are two agents, $k_i \in \{0, 1, 2\}$:
  - One borrower ($k_i = 0$) arrives at $t = 0$
  - Investor SPE_i ($k_i = 1$) arrives at $t \in \{0, 1, 2\}$
- Agents start with $W_{i,t}^k$ of cash and \$0 mortgages.
- Each agent is subject to an endowment shock of $z_{i,k}$ units of mortgages at time k.
  - For $k_i = 0$ (respectively $k_i = 1$) the shock $z_{i,0}$ (respectively $z_{i,1}$) is deterministic and happens at time 0 (respectively 1).
  - The total shock to the SPE_i investor $k_i = 2$ is also deterministic and clears the market, i.e. $z_{i,2} = -(z_{i,0})$.
- Excess demand (set by $1 - hazard_{i,t}$) determines the proportion of loans that remain to be securitized and must therefore continue to be funded through the repo channel.

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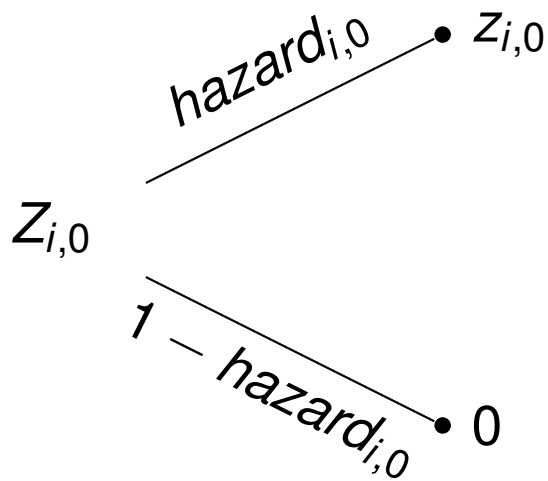
Borrowers and the Investor SPE by channel

- The risk of excess demand, excess supply of mortgage repo collateral, is captured with a uniform distribution



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Borrowers and the Investor SPE by channel

Each of the k_i agents (borrowers and the SPE) will issue a net demand schedule $y_{i,t}^{k_i}$ ($y_{i,t}^{k_i} < 0$ denoting supply) in order to maximize a CARA utility function over final wealth

- Utility is over final wealth

$$U(W_{i,2}^{k_i}) = E[-e^{-\delta_i W_{i,2}^{k_i}}]$$

- Wealth evolves according to

$$W_{i,t+1}^{k_i} = W_{i,t}^{k_i} + (p_{i,t+1} - p_{i,t})(y_{i,t}^{k_i} + z_i^{k_i}),$$

  where $p_{i,t}$ is the market price in channel i.
- In our setting, the repo rate is normalized to $r_i = 0$

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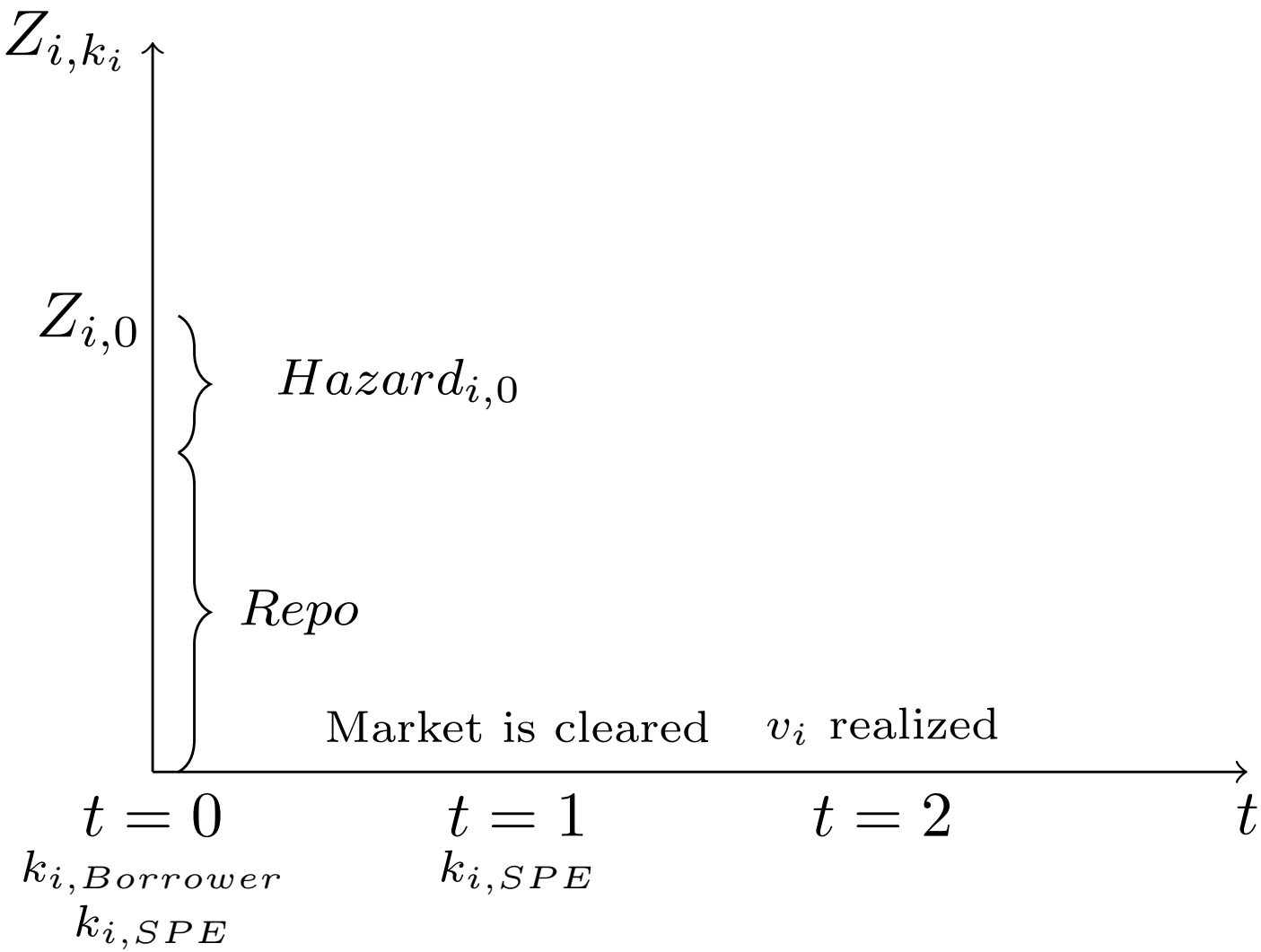
The market timeline for each channel



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The repo seller (the mortgage originator) by channel

Repo seller is risk neutral and maximizes expected final wealth $E[W_{i,2}^{k_i}]$

- Functions as an arbitrageur by holding the excess supply risk in order to earn price gains.
- Wealth evolves according to

$$W_{i,t+1} = W_{i,t} + (p_{i,t+1} - p_{i,t})x_{i,t}$$

  where $x_{i,t}$ is the repo seller's mortgage demand schedule.
- Smoothes out temporary market imbalances by buying assets at time t and holding the asset until $t + 1$

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Repo buyer (the warehouse lender) by channel

Repo buyer provides funding and controls his Value at Risk at 99%

- Repo buyer sets a haircut $h_{i,0}$ to ensure that the loan will be repaid with a given probability, i.e. in order to control the Value at Risk (VaR) on the portfolio being funded.
- Haircuts target a VaR of $1 - \pi_i$

$$\pi = \mathbb{P}(p_{i,1} - (p_{i,0} - h_{i,0}) < 0 | \mathcal{F}_{i,t})$$

- In **?** the key determinant of haircuts is whether the repo buyer is informed ($\mathcal{F}_{i,t} = \{p_{i,0}, v_{i,0}\}$) or uninformed ($\mathcal{F}_{i,t} = \{p_{i,0}\}$)
  - We assume the latter, so that the repo buyer cannot distinguish between price, $p_{i,0}$, and value, $v_{i,0}$.

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Setting the haircut by channel

We assume that price follows the stochastic process

$$\begin{aligned}\pi_i &= \mathbb{P}(\sigma_{i,1}\varepsilon_{i,1} + h_{i,0} < 0 | \mathcal{F}_{i,0}) \\ &= 1 - \Phi\left(\frac{h_{i,0}}{\kappa_i + \theta_i|\Delta p_{i,0}|}\right)\end{aligned}$$

- The haircut formula is thus:

$$h_{i,0} = \Phi^{-1}(1-\pi)(\kappa_i + \theta_i|\Delta p_{i,0}|) \tag{1}$$

- i.e. haircuts are increasing in baseline volatility, κ_i, and in the autocorrelation parameter, θ_i.

Proposition

Suppose $\Delta p_{i,0} < 0$. Then haircuts, $h_{i,0}$, are decreasing in the securitization hazard, $hazard_{i,0}$.

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$\kappa_{GSE,PL}$ and $\theta_{GSE,PL}$

Fitting the empirical liquidity metrics for the GSE and PL securitization channels.

ARCH	(1) $\Delta p_{FNMA,t+1}$	(2) $\Delta p_{FHLMC,t+1}$
$\beta_{i,1}$ (θ_i)	0.101	0.125
	(0.77)	(0.95)
$\beta_{i,0}$ (κ_i)	1.051***	1.024***
	(8.00)	(7.91)
Observations	106	106

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table: Model estimates by market segment.

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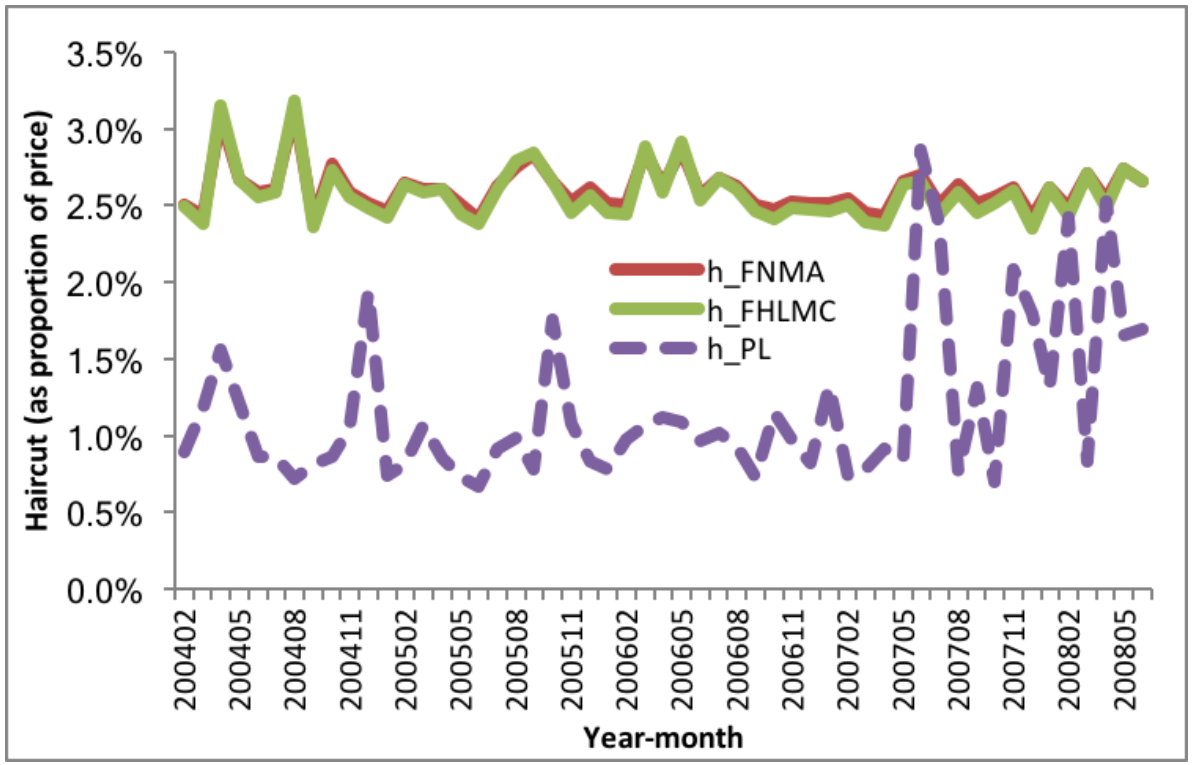
Estimated haircuts as percentage of par



- Average haircuts as a percentage of par:
  - 2.57% for Fannie Mae.
  - 2.52% for Freddie Mac.
  - 1.74% for PLS.

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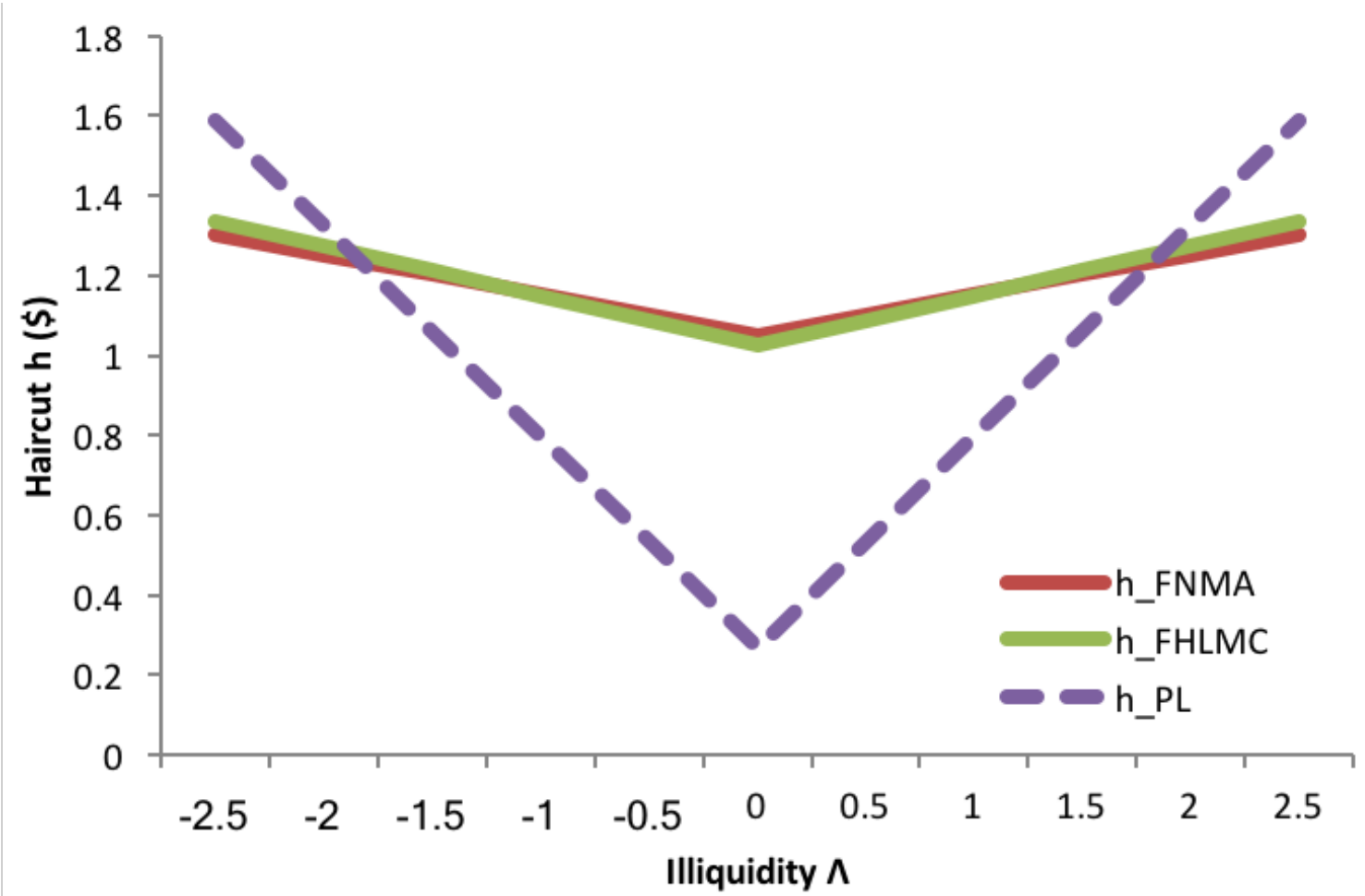
Haircuts and market fragility



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Haircuts and market fragility

Lemma

Given an illiquidity shock $\Lambda_{i,0}$ such that $\Delta p_{i,0} < 0$, it holds that

$$\frac{\partial h_{i,0}}{\partial \Lambda_{i,0}} \leq 0, \tag{2}$$

i.e. haircuts will increase in response to the illiquidity shock and markets are fragile. The higher θ_i^2, the higher the haircut sensitivity to illiquidity, i.e. $\frac{\partial h_{i,0}}{\partial \Lambda_{i,0}}$ is decreasing in θ_i^2.

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Conclusion

- We find important empirical differences across GSE and private label securitization channels:
  - The securitization hazards for newly originated mortgages.
  - The degree of autocorrelation in bond price volatility across the channels.
- We develop an equilibrium model of repo-funded mortgage origination under trade imbalances and find:
  1. Empirical differences across the securitization channels will be priced in the repo funding haircuts.
  2. Haircut percentages will be on average lower in private label markets however, they are much more volatile, due to the large autocorrelation coefficient in bond price volatility.
  3. PL securitization channels will be more fragile, in the sense that PL repo pricing dynamics will be pro-cyclical and thus susceptible to liquidity spirals and market breakdown.
  4. GSE repo price dynamics will be less fragile because they are NOT pro-cyclical.

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Policy Implications

- We define securitization channels to be fragile when mortgage repo haircuts are pro-cyclical and exacerbate existing market illiquidity.
- Our finding that the PL label is significantly more fragile and more prone to market crashes indicates a key and unpriced role for the GSEs as market-liquidity providers.
- This liquidity provision is different from, and potentially more important than, the credit and tail-risk insurance currently provided to the investors in the GSE mortgage backed securities.
- One outstanding unanswered question is whether this provision of stable liquidity is welfare enhancing.

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