How Quantitative Easing Works:
Evidence on the Refinancing Channel

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Motivation: The Only Game in Town

- Widespread use of Large-Scale Asset Purchases (LSAPs) for monetary stimulus

- Fed balance sheet size increased 5x w/ significant change in balance sheet composition

- Ongoing LSAPs globally by central banks, with wide choice set:
    - US: Treasuries, RMBS
    - Japan: Gov't debt, ETFs, Corporates
    - ECB: Gov't debt, covered bonds, ABS
    - Helicopter drops of money
    - Concerns over "Central Bankers as Central Planners"

View #1: Only Duration Matters

- Popular view that LSAPs inject money into the economy regardless of the security actually purchased

  "As investors **rebalance** their portfolios by **replacing** the MBS sold to the Federal Reserve with other assets, the prices of the **assets they buy** should rise and their yields decline as well. Declining yields and rising asset prices ease **overall** financial conditions and stimulate economic activity through channels similar to those for conventional monetary policy." –Bernanke, 8/31/2012

View #2: Flypaper Effect of Narrow Segmentation

- When stimulus is most needed, market is too segmented for investors to rebalance
    - i.e. bank-lending channel mostly inoperable
- Money sticks where it lands
    - Doesn't spillover into new credit
    - Fed policies 'allocate' credit
    - Will affect different segments of the market differently
    - Not only the duration but also the type of assets purchased is important

Monetary Policy Transmission Limited in Bad Times

"...[R]ecall again the limits of monetary policy. Monetary policy transmission may be hampered at times where banks... need to repair their balance sheets. At times of uncertainty and lack of confidence liquidity may be hoarded rather than be put to use for investment."

–Yves Mersch, Member of ECB Executive Board, May 2013

▸ Back

This Paper

- Understand QE transmission by contrasting responses of mortgage market segments

- If QE benefitted different segments of mortgage market differently...
  $\Rightarrow$ supports narrow segmentation view at the expense of the portfolio rebalancing view

- Add to previous literature by looking at Q in addition to P

Identification Challenge

- Classic time-series identification problem: how to identify the effects of aggregate policy (QE)

- Usual solution in literature: high-frequency event study on yields

    - Restricting to minutes before/after public QE announcement helps with identification concerns

- But reason to think that "real effects" may be over/understated by high-frequency changes in yields

    1. Secondary-primary market pass-through imperfect and uncertain
    2. Prices observed conditional on origination
    3. Initial market reaction to unknown policy

$\Rightarrow$ Need cross-sectional variation in exposure to QE.

Identification Solution

- Use market segmentation to absorb aggregate demand shocks
- Cross-sectional variation comes from mortgage-market segments that behave similarly, e.g., jumbo vs. non-jumbo

$$\text{Refi Volume}_{it} = \beta \cdot QE_t \cdot 1(i = Jumbo) + \alpha_i + \delta_t + \varepsilon_{it}$$

- <u>Identifying assumption</u>: segments A and B on parallel trends
    - Focus on refinance mortgages (largely free from demand effects)
    - Focus on post-2008 (no private securitization)
- β tells us how mortgage segments responded differently
    - $\beta \approx 0 \Rightarrow$ ample reallocation of Fed-provided capital
    - $\beta \ll 0 \Rightarrow$ evidence for narrow segmentation

Results Preview

1. During QE1, GSE-eligible originations increased by 177% while prime jumbo originations increased by less than 10%

   - Jumbo-conforming interest spread increases by 55 bps
   - Transmission of UMP can involve a "flypaper effect"
   - Contrast with no / much smaller differential effect in

     * QE2 (no MBS purchases)
     * QE3 (healthier banking sector)

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2 Important complementarity between accomodative monetary policy and GSE policy

- Relaxation of maximum LTVs would have resulted in:

  * More refinancing in distressed regions (**$86 bn increase** in the first five months of QE1)
 * Less household deleveraging: Less cash-in refis and more cash-out refis (**28% increase in equity extraction**)

Outline

1 Introduction
- Motivation
- Background
- Data

2 Main Results
- Prices: Interest Rate Results
- Quantities: Refinance Volumes

3 Households' Behavioral Response
- The Intensive-Margin of Refinancing
- Consumption
- Counterfactual

4 Conclusion

Context in Literature

- Theory *Before the crisis*
    - Wallace (1981), extended by Eggertsson and Woodford (2003)

- Theory *After the crisis*
    - Curdia and Woodford (2011), Brunnermeier and Sannikov (2015), Del Negro, Eggertsson, Ferrero and Kiyotaki (2013), Drechsler, Savov, and Schnabl (2015), Gertler and Karadi (2011)

- Empirical Literature
    - Ashcraft et al. (2010) Baba et al. (2006) Gagnon et al. (2010) Sarkar (2009) Hancock and Passmore (2011) Sarkar & Shrader (2010) Krishnamurthy & Vissing-Jørgensen (2011, 2013)
    - Fuster & Willen (2010), Beraja et al. (2015), Rodnyansky and Darmouni (2016)
    - Best, Cloyne, Ilzetzki & Kleven (2015), DeFusco & Paciorek (2015)

What (and When) Did the Fed Buy?
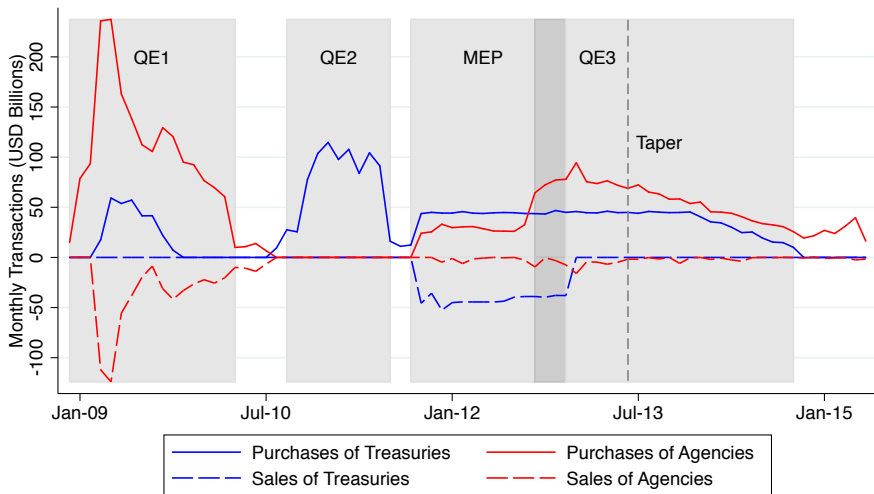
Common QE Misconception

- Stylized view of QE: Fed purchased (underperforming) legacy assets
  - This freed up cash on balance sheet
- Actually: Fed funded *new* refi origination via TBAs (mortgage forwards)
- Some of the corresponding prepayments freed up cash on bank balance sheets
  - *regardless* of who actually sold TBA to Fed
- Requires given mortgage being currently GSE-eligible for a refi
  ⇒ 'worst' loans still stuck on bank balance sheets

Mortgage Market Segmentation

- GSE involvement in mortgage market results in defined segments:
    1. Non-prime: FHA, subprime, Alt-A
    2. Prime/Conforming: <80% LTV, <CLL
    3. Jumbo conforming/jumbo prime: Over CLL but otherwise prime
- To be GSE-eligible (Fannie & Freddie), loan must meet criteria
- Key magic numbers:
    - 20% down-payment $\Leftrightarrow$ 80% LTV
    - Loan size $\leq$ Conforming Loan Limit (CLL)
- Fed RMBS purchases were new GSEs

Data

- Novel data: LPS/Equifax merge to follow borrower across mortgages
  - Rich mortgage data from LPS
  - 60%+ of mortgage market from top 10 servicers
- Combined with Equifax data on every LPS borrower extending ± 6 months around the life of any LPS mortgage
  - used to study QE by Beraja et al. (2015)
- Microdata on Fed purchases data from NY Fed

Outline

Market Interest Rate Estimation

- To form comparable jumbo/conforming sample, we consider loans that are vanilla 30-year fixed-rate refis on single-family homes
- Estimate regressions separately by category (above/below CLL) controlling for FICO, LTV

$$r_{it} = \alpha_t + \beta_1(FICO_i - 720) + \beta_2(LTV_i - .75) + \varepsilon_{it}$$

- $\hat{\alpha}_t$ for jumbo and conforming are "rate-sheet adjusted" interest rates

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- Window around QE dates (± 3 months)

$$r_{icst} = \theta_0 QE_t + \theta_1 Jumbo_s + \theta_2 QE_t \cdot Jumbo_s + X_i'\beta + \varepsilon_{icst}$$

- Cluster all results by month, X_i has LTV bins and FICO bins

Below CLL Interest Rate Responded More to QE1
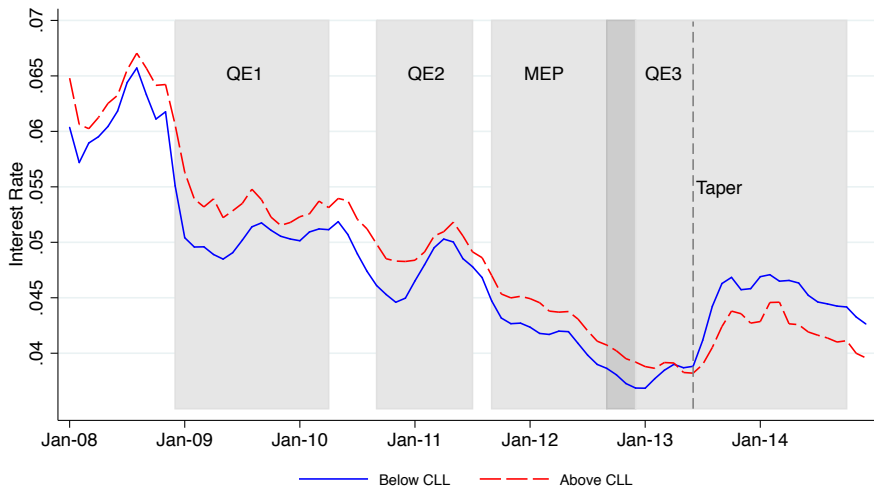
Interest Rate Response (bps) Varies by Segment and QE

Program	(1) QE1	(2) QE2	(3) MEP	(4) QE3	(5) Tapering
	Panel I. Without Controls				
Program Indicator	-120.607***	-36.271***	-47.290***	-19.874***	18.711
	(14.341)	(9.808)	(7.045)	(5.568)	(11.642)
Jumbo Indicator	26.246***	45.060***	33.398***	12.668*	-4.955**
	(8.029)	(12.810)	(7.835)	(7.033)	(2.161)
Program x Jumbo	55.188**	-5.143	6.051	2.467	-14.532
	(18.762)	(13.640)	(10.457)	(7.955)	(12.765)
Observations	466,831	604,596	450,059	527,983	674,959
R-squared	0.382	0.151	0.176	0.041	0.029
	Panel II. With Controls				
Program x Jumbo	43.916***	-6.611*	-5.002	6.392***	-15.649**
	(5.337)	(3.187)	(2.961)	(1.648)	(5.945)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	466,831	604,596	450,059	527,983	674,959
R-squared	0.616	0.599	0.684	0.614	0.615

$$r_{icst} = \theta_0 QE_t + \theta_1 Jumbo_s + \theta_2 QE_t \cdot Jumbo_s + X_i'\beta + \varepsilon_{ict}$$

Interest Rate Results Summary

- QE effect on interest rates depends on what was purchased, macroeconomic context

- Size of QE1 effect on jumbo-conforming spread comparable to 2007Q3 lock-up of securitization market

- Spillover: jumbo interest rates also decline during QE1, but conforming falls by 55 bp more

Value-added of Looking at Quantities

- Arguably, we care about interest rates only because we think that real effects are spurred by changes in rates.

- but changes in rates may overstate UMP effectiveness by assuming perfect and immediate availability of credit
  - Interest rates are observed conditional on origination
  - GSE ineligibility $\Rightarrow$ have to do more than pay a spread
   - e.g. can't get a jumbo mortgage w/o substantial equity

- A solution: look at quantities (volume of debt issuance)

Below CLL Issuance Response (Dollar Value of Loans)
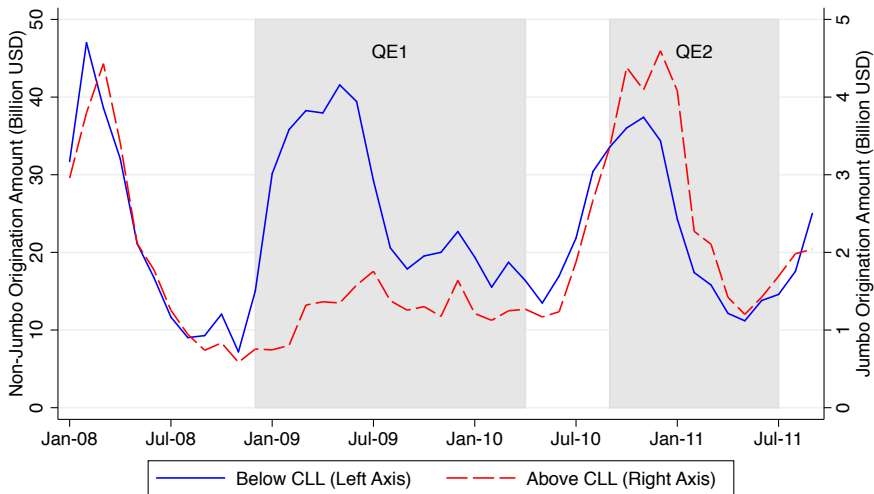
Why did Quantity move more than Price?

- QE1 jumbo vs. conforming Q can't be entirely explained by rate spreads
- Highlights importance of studying quantities and not stopping with yields and rates
- Consistent with Merch comment that banks reluctant to invest (e.g., jumbo) in bad times
- Consistent with other evidence that mortgage market clears on quantities not prices (e.g., DeFusco, Johnson, Mondrigon, 2017)
  - Our data: coupon gap only explains 50% of response
- Consistent with other evidence that non-price factors important drivers of mortgage demand (e.g., Buchak, Matvos, Piskorski, Seru, 2017)
  - Our data: QE1 effect concentrated among off-balance-sheet refis

Below CLL Issuance Response (Dollar Value of Loans)
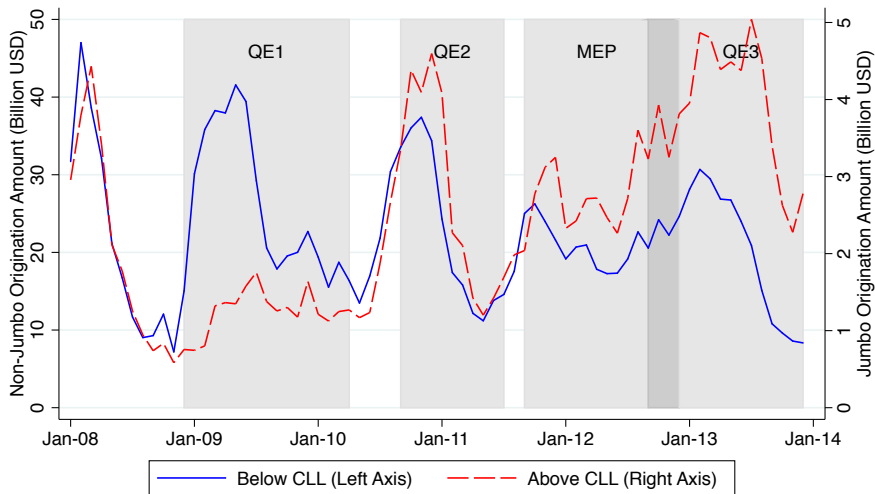
Non-jumbo Segment Responds to QE1, Jumbo Doesn't

Program	(1) QE1	(2) QE2	(3) MEP	(4) QE3	(5) Tapering
	Panel I. Without Controls				
Program Indicator	1.019***	0.597***	0.544***	0.122	-0.346**
	(0.279)	(0.164)	(0.075)	(0.080)	(0.139)
Jumbo Indicator	-2.138***	-2.169***	-1.757***	-1.543***	-1.435***
	(0.156)	(0.188)	(0.116)	(0.098)	(0.036)
Program x Jumbo	-0.831**	0.067	-0.057	0.060	0.416**
	(0.289)	(0.208)	(0.143)	(0.114)	(0.146)
Observations	492	492	492	492	492
R-squared	0.637	0.560	0.466	0.355	0.292
	Panel II. With Controls				
Program x Jumbo	-0.810***	0.073	0.231	-0.151**	0.230
	(0.197)	(0.104)	(0.154)	(0.066)	(0.157)
Controls	Yes	Yes	Yes	Yes	Yes
Observations	492	492	492	492	492
R-squared	0.975	0.991	0.988	0.988	0.994

$$\log Q_{cst} = \psi_0 QE_t + \psi_1 Jumbo_s + \psi_2 QE_t \cdot Jumbo_s + X'_{cst}\beta + u_{cst}$$

Small Differential Effect of QE3

- Consistent with Krishnamurthy & Vissing-Jørgensen (2013) who find that QE3 effect on Agency MBS yields was 15% of QE1's
- Also consistent with reduced segmentation (i.e. narrow segmentation channel less relevant)
- Also consistent with improved banking-sector health (Mersch comment applies less)

Stronger Effect of Tapering

- If segmentation down and banking-sector health improved, why differential effect of tapering?

- Known asymmetry of rate increase/decreases, especially for mREITs

- Avdjiev, Gambacorta, Goldberg, Schiaffi (2017) strong effects of tapering on global liquidity/inflows

- Investigating alternative explanations with higher-frequency g-fee data

Refinance Quantity Results Summary

- During QE1, the increase in GSE-eligible mortgage origination is at least 130% larger than non-GSE eligible mortgage origination

    - Quantity is a more revealing indicator of *de facto* allocation of credit by Fed purchases
    - Fed purchase of MBS (instead of treasuries) increased refinancing volume by \$102 bn.

- Parallel trends: Early-2008, during QE2, and during the European debt crisis, the two segments of the market behave similarly.

Robustness Checks

✓ Supply shocks: Controlling for corporate credit spreads, g-fees, bank CDS spreads

✓ Demand shocks/local economic conditions

    1 refinancing not purchasing
    2 County $\times$ month FEs

✓ Accounting for the reduction in Conforming Loan Limits in high cost areas in Sep 2011.

✓ Allowing for 6-month window around event dates

✓ Measuring counts instead of aggregate loan amounts

✓ Endogeneous segment choice around the CLL

Robustness to Time-Varying Shocks

- Identifying assumption: mortgage market segments on parallel trends
    - Appears valid in graphs (especially in short-run)
- Robustness check: control for factors that affect specific segments
    - Credit spreads (BBB-AAA) measure default risk, relevant to jumbos.
    - GSE guarantee fees ("g-fees") affect relative market share, etc.
    - Together, explain over 70% of variation in interest rates.
- Estimate effect of credit spreads and GSE guarantee fees for each event using coefficients estimated on a sample excluding window around each event
    - g-fees from Fuster et al. (2013), credit spreads from St. Louis Fed
- Also robust to controlling for bank CDS spreads

Outline

Refinancing and Consumption

- Three types of refinancing:
  1. Cash-in
  2. No cash-out (same amount or rolling in closing costs)
  3. Cash-out

- Refinancing can affect consumption through three channels:
  - Lower monthly payments $\Rightarrow$ More disposable income
  - Lower interest payments $\Rightarrow$ Positive wealth shock for borrowers
  - Cash-in/Cash-out $\Rightarrow$ Change in the stock of liquid wealth

- Cash-in refinancing: may even have negative multiplier on economic activity

- Highlights segmented nature of response to QE

Measuring Cash-in Refis

- Measure cash-in refinancing by linking new refinance to unpaid balance on borrower's prior loan
- Allow for $3,000 closing costs to be rolled into new loan without being classified as cash-in refi
- The panel nature of the data allows us to observe loan amounts before refinancing and to estimate the LTV prior to the refinance
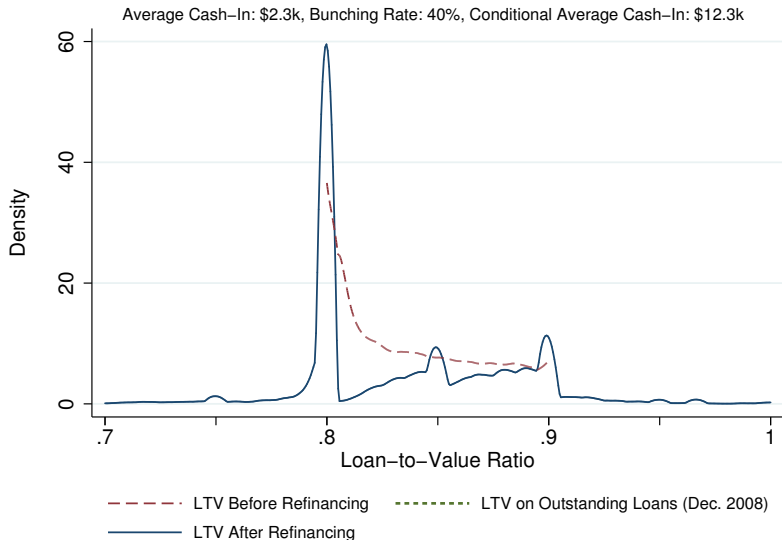- Estimate bunching from fraction of borrowers over 80% current LTV that originate a new mortgage at 80% LTV

Substantial Cash-in Refinancing (Before HARP)
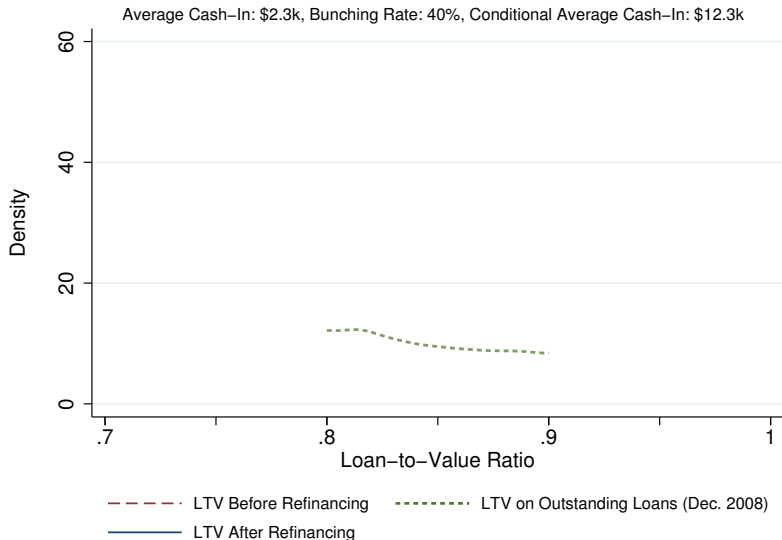
Average Cash–In: $2.3k, Bunching Rate: 40%, Conditional Average Cash–In: $12.3k

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LTV Before Refinancing   LTV on Outstanding Loans (Dec. 2008)
LTV After Refinancing
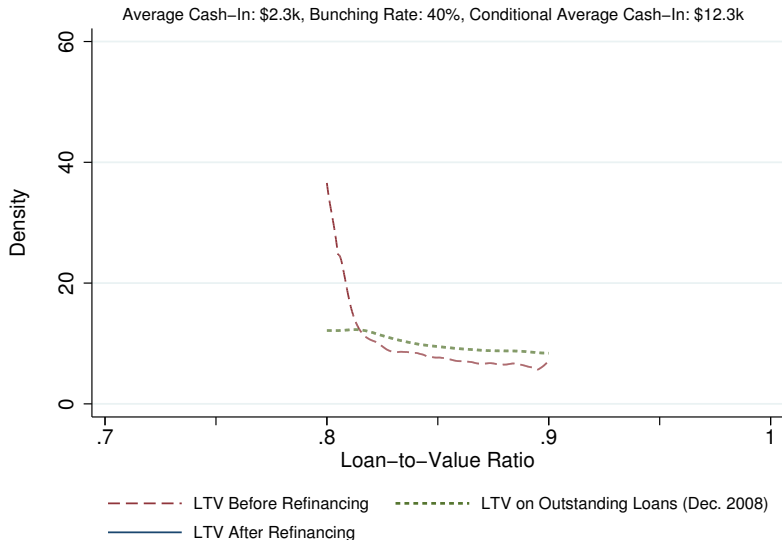
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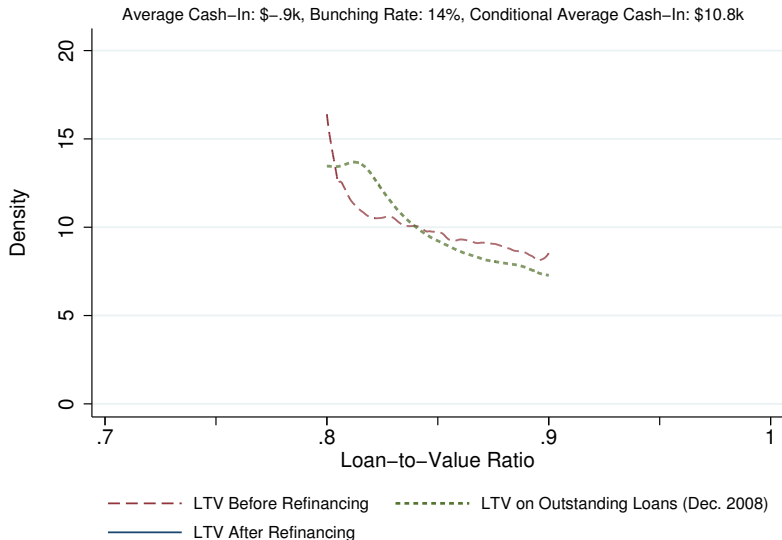
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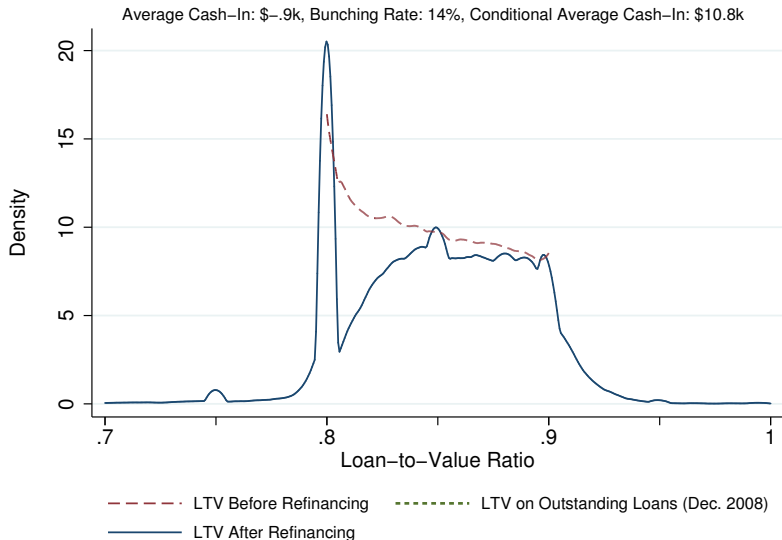
Also Significant Bunching to Get Under CLL

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Average Cash-In: $27k, Bunching Rate: 43%, Conditional Average Cash-In: $81k
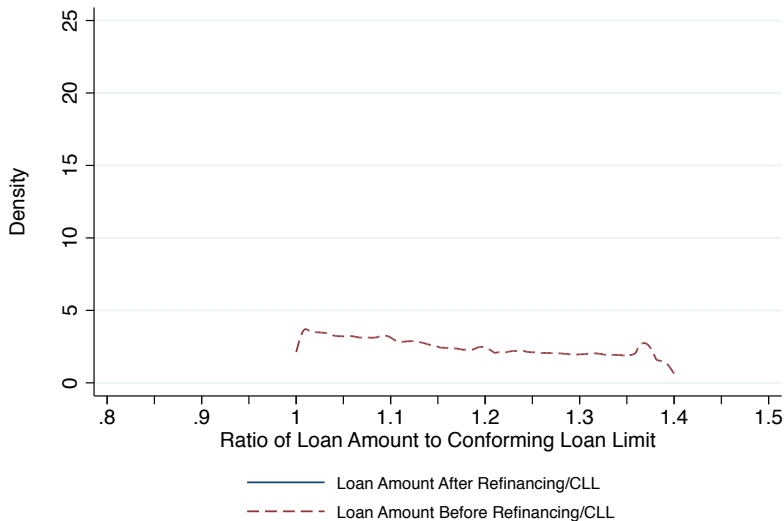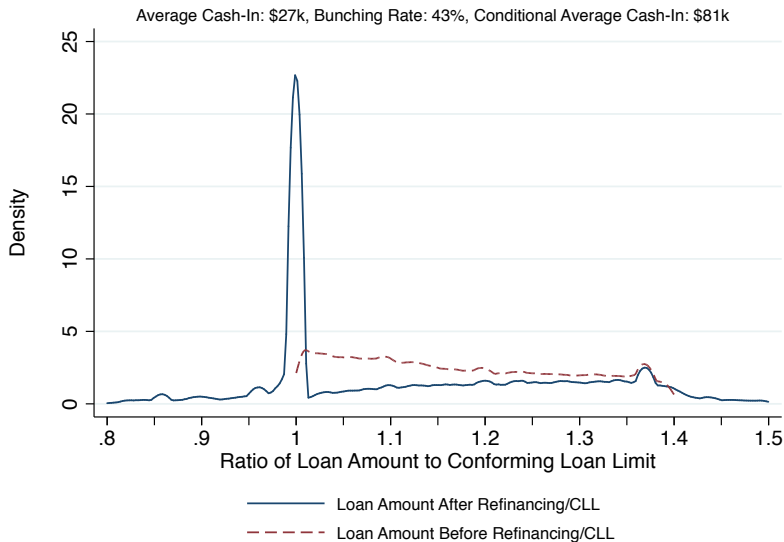
Cash-out refinancing important for counterfactual

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Average Cash-Out: $4k, Bunching Rate: 22%, Conditional Average Cash-Out: $9.5k
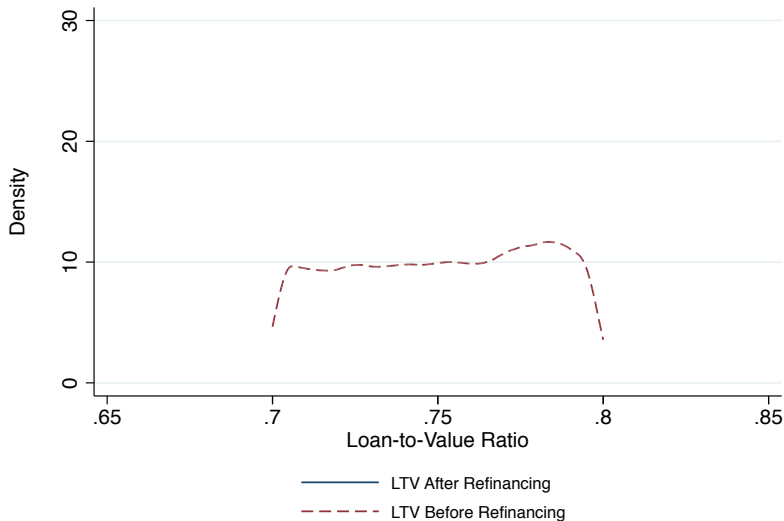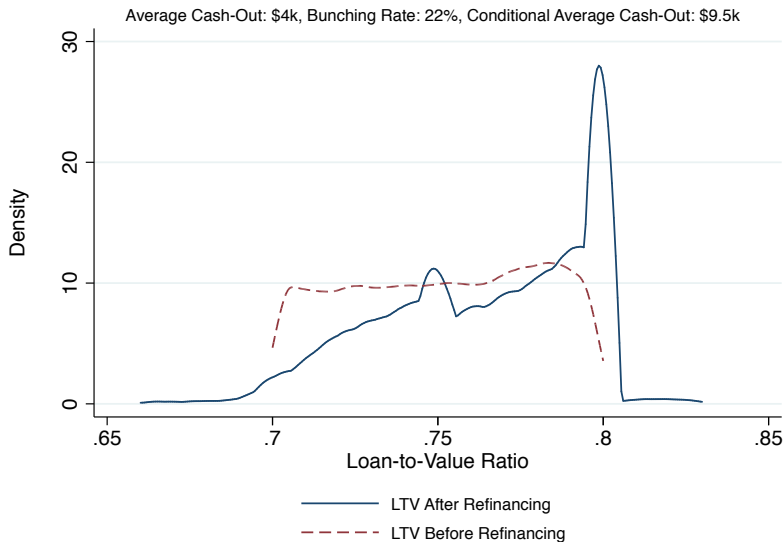
Refinancing and Consumption

- Refinancing helps borrowers to lower their interest rates, and increase their monthly disposable income.

    - Saved on average $250 per month or $3,000 per year due to the lower interest rates.
    - Assuming MPC of 75%, this resulted in an increase in borrowers consumption by about $1 billion.

- Many borrowers cash out equity while refinancing, providing cash on hand to support new expenditures.

    - amount of equity cashed out is about 11%.
    - $100 bn of new refi volume translates into $11 billion increase in equity extraction.

Consumption
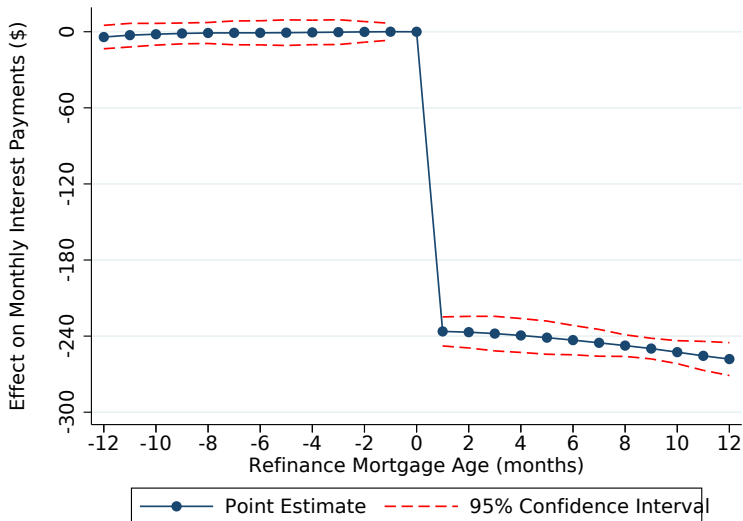
Consumption
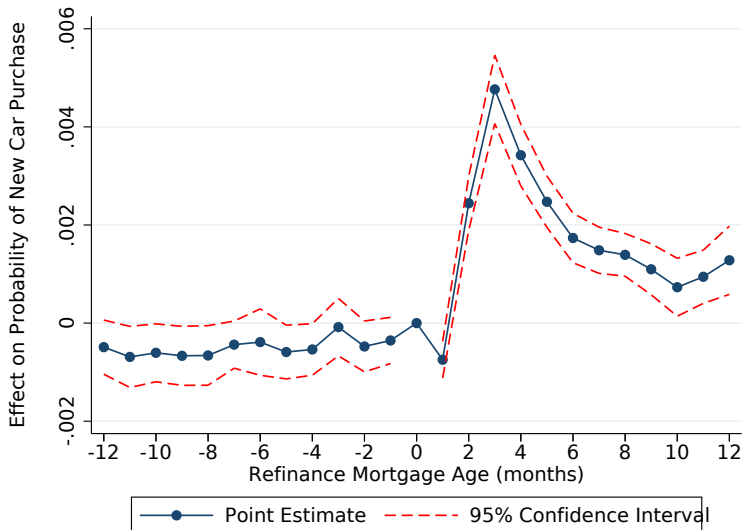
Counterfactual: Change in LTV

- What was the effect of a countercyclical leverage caps? (an increase in the LTV cap from 80% to 90%)

- Extensive margin: more borrowers with small equity being able to refinance.

- Intensive margin:enable borrowers with lower LTV to cash-out additional equity, supporting their spending behavior.

- This policy is different from HARP; which prohibited borrowers from extracting any equity out of their homes.

Counterfactual: Change in LTV

| Current LTV Bin	Number of Mortgages in Bin	Without LTV Change		LTV Cap		Counterfactual Increase	
		Baseline Percent Prepaid	Actual Average Cash-Out (In)	Predicted Prepaid	Predicted Average Cash-Out (In)	Increase in Number of Refinances	Increase in Aggregate Equity Cashed-Out
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
[0%, 60%]	10,058,221	7.8%	$39,176	7.8%	$40,371	0	$937,367,289
(60%, 70%]	4,319,690	7.6%	$17,752	7.5%	$32,076	(4,320)	$4,564,050,321
(70%, 80%]	8,155,314	7.1%	$9,316	7.6%	$14,580	40,777	$3,642,277,178
(80%, 90%]	3,577,874	5.6%	$2,700	7.5%	$7,982	67,980	$1,600,836,844
(90%, 100%]	3,523,964	3.5%	$2,170	5.7%	$501	77,527	($167,051,775)
(100%, 110%]	152,520	2.0%	($3,796)	3.5%	$2,391	2,288	$24,342,056
(110%, 120%]	11,842	1.0%	($89,126)	2.0%	($12,855)	118	$7,509,850
Above 120%	15,483	0.5%	($144,764)	0.5%	($144,184)	0	$44,875
Totals	29,814,908	6.8%	$18,787	7.4%	$23,204	184,370	$10,609,376,637
Total Adjusting for Data Coverage	62,114,392	6.8%	$18,787	7.4%	$23,204	384,104	$22,102,867,994

- This is an increase of $22 bn in cash-outs during the first five months of QE1 (28% increase)

Conclusion

- When UMP needed the most, LSAPs seem to transmit through a *direct-lending channel* arising from market segmentation

    - Matters what central bank purchases
    - Purchase of MBS (instead of treasuries) during QE1 increased refinancing by $100 bn
    - This additional refinancing increased borrowers consumption by ~$14 bn

- Important role for complementary macroprudential policy

    - Countercyclical LTV caps would have induced more refis, less cash-in, more cash-outs

BACKUP SLIDES

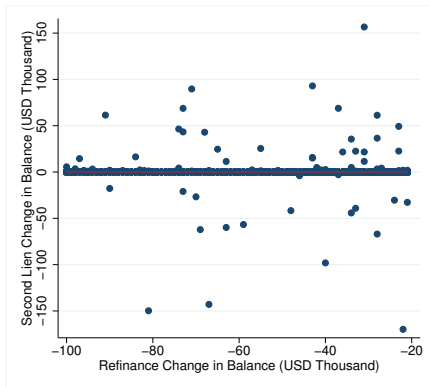# Conforming loan originations track Fed MBS purchases
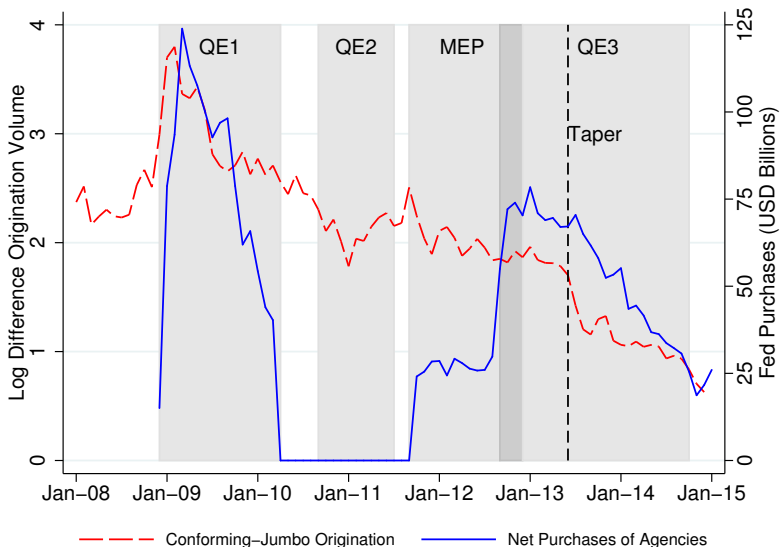
Cash-in Refinances Small on Aggregate
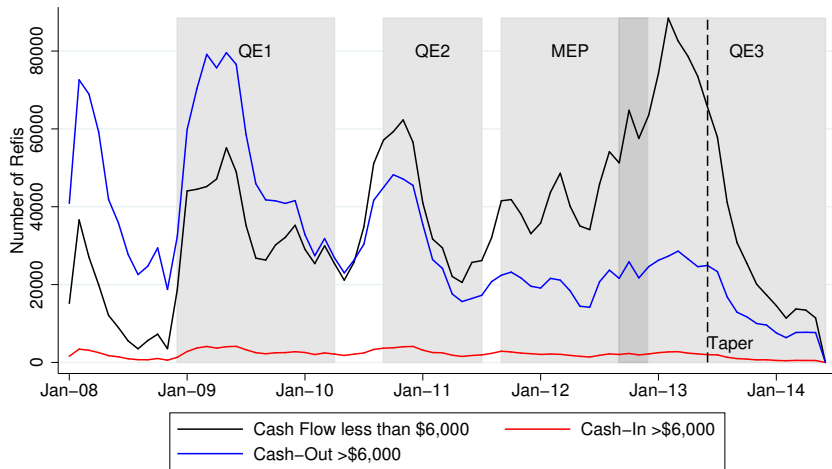
Was Cash-In Refinancing Just Debt Relabeling? (No.)