How Quantitative Easing Works: Evidence on the Refinancing Channel

Marco Di Maggio
HBS & NBER

Amir Kermani
Berkeley & NBER

Christopher Palmer
Berkeley

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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”
How Unconventional MP Works

1. Complete markets - no effect
How Unconventional MP Works

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2. Portfolio rebalancing / Duration segmentation
   - Only the duration / risk profile of assets purchased matter.
   - Investors rebalancing $\Rightarrow$ spillover of Fed purchases to other assets.
   - e.g., Vayanos and Vila (2009), Greenwood, Hanson and Liao (2015)
How Unconventional MP Works

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3. Narrow segmentation + Capital constraints / MBS Scarcity
   - Fed asset purchases offset the decline in private lending.
   - Very limited spillover to other asset classes not purchased by the Fed.
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

⇒ 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

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

- Identifying assumption: segments A and B on parallel trends
  - Focus on refinance mortgages (largely free from demand effects)
  - Focus on post-2008 (no private securitization)
- \(\beta\) 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
During QE1, GSE-eligible originations increased by 170% while prime jumbo originations increased by 20%

- Jumbo-conforming interest spread increases by 50 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)
Results Preview

1. During QE1, GSE-eligible originations increased by 170% while prime jumbo originations increased by 20%
   - Jumbo-conforming interest spread increases by 50 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)

2. Important complementarity between accommodative monetary policy and GSE policy
   - Relaxation of maximum LTVs would have resulted in:
     * More refinancing in distressed regions ($92 bn increase)
     * Less household deleveraging: Less cash-in refis and more cash-out refis (20% increase in equity extraction)
Outline

1. Introduction
   - Motivation
   - Background
   - Data

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

3. Regional Results

4. Households’ Behavioral Response
   - The Extensive Margin of Refinancing
   - The Intensive-Margin of Refinancing
   - Counterfactual

5. Conclusion
Context in Literature

- **Theory *Before the crisis***

- **Theory *After the crisis***

- **Empirical Literature**
QE Timeline

Mar-09: QE1 expanded to purchase an additional $750 billion of MBS.

Oct-11: Maturity Extension Program (MEP) begins.

Dec-12: MEP ends. QE3 expands.

June-13: QE3 tapered over 10 months.
What (and When) Did the Fed Buy?

- QE1
- QE2
- MEP
- QE3

Monthly Transactions (USD Billions)

Jan-09  Jul-10  Jan-12  Jul-13  Jan-15

Purchases of Treasuries
Purchases of Agencies
Sales of Treasuries
Sales of Agencies

Di Maggio-Kermani-Palmer
How QE Works
 September 2016
Fed Became Dominant Player in Agency MBS

How QE Works

Di Maggio-Kermani-Palmer
Common QE Misconception

- Stylized view of QE: Fed purchased (underperforming) legacy assets
  - This freed up cash on balance sheet
- Actually: Fed funded \textit{new} refi origination via TBAs (mortgage forwards)
- Some of the corresponding prepayments freed up cash on bank balance sheets
  - \textit{regardless} of who actually sold TBA to Fed
- Requires given mortgage being currently GSE-eligible for a refi
  \Rightarrow ‘worst’ loans still stuck on bank balance sheets
QE GSE cohorts most likely to be purchased by Fed

Percentage of CUSIPs owned by Fed, by Issuance Quarter

Quarter of Issuance

% Owned By Fed

2006q1  2007q1  2008q1  2009q1  2010q1  2011q1  2012q1  2013q1  2014q1

QE1  QE2  MEP  QE3
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 ⇔ 80% LTV
  - Loan size ≤ 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
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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
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

\[ r_{it} = \alpha_t + \beta_1(FICO_i - 720) + \beta_2(LTV_i - 0.75) + \varepsilon_{it} \]

- \( \hat{\alpha}_t \) for jumbo and conforming are “rate-sheet adjusted” interest rates
- Window around QE dates (±3 months)

\[ r_{ict} = X_i' \beta + \theta_1 QE_jt + \theta_2 QE_jt \cdot Jumbo_i + \gamma_{ct} + \varepsilon_{ict} \]

- Cluster all results by month, \( X_i \) has LTV bins and FICO bins
Below CLL Interest Rate Responded More to QE1

![Graph showing interest rates over time with shaded areas for QE1, QE2, MEP, and QE3, and a vertical line indicating the taper phase. The graph compares the interest rate responses below and above the CLL.](image-url)
Interests Rate Response (bps) Varies by Segment and QE

<table>
<thead>
<tr>
<th>Program</th>
<th>(1)</th>
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<th>(3)</th>
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<td>MEP</td>
<td>QE3</td>
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<td></td>
<td>(13.549)</td>
<td>(10.338)</td>
<td>(7.020)</td>
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<td>Program x Jumbo</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Observations</td>
<td>331,895</td>
<td>292,290</td>
<td>180,055</td>
<td>201,060</td>
<td>262,493</td>
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<tr>
<td>R-squared</td>
<td>0.564</td>
<td>0.297</td>
<td>0.364</td>
<td>0.219</td>
<td>0.203</td>
</tr>
</tbody>
</table>

\[ r_{ict} = X'_i \beta + \theta_1 QE_j + \theta_2 QE_j \cdot Jumbo_i + \gamma_c + \varepsilon_{ict} \]
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 50 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 overstates 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)

Quantities: Refinance Volumes

QE1
QE2

Jumbo Origination Amount (Billion USD)
Non-Jumbo Origination Amount (Billion USD)

Jan-08 Jul-08 Jan-09 Jul-09 Jan-10 Jul-10 Jan-11 Jul-11

Below CLL (Left Axis)
Above CLL (Right Axis)
Non-jumbo Segment Responds to QE1, Jumbo Doesn’t

<table>
<thead>
<tr>
<th>Program</th>
<th>(1) QE1</th>
<th>(2) QE2</th>
<th>(3) MEP</th>
<th>(4) QE3</th>
<th>(5) Tapering</th>
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<tbody>
<tr>
<td>Program Indicator</td>
<td>1.007**</td>
<td>0.497**</td>
<td>0.537***</td>
<td>0.151</td>
<td>-0.343*</td>
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<td>(0.290)</td>
<td>(0.153)</td>
<td>(0.076)</td>
<td>(0.087)</td>
<td>(0.145)</td>
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<td>Program x Jumbo</td>
<td>-0.863***</td>
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<td>Jumbo Indicator</td>
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<td>-1.587***</td>
<td>-1.503***</td>
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<td>(0.067)</td>
<td>(0.086)</td>
<td>(0.062)</td>
<td>(0.007)</td>
<td>(0.024)</td>
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<td>576</td>
<td>576</td>
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<tr>
<td>R-squared</td>
<td>0.651</td>
<td>0.584</td>
<td>0.462</td>
<td>0.362</td>
<td>0.307</td>
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\[
\log Q_{st} = \beta_1 QE_{jt} + \beta_2 QE_{jt} \cdot Jumbo_s + \beta_3 Jumbo_s + \varepsilon_{st}
\]
Refinance Quantity Results Summary

- During QE1, the increase in GSE-eligible mortgage origination is at least 150% 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 $600 bn.
- Tapering affected only GSE-eligible mortgage origination.
- 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 credit spreads and g-fees
✓ Demand shocks/local economic conditions
  ① refinancing not purchasing
  ② County × month FEs

✓ Accounting for the reduction in Conforming Loan Limits in high cost areas in Sep 2011. Details
✓ Allowing for 6-month window around event dates
✓ Measuring counts instead of aggregate loan amounts

✓ Endogeneous 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
# Interest Rate Response Robust to Time-Series Controls

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<td>Tapering</td>
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<tr>
<td>Program x Jumbo</td>
<td>29.259**</td>
<td>-0.576</td>
<td>-4.564</td>
<td>5.878</td>
<td>-22.961**</td>
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<td>(7.555)</td>
<td>(5.201)</td>
<td>(3.295)</td>
<td>(3.003)</td>
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<td>(2.261)</td>
<td>(4.596)</td>
<td>(2.318)</td>
<td>(0.918)</td>
<td>(1.670)</td>
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<td>Yes</td>
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<tr>
<td>County*Month FEs</td>
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<td>Yes</td>
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<td>0.326</td>
<td>0.381</td>
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\[
r_{ict} = X_i \beta + \theta_1 QE_j t + \theta_2 QE_j t Jumbo_i + \theta_3 g fee_t Jumbo_i + \theta_4 credit spread_t Jumbo_i + \gamma_c t + \varepsilon_{ict}
\]

\[
\]
## Quantity Response Robust to Time-Series Controls

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<td>QE1</td>
<td>-0.711*</td>
<td>0.056</td>
<td>0.160</td>
<td>-0.108</td>
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<td>QE2</td>
<td>(0.351)</td>
<td>(0.185)</td>
<td>(0.205)</td>
<td>(0.091)</td>
<td>(0.183)</td>
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<td>MEP</td>
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<td>QE3</td>
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<th>Program x Jumbo</th>
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<td></td>
<td>-2.419***</td>
<td>-2.432***</td>
<td>-2.363***</td>
<td>-2.044***</td>
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<td>(0.172)</td>
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<th>County*Month FEs</th>
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<td>576</td>
<td>576</td>
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<tr>
<td>R-squared</td>
<td>0.930</td>
<td>0.938</td>
<td>0.941</td>
<td>0.933</td>
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\[
\log Q_{sct} = \beta_1 QE_j + \beta_2 QE_j \text{Jumbo}_s + \beta_3 \text{Jumbo}_s + \beta_4 g_{fee} \text{Jumbo}_s + \beta_5 \text{Credit spread}_t \text{Jumbo}_s + \epsilon_{sct}
\]
Refinance Volumes excluding loans around CLL

- Concern: Endogenous choice around the CLL.
- All the loans in the \([90\%,140\%]\) interval have been dropped.
Regional Results

Are most distressed areas receiving credit? No.

- Mortgagors benefitted from QE unequally. So where did credit supply flow?
  - Not to areas w/ high LTVs ⇔ the most constrained (and highest MPC) areas
  - (n.b. would have benefitted equally with ARMs)
Regional Results

Are most distressed areas receiving credit? No. (HPI)

House Prices (2006–08) & Refi Activity (Jan–Mar 2009)
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5 Conclusion
Individual-level Prepayment Behavior

\[
\lambda_{it} = \exp(X'_{it} \beta) \lambda_0(\text{age}_{it})
\]

\[
X'_{it} \beta = \theta'_L W_{it}^{\text{loan}} + \theta'_B W_{i}^{\text{borrower}} + \sum_k \beta_{kt} \cdot QE1_t \times X_{k, it}
\]

- Prepayment hazard \( \lambda \) is the conditional likelihood of prepaying
- Sample is ±3 months around QE1 announcement
- Loan controls include current LTV, original balance, current jumbo
- Borrower controls include FICO bins, DTI, DTI missing indicator
- \( Xs \) interacted with QE1 include a constant, LTV>.8, LTV>.9, jumbo
- \( \lambda_0(\text{age}) \) is a non-parametric baseline hazard function
- ML estimator as in Palmer (2015)
Hazards: GSE-ineligible Borrowers Less Likely to Prepay

<table>
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<td><strong>QE1 Indicator</strong></td>
<td>0.673***</td>
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<td>0.728***</td>
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<td><strong>Current LTV &gt; .9 x QE1</strong></td>
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<td>-0.268***</td>
<td>-0.255***</td>
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<td><strong>Observations</strong></td>
<td>2,053,902</td>
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<td>2,053,902</td>
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<td>2,053,902</td>
<td>2,053,902</td>
</tr>
</tbody>
</table>

- At most 25-40% of the increase in refinancing activity is predicted by movements in the interest rate.
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 ⇒ More disposable income
  - Lower interest payments ⇒ Positive wealth shock for borrowers
  - Cash-in/Cash-out ⇒ 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
Substantial Cash-in Refinancing (Before HARP)

Average Cash–In: $2.3k, Bunching Rate: 40%, Conditional Average Cash–In: $12.3k

- LTV Before Refinancing
- LTV After Refinancing
- LTV on Outstanding Loans (Dec. 2008)
Substantial Cash-in Refinancing (Before HARP)

Average Cash–In: $2.3k, Bunching Rate: 40%, Conditional Average Cash–In: $12.3k
HARP Alleviated LTV Bunching
HARP Alleviated LTV Bunching

Average Cash−In: $−.9k, Bunching Rate: 14%, Conditional Average Cash−In: $10.8k

- LTV Before Refinancing
- LTV on Outstanding Loans (Dec. 2008)
- LTV After Refinancing
HARP Alleviated LTV Bunching

Average Cash-In: $-0.9k, Bunching Rate: 14%, Conditional Average Cash-In: $10.8k

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

Average Cash-In: $27k, Bunching Rate: 43%, Conditional Average Cash-In: $81k

[Graph showing density distribution of loan amounts after refinancing and before refinancing, with peaks indicating bunching behavior.]
Was Cash-In Refinancing Just Debt Relabeling? (No.)

Second Liens

HELOCs
Cash-out refinancing important for counterfactual
Cash-out refinancing important for counterfactual

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

- LTV After Refinancing
- LTV Before Refinancing
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 $10bn.

- Many borrowers cash out equity while refinancing, providing cash on hand to support new expenditures.
  - amount of equity cashed out is about 11%.
  - $600 bn of new refi volume translates into $67 billion increase in equity extraction.
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

<table>
<thead>
<tr>
<th>Current LTV Bin</th>
<th>Number of Mortgages in Bin</th>
<th>Without LTV Change</th>
<th>Counterfactual Higher LTV</th>
<th>Counterfactual Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Baseline Percent Prepaid</td>
<td>Actual Average Cash-Out (In)</td>
<td>Predicted Prepaid</td>
</tr>
<tr>
<td>Current LTV &lt;= 60%</td>
<td>10,974,369</td>
<td>7.9%</td>
<td>$39,176</td>
<td>7.9%</td>
</tr>
<tr>
<td>60% &lt; Current LTV &lt;= 70%</td>
<td>3,740,057</td>
<td>7.3%</td>
<td>$17,752</td>
<td>7.3%</td>
</tr>
<tr>
<td>70% &lt; Current LTV &lt;= 80%</td>
<td>4,337,909</td>
<td>6.7%</td>
<td>$9,316</td>
<td>7.7%</td>
</tr>
<tr>
<td>80% &lt; Current LTV &lt;= 90%</td>
<td>3,795,757</td>
<td>4.3%</td>
<td>$2,700</td>
<td>6.9%</td>
</tr>
<tr>
<td>90% &lt; Current LTV &lt;= 100%</td>
<td>2,869,281</td>
<td>2.4%</td>
<td>$2,170</td>
<td>4.4%</td>
</tr>
<tr>
<td>100% &lt; Current LTV &lt;= 110%</td>
<td>1,713,517</td>
<td>1.2%</td>
<td>($3,796)</td>
<td>1.2%</td>
</tr>
<tr>
<td>110% &lt; Current LTV &lt;= 120%</td>
<td>585,146</td>
<td>0.5%</td>
<td>($89,126)</td>
<td>0.5%</td>
</tr>
<tr>
<td>120% &lt; Current LTV</td>
<td>740,546</td>
<td>0.4%</td>
<td>($144,764)</td>
<td>0.4%</td>
</tr>
<tr>
<td>Totals</td>
<td>28,756,582</td>
<td>5.9%</td>
<td>$13,470</td>
<td>6.5%</td>
</tr>
<tr>
<td>Total Adjusting for Data Coverage</td>
<td>59,909,546</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

This is an increase of $10 bn in cashouts during the first five months of QE1. (20% increase)
Conclusion

- When UMP needed the most, LSAPs seem to transmit through a direct-lending channel arising from market segmentation.
- Fed purchases *de facto* allocate credit:
  - Matters what central bank purchases
  - Benefits flow to least distressed areas, borrowers
- Role for complementary GSE policy:
  - Countercyclical LTV caps would have induced more refis, less cash-in, more cash-outs
BACKUP SLIDES
Consumption

![Graph showing the total effect on monthly interest payments with refinance mortgage age on the x-axis and total effect on monthly interest payments on the y-axis. The graph includes a point estimate and a 95% confidence interval.](image-url)
Consumption

![Graph showing the effect of probability of new car purchase on refinance mortgage age. The graph has a y-axis labeled 'Effect on Probability of New Car Purchase' ranging from -0.002 to 0.006, and an x-axis labeled 'Refinance Mortgage Age (months)' ranging from -12 to 12. The graph includes a point estimate line and a 95% confidence interval line.](image-url)
UMP involves many more choices than conventional MP

- Fed MBS purchases exceeded pre-crisis entire balance sheet
- Infinite degrees of freedom: what to purchase, how much

Source: Fed H4.1 Consolidated Balance Sheet Data
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
Conforming loan originations track Fed MBS purchases

- **QE1**
- **QE2**
- **MEP**
- **QE3**
- **Taper**

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How QE Works

September 2016
Threat to Validity: Increase in CLL

- Could increase in conforming loan limits be the cause of relative increase in non-jumbo issuance?
- No effect on relative jumbo/conforming issuance when CLL raised, but maybe housing market too sick to respond at that moment
- Can look at regions that didn’t have an increase in CLL to see whether they still have same size differential increase in prime vs. jumbo origination.
Change in CLL

[Graph showing Change in CLL from Jan-00 to Jan-15, with two lines representing National CLL and County-Varying Max CLL.]
High vs. Low-Cost Areas

- Red: High Cost (> $41.7k)
- Gray: Non-High Cost
Conforming Loan Originations in Low-Cost Areas

Refinance Origination Count - Low Cost Areas

- QE1
- QE2
- MEP
- QE3

Non-Jumbo Originations

- Below CLL (Left Axis)
- Above CLL (Right Axis)

Month

Jan 2008 to Jan 2014

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How QE Works
September 2016
Cash-in Refinances Small on Aggregate

- **QE1**
- **QE2**
- **MEP**
- **QE3**

<table>
<thead>
<tr>
<th></th>
<th>Jan-08</th>
<th>Jan-09</th>
<th>Jan-10</th>
<th>Jan-11</th>
<th>Jan-12</th>
<th>Jan-13</th>
<th>Jan-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash Flow less than $6,000</td>
<td>0</td>
<td>20000</td>
<td>40000</td>
<td>60000</td>
<td>80000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash-In &gt;$6,000</td>
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<td></td>
</tr>
<tr>
<td>Cash-Out &gt;$6,000</td>
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Di Maggio-Kermani-Palmer

How QE Works

September 2016
Non-FHA → FHA Refis Respond to QE1

The graph illustrates the monthly cash flows in million USD from January 2005 to January 2014, showing the response of FHA mortgage market to different phases of QE policies: QE1, QE2, MEP, and QE3, and the taper phase. The graph distinguishes between net, cash-out only, and cash-in only cash flows.

- **Net**: Represented by black line, showing the overall net cash flow.
- **Cash-Out Only**: Represented by red line, indicating cash flows due to cash-out refinances.
- **Cash-In Only**: Represented by blue line, indicating cash flows due to cash-in refinances.

The shaded areas indicate the different phases:
- **QE1**: January 2009 to January 2010
- **QE2**: January 2010 to January 2011
- **MEP**: January 2011 to January 2012
- **QE3**: January 2012 to January 2013
- **Taper**: January 2013 to January 2014

The graph does not explicitly mention the process of how QE works in detail, but it visually represents the impact of different phases of QE policies on the FHA mortgage market.

*How QE Works* by Di Maggio-Kermani-Palmer, September 2016