Online Appendix

A Quantitative Easing Background

In this section, we provide a brief summary of the Federal Reserve's Quantitative Easing program and discuss how its MBS purchases were conducted on the secondary mortgage market. For reference, panel II of Figure 1 provides a timeline of the various Fed LSAP programs and panel I of Appendix Figure 6 shows the time series of asset purchases and sales.

In late November 2008, the Fed announced its mortgage-buying program (known as QE1) with the intent to purchase about $500 billion in mortgage-backed securities, consisting of mortgages guaranteed by Fannie Mae, Freddie Mac, and to a lesser extent, Ginnie Mae. In March 2009, the Fed announced an expansion to this program, subsequently purchasing an additional $750 billion in mortgage-backed securities with 50-70% of agency originations each month ending up on the Fed's balance sheet (Appendix Figure 6). QE1 lasted until March 2010 with a total of $1.25 trillion in purchases of mortgage-backed securities and $175 billion of agency debt purchases. QE2 was first announced in mid-August 2010, ran from November 2010 to June 2011, and exclusively focused on Treasuries. We consider QE2 to have begun in September 2010 when the Fed signaled that it was considering a second round of monetary stimulus.[45] In September 2011, the Fed began a program known as the Maturity Extension Program (MEP) or Operation Twist. Under the MEP, the Federal Reserve began reinvesting repaid MBS principal and reduced the supply of longer-term Treasury securities in the market by selling and redeeming about $600 billion in shorter-term Treasury securities and using the proceeds to buy longer-term Treasuries. QE3 was announced in September 2012, and was roughly equally weighted between Treasuries and MBS. We treat the beginning of the Fed's tapering its MBS purchases as June 2013, following Bernanke's tapering announcement on May 22, 2013.

As Appendix Figure 6 shows, a greater fraction of each QE campaign's MBS purchases have occurred at the beginning of each program, with purchases slowly declining over the course of each LSAP campaign.[46] Panel II of Appendix Figure 6 shows the relative magnitude of GSE MBS net purchases compared with the total size of the GSE-guaranteed mortgage market. During QE1, the volume of Fed purchases was similar in magnitude to the volume of new issuance of GSE-guaranteed MBS. During QE3, Fed net GSE MBS purchases were roughly half of the GSE market.

To comply with the Federal Reserve Act, Fed MBS purchases had to consist of government-guaranteed debt. Contrary to popular perception, Fed MBS purchases did not involve buying legacy (and underperforming) MBS from banks. Instead, Fed MBS purchases were forward contracts on the TBA (To-be Announced) mortgage market, consisting mostly of newly orig-

[45] Krishnamurthy and Vissing-Jørgensen (2013) find that most of the market reaction to QE2 was when it was first signaled in September 2010. Interest rates actually increased after the official announcement in November 2010 as it failed to live up to market expectations.

[46] Note that the policy of the Fed to reinvest principal prepaid on its MBS holdings into new MBS purchases results in non-zero MBS purchases even after QE3 officially ends.

inated GSE-eligible mortgages (see Appendix Figure 7). The strict eligibility rules for GSE guarantees allow us to compare origination volumes by loan size. Specifically, GSE guarantees require loan sizes to be beneath published conforming loan limits (CLLs).[47] Mortgages with a loan size exceeding geographically and time-varying CLLs (known as jumbo mortgages) are essentially ineligible for inclusion in GSE MBS. Many of our results test for a deviation in mortgage origination volume for loans below the CLL, which should be directly affected by Fed purchases because of their TBA eligibility, and loans above the CLL, which should only be indirectly affected by Fed MBS purchases.

B Robustness to Increasing Conforming Loan Limits

In this appendix, we investigate the concern that the stronger response of GSE-eligible originations relative to jumbo originations around QE event dates simply reflects the establishment of high-cost area designations. Ultimately, this initial increase in conforming loan limits happened much too early to explain the differential response of mortgage market segments to QE1, and the eventual decrease in conforming loan limits (September 2011) did not coincide with any particular LSAP window (see Appendix Figures 8 and 9).

The conforming loan limit increased from about $400,000 to about $700,000 for certain high-cost areas over time (see panel I of Appendix Figure 8). As mapped in panel II of Appendix Figure 8, areas with the high-cost designation are mainly counties on the coasts with higher land values. Although this increase occurred nearly a year before the beginning of QE1, expanding the size of the conforming market by increasing the CLL in certain areas should tilt originations from the jumbo segment to the GSE-eligible segment. To address this concern, we construct an estimation sample using only non-high-cost counties whose conforming loan limits last changed in 2006 (and even then only incrementally). Appendix Figure 9 shows that even when we restrict attention to these areas, we observe a significant and differential increase in the origination of conforming loans around QE1. As before, origination volumes in the jumbo and conforming segments track each other closely except during the QE1 period, confirming that changes in the conforming loan limit cannot explain the differential origination pattern we observe in response to QE1.

C Counterfactual Simulation of Countercyclical LTV Caps

Using our statistical model of the relationship between the LSAPs, debt origination, and equity extraction, we can demonstrate the importance of the interaction between QE and an oft-proposed macroprudential tool: countercyclical leverage caps. A key implication of our main results is that when the banking sector is impaired, Fed MBS purchases have significant effects on the mortgage market and the wider economy. Given that Fed MBS purchases are restricted to conforming mortgages, there is significant potential to enhance the effectualness of these purchases by temporarily expanding the definition of conforming mortgages in a crisis. Specifically, we analyze the complementarity between the maximum loan-to-value

[47]See Adelino et al. (2013) and DeFusco and Paciorek (2017) for studies of the consequences of the sharp change in GSE eligibility at the conforming loan limit.

ratio allowed by the GSEs (that is, the maximum allowable without credit enhancements such as PMI) and QE by investigating what would have been the effects of an increase in the LTV cap from 80% to 90%. This exercise highlights the degree to which seemingly unrelated GSE policy can be an important factor in modulating the effectiveness of LSAPs. While low-downpayment loans have been maligned as an contributor to the housing crisis, ideally leverage ratios would be tight during credit expansions and loose during contractions to smooth macroeconomic shocks. Our bunching and loan-level prepayment model results highlight the importance of this LTV cap in determining the effectiveness of MBS purchases.

Adopting a countercyclical LTV policy might have several effects. First, it might allow borrowers with LTV higher than 80% that would not have been able to qualify for a new mortgage to refinance their current mortgages. Second, it might enable borrowers with lower LTVs to cash-out additional equity, supporting their spending behavior during the downturn. This policy intervention is substantially different from HARP; whereas HARP relaxed the requirements to qualify for a refinance loans, it prohibited borrowers from extracting any equity out of their homes (see Amromin and Kearns, 2014 and Agarwal et al. 2017). Third, borrowers with LTV higher than 80% that might liquidate accumulated wealth to cash-in refinance could do so without deleveraging as much.

Appendix Table 3 reports the results of this exercise. For each of several LTV bins, we measure in our data the number of loans, the fraction of borrowers that refinanced, and the average amount cashed-out (or cashed-in) again, allowing for $3,000 in closing costs in columns 1–3. To estimate the counterfactual prepayment rate in column 4, we estimate hazard models following Palmer (2015) to simulate what would have happened if the maximum allowable LTV were 90% instead of 80% (see Appendix Table 4 for these results). Specifically, we shift the coefficients for the LTV bins between 60–100% LTV up by one bin, effectively assuming that with a maximum LTV of 90% instead of 80%, for example, it would be as easy for an 85% current LTV loan to refinance as it had been for a 75% LTV loan to refinance in the factual world of an 80% LTV cap. Conservatively, we do not shift the coefficients for borrowers in the lowest (current LTV below 60%) and highest (current LTV above 120%) bins, as the elasticity of refinancing with respect to equity is near zero for these groups with high levels of positive or negative equity. Likewise, we perform a similar exercise for the counterfactual amount of equity cashed out by estimating an OLS regression of the actual amount cashed out on a similar set of controls (reported in Appendix Tables 5 and 6). In addition to shifting the LTV bin coefficients in the counterfactual, we also replace the amount of available equity to be cashed out (actual equity minus 20% of property value) with actual equity minus 10% of the property value. Columns 4 and 5 of Appendix Table 3 report the predicted fraction of borrowers who would be able to refinance and the predicted average cash out under the counterfactual policy. Columns 6 and 7 report the increase in the number of refinances and the increase in aggregate equity cashed-out as the difference between the actual number and the predicted ones.

We find that the biggest increases in the number of refinances come from the 80% to 90% bin, as these borrowers were not able to refinance before without deleveraging to get their current LTV ratio under 80%, and from the 90% to 100% bin, as these borrowers now have to delever much less. However, we also find that there is a significant increase in the aggregate amount cashed out, a result that is mainly driven by the borrowers with current LTVs below 90%, as these borrowers are now able to extract equity in their houses and still be able to refinance. Are such borrowers with substantial equity actually likely to be affected by a change in the maximum allowable LTV from 80% to 90%? Appendix Figure 10 shows that the 80% cutoff is relevant even for those with very low LTVs that are refinancing. The effects from the below 60% LTV bin are particularly important because, although only a small fraction of these borrowers cash out, it is the group with the largest number of borrowers. We find in our data that about 5.6% of borrowers in the below 60% LTV cash out by bunching at the 80% threshold, so it is plausible that we would see an increase of a comparable magnitude for people refinancing to 90% LTV.[48]

Can this policy have large effects? Yes. Accounting for the 48% coverage ratio of our data (that is, we estimate it covers 48% of nationwide 2009 mortgage origination as measured by HMDA), our estimates show that this simple policy would have increased the number of refinancing households by over 380,000. If we multiply this number by the average mortgage size (i.e., $224,262), this policy would have resulted in a $86 billion increase in refinance mortgage origination, including a 28% increase in equity cashed-out ($22 billion) with potentially important effects on aggregate demand. One way to benchmark the magnitude of these numbers is to contrast them with estimated effects in the literature of the effect of the HARP program that explicitly supported the refinancing of high LTV mortgages owned by the GSE. We find that the change in the LTV requirement would have been more effective in terms of refinances and aggregate volume than HARP, partly because our policy experiment would have had a significant impact on cash-out activities, and thus on the consumption expenditures, of these borrowers.

Overall, an important implication of our findings is the complementarity between unconventional monetary policy and mortgage-market policies that may play a key role in supporting aggregate demand through their effects on borrowers' ability to cash out equity from their houses.

D Allocation of Credit Across Regions

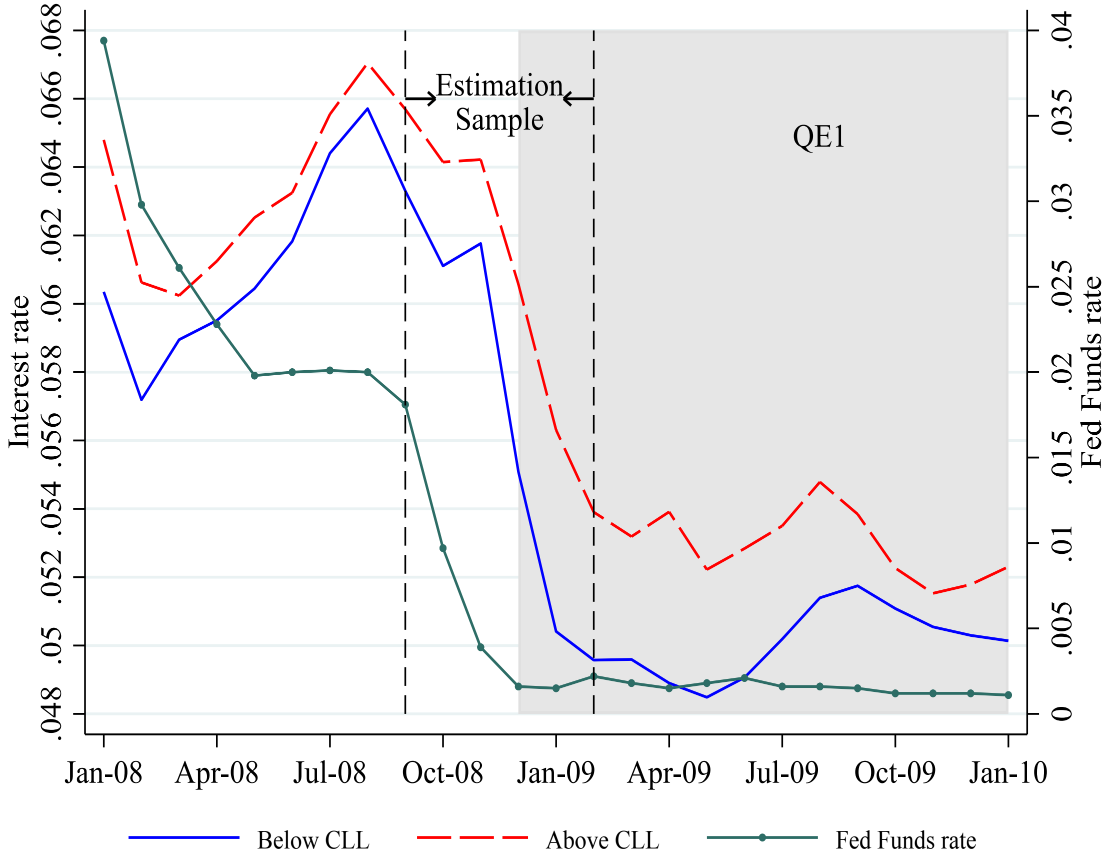
Given our evidence that unconventional monetary stimulus from QE1 was not distributed evenly across the mortgage market, what implications did this have for the geography of credit allocation? We investigate this by analyzing where 2009 refinancing activity was concentrated (see Beraja et al., 2018 for a full treatment of regional heterogeneity in the effects of QE). To ensure full coverage of the mortgage market, we use Home Mortgage Disclosure Act data, which reports the universe of mortgage originations by institutions large enough to be regulated by the act. In Appendix Figure 11, we plot the state-level percentage of outstanding mortgage balance refinanced in 2009 against two lagged measures of state-level economic health: 2006-2008 home price appreciation (top panel) and 2006-2008 real GDP growth (bottom panel).

Panel I shows that even though a clear objective of QE1 was to stimulate distressed housing markets, there is a strong positive relationship between past home price appreciation and new refinancing activity, suggesting that the QE1-induced increased availability of refinancing credit may not have reached the areas that arguably needed it the most. In

[48]We note that this equity-extraction channel is not present with other policy interventions such as HARP that target exclusively on high-LTV loans and prohibit cash-out refinancing.

particular, note that the states most affected by the housing bust (the so-called "sand states" of California, Florida, Arizona and Nevada) were the states with the lowest refinancing activity. Note that while the correlation between *purchase* mortgage credit growth could also be driven by shocks to fundamentals that simultaneously reduced demand for mortgage credit and lowered home prices, this is less of a concern for the refinancing activity measure shown here. Panel II of Appendix Figure 11 repeats this exercise, relating refinancing activity to state-level growth in real GDP from 2006–2008. Again, there is a clear positive relationship with contracting states benefiting less from QE1. Taken together, these figures provide evidence that mortgage market segmentation and contemporaneous banking sector stress allocated credit to the regions with the most potential GSE-eligible refinances (areas with fewer underwater borrowers and correspondingly stronger local economies). These across-region correlations highlight the important interplay between GSE mortgage-market policy and the effectiveness of monetary stimulus at reaching the local economies that would benefit the most.

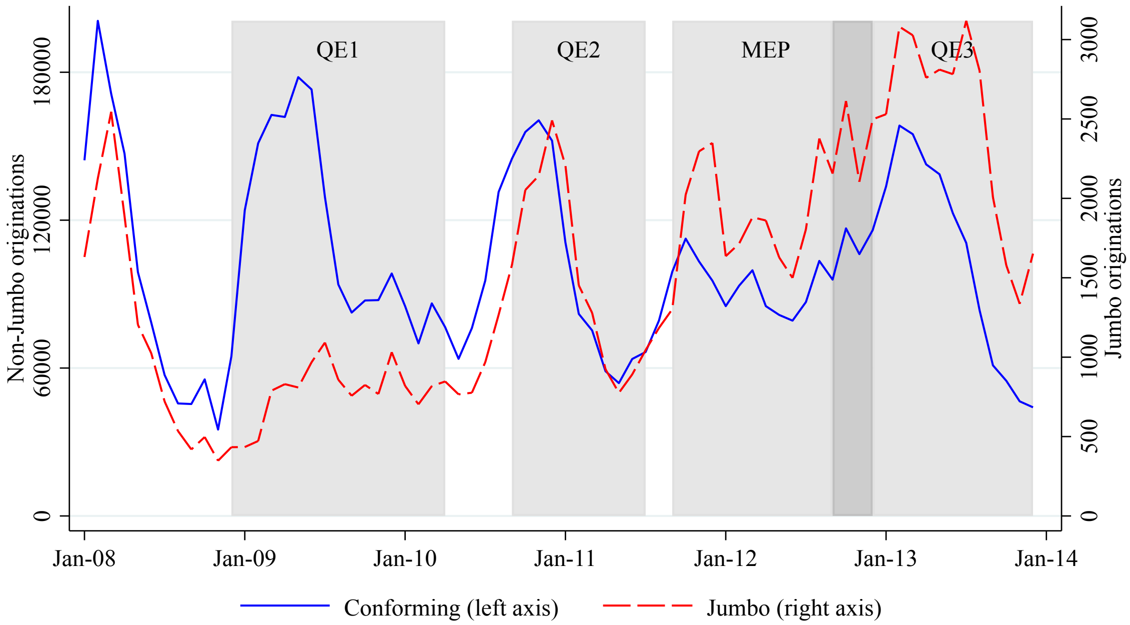
Appendix Figure 1. Federal Funds Rate and Mortgage Interest Rates Around QE1



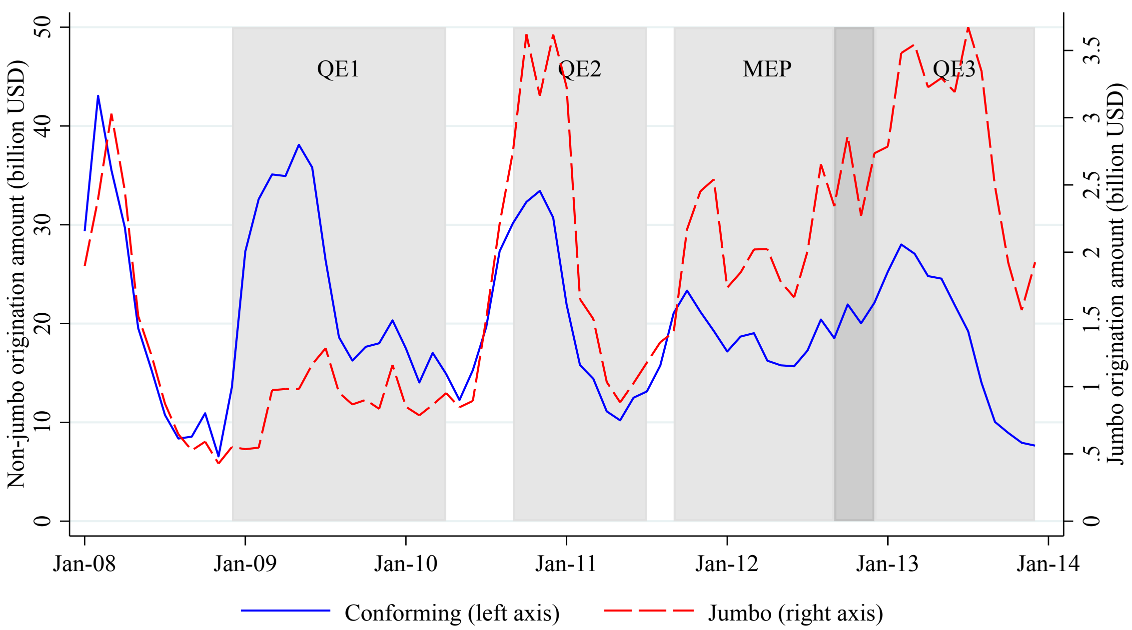
Notes: Figure plots estimated monthly interest rates for 30-year fixed-rate refinance loans above and below the conforming loan limit (CLL) on the left axis against the Federal Funds Rate on the right axis obtained from FRED. See notes to Figure 2.

Appendix Figure 2. Refinance Volume Excluding Loans Near CLL

Panel I. Number of Originations



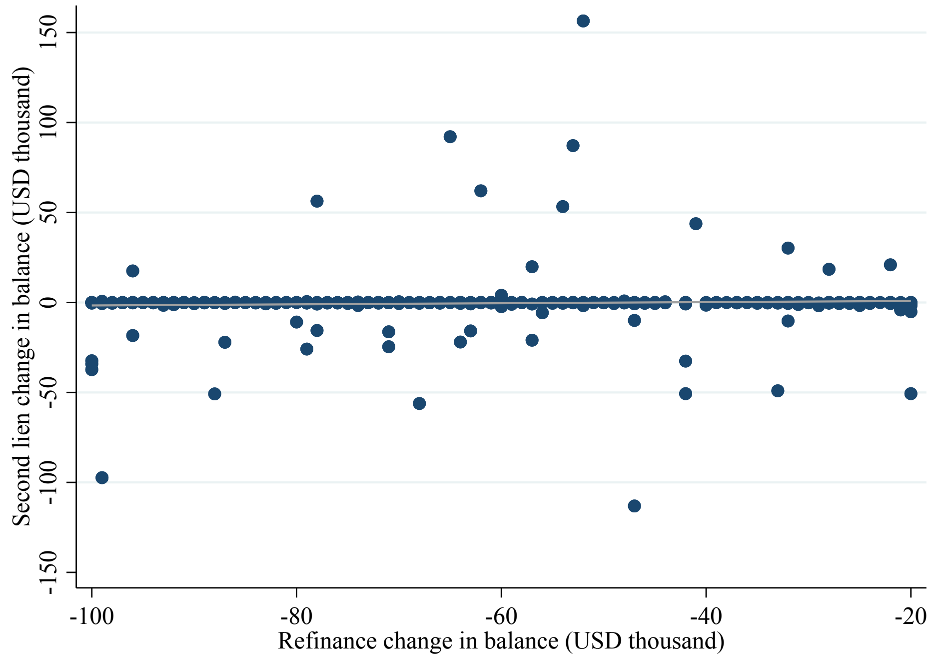
Panel II. Origination Volume



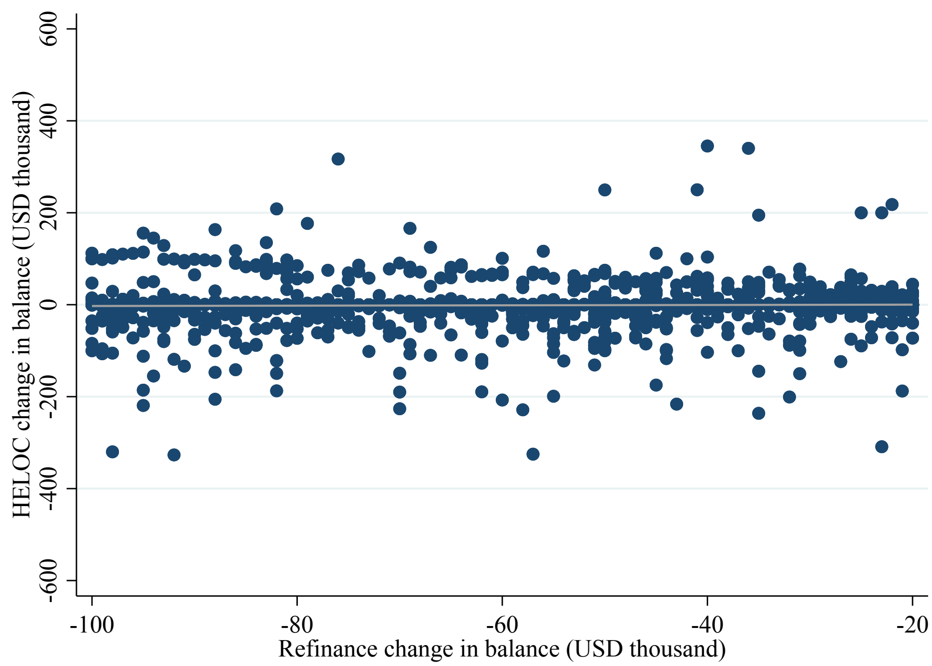
Notes: Figure plots the number of originations (top panel) and the origination volume (bottom panel) of refinance mortgages below the conforming loan limit (CLL) and above the CLL as recorded by LPS after dropping all loans within [90%, 140%] of the CLL. See notes to Figure 3.

Appendix Figure 3. Changes in Second- and First-lien Balances

Panel I. Closed-end Second Mortgages



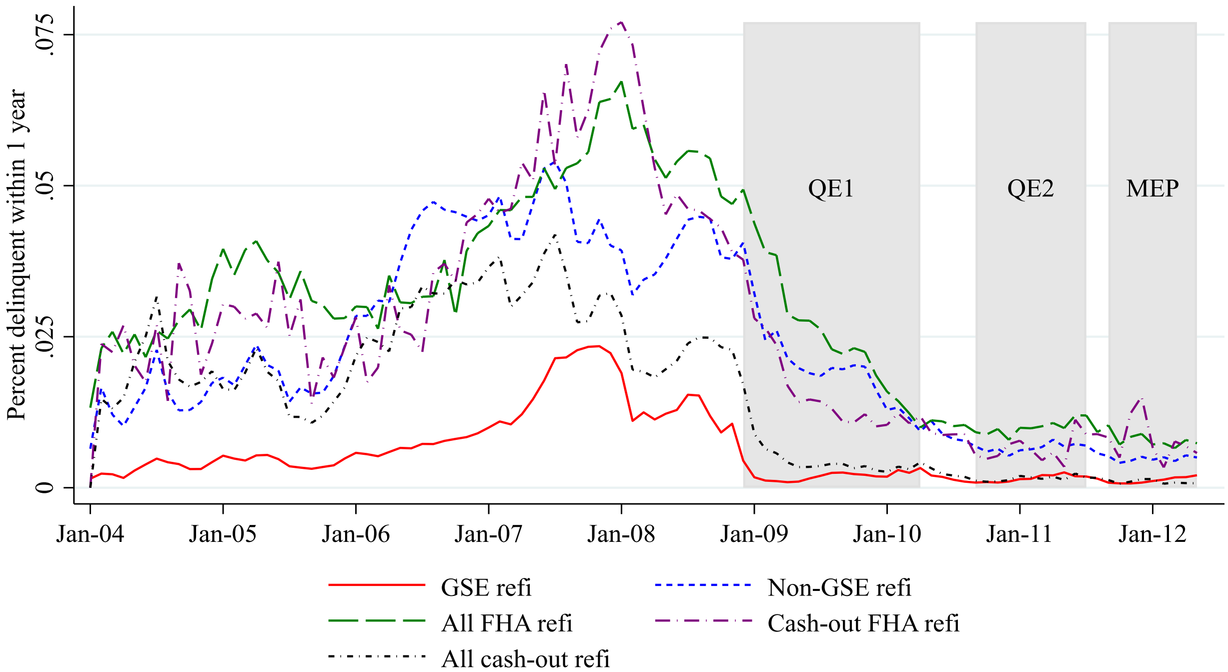
Panel II. Home Equity Lines of Credit



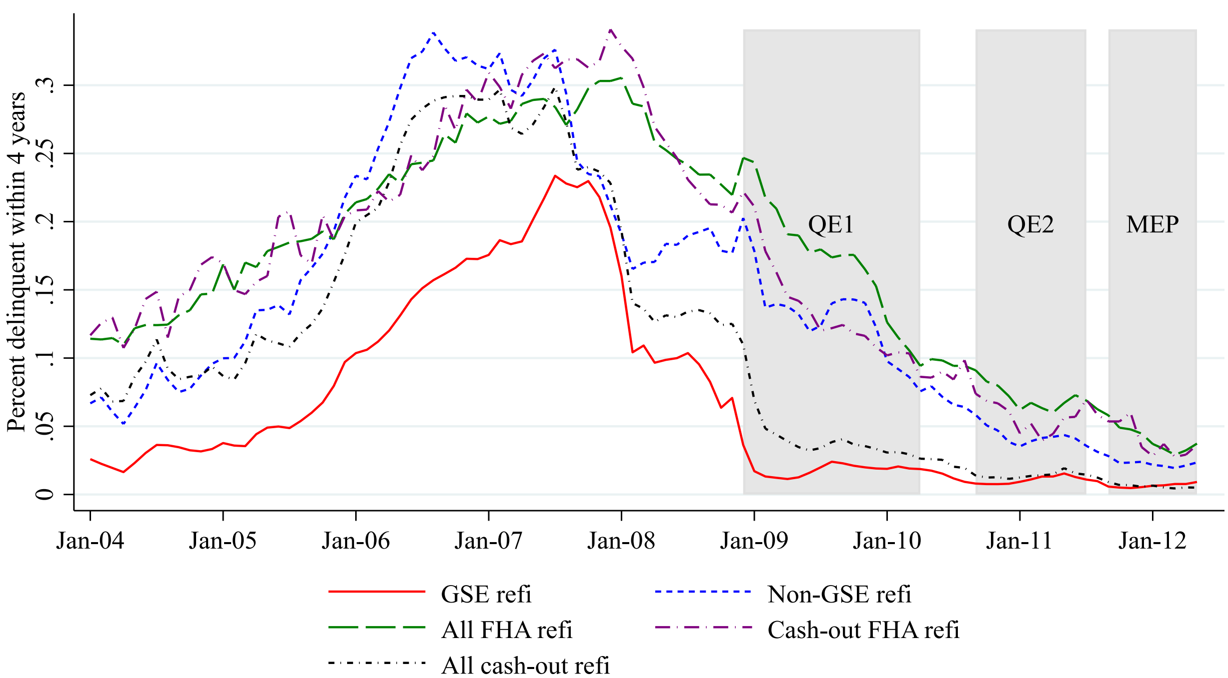
Notes: Figure plots the change in second-lien balances at refinancing as a function of change in first-lien balances with closed-end second mortgages (top panel) and home-equity lines of credit (bottom panel) for refinance mortgages that cashed in between \$20,000 and \$100,000 during QE1 along with bivariate regression lines. Debt relabeling or mortgage splitting would appear as an increase in second-lien balance to finance lowering first-lien balance.

Appendix Figure 4. Default Rates by Origination Date and Mortgage Segment

Panel I. Delinquent within 1 year



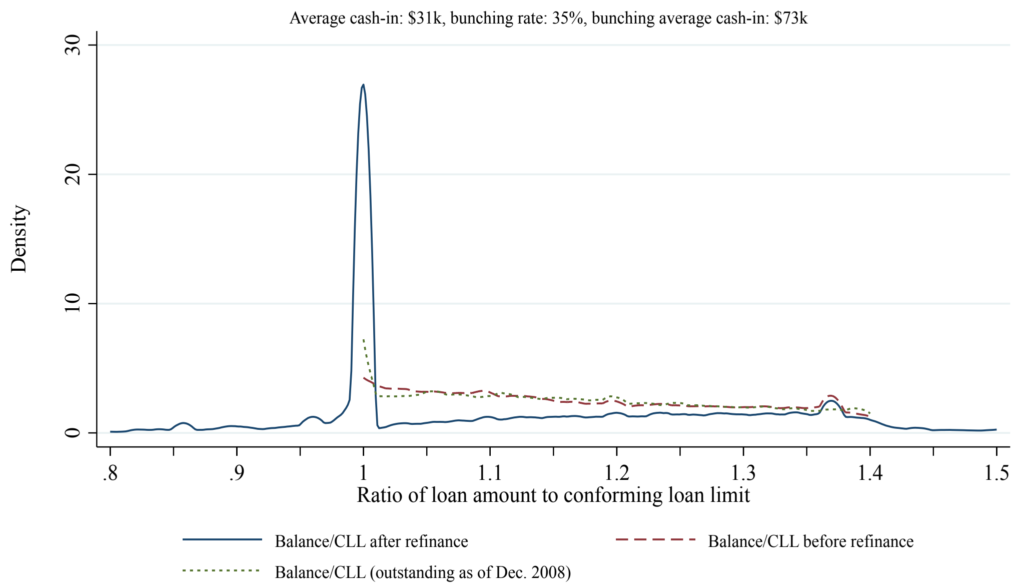
Panel II. Delinquent within 4 years



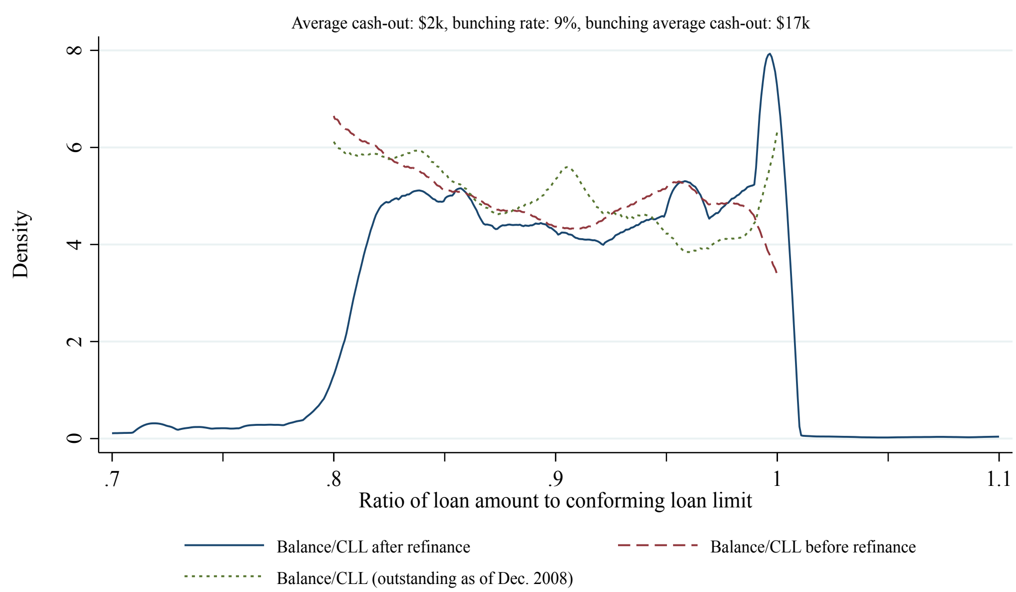
Notes: Figure plots the percent of loans delinquent within 1 year (top panel) and within four years (bottom panel) from refinancing for different types of refinances: GSE, FHA, cash-out and non-GSE as recorded by LPS.

Appendix Figure 5. Conforming Loan Limit Bunching

Panel I. Distribution of Loan Size/CLL for Original Balances 100-140% of CLL



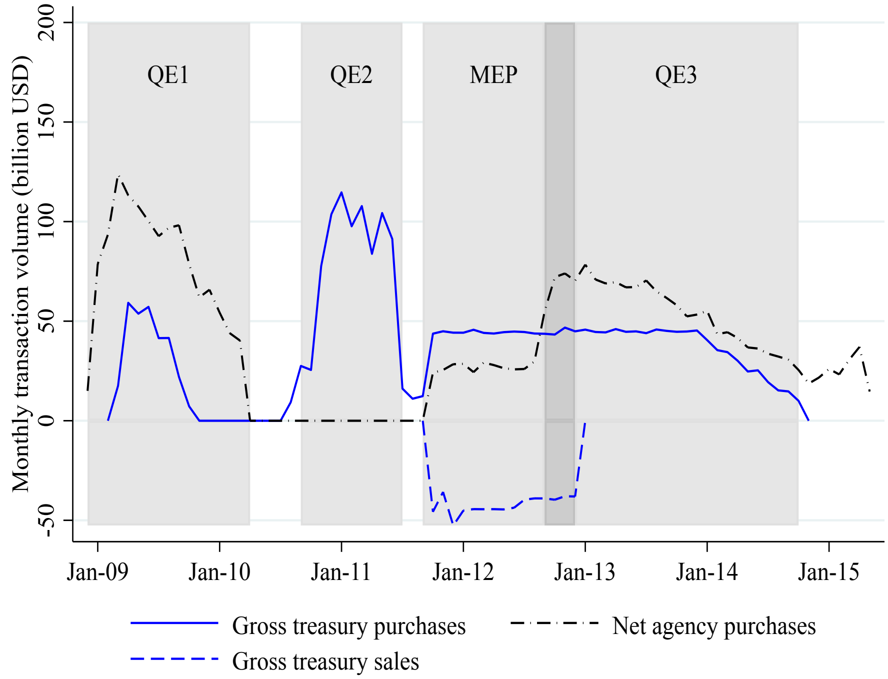
Panel II. Distribution of Loan Size/CLL for Original Balances 80-100% of CLL



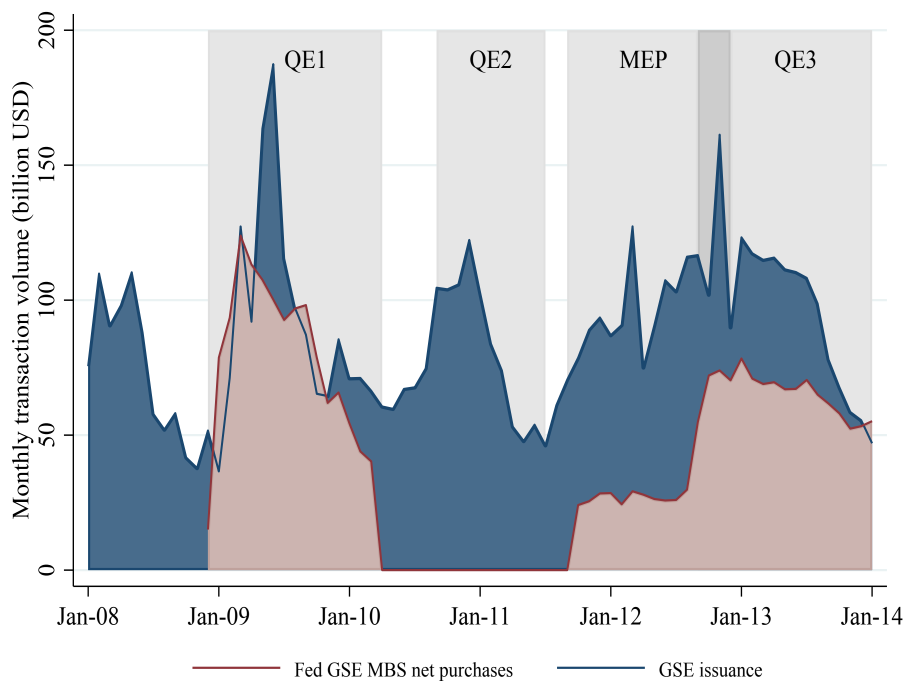
Notes: Figures plot distribution of loan sizes relative to the local conforming loan limit (CLL). Dotted lines plot the LTV distribution of all outstanding mortgages in the given LTV range. Dashed lines plot the distribution of predecessor normalized loan sizes (measured three months before refinancing) for refinancing borrowers. Solid lines shows the distribution of normalized loan sizes for that group's new refinance mortgages. Panel I includes loans for which we observe the predecessor loan with outstanding principal between 100 and 140% of the local CLL and whose origination balance (adjusted for expected refinancing costs) is between 80 and 150% of the CLL. Panel II includes loans for which we observe the predecessor loan with outstanding principal between 80 and 100% of the local CLL and whose outstanding balance is between 70 and 110% of the CLL. Bunching rate is share of new refinance loans in each sample that have are between 99.5% and 100.5% of the CLL at origination.

Appendix Figure 6. Federal Reserve Asset Purchases

Panel I. Federal Reserve Asset Purchases and Sales (Gross)

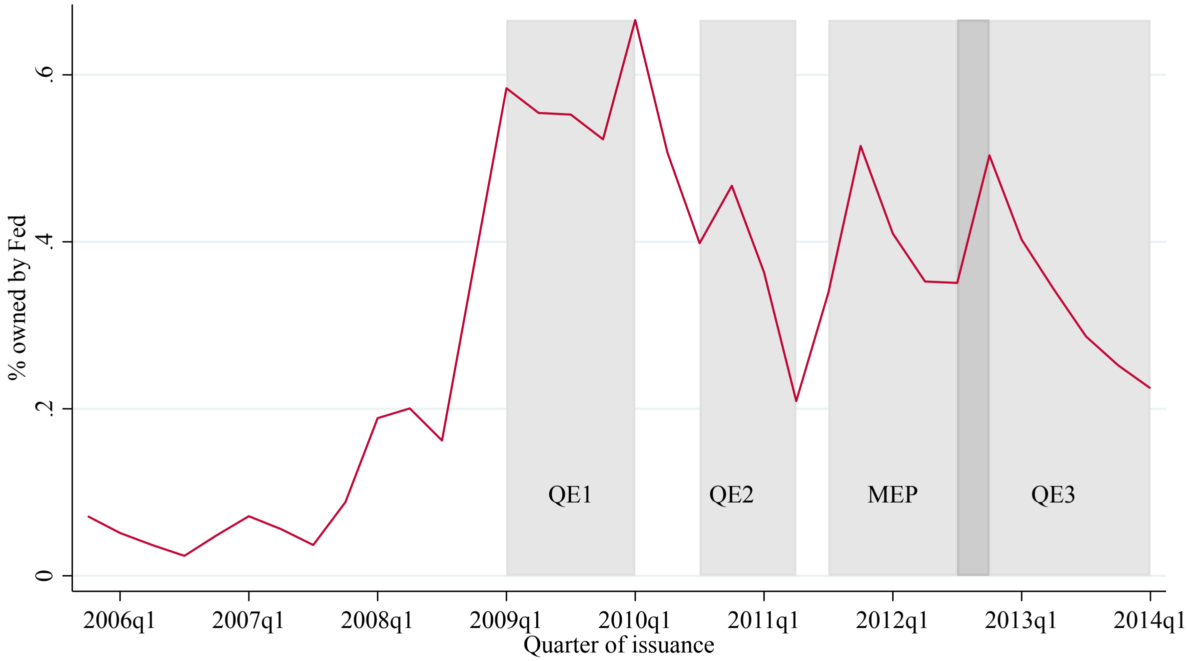


Panel II. Fed GSE MBS Net Purchases vs. Monthly GSE Issuance



Notes: Panel I plots monthly gross Fed purchase and sale amounts for mortgage-backed securities (in black) and Treasuries (in blue) during the each QE operation. MEP shading represents the period of the Matury Extension Program that involved the swapping of short- and long-term Treasuries. Panel II plots the transaction amounts for Fed purchases of mortgage-backed securities and the issuance of GSE securities during the three quantitative easing operations. Source: NY Fed Open Market Operations Data, Fannie Mae, and Freddie Mac.

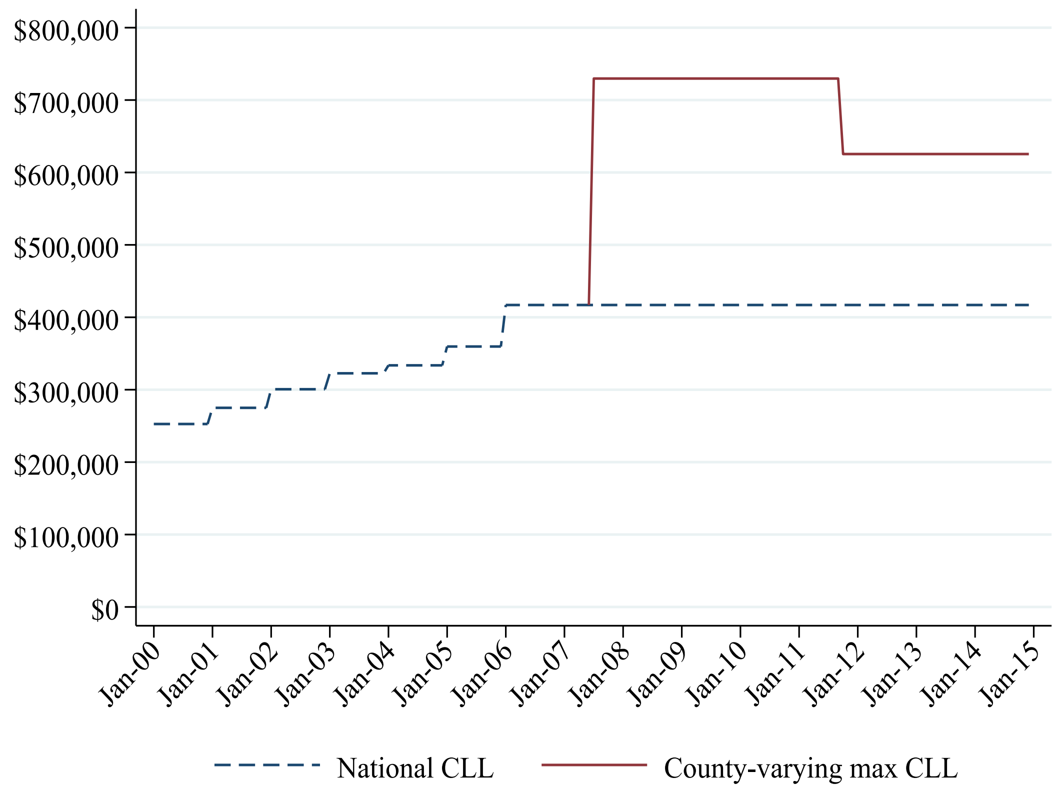
Appendix Figure 7. Share of GSE Origination Owned by Federal Reserve by Issuance Quarter



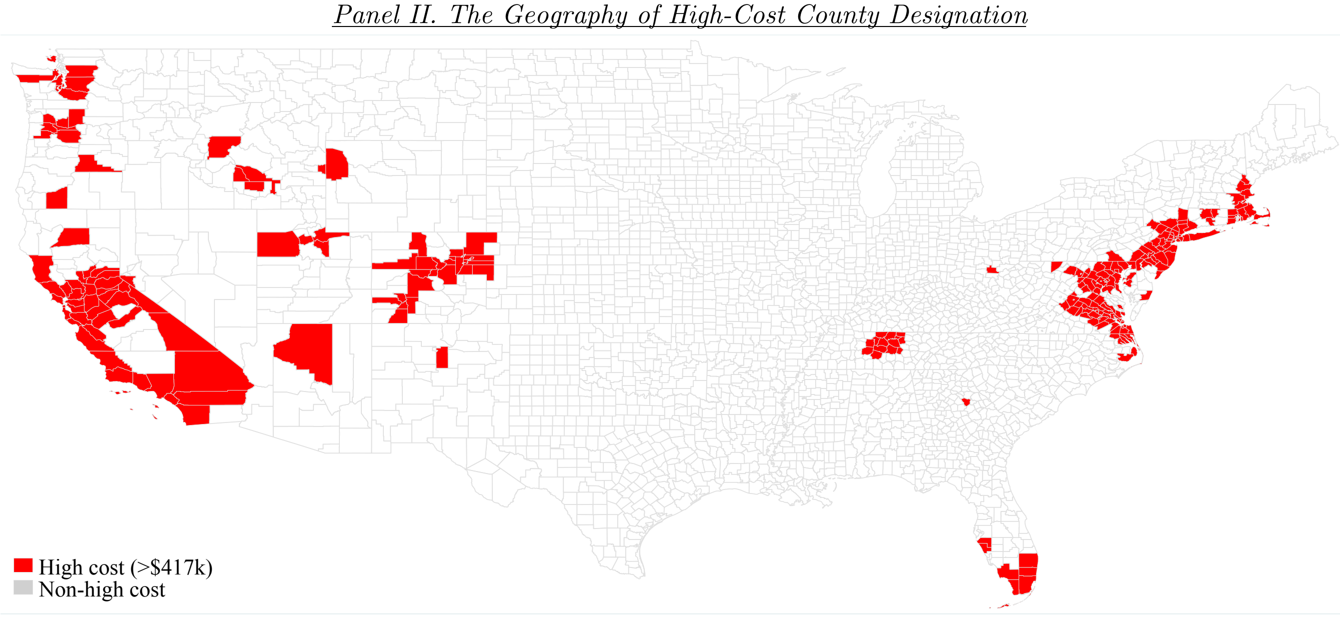
Notes: Figure plots the percentage of GSE MBS volume issued in each quarter that was ultimately owned by the Federal Reserve. Shaded regions indicate QE programs. Source: Fannie Mae, Freddie Mac, and New York Federal Reserve Open Market Operations data.

Appendix Figure 8. Conforming Loan Limits

Panel I. National and Maximum High-Cost Area Conforming Loan Limits

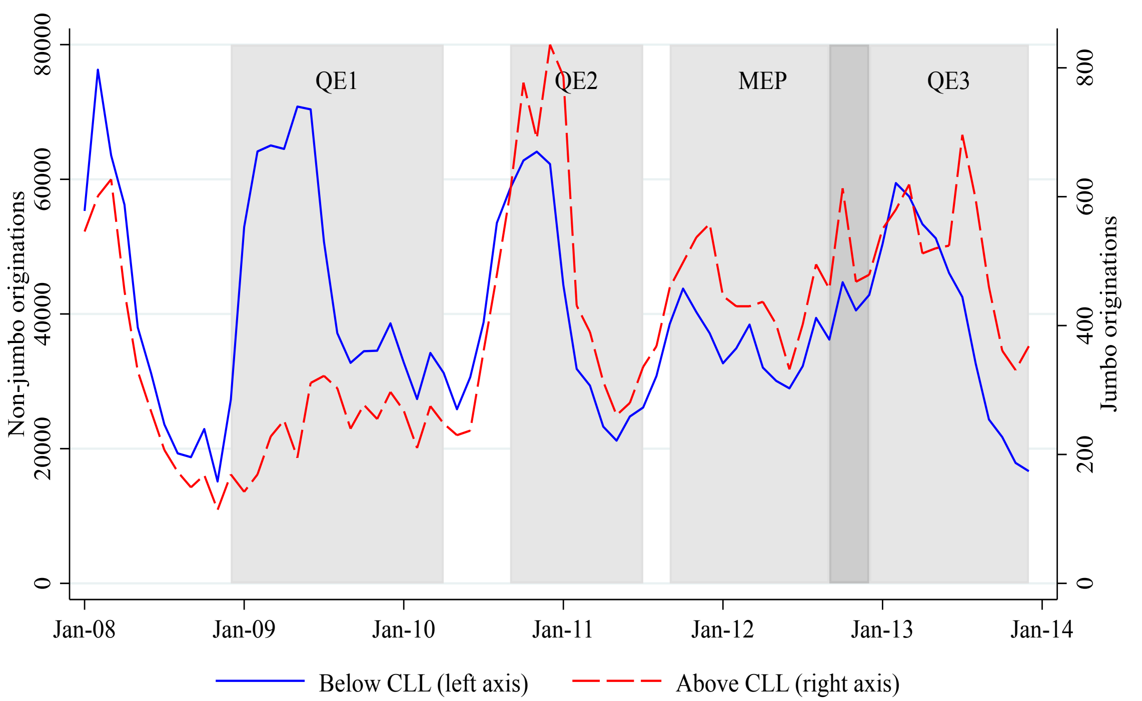


Panel II. The Geography of High-Cost County Designation



Notes: Panel I plots the national conforming loan limit over time and its maximal increase among certain high-cost counties in early 2008. Some of these temporary high-cost exemptions expired on October 1, 2011. Panel II plots all counties in the contiguous state. Darkly shaded areas indicate counties designated as high cost, defined as counties with conforming loan limits greater than $417,000.

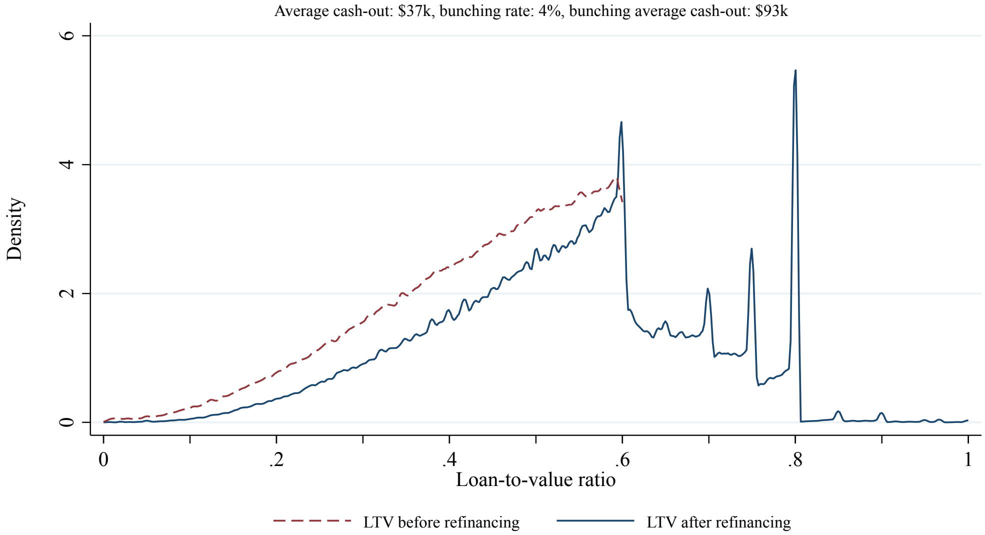
Appendix Figure 9. Refinance Origination Count in Low-Cost Areas



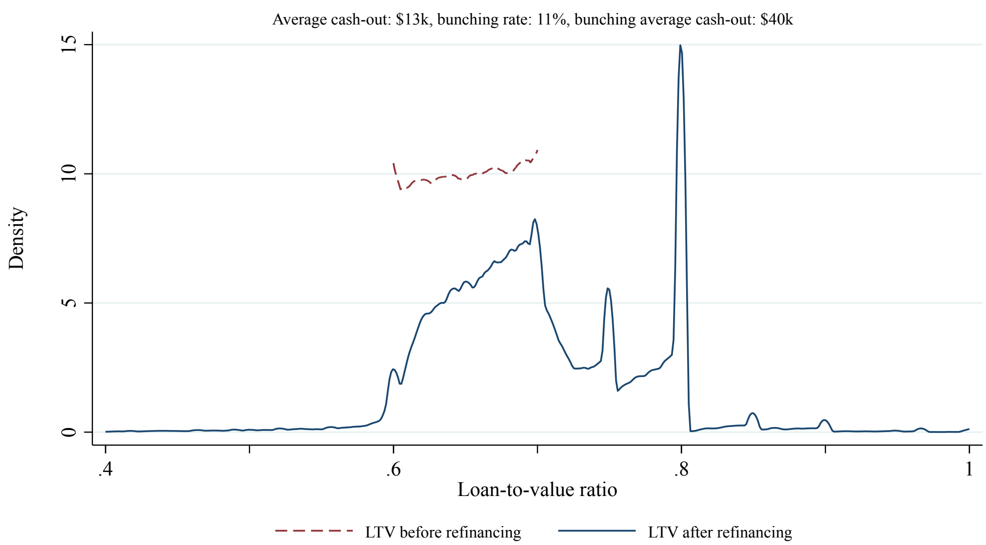
Notes: Figure plots the count of refinance mortgage originations in low-cost areas recorded by LPS for loans below and above the GSE conforming loan limit (CLL). See notes to Figure 3.

Appendix Figure 10. Loan-to-Value Ratio Bunching for Original Loans Below 70%

Panel I. Distribution of LTV for Original LTVs 0-60%



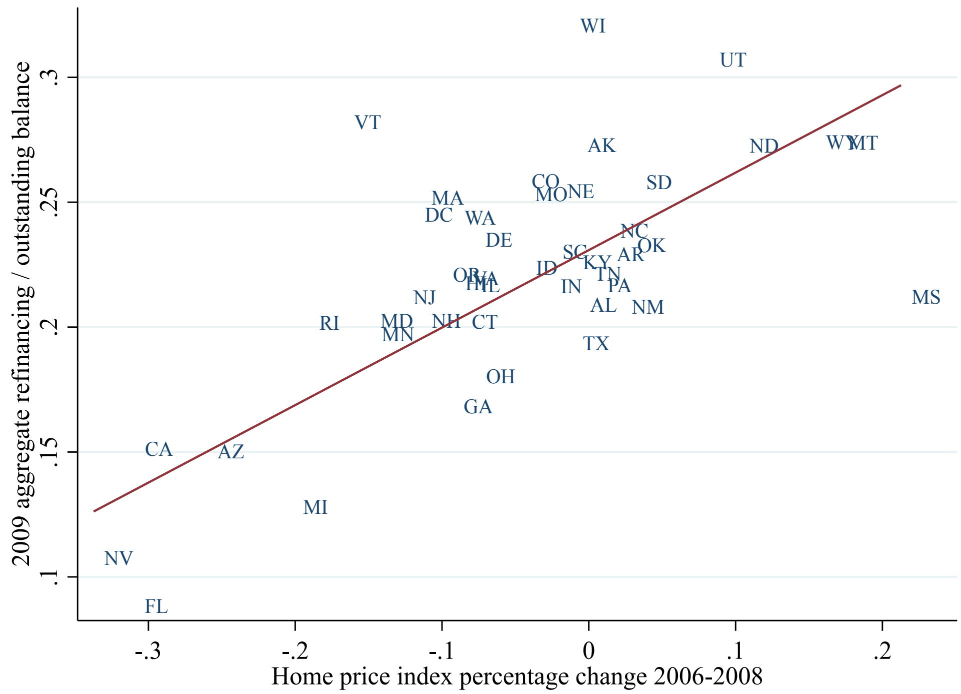
Panel II. Distribution of LTV for Original LTVs 60-70%



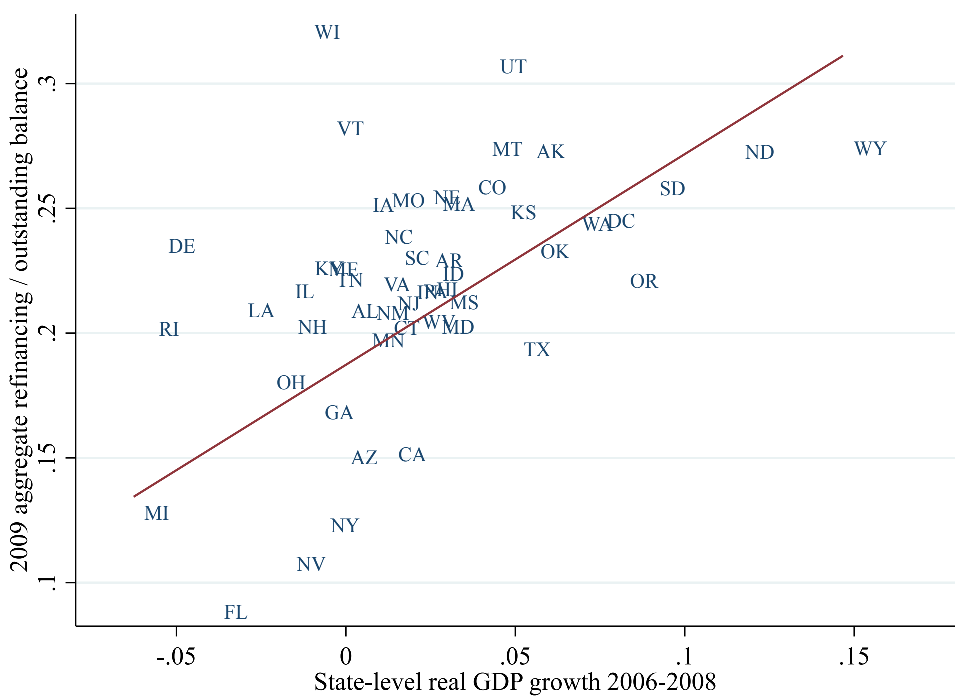
Notes: Figures report the distribution of borrower LTV ratios during QE1 but before the start of the Home Affordable Refinance Program (HARP) (Dec. 2008 to May 2009). Panel I includes loans for which we observe the predecessor loan with imputed LTV 0-60%. Panel II includes loans for which we observe the predecessor loan with imputed LTV below 60-70%. Dashed lines represent the imputed LTV distribution for mortgages that will be refinanced during the time period. To account for rolling closing costs into the balance of the new loan, we add average refinancing costs ($3,000) to the loan balance before the refinance. The solid blue lines report the distribution of actual LTV ratios for originated refinance mortgages. The bunching rate is the number of refinance mortgages with an LTV ratio between 79.5% and 80.5% at origination divided by the total number of loans in the given original LTV range that refinance. Bunching average cash-out is the average amount borrowers refinancing provide at the closing of their new refinance mortgage.

Appendix Figure 11. State-level Refinancing Activity and Economic Conditions

Panel I. Refinancing Activity and House-Price Growth



Panel II. Refinancing Activity and Real GDP Growth



Notes: Figures plot the state-level percentage of 2009 outstanding mortgage balances that were refinanced in 2009 against state-level 2006-2008 Zillow Home Price Index percentage changes (top panel) and 2006-2008 state-level real GDP growth (bottom panel) from the BEA, along with the corresponding bivariate regression line. The robust t-stats are 4.7 for panel I and 4.2 for panel II.

Appendix Table 1. Coefficients on Time-Series Controls

	(1) Interest Rates	(2) Log(Refinance Origination Volume)
G-Fee × Jumbo	-1.523***	2.678***
	(0.117)	(0.286)
FICO Spread × Jumbo	-0.264	0.006
	(0.503)	(0.011)
Bank CDS × Jumbo	0.070***	-27.526***
	(0.019)	(5.136)
Controls	Yes	Yes
County-Month FEs	Yes	Yes
County-Segment FEs	No	Yes
Observations	6,740,267	5,904
R-squared	0.816	0.963

Notes: Table estimates the relationship between interest rates (column 1) and origination volumes (column 2) to guarantee fees, mortgage credit spreads, and bank credit default swap spreads between 2008-2013 (see Section 3 for details). The sample for column 1 includes loans with nonmissing LTVs, controlling for 5-point LTV bins, 20-point FICO bins, a categorical interaction of interest rate type, interest-only indicator, and original term, an indicator for missing FICO, and county by month fixed effects. The sample for column 2 has two observations for each county-month: log of total refinance origination below the conforming loan limit and above the conforming loan limit for counties that had non-zero refinancing activity in both the jumbo and non-jumbo segments throughout the sample period. Column 2 controls include mean FICO, mean LTV, share of loans not missing FICO, and county by month fixed effects. Standard errors clustered by month-segment are reported in parentheses. Asterisks denote significance levels (***=1%, **=5%, *=10%).

Appendix Table 2. OLS Estimation of Treasury Rates and Predicted Mortgage Rates

	(1)	(2)	(3)	(4)	(5)	(6)
	Predicted Jumbo Rate	Predicted Conforming Rate	Predicted Jumbo Rate	Predicted Conforming Rate	Predicted Jumbo Rate	Predicted Conforming Rate
5-year Treasury Yield	0.643***	0.635***			0.113	0.199***
	(0.023)	(0.018)			(0.085)	(0.070)
10-year Treasury Yield			0.854***	0.836***	0.711***	0.585***
			(0.028)	(0.019)	(0.117)	(0.093)
Constant	0.038***	0.037***	0.025***	0.024***	0.027***	0.028***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Observations	156	156	156	156	156	156
R-squared	0.790	0.862	0.823	0.883	0.824	0.888

Notes: Table estimates the relationship between interest rates to constant maturity treasury yields. The odd columns consider the jumbo rates, while the even columns analyze the conforming rates. Columns 1 and 2 consider the relation between mortgage rates and the treasury rate with 5 year maturity, while Columns 3 and 4 investigate the relation to the 10 year maturity. Columns 5 and 6 include both treasury rates in the specification. Robust standard errors are reported in parentheses. Asterisks denote significance levels (***=1%, **=5%, *=10%).

Appendix Table 3. Higher LTV Cap Simulation during QE1 (Dec. 2008—May 2009)

		Without LTV Change		Counterfactual Higher LTV Cap		Counterfactual Increase	
	Number of Mortgages in Bin	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
Current LTV Bin	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LTV ≤ 60%	10,058,221	7.8%	$39,176	7.8%	$40,371	0	$937,367,289
60% < LTV ≤ 70%	4,319,690	7.6%	$17,752	7.5%	$32,076	(4,320)	$4,564,050,321
70% < LTV ≤ 80%	8,155,314	7.1%	$9,316	7.6%	$14,580	40,777	$3,642,277,178
80% < LTV ≤ 90%	3,577,874	5.6%	$2,700	7.5%	$7,982	67,980	$1,600,836,844
90% < LTV ≤ 100%	3,523,964	3.5%	$2,170	5.7%	$501	77,527	($167,051,775)
100% < LTV ≤ 110%	152,520	2.0%	($3,796)	3.5%	$2,391	2,288	$24,342,056
110% < LTV ≤ 120%	11,842	1.0%	($89,126)	2.0%	($12,855)	118	$7,509,850
120% < LTV	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

Note: Baseline percent of loans prepaying over Dec. 2008—May 2009 are predicted values from column 2 of Appendix Table 4. The number of mortgages includes all single family, first-lien mortgage as of December 2008 in LPS. Counterfactual Predicted Prepaid percent also uses column 2 of Appendix Table 4 along with modified LTV bins as described in Appendix C. Actual average cash-out and predicted average cash-out are from Columns 1

Appendix Table 4. Prepayment Probability during QE1 using Refinance Hazard Model Results

	(1)	(2)
Ln(Original Loan Amount)	-0.168***	-0.178***
	(0.005)	(0.005)
Current Balance > CLL + 60,000	-0.458***	-0.545***
	(0.023)	(0.023)
60%< LTV <=70%	-0.004	0.047**
	(0.022)	(0.023)
70%< LTV <=80%	-0.084***	-0.018
	(0.021)	(0.021)
80%< LTV <=90%	-0.386***	-0.304***
	(0.022)	(0.022)
90%< LTV <=100%	-0.942***	-0.800***
	(0.031)	(0.031)
100%< LTV <=110%	-1.570***	-1.377***
	(0.048)	(0.048)
110%< LTV <=120%	-2.213***	-2.012***
	(0.094)	(0.094)
120%< LTV	-2.943***	-2.693***
	(0.159)	(0.159)
Loan Controls	Yes	Yes
Borrower Controls		Yes
Observations	2,035,027	2,035,027

Notes: Table reports the results of a hazard model estimating the propensity to refinance. All specifications include a cubic function of loan age as a non-parametric baseline hazard. Loan-level controls include current LTV bin, loan size at origination, and current balance over the conforming loan limit. Borrower controls include DTI, a missing DTI indicator, and FICO bins. Jumbo is an indicator for loan amount at least $60,000 above the CLL to account for cash-in refinancing. Robust standard errors in parentheses. Asterisks denote significance levels (***=1%, **=5%, *=10%).

Appendix Table 5. Cash-Out Estimate during QE1 (Dec. 2008—May 2009)

	(1)	(2)	(3)
Current LTV Bin	Actual Average Cash-Out	Cash-Out Model (Loan & Equity Controls)	Prediction for LTV Increase & Equity Decrease (Col. 3)
[0%, 60%]	$39,176	$39,176	$40,371
(60%, 70%]	$17,752	$17,752	$32,076
(70%, 80%]	$9,316	$9,316	$14,580
(80%, 90%]	$2,700	$2,700	$7,982
(90%, 100%]	$2,170	$2,170	$501
(100%, 110%]	($3,796)	($3,796)	$2,391
(110%, 120%]	($89,126)	($89,126)	($12,855)
Above 120%	($144,764)	($144,764)	($144,184)

Note: Table reports the actual cash-out amounts over Dec. 2008—May 2009 in column 1, and the predicted cash-out amounts using an OLS model with loan and equity characteristic controls in column 2. Column 3 predicts cash-out amounts by shifting the LTV bins down by one bin for loans with current LTV between 60% and 120%, and changing the equity calculation from 20% to 10%. Equity calculated as property value minus unpaid balance on original loan minus 20% of property value.

Appendix Table 6. Cash-Out Regression Estimates during QE1

	(1)	(2)	(3)
Equity Available (20%)		0.025***	0.023***
		(0.006)	(0.006)
Unpaid Balance > 80% LTV X Equity Available (20%)			0.451***
			(0.098)
Log Unpaid Balance	-5,942.455***	-7,736.501***	-5,584.112***
	(293.676)	(526.326)	(699.385)
Unpaid Balance > CLL+$60,000	-89,972.064***	-94,673.259***	-89,991.239***
	(2,765.606)	(2,889.990)	(2,808.333)
60%<LTV<=70%	-17,270.706***	-13,462.585***	-14,157.241***
	(404.527)	(1,017.086)	(968.142)
70%<LTV<=80%	-22,716.783***	-17,938.175***	-18,871.462***
	(412.408)	(1,246.156)	(1,186.598)
80%<LTV<=90%	-27,876.773***	-22,551.291***	-19,801.435***
	(353.535)	(1,361.538)	(1,341.236)
90%<LTV<=100%	-26,181.303***	-20,318.167***	-6,619.607**
	(328.689)	(1,487.384)	(3,150.314)
100%<LTV<=110%	-31,690.277***	-26,046.732***	-10,656.271***
	(353.255)	(1,439.077)	(3,467.823)
110%<LTV<=120%	-110,364.624***	-101,578.779***	-60,053.387***
	(3,989.665)	(4,443.665)	(9,589.823)
120%<LTV	-166,534.843***	-156,179.071***	-86,735.836***
	(5,896.883)	(6,131.483)	(12,833.365)
R-squared	0.035	0.038	0.040
Observations	820,653	820,653	820,653

Notes: Table reports regression estimates of cash-out refinances. Left-hand side variable is cash-out amount. To account for rolling closing costs into the balance of the new loan, we add average refinancing costs ($3,000) to the loan balance before the refinance. All specifications include a cubic function of loan age as a non-parametric baseline hazard. Equity Available is calculated as property value minus unpaid balance on the borrower's previous mortgage, minus a 20% down payment (calculated as 20% of the original loan amount). Loan-level controls include current LTV bin, and loan size at origination. Jumbo is an indicator for loan amount at least $60,000 above the CLL to account for cash-in refinancing. Robust standard errors in parentheses. Asterisks denote significance levels (***=1%, **=5%, *=10%).