Supplemental Appendix:

Borrowing and Spending in the Money: Debt Substitution and the Cash-out Refinance Channel of Monetary Policy

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A Appendix

A.1 Data Construction

A.1.1 Defining Prepayment Types

In McDash, we observe when a loan prepays but not the reason for the loan's prepayment; we cannot distinguish between a rate-term refinance, a cash-out refinance, or a move. We use the credit report data from CRISM, which reports when and where a borrower opens a new mortgage and the new mortgage size, to differentiate between different types of prepayment.

- First, we classify a prepaying mortgage as a move, if within 12 months of the mortgage pay off date the borrower's zipcode changes.
- Second, we classify a prepaying mortgage as a rate-term refinance if:

1. The prepaying mortgage is not a move.
2. The borrower opened a new mortgage in either the previous month, the current month, or the following month.
3. The new mortgage has an opening balance such that 0.98 of the new balance is less than the paid off amount plus $5,000, to account for closing costs.
   (a) Following Berger et al. (2021), we treat a refinance where equity is extracted to pay down other housing debt as a rate-term refinance. If condition (3) does not hold BUT total housing debt (first mortgage plus HELOC balance plus CES balance) after the refinance is less than $5,000 plus total housing debt before the refinance plus closing costs, then the borrowing event is coded as a rate-term refinance.
4. The LTV of the new mortgage is less than 1.2. We calculate the home value in the LTV using the mark to market LTV of the prepaying mortgage.

- Third, we classify a prepaying mortgage as a cash-out refinance if:
  1. The prepaying mortgage is not a move.
  2. The prepaying mortgage is not a rate-term refinance.
  3. The borrower opened a new mortgage in either the previous month, the current month, or the next month.
  4. The new mortgage has an opening balance such that 0.98 of the new balance is greater than or equal to the paid off amount plus $5,000, to account for closing costs. A refinance where equity is extracted to pay down other housing debt will satisfy condition (4) but not condition (2) and so will not be classified as a cash-out refinance.
  5. The LTV of the new mortgage is less than 1.2. We calculate the home value in the LTV using the mark to market LTV of the prepaying mortgage.
- We apply these same rules to define rate-term refinances and cash-out refinances for second mortgages.
- Finally, we define a loan as a pay off if the mortgage prepays but is not a move, a rate-term refinance, or a cash-out refinance.

A.1.2 Defining Borrowing Events

We construct five different borrowing events in CRISM.

- Cash-out refinance: We measure the amount borrowed through a cash-out refinance using the method described in Section A.1.1.
- Credit card: We measure credit card balance as the sum of the total balance of all retail accounts and all bank accounts.
- Personal loan: We measure personal loan balance as the sum of balances for other accounts and balances for all consumer finance accounts.
- HELOC/CES: HELOC and CES balances are reported directly in CRISM.

Identifying borrowing events:

- Credit card
  - We define a credit card borrowing event as occurring at time t if in time t, the credit card balance increases by at least \$5,000, the balances in the subsequent 3 months are at least \$5,000 greater than the balance at time $t-1$, and if the balance at time t is greater by at least \$5,000 than the balances in the preceding three months. We also require that the change in balance at time t be less than \$100,000.
  - To eliminate borrowing events where borrowing has been gradually ramping up over time, we set credit card borrowing events to 0 in which the 1-month change in the credit card balance in each of the preceding three months is greater than \$5,000 and less than \$100,000.
- Personal loan
  - We define a personal loan borrowing event as occurring at time t if in time t, other balance increases by at least \$5,000, the balances in the subsequent 3 months are at least \$5,000 greater than the balance at time $t-1$, and if the balance at time t was greater by at least \$5,000 than the balances in the preceding three months. We also require that the balance at time $t-1$ and at time t be less than \$1,000,000.

- To eliminate borrowing events where borrowing has been gradually ramping up over time, we set personal loan borrowing events to 0 in which the 1-month change in the personal loan balance in each of the preceding three months is greater than \$5,000.

- HELOCs
  - We define a HELOC borrowing event as occurring at origination and also following origination, to account for the fact that borrowers can make draws on a previously-opened HELOC.
  - For newly opened HELOCs, we define the borrowing amount as the maximum observed borrowing amount over the five months following the HELOC origination.
  - We also require the maximum HELOC balance observed since the new HELOC borrowing event be at least \$5,000.
  - We are careful to not treat refinances of HELOCs as borrowing events. If the origination date of the HELOC changes and the maximum balance observed after the new origination is less than \$5,000 greater than the balance observed 3 quarters before the new origination, then we do not consider that new origination to be an extraction event.
  - We define a HELOC draw (following origination) as occurring when the HELOC balance increases by at least \$5,000, the balance increase is less than \$1,000,000, the HELOC has been open already for at least 7 months, the HELOC is less than 30 years old, and the balances in the subsequent 3 months are at least \$5,000 greater than the balance at time $t-1$.
  - To eliminate borrowing events where borrowing has been gradually ramping up over time, we set HELOC borrowing events to 0 for existing HELOCs (older than 7 months and younger than 30 years), in which the 1-month change in the HELOC balance in each of the preceding three months is greater than \$5,000 and less than \$1,000,000.

- CES
  - We define the borrowing amount for a CES event as the maximum observed borrowing amount over the five months following the CES origination.

– We require that the CES balance at origination be at least $5,000.

– We are careful to not treat refinances of CES as borrowing events. We define CES borrowing events where the difference between the current CES balance and the three-month lagged CES balance is less than $5,000 to be a refinance.

– For a CES origination that occurs in the three months following a rate-term refinance, we set the date of the CES origination as the date of the rate-term refinance.

– Finally, we do not define CES originations that coincide with a move or a payoff as borrowing events.

A.1.3 Sample Filters

We apply several filters to the data. First, we drop mortgages linked to borrowers with multiple first liens, because we cannot assign a unique refinance incentive to the household. For similar reasons, we also drop loans financing non-owner occupied properties, because the credit report does not allow us to distinguish mortgage originations (such as HELOCs, CES, or refinances) on the property in the CRISM universe from originations on another property owned by the borrower. We also restrict to fixed-rate mortgages, as in Berger et al. (2021), because the dependence of the refinancing decision on the borrower's outstanding mortgage rate is likely to be strongest for fixed-rate mortgages. In Appendix Figure A.2, we show that our results are little changed when we add adjustable-rate mortgages, which constitute about 10% of outstanding mortgages in 2013. After applying these filters, we have a monthly panel of loans in 2013 corresponding to approximately 35 million loan-month observations.

We outline our data filters below in more detail:

- We drop mortgages for borrowers who have more than one mortgage.
- We drop households with multiple liens but also allow for the possibility that single liens will overlap slightly when refinancing. We first drop loans which ever have more than three loans outstanding at once because we cannot attribute three simultaneous loans outstanding to refinancing. We next drop loans which have at least six observations with more than two loans outstanding at once.

- A household can also have multiple liens where not all of the liens appear in McDash. We also drop loans which have at least six observations in which the difference between the McDash mortgage balance and the credit report mortgage balance is greater than $20,000, suggesting the borrower has another mortgage which does not appear in the servicing data.

- We also drop mortgages for non-owner-occupied properties.

- We consider a property owner-occupied if the borrower's zipcode matches the property zipcode. We drop loans which never have an observation of owner-occupancy and which have more than six observations in which the borrower zipcode does not match the property zipcode.

- Equifax produces a Match Confidence Score ranging from 0 to 0.9 to track the match quality between the mortgage servicing records and the credit bureau data. We require that mortgages in our sample have a confidence score of at least 0.8, capturing approximately 90% of mortgages.

- For a mortgage associated with multiple borrowers, we keep only the consumer classified by Equifax as the primary borrower.

A.2 Simulations of Model of Household Borrowing and Substitution

This section reports simulation results of the simple model of household borrowing and substitution presented in the main text. To see how $\partial p^{cash}/\partial r^m$ varies with a borrower's rate gap, Figure A.1 (a) plots results from a calibration of equation 6. We set $F = 0, r^a = 10, r^O = 6, l = 0.1, \sigma = 2, \lambda = 0.1$. We plot p^{cash} for a range of rate gap, which corresponds to a range of r^m because r^0 is fixed in the calibration. The probability of borrowing through the alternative borrowing product (not shown) is simply the mirror image of Figure A.1 (a). The simulation does a good job of matching the data, as shown in Figure 1. For high, positive levels of rate gap, p^{cash} is large and fairly flat. For these borrowers, cash-out refinancing brings substantial relative interest savings on both the liquidity need and the existing mortgage. Only a large value of ϵ would cause such a borrower to choose the alternative borrowing product. As rate gap decreases, the interest rate savings associated with a cash-out refinance decrease, more households are on the margin of choosing the alternative borrowing product, and the slope steepens. Eventually the slope flattens out again when rate gap is sufficiently negative. In this region, the alternative borrowing product dominates for almost all borrowers because the interest penalty on the existing mortgage from doing a cash-out refinance is so large. For low r^0, the alternative borrowing product dominates cash-out refinancing for most borrowers even though $r^m < r^a$.

To simulate the intensive margin, we parameterize the liquidity as $l \sim lognormal(\mu_l, \sigma_l)$. We simulate how $E[l|v^{cash} > v^{alt}]$ changes in response to a change in mortgage rates for different levels of the refinance incentive. We calibrate $\mu_l = -2.3$ and $\sigma_l = 0.9$ so that the mean and variance of the distribution of l as a share of the outstanding mortgage principal balance is consistent with the corresponding distribution in our data. For the other parameters, we set $F = 0, r^a = 10, r^O = 6, \sigma_l = 1.2$. We chose these parameters to produce a simulation that looks close to our intensive margin empirical results that we present below. We consider an 80 basis point increase in the mortgage rate, consistent with the size of the mortgage rate increase we use in our empirical work. Figure A.1 (b) shows the percent change in $E[l|v^{cash} > v^{alt}]$ after the increase in the mortgage rate for different levels of the refinance incentive, $r^0 - r^m$, where r^m is the mortgage rate measured prior to the 80 basis point increase.

A.3 Hurdle Model for Aggregate Borrowing Elasticity

To estimate the total elasticity of borrowing to a change in mortgage rates, we need to combine the estimates in sections IV.B and IV.C. An appealing approach may be to combine the two dimensions by using the dollar volume as the dependent variable. However, modeling the dollar volume as the dependent variable does not allow for the decision to borrow and the decision of how much to borrow to respond differently to covariates. This is especially problematic in our setting because the intensive and extensive margins of cash-out refinancing have different responses to rate gap.

To get around this concern, we instead estimate an elasticity of the total amount borrowed to mortgage rates using a two-tiered or "hurdle" model following Bhutta and Keys (2016) (see also Wooldridge (2002)). This approach combines intensive and extensive margin results while allowing the explanatory variables to affect the intensive and extensive margins differently.

The first tier of the hurdle model models the probability of borrowing and the second tier models the amount borrowed conditional on a borrowing event occurring. The decisions of whether to borrow and how much to borrow, l, are separate.

Specifically, we define the two tiers:

1. $Pr(borrow_{i,t} = 1|x) = (x\gamma)$

2. $E[l_{i,t}|x, borrow_{i,t} = 1) = exp(x\beta + \frac{\sigma^2}{2})$

Where σ is the standard error from the intensive margin OLS regression.[1] We determine the covariates x in each model according to the intensive and extensive margin specifications described in Section IV. We can then write the expected value of borrowing at the mean of the covariates as:

$$(\boldsymbol{x}\hat{\gamma})exp(\boldsymbol{x}\hat{\beta} + \frac{\hat{\sigma}^2}{2}) \tag{10}$$

We calculate the total predicted amount borrowed pre- and post- Taper using Equation 10. We then calculate the percentage change in the total predicted amount borrowed pre- and post-Taper and scale this change by the size of the mortgage rate increase to produce an aggregate borrowing elasticity. Aggregate borrowing elasticities are reported in Figure 7; for a discussion, see Section IV.D.

A.4 Additional Empirical Results

A.4.1 Results Including Adjustable-Rate Mortgages

About 10% of outstanding mortgages in 2013 are ARMs in our sample. Figure A.2 shows the extensive margin results when we include all product types in the sample and do not restrict to fixed-rate mortgages. The results are very similar to Figure 4.

A.4.2 Comparison to Bhutta and Keys (2016)

Figure A.3 presents regression results from Equation 7 where the dependent variable is "any home equity extraction," equal to one if the borrower does a cash-out refinance, a HELOC extraction, or a CES extraction. This dependent variable corresponds to

[1] Consistent with our estimation of Equation 7, we estimate the first tier of the hurdle model using OLS instead of probit because OLS more easily handles the large number of fixed effects in our model.

Bhutta and Keys's (BK) dependent variable and allows us to compare our estimates with BK. The figure shows that home equity borrowing responds negatively to the rise in mortgage rates during the Taper Tantrum, but less so than cash-out refinancing. In addition, the any home equity borrowing response depends less on rate gap compared to the cash-out refinancing response. These patterns are consistent with borrowers substituting from cash-out refinances to other home equity borrowing products when mortgage rates rise, especially for borrowers who are pushed out of the money by the mortgage rate increase.

Averaging across rate gap bins, we estimate an elasticity of home equity borrowing to mortgage rates of 16. This is similar but a little smaller in absolute terms than BK's estimate of 28. The difference in our estimates could reflect different identification strategies. We use a monetary policy shock whereas BK exploit yearly variation in mortgage rates, controlling for observables that could affect both interest rates and equity extraction. In addition, our sample comes from the post GFC-period whereas BK's sample comes from the pre-GFC period. The mortgage market changed from pre- to post-crisis in a number of important ways which could influence the elasticity of borrowing to rates. For example, credit standards for cash-out refinancing tightened substantially following the crisis, borrowers may have become more debt averse post-crisis, and borrowers had less equity in their homes. Such changes may have reduced the sensitivity of borrowing to mortgage rates. For an analysis of how borrowing elasticities varies with equity levels, see Appendix Section A.4.5.

A.4.3 Evidence from QE1

The Taper Tantrum provides an increase in mortgage rates, resulting in a decrease in borrower refinance incentives. In this section, we consider a plausibly exogenous decrease in mortgage rates to test whether household borrowing and substitution responds asymmetrically to mortgage rate increases and decreases. This exercise also allows us to test the external validity of our Taper Tantrum results.

We exploit the decrease in mortgage rates in response to QE1. In late November of 2008, the Federal Reserve announced that it would start buying long-term securities to provide additional monetary accommodation during the financial crisis.[2] In response

[2] This event marks the start of the program whose potential unwinding sparked the Taper Tantrum in 2013. A number of papers have studied the mortgage borrowing response to the jump in rates from QE1 – see, for example, Beraja et al. (2019), Di Maggio, Kermani and Palmer (2020).

to this largely unanticipated announcement, Figure A.4 shows mortgage rates fell suddenly and significantly, declining about 100 basis points between late November 2008 and January 2009. As with the Taper Tantrum, QE1 allows us to compare household borrowing over a number of months with starkly different mortgage rate regimes, where the change in rate regimes is triggered by a monetary policy surprise.

QE1 is different from the Taper Tantrum, however, in that the Federal Reserve announced it in the middle of a financial crisis. In the months before and after the announcement of QE1, mortgage market and household borrowing conditions were changing rapidly, potentially affecting household borrowing, and differentially so across rate gap groups. For example, mortgage availability tightened considerably for borrowers with lower credit scores over this time period. Because these trends can potentially bias our results, we present the Taper Tantrum results as our preferred ones.

Figure A.5 shows the results from estimating equation 7 using a sample of fixed-rate mortgages between July 2008 and April 2009. Post is now a dummy for post-QE1, defined as December 2008 - April 2009. The blue line shows that cash-out refinance probability rises after QE1, and especially for borrowers with rate gaps that are pushed into the money by the decline in mortgage rates. Qualitatively, the response is very symmetric to the response shown in Figure 4 for the Taper Tantrum. The magnitude of the response is much larger during QE1. But the baseline probability of a cash-out refinance around QE1 was also much larger, possibly because a need for liquidity was relatively high during the financial crisis. Another possibility for the lower baseline probability during the Taper Tantrum is that rates increased after a long period of low rates, and so the more rate sensitive borrowers may have refinanced well before the Taper. Comparing the sizes of the responses to their respective baselines and accounting for the somewhat larger change in mortgage rates during QE1, the magnitudes of the cash-out elasticity are fairly similar across the two episodes.

The black line of Figure A.5 shows the results when $Y_{i,t}$ is a dummy for an "other borrowing event." Consistent with the results in Figure 4, the black line generally has the opposite pattern from the blue line, suggestive of substitution. After QE1, households are less likely to borrow through a non cash-out refinance product, and the magnitude of the decrease is comparable to the magnitude of the increase for cash-out refinance borrowing. In addition, the propensity for other borrowing declines the most for the rate gap borrowers whose propensity to cash-out refinance increases the most.

The red line shows the results when $Y_{i,t}$ is a dummy for any type of borrowing event. Overall, the decline in mortgage rates during QE1 has little effect of the probability of borrowing. The point estimates show some dependence of the effect on rate gap for borrowers with negative pre-QE rate gaps. The magnitude of this dependence is a little larger than the dependence we estimated in Figure 4 during the Taper Tantrum. But overall, the red line is much closer to zero and flatter with respect to the rate gap than the blue line, consistent with the results shown in Figure 4 for the Taper Tantrum.

Figure A.6 shows the intensive margin results. The results are very symmetric to those shown in Figure 5. Average borrowing amount among cash-out refinancers decreases after QE1, especially for borrowers with intermediate values of rate gap, consistent with a selection effect caused by substitution out of other borrowing products. Overall, the red line shows a small positive intensive margin response to the decrease in mortgage rates, and only a small dependence on rate gap.

A.4.4 The Effect of Monetary Policy Shocks on Mortgage Rates

In Section VI, we showed that the in-the-money share affects borrowing, instrumenting for in-the-money share using the "path" monetary policy shock from GSS. We found that the "path" shock increases the in-the-money share in the first stage, where in-the-money share is defined using the 30-year fixed rate mortgage rate. This result implies that a contractionary monetary policy shock increases mortgage rates. In this section, we trace out how a contractionary monetary policy shock affects mortgage rates over time. We highlight how different monetary policy shocks, which affect different parts of the yield curve, have different effects on mortgage rates.

In the left panel of Figure A.7, mortgage rates respond immediately to the "path" shock, (left panel) and this effect is persistent and grows with time. Two years following a 1 standard deviation contractionary "path" shock, mortgage rates have increased by 0.12 ppt. In contrast, following a change in the "target" shock, mortgage rates are little changed (right panel).

Swanson (2021) refines and extends the monetary policy shock series from GSS. Swanson (2021) defines three types of monetary policy shocks: surprises to the fed funds rate (FFR), forward guidance (FG), and large-scale asset purchases (LSAP). Swanson (2021) estimates the first three principal components of the moves in asset prices in a 30-minute window following FOMC announcements. Swanson (2021) searches over rotations of these prinicpal components such that the first factor corresponds to changes in the fed funds rate, the second to forward guidance, and the third to changes in LSAPs. Similar to GSS, Swanson (2021) identifies forward guidance shocks by requiring that changes in forward guidance have no effect on the target fed funds rate. Swanson (2021) extends GSS by further identifying LSAP shocks through the restriction that the LSAP factor be as small as possible in the pre-ZLB period, and also have no effect on the target fed funds rate. Roughly speaking, the "path" factor from GSS corresponds to the FG and LSAP factors from Swanson (2021). Swanson (2021) discusses the importance of these shocks over various monetary policy episodes. He finds that his LSAP factor is large during QE1, and that both his LSAP and FG factors are large during the Taper Tantrum.

Figure A.8 estimates the effect of these shocks on mortgage rates over time, using data from Swanson (2023). The upper left panel shows that mortgage rates do not respond to a shock to the current federal funds rate. In the upper right panel, mortgage rates increase and remain elevated following a forward guidance shock. In the lower left panel, mortgage rates increase in the weeks immediately following an LSAP shock and then return to zero. These results are consistent with Gorea, Kryvtsov and Kudlyak (2022) and Ringo (2024), who both find using similar methods that mortgage rates respond persistently and strongly to shocks in forward guidance, but are little changed following shocks to the current fed funds rate.

Both the Swanson FG and GSS "path" factors have large and persistent effects on mortgage rates. We use the "path" GSS factor as the primary instrument for the in-the-money share in Equation 9 rather than the Swanson FG instrument because the Swanson FG series is defined only through 2019, whereas the "path" GSS series is defined through 2023. Given concerns about limited power, we preferred a monetary policy shock series with a longer history.

A.4.5 Heterogeneity in the Effect of Monetary Policy Shocks by Equity

The Taper Tantrum occurred when borrower equity was at record lows. Borrower equity amplifies the effect of interest rates on home equity borrowing (Bhutta and Keys (2016), Beraja et al. (2019)), suggesting that our cash-out elasticities derived from the Taper Tantrum may be lower than those derived when equity is higher. If the cash-out elasticity to rates is stronger when equity is higher and if the other borrowing elasticity is not also stronger when equity is higher, then the elasticity of total borrowing could also be stronger when equity is higher.

To test this possibility, we estimate the effect of equity on the relationship between borrowing and rates using the local projections approach of Jordà (2005), as in Section VI. We use the "path" monetary policy shock series from GSS to capture variation in rates and then we interact zip-code equity with the "path" series. We define equity at the zip-code level as one minus mark to market LTV. We estimate the following sequence of regressions for each horizon k:

$$\begin{aligned}\sigma_{s,t+k} = &\left[\alpha_1^k(\gamma)_t + \sum_{l=1}^{L}\beta_{1+l}^k\sigma_{s,t-l} + \alpha_2^k X_{s,t} + \phi_s^k\right] \\ &+ \left[\alpha_3^k equity_{s,t} * (\gamma)_t + \sum_{l=1}^{L}\beta_{1+l}^k equity_{s,t} * \sigma_{s,t-l} + \alpha_4^k equity_{s,t} * X_{s,t} + equity_{s,t} * \phi_s^k\right] \\ &+ \alpha_5^k equity_{s,t} + \epsilon_{s,t}^k\end{aligned} \tag{11}$$

$\sigma_{s,t}$ is the probability of a borrowing event in zip-code s in month t, $(\gamma)_t$ is the path monetary policy shock in month t, and $X_{s,t}$ is a vector of zip-code- and time-varying controls. As in Equation 9, we include zip-code fixed effects, ϕ_s, and weight each observation by the number of mortgages in each zip-code month. We estimate standard errors using the Driscoll-Kraay procedure to account for autocorrelation and cross-sectional dependence in zip-code borrowing. We interact mean zip-code equity at time t with each term in the first set of brackets in Equation 11. We estimate equation (11) separately for cash-out refinance borrowing events, other borrowing events, and any borrowing (i.e. cash-out refinance or other borrowing). Controls include time-varying zip-code unemployment, origination year, and principal balance.

Figure A.9 plots the results from estimating Equation 11 over a horizon of twelve months for each of the three borrowing types. We plot the coefficient α_3^k on the interaction of equity and the monetary policy shock for each horizon k. The cash-out response to a contractionary shock, (corresponding to a positive “path” GSS monetary policy value), becomes more negative when equity is higher. The other borrowing response to a contractionary shock becomes more positive when equity is higher. Overall, the total borrowing response to a contractionary shock does not vary with equity.

In sum, we find that while the response of cash-out borrowing to rates varies with equity, consistent with Bhutta and Keys (2016) and Beraja et al. (2019), we also find that the other borrowing response varies with equity with equal strength in the opposite direction, leaving the response of total borrowing to rates insensitive to equity. When households have lower equity and mortgage rates fall, households increase their cash-out refinancing less, and decrease other borrowing less, than when equity is higher. This suggests that while our cash-out elasticities derived from the Taper Tantrum would be higher when equity is higher, our overall borrowing elasticities would be little changed when equity is higher.

In Section VI, we analyzed how the cash-out elasticity varies with the yield curve slope by comparing elasticities from 2013, when the yield curve widened, to elasticities from 2022, when the yield curve narrowed. When mortgage rates rise and the yield curve narrows many borrowers continue to borrow via cash-out rather than substitute, reducing the sensitivity of cash-out to rates. We found smaller cash-out elasticities in 2022, when the yield curve narrowed, than in 2013, when the yield curve widened. Equity was much higher in 2022 than in 2013 and equity increases the sensitivity of cash-out to rates. Therefore, the small cash-out response we measure in 2022 would have been even weaker had not equity been so high in 2022, implying the yield curve has a significant effect on borrowing elasticities.

A.4.6 Comparison of OLS and IV results for Borrowing and In-the-Money Regressions

To understand how the monetary policy shock instrument affects bias, we compare OLS and IV results from regressions of borrowing on $frac$, as discussed in Section VI. For cash-out refinancing, reported in Appendix Table A.3, the IV estimates are substantially higher than the OLS estimates, meaning the OLS estimates of $frac$ are substantially downward biased. This downward bias is consistent with the idea that mortgage rates tend to fall with bad economic times, which could separately reduce cash-out demand, possibly due to changes in collateral values or to more stringent borrowing requirements. The OLS and IV estimates for other borrowing are reported in Appendix Table A.4. The IV estimates for $frac$ for other borrowing are generally noisier than the OLS estimates and do not follow a clear pattern relative to the OLS estimates over the six horizons we consider. By a horizon of six months, the IV estimates are clearly larger in absolute terms than the OLS estimates, which suggests that the OLS estimates are biased to zero. Finally, Appendix Table A.5 compares OLS and IV results from regressions of all borrowing on $frac$. The instrumented all borrowing estimates are generally more positive than the OLS estimates, although they remain insignificantly different from zero, consistent with the instrument substantially reducing downward bias in the cash-out estimates.

A.4.7 Aggregate Borrowing Elasticities in 2022

We calculate the elasticities of borrowing to rates in 2022 to more easily compare substitution in 2022 to 2013. To calculate these elasticities, we follow the approach in Section IV.D and use a hurdle model that combines intensive and extensive margin responses. The green line in Figure A.10 plots the elasticity of the cash-out refinancing probability (assuming no intensive margin response), and the blue line plots the elasticity of the cash-out amount borrowed, combining intensive and extensive margin responses. The green and blue lines both vary by rate gap, with intermediate rate gap values having larger elasticities just as in Figure 7 from the Taper Tantrum. In 2022, the blue line lies closer to zero than the green line, consistent with the cash-out intensive margin having the opposite sign from the cash-out extensive margin model. The red line plots the elasticity of other borrowing to rates. The other borrowing elasticity varies less by rate gap than the cash-out elasticity, reflecting the strong rise in the probability of other borrowing amongst low rate gap borrowers post-March 2022.

Table A.1

Extensive Margin Results

	(1) Cash-out Refi	(2) Other Borrowing	(3) Any Borrowing
post=1	-0.000474***	0.000646***	0.000173
	(0.0000304)	(0.000129)	(0.000132)
RateBin = -.5 × post=1	0.000148***	-0.0000508	0.0000996
	(0.0000394)	(0.000221)	(0.000225)
RateBin = -.25 × post=1	0.0000812*	0.0000230	0.000110
	(0.0000422)	(0.000199)	(0.000203)
RateBin = .25 × post=1	-0.000134***	0.000483***	0.000353**
	(0.0000449)	(0.000169)	(0.000175)
RateBin = .5 × post=1	-0.000316***	0.000774***	0.000469***
	(0.0000509)	(0.000168)	(0.000176)
RateBin = .75 × post=1	-0.000555***	0.000755***	0.000204
	(0.0000568)	(0.000164)	(0.000173)
RateBin = 1 × post=1	-0.000774***	0.000974***	0.000210
	(0.0000596)	(0.000163)	(0.000173)
RateBin = 1.25 × post=1	-0.000679***	0.000696***	0.0000266
	(0.0000576)	(0.000156)	(0.000166)
RateBin = 1.5 × post=1	-0.000501***	0.000379**	-0.000120
	(0.0000661)	(0.000165)	(0.000177)
RateBin = 1.75 × post=1	-0.000321***	0.0000398	-0.000279
	(0.0000693)	(0.000168)	(0.000182)
RateBin = 2 × post=1	-0.0000303	-0.0000663	-0.0000913
	(0.0000773)	(0.000174)	(0.000190)
RateBin = 2.25 × post=1	-0.000209***	0.000148	-0.0000675
	(0.0000748)	(0.000174)	(0.000189)
RateBin = 2.5 × post=1	0.000163**	-0.0000644	0.0000988
	(0.0000794)	(0.000180)	(0.000197)
RateBin = 2.75 × post=1	0.000246***	-0.000103	0.000158
	(0.0000812)	(0.000188)	(0.000205)
RateBin = 3 × post=1	0.000318***	0.0000901	0.000407*
	(0.0000927)	(0.000204)	(0.000224)
Observations	28180018	28180018	28180018

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Shows detailed results associated with the results in Figure 4.

Table A.2

Intensive Margin Results

	(1) Cash-out Refi	(2) Other Borrowing	(3) Any Borrowing
post=1	0.198***	-0.0362***	-0.0615***
	(0.0239)	(0.00468)	(0.00479)
RateBin = -.5 × post=1	-0.0345	0.0450***	0.0425***
	(0.0546)	(0.00735)	(0.00749)
RateBin = -.25 × post=1	0.0169	0.0132*	0.00957
	(0.0393)	(0.00692)	(0.00695)
RateBin = .25 × post=1	0.00457	0.0301***	0.0160**
	(0.0294)	(0.00635)	(0.00644)
RateBin = .5 × post=1	-0.00655	0.0475***	0.0320***
	(0.0274)	(0.00656)	(0.00656)
RateBin = .75 × post=1	0.000834	0.0657***	0.0465***
	(0.0261)	(0.00634)	(0.00629)
RateBin = 1 × post=1	0.00286	0.0701***	0.0405***
	(0.0263)	(0.00648)	(0.00654)
RateBin = 1.25 × post=1	-0.0208	0.0550***	0.0442***
	(0.0252)	(0.00612)	(0.00606)
RateBin = 1.5 × post=1	-0.0632**	0.0375***	0.0212***
	(0.0268)	(0.00662)	(0.00678)
RateBin = 1.75 × post=1	-0.0918***	0.0348***	0.0359***
	(0.0267)	(0.00682)	(0.00681)
RateBin = 2 × post=1	-0.120***	0.0272***	0.0225***
	(0.0273)	(0.00767)	(0.00769)
RateBin = 2.25 × post=1	-0.135***	0.0270***	0.0314***
	(0.0273)	(0.00746)	(0.00763)
RateBin = 2.5 × post=1	-0.165***	0.0247***	0.0315***
	(0.0288)	(0.00835)	(0.00849)
RateBin = 2.75 × post=1	-0.163***	0.0344***	0.0551***
	(0.0301)	(0.00910)	(0.00914)
RateBin = 3 × post=1	-0.169***	0.0453***	0.0606***
	(0.0324)	(0.0104)	(0.0106)
Observations	217641	1095168	1311246

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Shows detailed results associated with the results in Figure 5.

Table A.3

Instrumenting for Rate Gap with Monetary Policy Shocks: Cash-out Refinancing

Note: Reports results from regressions of cash-out borrowing on $frac$, defined as the zip-code share of borrowers with rate gaps between 0 and 2. Columns 1-6 correspond to regressions of the cash-out probability on $frac$, where the cash-out probability is defined at horizons of length $k = 1, ..., 6$. Columns 7-12 correspond to regressions of the cash-out probability on $frac$, where the cash-out probability is defined at horizons of length $k = 1, ..., 6$ and where $frac$ is instrumented for using the 12-month sum of the "path" monetary policy surprise series from Gürkaynak, Sack and Swanson (2004). Controls include lagged values of cash-out refinancing, zip-code unemployment, mark-to-market LTV, current principal balance, and origination year. Standard errors estimated using Driscoll-Kraay method.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Cash_t+1	Cash_t+2	Cash_t+3	Cash_t+4	Cash_t+5	Cash_t+6	Cash_t+1	Cash_t+2	Cash_t+3	Cash_t+4	Cash_t+5	Cash_t+6
$frac$	0.00315***	0.00287***	0.00254***	0.00215***	0.00189***	0.00169***	0.00387*	0.00377*	0.00379**	0.00369**	0.00373**	0.00366**
	(0.000458)	(0.000464)	(0.000480)	(0.000498)	(0.000527)	(0.000568)	(0.00211)	(0.00209)	(0.00192)	(0.00170)	(0.00149)	(0.00142)
$cashout_{t-1}$	0.0157***	0.0141***	0.0113***	0.0116***	0.00996***	0.00889***	0.0129***	0.0110***	0.00767**	0.00723*	0.00531	0.00400
	(0.00215)	(0.00186)	(0.00208)	(0.00250)	(0.00247)	(0.00212)	(0.00359)	(0.00351)	(0.00366)	(0.00404)	(0.00381)	(0.00345)
$cashout_{t-2}$	0.0140***	0.0112***	0.0112***	0.00988***	0.00875***	0.00906***	0.0116***	0.00832**	0.00751*	0.00577	0.00441	0.00459
	(0.00182)	(0.00211)	(0.00248)	(0.00254)	(0.00220)	(0.00262)	(0.00312)	(0.00355)	(0.00387)	(0.00371)	(0.00325)	(0.00376)
$cashout_{t-3}$	0.0114***	0.0117***	0.0103***	0.00950***	0.00961***	0.00783***	0.00894***	0.00859**	0.00653*	0.00552	0.00522	0.00359
	(0.00210)	(0.00256)	(0.00267)	(0.00250)	(0.00281)	(0.00236)	(0.00317)	(0.00374)	(0.00364)	(0.00336)	(0.00363)	(0.00307)
Reg.	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV	IV
F-stat Cragg Donald							355224.52	329695.54	325151.19	325316.95	328834.54	330758.8
F-stat RKF							22.49	20.2	19.8	19.69	19.77	19.79
Zip-code FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
NW Lags	4	4	4	4	4	4	4	4	4	4	4	4
R^2	0.0162	0.0154	0.0145	0.0138	0.0132	0.0127	0.0169	0.0161	0.0151	0.0142	0.0133	0.0127
N	3449102	3423189	3397797	3372966	3348687	3324877	3223453	3200247	3177371	3154831	3132567	3110571

Standard errors in parentheses
* p<.10, ** p<.05, *** p<.01

Table A.4

Instrumenting for Rate Gap with Monetary Policy Shocks: Other Borrowing

Note: Reports results from regressions of other borrowing on $frac$, defined as the zip-code share of borrowers with rate gaps between 0 and 2. Columns 1-6 correspond to regressions of the other borrowing probability on $frac$, where the other borrowing probability is defined at horizons of length $k = 1, ..., 6$. Columns 7-12 correspond to regressions of the other borrowing probability on $frac$, where the other borrowing probability is defined at horizons of length $k = 1, ..., 6$ and where $frac$ is instrumented for using the 12-month sum of the "path" monetary policy surprise series from Gürkaynak, Sack and Swanson (2004). Controls include lagged values of other borrowing, zip-code unemployment, mark-to-market LTV, current principal balance, and origination year. Standard errors estimated using Driscoll-Kraay method.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Other_t+1	Other_t+2	Other_t+3	Other_t+4	Other_t+5	Other_t+6	Other_t+1	Other_t+2	Other_t+3	Other_t+4	Other_t+5	Other_t+6
$frac$	-0.00344***	-0.00325***	-0.00297***	-0.00267***	-0.00226***	-0.00236***	0.0000423	-0.000979	-0.00317	-0.00346	-0.00386	-0.00444
	(0.000921)	(0.000871)	(0.000876)	(0.000819)	(0.000700)	(0.000696)	(0.00230)	(0.00266)	(0.00313)	(0.00293)	(0.00276)	(0.00276)
$other_{t-1}$	0.00927***	0.00707***	0.00399*	0.00476**	0.00163	0.000945	0.00613***	0.00380*	0.000703	0.00102	-0.00157	-0.00284
	(0.00244)	(0.00227)	(0.00219)	(0.00213)	(0.00153)	(0.00186)	(0.00186)	(0.00198)	(0.00192)	(0.00177)	(0.00157)	(0.00174)
$other_{t-2}$	0.00799***	0.00452**	0.00558**	0.00282	0.00137	0.00282	0.00436**	0.00151	0.00199	-0.000109	-0.00205	-0.000892
	(0.00240)	(0.00227)	(0.00225)	(0.00183)	(0.00190)	(0.00172)	(0.00186)	(0.00176)	(0.00172)	(0.00176)	(0.00178)	(0.00159)
$other_{t-3}$	0.00591**	0.00644***	0.00394*	0.00281	0.00385**	0.00607***	0.00248	0.00292*	0.000812	-0.000799	0.000110	0.00247
	(0.00254)	(0.00240)	(0.00209)	(0.00226)	(0.00192)	(0.00178)	(0.00170)	(0.00174)	(0.00177)	(0.00201)	(0.00166)	(0.00162)
Reg.	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV	IV
F-stat Cragg Donald							360613.14	335117.51	330685.17	331056.63	334934.27	337163.6
F-stat RKF							22.67	20.33	19.93	19.83	19.93	19.97
Zip-code FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
NW Lags	4	4	4	4	4	4	4	4	4	4	4	4
R^2	0.0225	0.0207	0.0186	0.0170	0.0161	0.0152	0.0123	0.0122	0.0113	0.0101	0.00923	0.00821
N	3449102	3423189	3397797	3372966	3348687	3324877	3223453	3200247	3177371	3154831	3132567	3110571

Standard errors in parentheses
* p<.10, ** p<.05, *** p<.01

Table A.5

Instrumenting for Rate Gap with Monetary Policy Shocks: All Borrowing

Note: Reports results from regressions of all borrowing on $frac$, defined as the zip-code share of borrowers with rate gaps between 0 and 2. Columns 1-6 correspond to regressions of the all borrowing probability on $frac$, where the all borrowing probability is defined at horizons of length $k = 1, ..., 6$. Columns 7-12 correspond to regressions of the all borrowing probability on $frac$, where the all borrowing probability is defined at horizons of length $k = 1, ..., 6$ and where $frac$ is instrumented for using the 12-month sum of the "path" monetary policy surprise series from Gürkaynak, Sack and Swanson (2004). Controls include lagged values of all borrowing, zip-code unemployment, mark-to-market LTV, current principal balance, and origination year. Standard errors estimated using Driscoll-Kraay method.

	(1) All_t+1	(2) All_t+2	(3) All_t+3	(4) All_t+4	(5) All_t+5	(6) All_t+6	(7) All_t+1	(8) All_t+2	(9) All_t+3	(10) All_t+4	(11) All_t+5	(12) All_t+6
$frac$	-0.000253	-0.000330	-0.000375	-0.000458	-0.000311	-0.000613	0.00384	0.00272	0.000533	0.000136	-0.000230	-0.000888
	(0.00111)	(0.00106)	(0.00104)	(0.000989)	(0.000885)	(0.000874)	(0.00284)	(0.00338)	(0.00384)	(0.00355)	(0.00336)	(0.00329)
all_{t-1}	0.0152***	0.0133***	0.0104***	0.0109***	0.00800***	0.00783***	0.00983***	0.00820***	0.00614***	0.00646***	0.00424***	0.00367**
	(0.00284)	(0.00260)	(0.00255)	(0.00245)	(0.00190)	(0.00221)	(0.00178)	(0.00182)	(0.00149)	(0.00158)	(0.00151)	(0.00160)
all_{t-2}	0.0140***	0.0109***	0.0116***	0.00915***	0.00824***	0.00946***	0.00864***	0.00633***	0.00712***	0.00523***	0.00415***	0.00544***
	(0.00258)	(0.00253)	(0.00252)	(0.00209)	(0.00218)	(0.00202)	(0.00170)	(0.00138)	(0.00161)	(0.00157)	(0.00156)	(0.00135)
all_{t-3}	0.0122***	0.0127***	0.0101***	0.00982***	0.0105***	0.0118***	0.00693***	0.00739***	0.00571***	0.00502***	0.00599***	0.00781***
	(0.00278)	(0.00275)	(0.00239)	(0.00258)	(0.00224)	(0.00205)	(0.00135)	(0.00156)	(0.00159)	(0.00162)	(0.00128)	(0.00147)
Reg.	OLS	OLS	OLS	OLS	OLS	OLS	IV	IV	IV	IV	IV	IV
F-stat Cragg Donald							356636.1	331416.84	327029.66	327409.63	331282.78	333533.32
F-stat RKF							22.51	20.19	19.78	19.68	19.78	19.82
Zip-code FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
NW Lags	4	4	4	4	4	4	4	4	4	4	4	4
R^2	0.0246	0.0228	0.0209	0.0190	0.0178	0.0168	0.0144	0.0140	0.0132	0.0120	0.0112	0.0105
N	3449102	3423189	3397797	3372966	3348687	3324877	3223453	3200247	3177371	3154831	3132567	3110571

Standard errors in parentheses
* p<.10, ** p<.05, *** p<.01

Table A.6

Correlations of Monetary Policy Shock with Rates

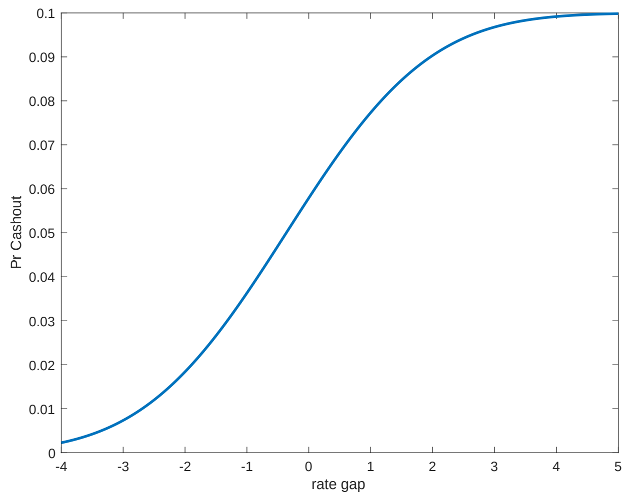
	(1) Path	(2) Path
$frac_{t-1}$	-0.0131	
	(0.0805)	
$frac_{t-2}$	-0.0288	
	(0.153)	
$frac_{t-3}$	0.0526	
	(0.0885)	
$30YRFRM_{t-1}$		0.0106
		(0.0117)
$30YRFRM_{t-2}$		-0.00831
		(0.0202)
$30YRFRM_{t-3}$		-0.00762
		(0.0144)
R^2	0.00806	0.0313
N	199	199

Standard errors in parentheses
* p<.10, ** p<.05, *** p<.01

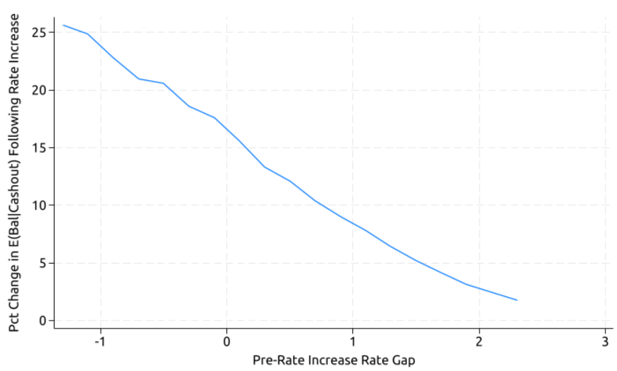
Note: Shows regressions of the "path" GSS monetary policy shock on lags of in-the-money share, $frac$, and mortgage rates. Mortgage rates from Freddie Mac (2024).

Figure A.1. Conceptual Framework Model Simulations

(a) Cash-out Refinance Probability by Rate Gap

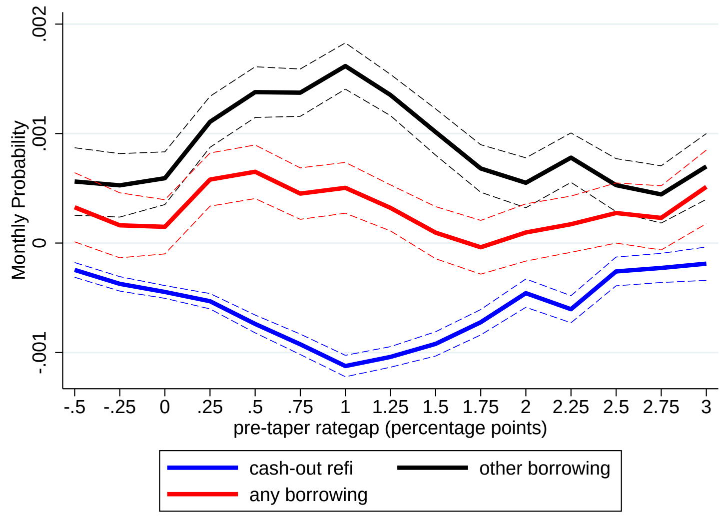


(b) Amount Borrowed Conditional on Cash-out Refinance by Rate Gap



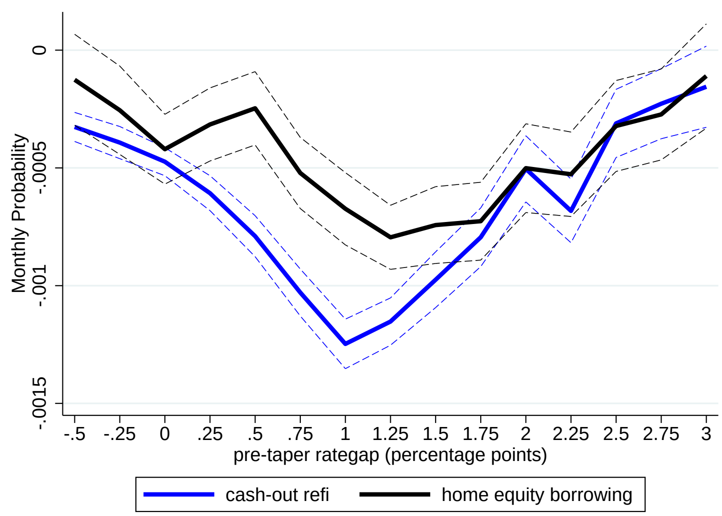
Note: Figure (a) shows probability of a cash-out refinance by rate gap according to simulations of the simple model of housebold borrowing and substitution. Figure (b) shows simulated average change in cash-out amount conditional on a cash-out refinance by rate gap following an 80 basis point increase in mortgage rates.

Figure A.2. Extensive Margin Results: Including Adjustable-Rate Mortgages



Note: Shows change in monthly probability of borrowing after the Taper Tantrum by pre-Taper rate gap when we include all product types in the sample and do not restrict to fixed-rate mortgages. Estimates from LPMs with standard errors clustered by loan id. Controls include a dummy for product type in addition to the variables listed in notes to Figure 4.

Figure A.3. Extensive Margin Results: BK Home Equity Borrowing Comparison

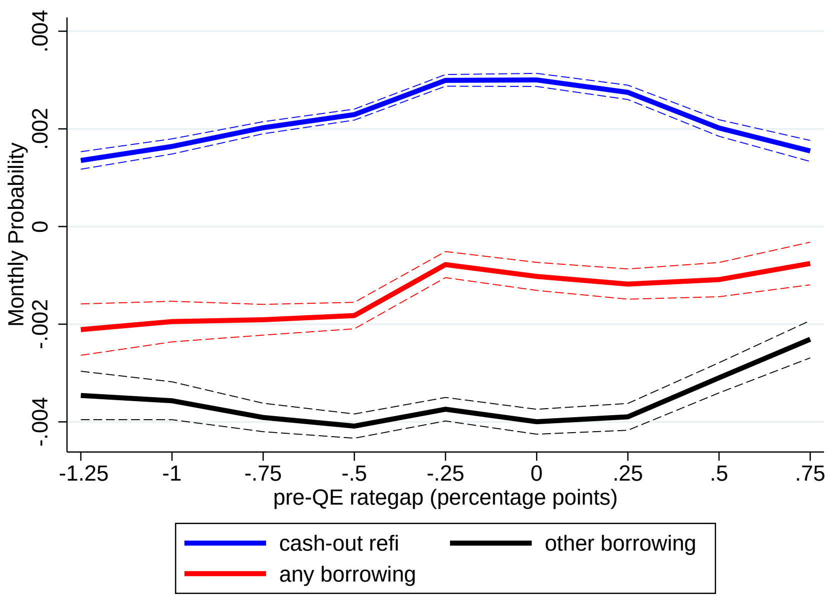


Note: Shows change in monthly probability of borrowing after the Taper Tantrum by pre-Taper rate gap. Home equity borrowing defined as equal to one if the borrower does a cash-out refinance, a HELOC extraction, or a CES extraction. Estimates from LPMs with standard errors clustered by loan id. Control variables listed in notes to Figure 4.

Figure A.4. Mortgages Rates Around QE1

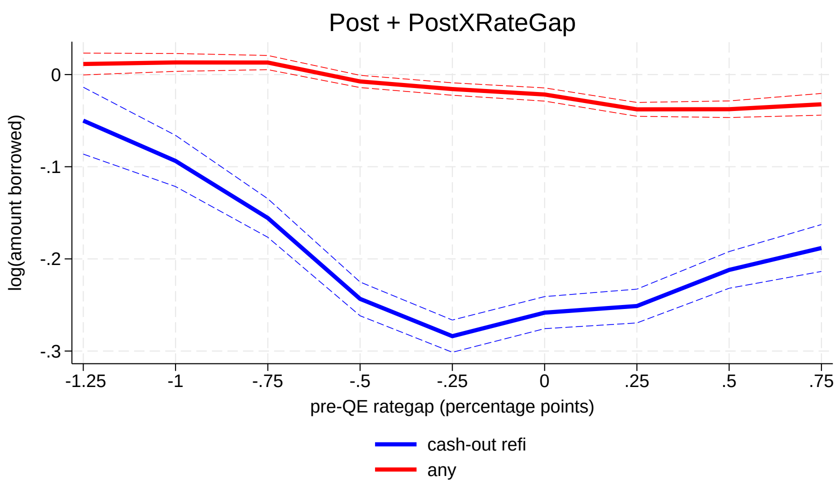
Note: Weekly mortgage rates from Freddie Mac primary mortgage market survey (Freddie Mac, 2021).

Figure A.5. Extensive Margin Results: QE1



Note: Shows change in monthly probability of borrowing after QE1 by pre-QE1 rate gap. Estimates from LPMs with standard errors clustered by loan id. Controls include a quadratic in mark-to-market LTV, a quadratic in current credit score, an interaction between LTV and credit score, outstanding principal balance, a quadratic in borrower age, a cubic in loan age, dummies for the term of the loan (e.g. 30 or 15 year), dummies for the purpose type of the loan (e.g. purchase or refinance), the county-unemployment rate, four-digit property zipcode FE, and origination year-month FE.

Figure A.6. Intensive Margin Results: QE1



Note: Shows change in amount borrowed conditional on borrowing after QE1 by pre-QE1 rate gap. Estimates from LPMs with standard errors clustered by loan id. Controls include a quadratic in mark-to-market LTV, a quadratic in current credit score, an interaction between LTV and credit score, outstanding principal balance, a quadratic in borrower age, a cubic in loan age, dummies for the term of the loan (e.g. 30 or 15 year), dummies for the purpose type of the loan (e.g. purchase or refinance), the county-unemployment rate, four-digit property zipcode FE, and origination year-month FE.

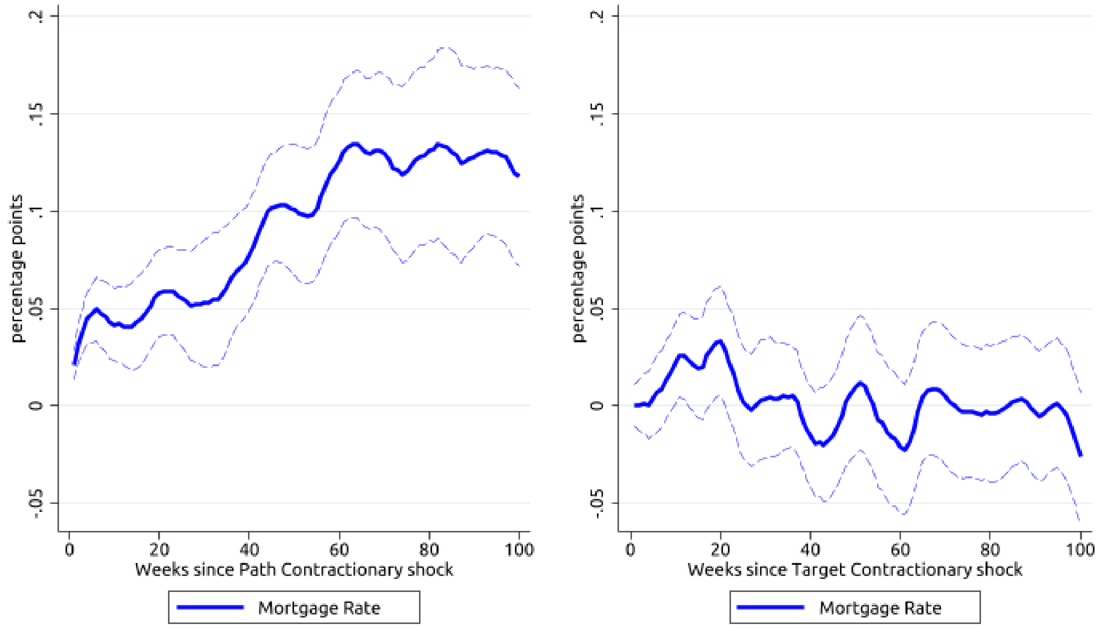


Figure A.7. Effect of GSS Monetary Policy Shocks on Mortgage Rates. This figure plots responses of the 30-year fixed rate mortgage rate to a one standard deviation increase in monetary policy shock measures. Mortgage rates are sourced from Freddie Mac (2025). Coefficients and 95% confidence intervals are estimated from a series of local projections regressions of mortgage rates on the GSS monetary policy surprises, nonfarm payrolls, and lags of the mortgage rate at weekly horizons of length 1,...,100. 95% confidence intervals are calculated using Huber-White heteroskedasticity-robust standard errors and are reported as dashed lines.

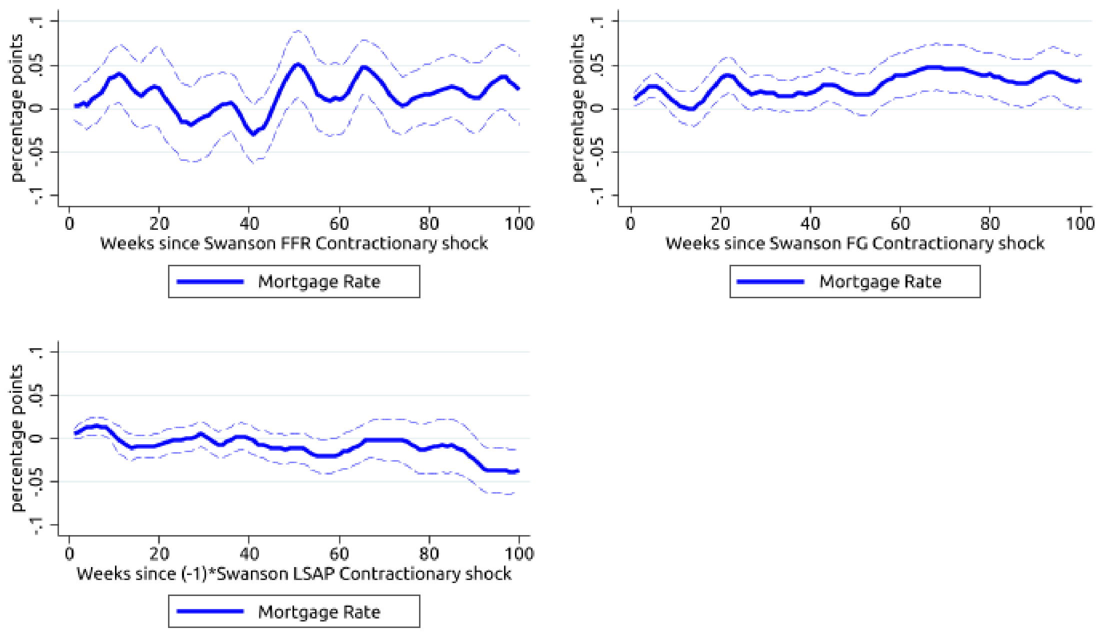


Figure A.8. Effect of Swanson Monetary Policy Shocks on Mortgage Rates. This figure plots responses of the 30-year fixed rate mortgage rate to a one standard deviation increase in monetary policy shock measures. Mortgage rates are sourced from Freddie Mac (2025). Coefficients and 95% confidence intervals are estimated from a series of local projections regressions of mortgage rates on the Swanson (2021) monetary policy surprises and lags of the mortgage rate and nonfarm payrolls at weekly horizons of length 1,...,100. 95% confidence intervals are calculated using Huber-White heteroskedasticity-robust standard errors and are reported as dashed lines.

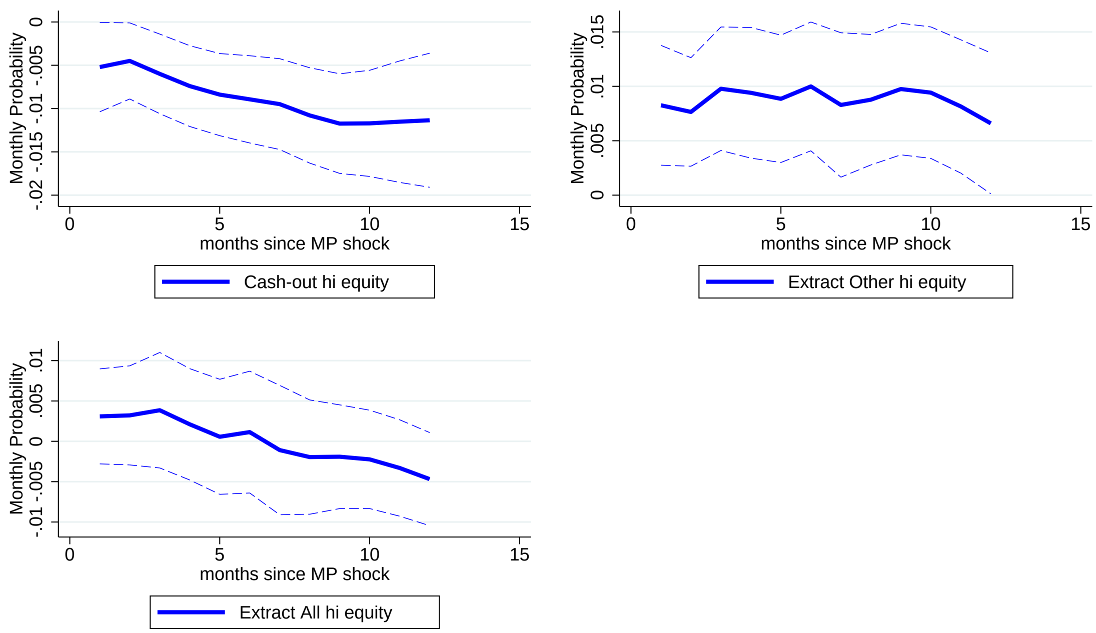


Figure A.9. Effect of Monetary Policy Shocks by Equity. This figure plots coefficients and 90% confidence intervals from a series of local projections regressions of borrowing on the "path" monetary policy shock series from GSS interacted with zip-code equity for horizons of length 1,...,12. 90% confidence intervals are calculated using Driscoll-Kraay standard errors and are reported as dashed lines.

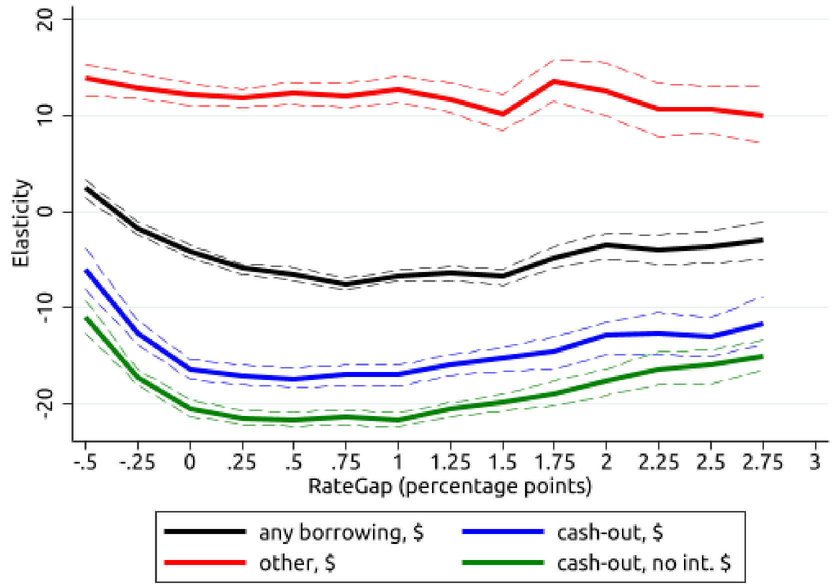


Figure A.10. Aggregate Borrowing Elasticities: 2022. The figure plots aggregate dollar borrowing elasticities to rates estimated in 2022. The elasticities are derived using a hurdle model described in Section IV.D which combines intensive and extensive margin responses. The blue line reports the cash-out borrowing elasticity and the green line reports the cash-out borrowing elasticity, assuming only an extensive margin response and no intensive margin response. The red line reports the other borrowing elasticity and the black line reports the aggregate borrowing elasticity. Confidence intervals are bootstrapped.

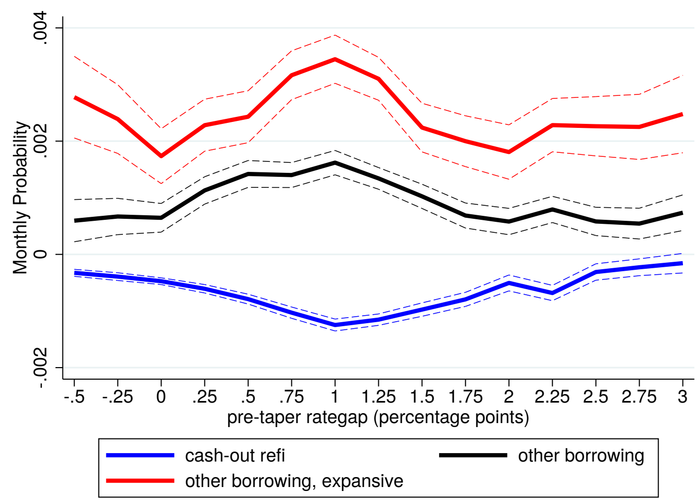
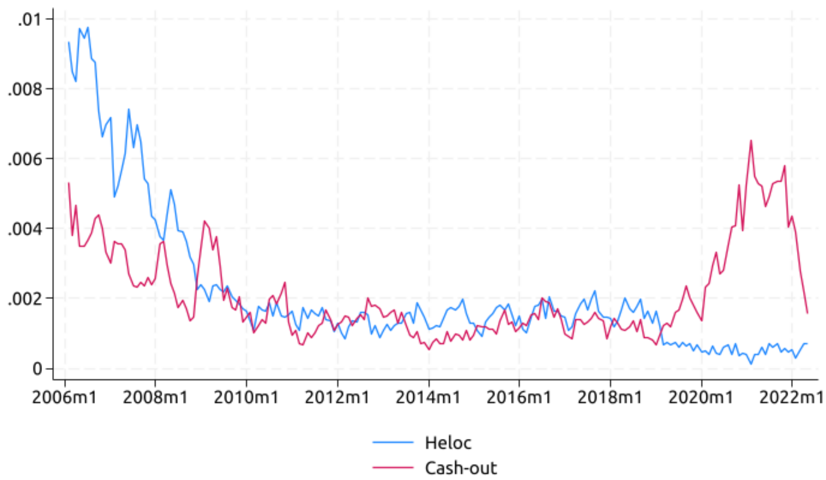


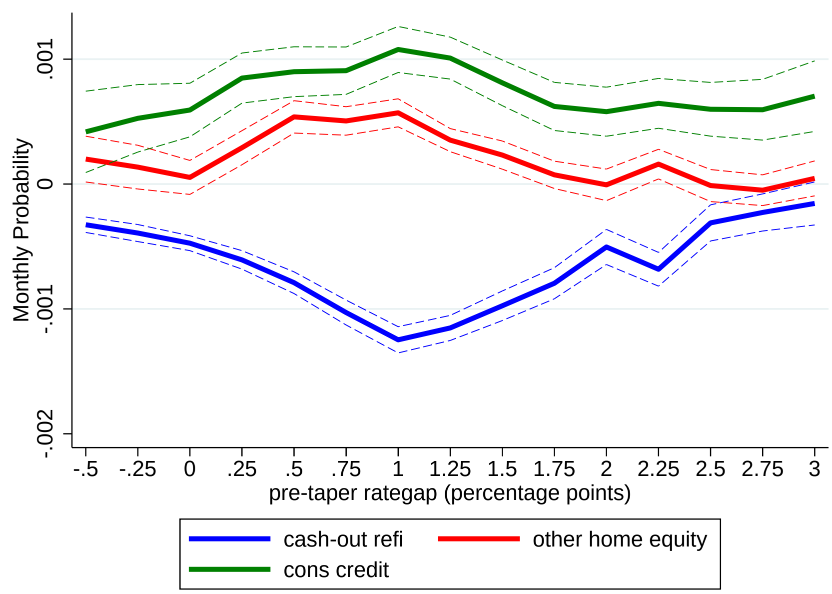
Figure A.11. Extensive Margin Borrowing Response, Including Auto Loans. Other borrowing shows the definition used in the paper. Other borrowing expansive includes auto loan borrowing events.

Figure A.12. Aggregate Time Series Borrowing, Extensive Margin

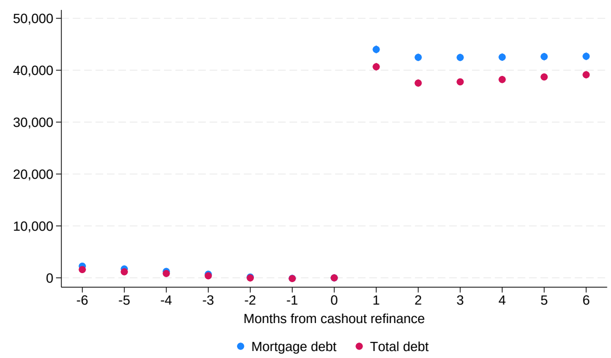


Note: Shows the aggregate probability of cash-out refinancing and HELOC borrowing over time.

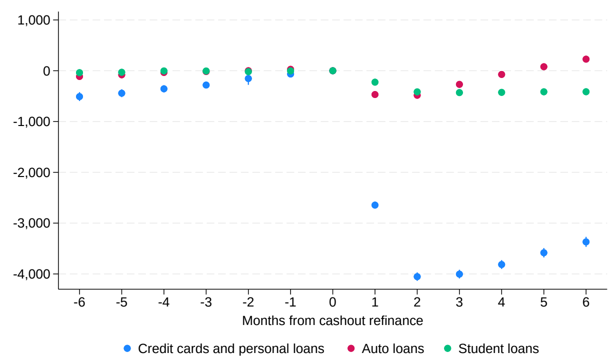
Figure A.13. Extensive Margin Results: By Borrowing Type



Note: Shows change in monthly probability of borrowing after the Taper Tantrum by pre-Taper rate gap. This figure breaks out "other borrowing event" from Figure 4 into "other home equity extraction" (i.e. HELOCs or CES) and "consumer credit" (i.e. personal loans or credit cards). Estimates from LPMs with standard errors clustered by loan id. Control variables listed in notes to Figure 4.

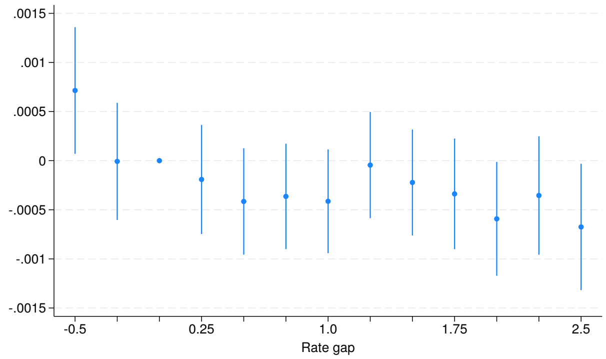


(a) Panel A: Substitution of Cash-out Refinancing with Existing Debt

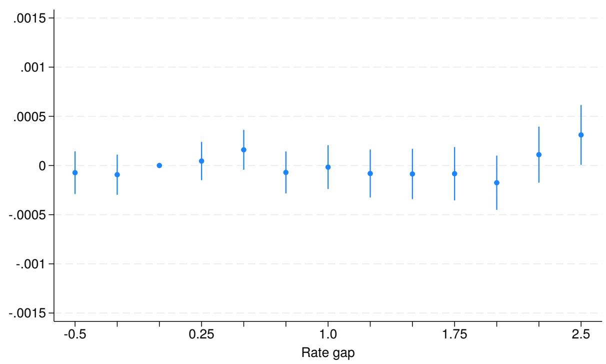


(b) Panel B: Evolution of non-mortgage debt

Figure A.14. Substitution with Existing Debt. Figure (a) shows the increase in mortgage debt and total debt following a cash-out refinance and (b) shows how different categories of non-mortgage debt change following a cash-out refinance. The top figure plots two time-to-event OLS regressions: one with total mortgage debt as the dependent variable and the second with total debt as the dependent variable. The omitted time period is the month of the cash-out refinance. Standard errors clustered by 4-digit zip. Additional controls include credit score, combined LTV (CLTV), an interaction of credit score and LTV, borrower age, and fixed effects for 4-digit zips, month of refinance, origination year, and loan type.



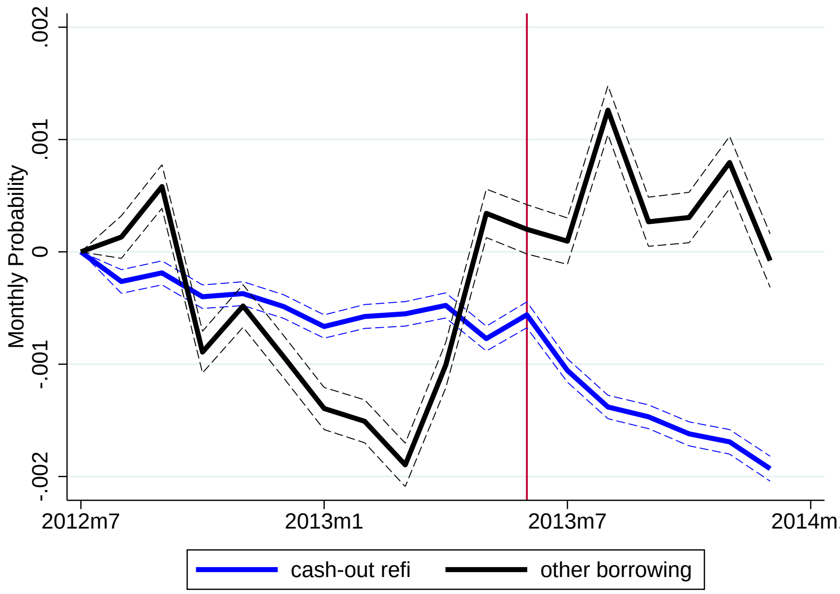
(a) Panel A: Seasonal pattern of other borrowing by rate gap



(b) Panel B: Seasonal pattern of cash-out borrowing by rate gap

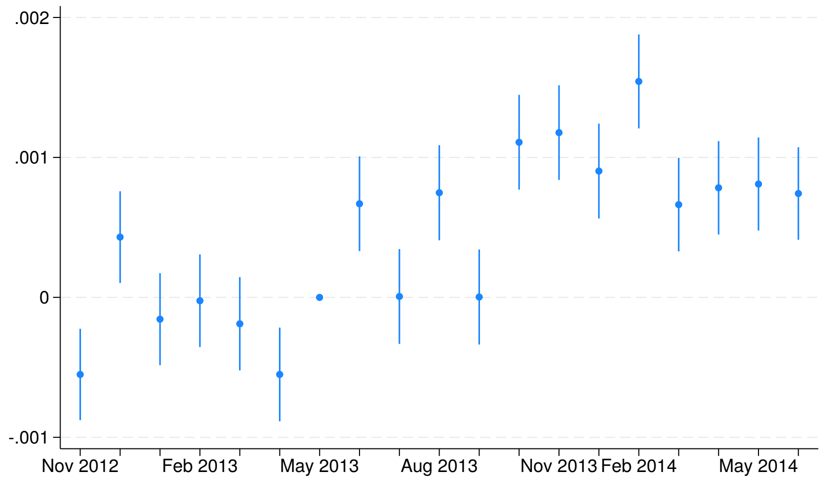
Figure A.15. Seasonal patterns of cash-out and other borrowing. Panel (a) shows coefficients from a regression of the monthly probability of other borrowing on rate gap bins interacted with a dummy variable indicating the second half of the year (the portion of the calendar year designated "post" in the Taper Tantrum analysis). Panel (b) shows coefficients from the same regression with the monthly probability of cash-out borrowing as the dependent variable. Controls include a quadratic in mark-to-market LTV, a quadratic in current credit score, an interaction between LTV and credit score, outstanding principal balance, a quadratic in borrower age, a cubic in loan age, dummies for the term of the loan (e.g. 30 or 15 year), dummies for the purpose type of the loan (e.g. purchase or refinance), the county-unemployment rate and four-digit property zipcode FE.

Figure A.16. Probability of Borrowing by Calendar Month in 2013



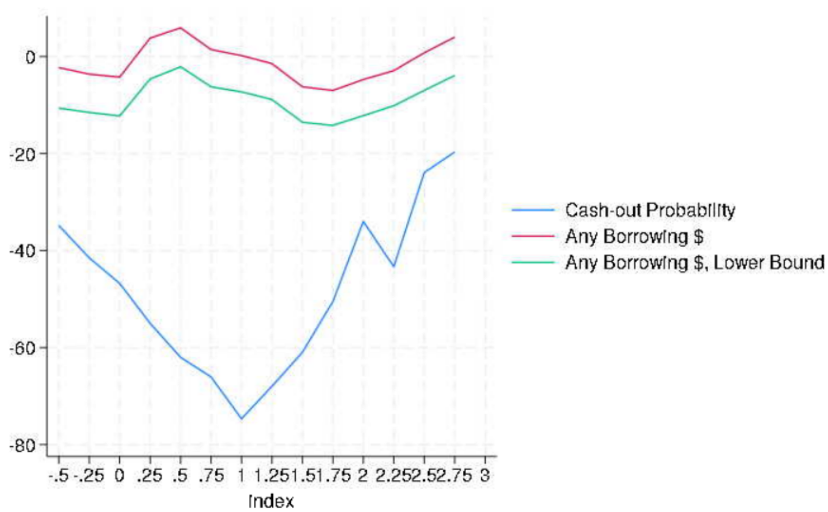
Note: Shows the monthly probability of borrowing across cash-out refinancing and other borrowing. Estimates from LPMs with standard errors clustered by loan id. Control variables listed in notes to Figure 4. Red line denotes the end of the pre-taper tantrum period, which we define as June 30, 2013.

Figure A.17. 12-month change in the probability of other borrowing

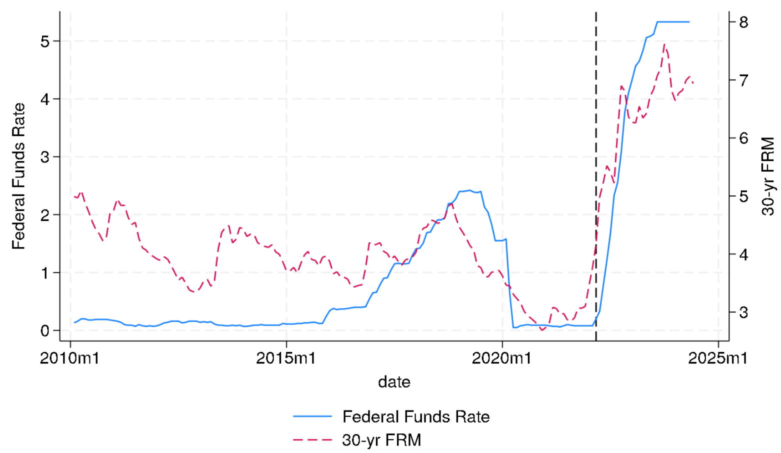


Note: Shows coefficients from a regression of the 12-month change in the monthly probability of other borrowing interacted with month dummies. Estimates from LPMs.

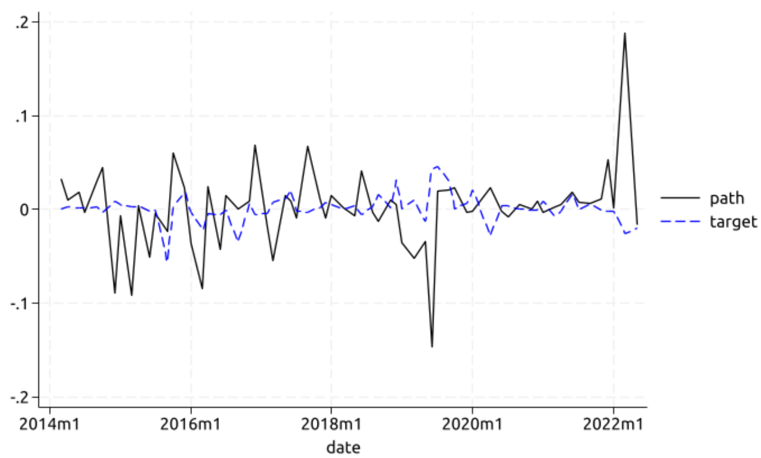
Figure A.18. Aggregate Borrowing Elasticities



Note: Shows the aggregate dollar borrowing elasticity to rates for cash-out and any borrowing. The elasticity of borrowing to rates is derived using a hurdle model described in Section IV.D which combines intensive and extensive margin responses. The lower bound of the aggregate elasticity of borrowing to rates is described in Section V.B.



(a) Panel A: Fed Funds Rate and Mortgage Rates around 2022



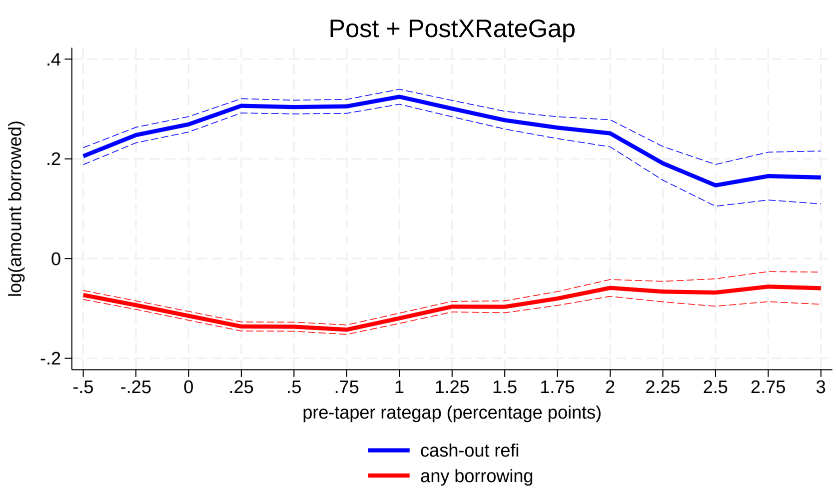
(b) Panel B: GSS Monetary Policy Shock Factors around 2022

Figure A.19. Interest Rates and Monetary Policy Shocks in 2022. Figure (a) shows the federal funds rate (Board of Governors of the Federal Reserve System (2025)) and the thirty-year conforming monthly fixed-rate mortgage rate from the Freddie Mac primary mortgage market survey (Freddie Mac (2024)). Figure (b) shows the "path" and "target" monetary policy shock factors from Gürkaynak, Sack and Swanson (2004). For details on the construction of the "path" and "target" factors, see the discussion in Section VI.A.

Figure A.20. Spread of Mortgage Rates to 1-yr Treasury Yield

Note: Monthly mortgage rates from Freddie Mac primary mortgage market survey (Freddie Mac (2024)). Treasury yields from the Board of Governors of the Federal Reserve System (2024).

Figure A.21. Intensive Margin Results: 2022



Note: Shows change in amount borrowed conditional on borrowing after March 2022 by pre-March 2022 rate gap. Estimates from LPMs with standard errors clustered by loan id. Control variables listed in notes to Figure 4.