The Home Purchase Effects of GSE Redistribution: Evidence from Difference-in-Discontinuity Estimates

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Abstract

Fannie Mae and Freddie Mac's guarantee fee (g-fee) pricing plays an important role in redistributing credit. We study the aggregate and distributional effects of g-fee pricing on home purchases. Utilizing a difference-in-discontinuities design based on recent g-fee adjustments, we estimate heterogeneous elasticities across credit score and income distributions. We find that, within low credit score groups, elasticities are larger for higher-income borrowers, and within high credit score groups, they are larger for lower-income borrowers. Then we develop a structural model, based on the reduced-form elasticities, to analyze counterfactual g-fee policies. We find that increasing g-fees has ambiguous distributional effects: progressive by credit score but regressive by income. Our simulation also suggests that the GSEs' cross-subsidy toward lower credit score borrowers can have regressive effects. These results highlights the need for careful consideration of distributional consequences in GSE reform efforts.

Keywords: Government Sponsored Enterprises (GSEs), Securitization, Redistribution, US Mortgage Market, Difference-in-Discontinuity.

JEL classification: G18, G21, G51

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1 Introduction

Fannie Mae and Freddie Mac, referred to as the government-sponsored enterprises (GSEs), provide credit guarantees for about half of residential mortgages in the United States. Pricing of the GSEs' guarantee fee (g-fee) plays an important role in redistributing credit. For example, the average level of g-fees relative to credit risk as well as the GSE's operating expenses implies a level of redistribution between homeowners and general taxpayers, because the GSEs continue to be under conservatorship since 2008. Moreover, earlier analyses suggest that g-fees are imperfectly adjusted to credit risk and provide a cross-subsidy from low-risk to high-risk borrowers (Gerardi, 2017). Although the intentional redistribution through g-fees is often controversial and subject to political debate,[1] there are few papers that analyze its real effects on home purchases. Understanding these effects is important for evaluating distributional impacts of a change in the g-fee pricing policy, which is likely to happen if there are serious efforts to recapitalize the GSEs to release them from conservatorship.[2, 3]

In this paper, we study the effects of g-fee pricing on home purchases and mortgage product choices across the distributions of credit scores and incomes. We investigate both dimensions because earlier studies have found that they are only moderately correlated (Beer et al., 2018). We estimate these reduced-form elasticities using recent adjustments to g-fees. Our estimates exhibit significant heterogeneity across income and credit score groups, which has implications for the distributional impacts of g-fee pricing schemes. We then use our reduced-form estimates to discipline a rich structural model in the style of Jiang (2023) and Buchak et al. (2024). Then we examine counterfactual g-fee pricing that the GSEs' exit from conservatorship is likely to entail, such as increasing g-fees uniformly and removing a cross-subsidy among GSE loans with different credit risk, as well as the effects of controversial g-fee adjustments in 2023.

It is unclear a priori whether and how much the g-fee influences home purchases. The effects of g-fees on home purchases will depend on how many households are at the margin between

[1] See media reports from e.g. Wall Street Journal, USA Today, and New York Times.

[2] Many market participants anticipate the second Trump administration will try to recapitalize the GSEs and release them from conservatorship. Amid the anticipation, the stock prices of the two GSEs sharply rose in days following the US presidential election in November 2024.

[3] "Increasing our returns [on equity] to a level sufficient to attract private equity investors may require increases in our pricing..." on page 25 of Fannie Mae's 10-K for 2024.

renting and purchasing homes with GSE loans over other loan types. For example, many households with low credit scores and low incomes may prefer FHA or VA mortgages, which have federal guarantees and are securitized into Ginnie Mae MBS. Moreover, households with high credit scores and high incomes may adjust their loan characteristics without giving up on home purchases or may be able to take "non-agency loans," which are held on a private lender's balance sheet or securitized into non-agency MBS. Thus, the effect of g-fees on home purchases may be muted for some households, and it is important to consider potential heterogeneous effects of g-fees across households with different characteristics.

For identification of the effects of g-fees on home purchases, we use a difference-in-discontinuities design, exploiting a recent change in g-fees. Sellers of loans to the GSEs pay an upfront g-fee based on the loan-level price adjustment (LLPA), which differs by discrete grids of credit score and loan-to-value ratio (LTV). In January 2023, the GSEs made significant changes to the LLPA, leading to differential changes to g-fees across LLPA grids. In particular, the differences in the g-fee changes were particularly large for borrowers in credit score grids below and above 680, 720, 760, and 780, although credit scores just below and above these boundaries (for example, 679 vs 680) are likely to have nearly identical credit risk. By examining differences in prices and volumes pre-and-post the announcement across credit score cutoffs, we estimate the effects of the policy on borrowers across the credit score distribution. We also estimate how these semi-elasticities differ by income conditional on credit scores. Although the LLPA varies with LTVs, we do not use LTV cutoffs for identification because LTVs can be endogenous for households that are relatively liquidity unconstrained.

Our identification approach rules out many forms of borrower and lender confounders. First, exact tri-bureau credit scores used for g-fee pricing are difficult to predict ex ante and are unlikely to be manipulated right around the thresholds.[4] Second, We can also allow for time-varying shocks in demand that are correlated with credit scores as long as those shocks are not also discontinuous at the cut-offs. Third, another important advantage over a regression discontinuity approach is that we allow for time-invariant differences in underwriting at the

[4]Other papers using sharp credit score thresholds as identification include Keys et al. (2010); Collier and Ellis (2024).

credit score discontinuities. Lastly, examining pre-trends, we see little evidence of pre-trends in our estimates, which is evidence of limited lender and borrower anticipation.

Our estimates show that changes in g-fees have effects on the total number of home purchases in all of the four credit score cutoffs, but the estimated semi-elasticities of home purchases vary across the credit score cutoffs and income groups. In particular, the effects of g-fees on home purchases are muted for borrowers who are most likely to be financially constrained (low credit scores and low incomes) and borrowers who are least likely to be financially constrained (high credit scores and high incomes).

Towards the lower end of the credit score distribution, the semi-elasticity for the 680 credit score cutoff (about the 25th percentile in the credit score distribution) is estimated to be about 16% per 100 bps decline in g-fees, which is lower than the semi-elasticity estimate for the 720 cutoff of 24%. Moreover, within the 680 cutoff, the semi-elasticity is higher for above-median income borrowers (22%) than below-median income borrowers (11%). One reason for this may be due to above-median income borrowers with credit scores around 680 are less constrained by down payment constraints, which is reflected in a higher GSE share among above-median income borrowers at the 680 cutoff, at 38%, versus 28% for below-median income borrowers,. This result suggests that a cross-subsidy to borrowers with lower credit scores will benefit higher-income borrowers much more.

Towards the higher end of the credit score distribution, the semi-elasticity for the 780 cutoff (about the 75th percentile in the credit score distribution) is 7%, which is lower than semi-elasticity estimates for the three other lower credit score cutoffs. The semi-elasticity for above-median income borrowers at the 780 cutoff, who are least likely to be financially constrained, is close to zero and statistically insignificant. In contrast, the semi-elasticity for below-median income borrowers at this cutoff is 15%. One reason for this is lower reliance on GSE loans and greater reliance on non-agency loans by above-income borrowers at the 780 cut-off, at 43% and 49% market share, respectively, versus a GSE market share of 56% and non-agency market share of 31% among among below-median income borrowers. This result suggests that a cross-subsidy from high-score borrowers may disproportionately hurt lower-income borrowers.

For the 720 and 760 cutoffs, near the median credit score (740), the semi-elasticity estimates are at least as large as that for the 680 cutoff, although borrowers around these two middle cutoffs are less likely to be financially constrained. Moreover, the semi-elasticity estimates are similar between the two income groups at these two cutoffs.

Although the reduced-form estimates are useful, examining both the aggregate and distributional effects of alternative g-fee pricing requires applying interpolated semi-elasticities across the entire credit score and income distributions. For that purpose, we estimate a structural model of borrower demand in the style of Jiang (2023); Buchak et al. (2024) to interpolate our estimates for credit scores that are not covered by the four credit score cutoffs used in the reduced-form estimates and extrapolate at the very lower end. Our model closely matches our reduced-form estimates while being more parsimonious in terms of parameters, which allows us to interpolate in an internally consistent manner. We also estimate a supply side based on back-of-the envelope estimates of loan credit risk, taking into account the effects of private mortgage insurance. We find that the GSEs cross-subsidize low credit score, high LTV borrowers in a manner consistent with Gerardi (2017) as well as its cited references from FHFA, and that this redistribution increased following May 2023. Thus, our supply side estimates imply that the alignment of g-fees with credit risk decreased following May 2023.

Using our model, we conduct three counterfactual analyses of alternative g-fee pricing policies, motivated by recent policy discussions. Because efforts to release the GSEs from conservatorship are expected to increase g-fees overall and limit a cross-subsidy to high-risk borrowers, we consider the effects of a uniform increase in g-fees for all GSE loans and the effects of removing a cross-subsidy among GSE borrowers. We also consider the effects of reversing the recent May 2023 LLPA change, which was accused of increasing a cross-subsidy to high-risk borrowers.

First, we simulate the effect of a uniform 50 basis point increase in upfront g-fees. We find that the overall home-purchase originations will decline by 8 percent. Assuming 2023 origination volumes, which are low by historic standards, our back-of-the-envelope calculation suggests that GSE earnings will increase by approximately $3.3 billion per year (12 percent of their 2023 net incomes) at the expense of 105,000 fewer home-purchase originations. However,

the distributional effects of this g-fee increase are more ambiguous: progressive in terms of credit scores but regressive in terms of incomes. The uniform g-fee increase will have the largest negative home purchase effects among middle and higher credit score borrowers, whereas the effects on lower-credit-score borrowers are more muted due to their reliance on FHA/VA mortgages. On the other hand, home purchases will decline for below-median income households about 10 percent more than above-median income households, particularly driven by lower-income and high-credit-score borrowers.

Second, we simulate the effects of removing the GSE cross-subsidy by credit scores and LTV, while holding the average level of the GSE subsidy constant. Because the current LLPA favors borrowers with lower credit scores, we estimate that removing the cross-subsidy will decrease home purchases for borrowers with lower credit scores and increase home purchases for borrowers with higher credit scores. Although we hold constant the average level of the GSE subsidy, the aggregate number of home purchases will decline by 4.5 percent because borrowers receiving the cross-subsidy currently are more sensitive to g-fees than those providing the cross-subsidy. However, our results also suggest that the current cross-subsidy benefits higher-income borrowers much more. Removing the cross-subsidy will reduce home purchases of above-median income borrowers 38 percent more than those of below-median income borrowers. The group of borrowers that pay the highest price for the cross-subsidy is below-median income borrowers in the highest credit score bin. This finding suggests that the current cross-subsidy has unintended distributional effects, benefiting higher-income borrowers much more.

Third, we analyze the effect of reversing the May 2023 g-fee change. We find that rolling back the change would benefit middle credit score borrowers with credit scores between 720–759, at the expense of lower credit score borrowers with credit scores between 620–660. Overall, there is little impact on total volume for either above-median and below-median income borrowers. Therefore, the May 2023 change's redistributive effect on home purchase effect lies primarily in the credit score rather than income dimension.

Altogether, our counterfactual simulations show that g-fee pricing has significant effects on home purchases. If efforts to release the GSEs from conservatorship leads to an increase in g-fees, the aggregate home purchases will decline. However, the distributional consequences

of g-fee changes are less clear and depend on how g-fees are increased. One reasonable way to increase the GSEs' earnings is to increase g-fees more for households with lower credit scores than those with higher credit scores. This differential g-fee increase will be progressive in the income dimension and can potentially lead to more efficient g-fee pricing by aligning g-fees more with credit risk across borrower groups.

Previous papers studied how relatively homogeneous g-fee pricing leads to cross-subsidies across regions with different house price risk (Hurst et al., 2016), across borrowers with different prepayment speeds (Huh and Kim, 2023; Berger et al., 2024; Zhang, 2024), and across houses facing different climate risk (Ouazad and Kahn, 2022; Sastry et al., 2023; Gete et al., 2024). However, these cross-subsidies were mostly unintended consequences of the GSEs' relatively homogeneous pricing structure, whereas the GSEs' imperfect adjustment of their g-fees by credit scores and LTVs, as well as the level of their g-fees, were purposeful actions. We provide novel evidence on the effectiveness and efficiency of these purposeful g-fee pricing structures.

Our paper contributes to policy discussions regarding the role of GSEs, which have a large impact on the market through their credit guarantee (Lucas and McDonald, 2010; Jeske et al., 2013; Elenev et al., 2016; Gete and Zecchetto, 2018; Grundl and Kim, 2021; Gete et al., 2023; Amornsiripanitch and Ricks, 2024; Bosshardt et al., 2024) and the liquidity of their mortgage-backed securities (Vickery and Wright, 2013; Huh and Kim, 2022). The cross-subsidies embedded in GSE pricing strategies can be controversial. For example, Richardson et al. (2017) argues against GSE redistribution by noting that "any subsidies should be transparent, explicit, and on-budget; none of those characteristics apply to the cross-subsidies that would occur through a distorted PLMBS market [i.e. the GSEs]." Our paper contributes to increased transparency regarding GSE cross-subsidies by credit scores and LTVs as well as their distributional impacts.

Our paper contributes to the literature on the industrial organization of the US mortgage market. This literature includes Jiang (2023); Buchak et al. (2024), which examines the interaction between shadow banks and banks, whose models we build upon. Buchak et al. (2023) estimates the effect of integrated lender-servicers on borrower refinancing and recapture. In the UK context, Benetton (2021) estimates a structural model of bank competition in

UK mortgage market, and Robles-Garcia (2019) estimates a model of brokers incentives on consumer search. We use a structural model in the style of Jiang (2023); Buchak et al. (2024) to estimate how GSE fee changes affect borrower home purchase decisions, interpolating between our reduced-form estimates in a disciplined way.

Finally, our paper adds to the literature on post-crisis changes in the US mortgage market. This includes the increased use of leverage regulation (DeFusco et al., 2020), regressive redistribution across loan sizes (D'Acunto and Rossi, 2022), changes in the price of financial intermediation (Fuster et al., 2017), and the role of servicers in COVID-19 forebearance relief (Kim et al., 2024). Another strand of this literature analyzes the effect of interest rates on home buying from a FHA mortgage insurance premium (MIP) cut (Bhutta and Ringo, 2021) as well as from high frequency monetary policy shocks (Ringo, 2024), both of which find that lower income borrowers were more responsive to interest rates, which is in apparent contrast to our result that lower income, lower credit score borrowers are less responsive to GSE fee changes. A natural explanation for the difference is in the types of mortgages affected by the policy shocks: lower income, lower credit score borrowers are likely more reliant on the FHA market due to their liquidity constraints, and so they may be less sensitive to GSE pricing even though they may be more sensitive to FHA interest rates as well as interest rates more broadly. Relatedly, DeFusco and Paciorek (2017) studies the interest elasticity of the intensive margin of loan size demand using the conforming-jumbo spread, and finds muted effects on loan size, which justifies our focus on the extensive margin.

2 Background

The GSEs charge two types of g-fees to lenders selling loans to them: ongoing g-fees and upfront g-fees. The ongoing g-fees are monthly charges, which do not vary by borrower credit characteristics. The upfront g-fees is a one-time fee paid at the time of selling loans to the GSEs. In the aftermath of the Great Financial Crisis, the GSEs introduced risk-based pricing of the upfront g-fees based on the loan level price adjustments (LLPAs), which adjust the upfront

g-fees to credit risk implied by credit score and LTV.[5] This risk-based pricing for the GSEs stands in contrast with the Federal Housing Administration (FHA) and Department of Veteran Affairs (VA) loans. FHA and VA charge lenders a flat rate/premium proportional to the loan amount, regardless of the underlying credit characteristics, in exchange for providing insurance and guarantees against borrower default.

Figure 1(a) shows that the upfront fee generally increases for loans with higher credit risk (lower credit scores and higher LTVs). However, empirical estimates suggest that the LLPA does not fully adjust prices to underlying risk (Gerardi, 2017; Tsai, 2023). The LLPA had remained largely stable until recently, when a series of adjustments were made to GSE pricing. This is the first set of major changes since their introduction of the LLPA in April 2008, which we take advantage of in our research.

The g-fee changes that we examine was announced on January 19, 2023. The GSEs implemented a set of changes to the upfront g-fees that took effect for loans purchased by the GSEs beginning May 1, 2023.[6] Figure 1(b) shows the changes in upfront g-fees for different combinations of credit score and LTV ranges of home-purchase mortgages, measured in percentages of the loan amount. Red cells represent combinations where the LLPAs increased after May 1st, and green cells represent combinations where LLPAs decreased. Importantly, first-time home buyers with low to moderate incomes (LMI) are exempt from upfront G-fees during this time period and are therefore unaffected by the May 2023 LLPA change. While we cannot identify first-time home buyers in our data, we exclude low to moderate income borrowers from our sample.

Figure 1(b) suggests that g-fees might have been changed very differently for borrowers with similar credit risk because the LLPA is based on discrete grids of credit scores and LTVs. For example, the g-fee for a borrower with the credit score of 679 and the LTV of 80 declined by 87.5 bps, while the g-fee for a borrower with the credit score of 680 and the LTV of 80 was unchanged, although these two borrowers are likely to have nearly identical credit risk. In fact, as long as their LTVs are greater than 60, g-fees were changed more favorably for all borrowers

[5]Fannie Mae refers to upfront fees as "loan level price adjustments," while Freddie Mac refers to them as "credit fees in price." Because the industry typically uses the term LLPAs, in this paper we adopt the Fannie Mae term.

[6]See the directive HERE and an overview of the changes HERE.

with credit scores just below 680 than those just above 680 conditional on their LTV choices.

There are also other credit score cutoffs (720, 760, and 780), where g-fees were changed more favorably for all borrowers with credit scores on one side of the cutoff than those on the other side conditional on their LTV choices, as long as their LTVs are high enough. For example, the g-fee was changed more favorably for a borrower with credit score of 719 than for a borrower with credit score of 720 for any LTV greater than 60, although some borrowers below the 720 cutoff experienced an increase in g-fees. The g-fee was increased for a borrower with the credit score of 719 with an LTV choice between 75.01 and 95, but the g-fee was increased even more for a borrower with the credit score of 720 with the same LTV. For the cutoffs of 760 and 760, g-fees were changed more favorably for borrowers just above the cutoffs than those just below in contrast to the cutoffs of 680 and 720.

We adopt a difference-in-discontinuities (DIDC) regression design (Grembi et al., 2016; Butts, 2023) to estimate the effects of the changes in sharp discontinuities in g-fees around these critical score cutoffs at 680, 720, 760, and 780, while controlling for unobservable differences in underwriting standards at these cutoffs. Even though the LLPA changes also depend on the LTV of the loans, we do not apply a similar DIDC strategy to LTV cutoffs, because the LTVs are inherently endogenous. Section 4 discusses our identification strategy in more detail.

3 Data

Our main analysis relies on the confidential HMDA data from 2022 to 2023. The confidential HMDA data include loan origination dates, credit scores, property values, and loan amounts. This information allows us to determine the amount of the upfront g-fee and the change in the g-fee for each loan based on its characteristics, using the LLPA matrix shown in Figure 1(b).

We consider conventional loans, FHA loans, and VA loans in our sample, and exclude USDA or Farm Service Guaranteed loans. We only consider the home-purchase loans and exclude refinance loans, although the May 2023 LLPA changes also apply to refinance loans sold to the GSEs. Our identification strategy based on credit score cutoffs may not work very well for refinance borrowers are more likely to be flexible in terms of the timing of loan

Figure 1: LLPA Matrix and Its Change in May 2023

Representative Credit Score	LTV Range								
	Applicable for all mortgages with terms greater than 15 years								
	≤ 60.00%	60.01 – 70.00%	70.01 – 75.00%	75.01 – 80.00%	80.01 – 85.00%	85.01 – 90.00%	90.01 – 95.00%	95.01 – 97.00%	>97.00%
≥ 740	0.000%	0.250%	0.250%	0.500%	0.250%	0.250%	0.250%	0.750%	0.750%
720 – 739	0.000%	0.250%	0.500%	0.750%	0.500%	0.500%	0.500%	1.000%	1.000%
700 – 719	0.000%	0.500%	1.000%	1.250%	1.000%	1.000%	1.000%	1.500%	1.500%
680 – 699	0.000%	0.500%	1.250%	1.750%	1.500%	1.250%	1.250%	1.500%	1.500%
660 – 679	0.000%	1.000%	2.250%	2.750%	2.750%	2.250%	2.250%	2.250%	2.250%
640 – 659	0.500%	1.250%	2.750%	3.000%	3.250%	2.750%	2.750%	2.750%	2.750%
620 – 639	0.500%	1.500%	3.000%	3.000%	3.250%	3.250%	3.250%	3.500%	3.500%
< 620[1]	0.500%	1.500%	3.000%	3.000%	3.250%	3.250%	3.250%	3.750%	3.750%

(a) LLPA Matrix for 2022

Credit Score	LTV Range								
	Applicable for all loans with terms greater than 15 years								
	≤ 30.00%	30.01 – 60.00%	60.01 – 70.00%	70.01 – 75.00%	75.01 – 80.00%	80.01 – 85.00%	85.01 – 90.00%	90.01 – 95.00%	>95.00%
≥ = 780	0.000%	0.000%	-0.250%	-0.250%	-0.125%	0.125%	0.000%	0.000%	-0.625%
760 – 779	0.000%	0.000%	-0.250%	0.000%	0.125%	0.375%	0.250%	0.250%	-0.500%
740 – 759	0.000%	0.000%	-0.125%	0.125%	0.375%	0.750%	0.500%	0.375%	-0.250%
720 – 739	0.000%	0.000%	0.000%	0.250%	0.500%	0.750%	0.500%	0.375%	-0.250%
700 – 719	0.000%	0.000%	-0.125%	-0.125%	0.125%	0.500%	0.250%	0.125%	-0.625%
680 – 699	0.000%	0.000%	0.125%	-0.125%	0.000%	0.375%	0.250%	0.125%	-0.375%
660 – 679	0.000%	0.000%	-0.250%	-0.875%	-0.875%	-0.625%	-0.500%	-0.625%	-1.000%
640 - 659	-0.500%	-0.500%	-0.125%	-1.250%	-0.750%	-0.750%	-0.750%	-0.875%	-1.250%
620 - 639	-0.500%	-0.375%	0.000%	-0.875%	-0.250%	-0.375%	-0.625%	-1.000%	-1.750%
≤ 619[1]	-0.500%	-0.375%	0.000%	-0.875%	-0.250%	-0.375%	-0.625%	-1.000%	-2.000%

(b) G-fee Changes in May 2023

Note: Figure 1(a) shows the level of the LLPA for loans sold to the GSEs in 2022. Figure 1(b) shows the changes in g-fees for home purchase loans effective in May 2023. The values are in percentages of the loan amount. Green cells represent decreases in g-fees, while red cells represent increases.

application to be located in the LLPA cell with a more favorable g-fee change. Moreover, there were very low levels of refinancing activity due to the interest rate environment around the time when the LLPA change was implemented. As discussed earlier, we also exclude borrowers with low to moderate incomes because first-time home buyers with low to moderate incomes are exempt from upfront g-fees during this time period and are therefore unaffected by the May 2023 LLPA change. Because we cannot identify first-time home buyers using HMDA, we exclude all borrowers with low to moderate incomes.

We determine whether a loan was purchased by the GSEs using a HMDA field called "purchaser type," which provides information on the type of entity to whom the HMDA reporter sold the loan. We use Code 1 (Fannie Mae) and 3 (Freddie Mac) to capture the loans that were sold to the GSEs. We refer to conventional loans that are not sold to the GSEs as "non-agency loans" because they are typically held on a lender's portfolio or securitized into non-agency MBS. In our analysis, we group FHA loans and VA loans together into the same loan type because these two loan types have similar characteristics with relatively low credit scores and high LTVs and are securitized into Ginnie Mae MBS with explicit government guarantees.

The HMDA "purchaser type" field suffers from two known deficiencies. First, many small HMDA reporters may not directly sell the loans to the GSEs but would sell the loans to aggregators who subsequently sell the loans to the GSEs. In this case, these small HMDA reporters would not report the GSEs as the purchaser but another financial institution as the purchaser. We address this second deficiency by using a Universal Loan ID, which allows us to track a loan from its originator to its purchaser and eventually determine whether the purchaser sold the loan to the GSEs. An additional 17 percent of GSE loans are identified in this way.

Second, the "purchaser type" field has a censoring issue for some loans because loans that had not been sold by the end of the year but were eventually sold in the next year would be reported as "not sold." This data censoring issue mainly affects loans originated towards the end of the year, as the median interval from the date of origination to a loan being sold was about 16 days based on our calculation, with mean being 32 days and 95th percentile at 56 days. Thus, we drop loans originated in December of each calendar year from our sample.

Summary Statistics Figure 2(a) shows that the number of home-purchase loan originations in 2022 for each of the three loan types that we consider: GSE loans, FHA or VA loans, and non-agency loans. Figures 2(b) and 2(c) show the average LTV and the average household income relative to the median family income of the relevant Metropolitan Statistical Area or Metropolitan Division by loan type and credit score, respectively. These three figures show a large degree of heterogeneity in loan characteristics among households with different credit

scores, possibly influenced by the LLPA. This large heterogeneity also suggests that the effects of changes in g-fee pricing will be heterogeneous effects among households with different credit scores and incomes.

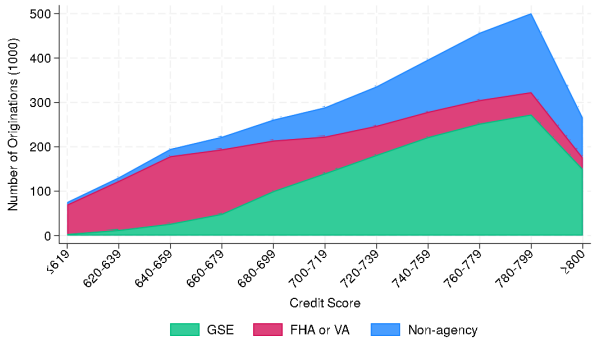
First, a vast majority of households with very low credit scores below 680 choose FHA or VA loans, which generally have very high LTVs (as shown in figure 2(b)). This data pattern is consistent with the fact that the mortgage insurance premium charged for FHA or VA loans does not depend on credit scores or LTV, while the LLPA is higher for borrowers with lower credit scores and higher LTVs despite the GSEs' cross-subsidy for such borrowers. Accordingly, the average LTVs of the small number of GSE loans with very low credit scores are much lowers than those for FHA loans, as shown in figure 2(b). Moreover, non-agency loans, which include loans kept on a lender's portfolio and loans securitized into private-label MBS, do not carry credit guarantee, causing the interest rate much higher for households with low credit scores. The premium of private mortgage insurance, which is required for conventional loans (GSE or non-agency loans), is also likely to higher for loans with lower credit scores and higher LTVs.

Second, figure 2(a) also shows that GSE originations account for significant shares of total loan originations for households with credit scores at least 680, suggesting that lower LLPAs for higher credit scores make GSE loans a cheaper option for such households than FHA or VA loans. Non-agency loans also account for higher shares for higher-score households likely because of their lower credit risks. Figure 2(b) shows that the average LTV of GSE loans for households with credit scores at least 680 is slightly higher than that for households with credit scores below 680, but the average LTV of GSE loans always remains much lower than the average LTV for FHA or VA loans because the LLPA is still higher for higher LTVs even for higher credit scores.

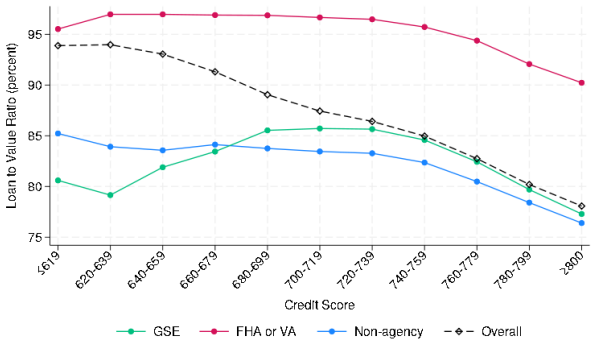
Lastly, figure 2(c) shows that, for most credit score bins, households with GSE or non-agency loans generally have higher incomes relative to the median family income of the area where their homes are located. This data pattern suggests that the GSEs' cross-subsidy for loans with lower credit scores may not benefit borrowers with lower relative incomes because they generally prefer FHA or VA loans. On the other hand, the cross-subsidy may have to be provided by households with higher credit scores but relatively lower relative incomes because

the highest-income households take non-agency loans.

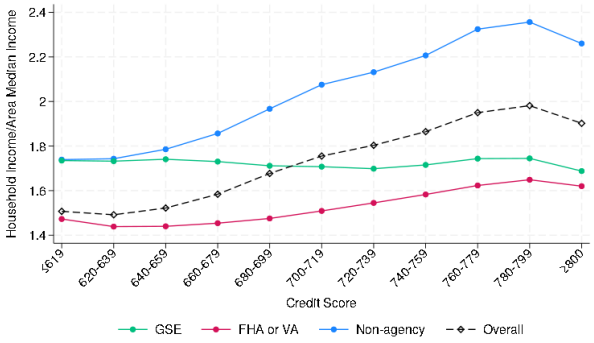
Figure 2: Loan Characteristics by Credit Score, Home Purchase Loans



(a) Number of Originations



(b) Average LTV



(c) Average Ratio of Household Income to Area Median Family Income

Note: Panel (a) shows the number of home-purchase loan originations for each loan type by credit score. Panel (b) shows the average LTVs of each loan type by credit score. The sample is loans originated in 2022, excluding December.

Table 1 presents the summary statistics by loan type. The variation in credit scores and LTVs in this table is consistent with figures 2(a) and 2(b). Accordingly, property values are much higher for GSE and non-agency loans than for FHA or VA loans, although origination loan sizes are not very different across loan type. DTIs are lower for GSEs and non-agency loans than for FHA or VA loans, suggesting that households with lower incomes are less likely to choose GSE or non-agency loans. The average mortgage rate is about 5.6 percent in our sample period. Lastly, borrowers in the sample pay about $3,000 for points and origination fees net of lender credits, which is about 90 bps of the average loan origination balance.

Table 1: Summary statistics by loan type

	GSE	Non-Agency	FHA/VA	All
Credit Score	752	749	689	731
	(42)	(45)	(55)	(56)
LTV	81.7	81.98	97.0	86.8
	(15.6)	(16.0)	(8.2)	(15.4)
DTI	37.7	36.6	44.4	39.7
	(8.9)	(9.1)	(8.9)	(9.5)
Loan Amount ($000s)	344.1	338.7	316.0	334.0
	(165.7)	(187.5)	(137.7)	(161.7)
Property Value ($000s)	436.7	435.4	330.4	401.5
	(228.9)	(274.0)	(148.7)	(220.8)
Interest Rate (%)	5.647	5.793	5.560	5.643
	(1.227)	(1.414)	(1.205)	(1.256)
Net Origination Charges ($)	3,084	2,849	2,827	2,960
	(3,316)	(3,443)	(3,376)	(3,360)
Share of Loans (%)	50.3	16.9	32.9	100

Note: The sample consists of loans originated in 2022 and 2023, excluding Decembers, limited to closed-end, non-reverse mortgages, 30-year fixed rate, non-IO, home-purchase mortgages secured by site-built, one-unit, first-lien, principal residence. Standard deviations are in parentheses.

4 Effects of G-fees on Home Purchases

We examine the effects of g-fees using the LLPA change in May 2023 in this section. As discussed in Section 2, the amount of upfront g-fee change in May 2023 is determined by the discrete grid of credit scores and LTVs. We exploit the discrete nature of this change for identification of the effects of g-fees. In particular, we use a difference-in-discontinuties (DIDC) approach (Grembi et al., 2016; Butts, 2023), which exploits differences in the amount of the upfront g-fee changes depending on whether a borrower's credit score is just below or above a credit score cutoff (for example, 679 vs 680). Although credit scores just below and above these boundaries are likely to have nearly identical credit risk, upfront g-fees for borrowers with credit scores just below certain cutoffs have changed by different amounts, compared with borrowers with credit scores just above the cutoffs. We focus on differences in how much g-fees changed across borrowers with different credit scores rather than different LTVs because LTVs are more likely to be endogenous.

For estimation, we focus on borrowers with credit scores around the four different cutoffs:

680, 720, 760, and 780. The differences in the g-fee changes were particularly large for borrowers in credit score grids below and above the four cutoffs. For credit scores around 680, g-fees declined by 68 bps for credit scores from 660 to 679 relative to credit scores from 680 to 699, using the LTV distribution prior to the g-fee change. For credit scores around 720, g-fees increased less by 26 bps for credit scores from 700 to 719 relative to credit scores from 721 to 739. For credit scores around 760, g-fees increased by 18 bps for credit scores from 740 to 759 relative to credit scores from 760 to 779. For credit scores around 780, g-fees increased by 19 bps for credit scores from 760 to 779 relative to credit scores from 780 to 799.

4.1 Regression specifications

We estimate the effects of g-fee changes for borrowers with credit scores around the four cutoffs separately to examine how the effects vary across the credit score distribution. For loan-level regressions of loan characteristics like interest rates, we estimate a linear regression of the following form:

$$\begin{aligned} y_{it} = {} & \alpha_{00} + \alpha_{01}(x_{it} - X) + Post_{it} \times [\beta_{00} + \beta_{01}(x_{it} - X)] \\ & + \mathbf{1}(x_{it} \leq X)\,[\alpha_{10} + \alpha_{11}(x_{it} - X)] + Post_{it} \times \mathbf{1}(x_{it} \leq X)\,[\beta_{10} + \beta_{11}(x_{it} - X)] \\ & + \xi_c + \xi_t + \epsilon_{it}. \end{aligned} \tag{1}$$

We consider four different values of X: 680, 720, 760, and 780. We use a local linear regression to estimate Equation 1 on a narrow credit score range, as in Imbens and Wager (2019). Our sample includes borrowers with credit scores from $X - 19$ to $X + 20$. For example, when $X = 680$, our sample is borrowers with credit scores between 661 and 700. For the same LTV, borrowers with credit scores from $X - 19$ to X belong to a single LLPA grid, and borrowers with credit scores from $X + 1$ to $X + 20$ belong to another LLPA grid. Although borrowers with credit scores with X and $X + 1$ pose nearly identical credit risk, the upfront g-fees are different because they belong to different LLPA grids.

The main coefficient of interest is β_{10}, which captures the effect of the differential changes

in the g-fees depending on the treatment status. We define $Post_{it}$ to be one if a loan is originated after January 2023, as the LLPA change was announced in January 2023. We examine pre-trends around this date in Appendix Figure A.4.

The specification in Equation 1 allows us to control for how the outcome variable y_{it} is correlated with credit scores flexibly before and after the policy. We allow for the possibility that the correlation between the outcome variable y_{it} and credit scores differs depending on whether a borrower's credit score is above or below the threshold and whether the loan is originated before or after the announcement of the new LLPA, and also allow for a pre-policy discontinuity α_{10} at the threshold X. The main assumption is that the discontinuity at X would remain constant absent the policy. Lastly, ξ_c and ξ_t refer to the county fixed effects and the origination year-month fixed effects.

When we examine the effect of the g-fee change on the number of loan originations, we estimate a Poisson regression at the level of each credit score (cs) $\times$ origination year-month (t). We assume that the number of loan originations for each $cs \times t$ has the conditional expectation of the following form:

$$\begin{aligned}\ln\left(E\left[y_{cs,t}|cs,t\right]\right) = {} & \alpha_{00} + \alpha_{01}(x_{it} - X) + Post_{it} \times \left[\beta_{00} + \beta_{01}(x_{it} - X)\right] \\ & + \mathbf{1}(x_{it} \leq X)\left[\alpha_{10} + \alpha_{11}(x_{it} - X)\right] + Post_{it} \times \mathbf{1}(x_{it} \leq X)\left[\beta_{10} + \beta_{11}(x_{it} - X)\right] \\ & + \xi_t . \end{aligned} \tag{2}$$

4.2 Borrowing Cost

We first estimate the effects of the g-fee changes on borrowing costs. Because mortgage pricing is multi-dimensional, we consider not only mortgage interest rates but also the upfront fees and points paid by the borrowers directly to the lenders. For the upfront price, we calculate the net origination charges, defined as fees and points paid by borrowers net of lender credits. Examples of origination charges include origination fees, underwriting fees, application fees, as well as discount points borrowers pay to buy down the interest rate. In the rest of the paper, we measure the net origination charges in percentages of the loan amount at origination.

Figure 3 presents data patterns driving the estimates graphically after residualizing mortgage rates and net origination charges by the fixed effects included in the regressions. In all panels, there is a visibly clear change at the cutoff before and after the g-fee change, and the change in the discrete jump at the cutoff is consistent with the regression estimates reported in table 2.

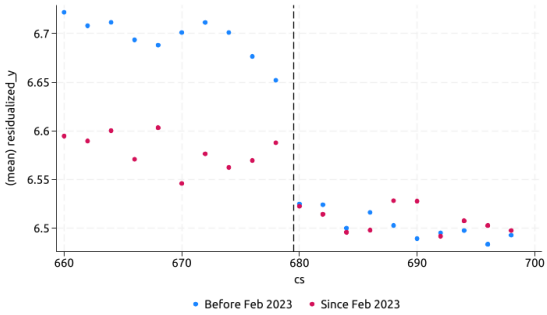
Table 2 presents the estimates for β_{10} in equation (1) per 100 bps increase in g-fees for borrowers below the cutoff for mortgage rates and net origination charges by loan type, respectively. In addition to the county fixed effects and origination year× fixed effects in equation (1), we also include extra controls for these regressions: the lender fixed effects, the fixed effects for each LLPA grid, an indicator for adjustable-rate mortgages, its interaction with $\mathbb{1}[x_{it} \leq X]$, an indicator for GSE loans, non-agency loans, and FHA/VA loans, and its interaction with $\mathbb{1}[x_{it} \leq X]$.

The estimates show that the LLPA change in May 2023 led to considerable changes in borrowing costs of the GSE loans, both in terms of mortgage rates and net origination charges. How much a g-fee change is passed down in the forms of mortgage rates and net origination charges is slightly different across credit score thresholds. However, the total change in borrowing costs, encompassing both mortgage rates and net origination charges, amounts to the g-fee change roughly for each threshold. For the 680 cutoff, for example, column (5) in table 2(a) shows that about 40% of the g-fee change was passed through to borrowers in the form of net origination charges. Column (1) of the same table shows that a 100 bps increase in g-fees leads to a 13.5 bps increase in mortgage rates, which is roughly equivalent to 60 bps (= 14×4.4) increase in the upfront fee per a dollar of the loan.[7]

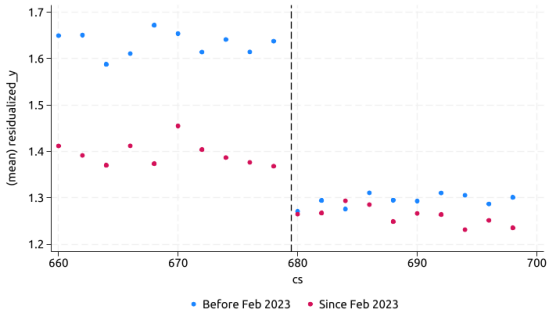
The total effects on borrowing costs for all loans, not just GSE borrowers, are much smaller primarily because many borrowers choose other loan types. The GSE share is generally greater for borrowers with higher credit scores. Thus, the difference between the effects on GSE loans and the total effects is smaller for higher credit score thresholds. Changes in borrowing costs for non-GSE loans can also affect the total effects. We do not find any statistically significant changes in FHA or VA loans. However, the estimates for borrowing costs for non-

[7]The normalization by 4.4 is based on a back-of-envelope calculation using the estimate from Huh and Kim (2023), in which a 100 bps change in MBS price is associated with 100/4.4 bps difference in mortgage rates.

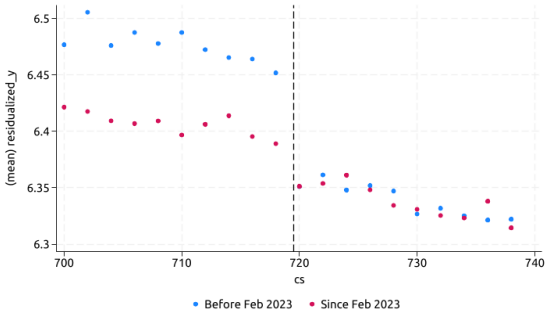
Figure 3: Interest Rates and Net Origination Charges for GSE loans



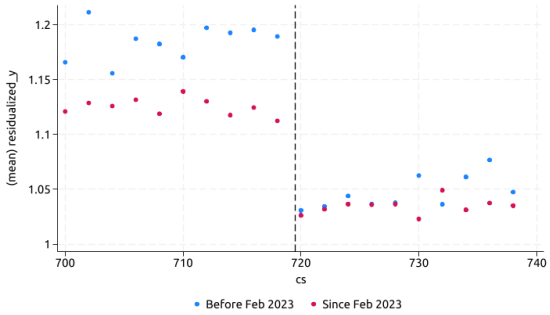
(a) Mortgage rates (credit score 680)



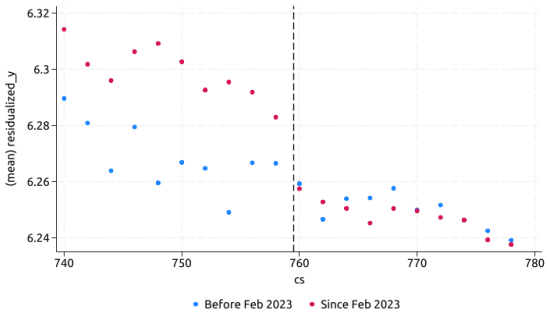
(b) Net origination charges (credit score 680)



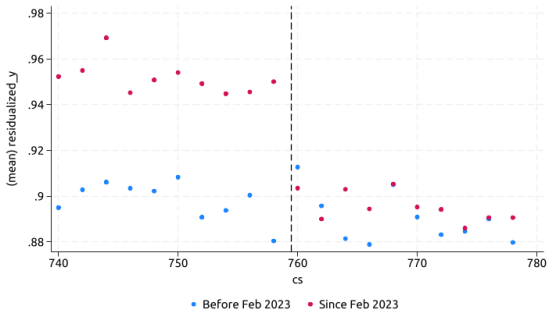
(c) Mortgage rates (credit score 720)



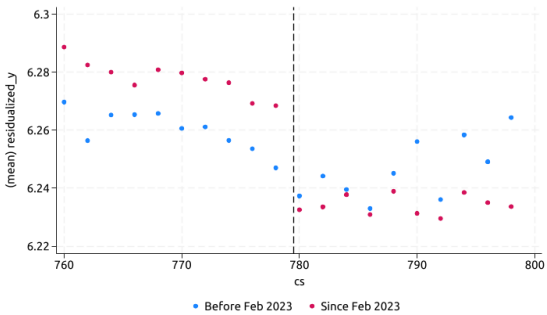
(d) Net origination charges (credit score 720)



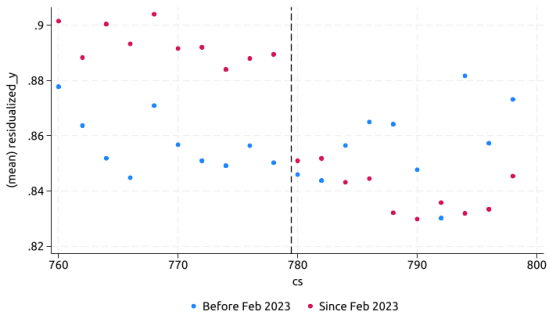
(e) Mortgage rates (credit score 760)



(f) Net origination charges (credit score 760)



(g) Mortgage rates (credit score 780)



(h) Net origination charges (credit score 780)

Note: mortgage rates and net origination charges residualized by the fixed effects in equation (1).

agency loans have the same sign as the estimates for GSE loans, and they are often statistically significant. These results suggest that the pricing for non-agency loans responds to GSE loan pricing to the extent that non-agency securitization or balance-sheet lending competes with GSE securitization.

4.3 Number of loan originations

We now examine the effects on home purchases. Figure 4 plots the log number of originations by credit score pre-and-post policy. Table 3 presents estimates of β_{10} for the number of loan originations for different loan types using a Poission regression in equation (2). The table reported the estimates β_{10} per 100 bps increase in g-fees, so the estimates represent semi-elasticities of the number of home-purchase originations per 100 bps increase in g-fees. Unlike the earlier regressions of borrowing costs, this Poisson regression does not control for loan characteristics like lenders and LTVs because we want to measure changes in the aggregate number of originations as is identified using the difference-in-discontinuity approach.

Our result show that the g-fee changes had large effects on GSE loan originations. The largest effects are at the 680 cutoff with the semi-elasticity of 39% for GSE originations, in column (1) of Table 3(a)), and the smaller effects are at the 780 cutoff with the semi-elasticity of 19% for GSE originations in column (1) of Table 3(a)). The elasticities for the 720 and 760 cutoffs are in between those for the 680 and 780 cutoffs.

We also find that the substitutions with other loan types are fairly limited and do not offset the change in GSE originations very much. In particular, the substitution between GSE loans and FHA/VA loans is relatively small even for the 680 cutoff, although nearly a half of borrowers at this cutoff choose FHA/ VA loans. This finding suggests that the substitution between the two loan types, though statistically significant at the 10% level, is far from perfect, consistent with the estimates from Bhutta and Ringo (2021), who also find a similar partial substitution after the 2015 cut in the FHA mortgage insurance premium.

Although the GSE elasticity is the largest for the 680 cutoff, the elasticity for the total home-purchase originations for this cutoff (16%, column (4) of table 3(a)) is not larger than the estimated elasticities for the 720 and 760 cutoffs (column (4) of tables 3(b) and 3(c)). This

Table 2: Effects of a 100 bps increase in g-fees on mortgage rates and net origination charges

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	0.135***	-0.003	0.023	-0.036**	0.392***	0.025	0.121**	0.098***
	(0.029)	(0.015)	(0.040)	(0.016)	(0.032)	(0.030)	(0.050)	(0.023)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	75,471	142,093	45,452	266,328	74,534	139,332	44,383	261,498
Adj. R^2	0.60	0.63	0.74	0.61	0.24	0.26	0.51	0.28

(a) Credit scores around 680

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	0.223***	0.089	0.081	0.072***	0.276***	-0.013	0.089	0.117***
	(0.030)	(0.055)	(0.058)	(0.024)	(0.035)	(0.068)	(0.064)	(0.027)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	182,613	91,770	108,708	386,564	179,880	89,886	106,333	379,664
Adj. R^2	0.64	0.63	0.74	0.64	0.21	0.25	0.46	0.28

(b) Credit scores around 720

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	0.204***	-0.041	-0.075	0.078**	0.306***	-0.021	0.050	0.176***
	(0.050)	(0.114)	(0.045)	(0.030)	(0.065)	(0.117)	(0.056)	(0.031)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	310,313	74,687	211,586	599,890	305,211	73,165	207,206	589,011
Adj. R^2	0.66	0.63	0.74	0.67	0.19	0.21	0.41	0.27

(c) Credit scores around 760

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	0.105***	-0.099	0.026	0.016	0.211***	-0.190	0.066	0.097***
	(0.028)	(0.089)	(0.044)	(0.026)	(0.055)	(0.122)	(0.042)	(0.031)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	365,831	74,883	268,702	712,662	359,907	73,339	263,292	699,884
Adj. R^2	0.65	0.63	0.74	0.68	0.18	0.19	0.39	0.26

(d) Credit scores around 780

Note: The estimates of equation (1) for mortgage rates and net origination charges as percent of loan amount per 100 bps increase in g-fees for borrowers below each cutoff. All columns include origination year-month fixed effects, county fixed effects, and fixed effects for discrete grid of LTVs used in the LLPA. Standard errors are clustered by the credit score.

finding suggests that there are still relatively few would-be home buyers at the 680 cutoff, who would prefer GSE loans over other loan types, in particular FHA/ VA loans. Despite the cross-subsidy in g-fees for these borrowers, the level of g-fees is still high for borrowers with lower credit scores and higher LTVs. Thus, without enough downpayments to reduce LTVs, many would-be home buyers at the 680 cutoff may still prefer FHA/VA loans, whose mortgage insurance premiums do not vary with credit risk. The semi-elasticity for the total originations is still the smallest at the 780 cutoff (6.5%), reflecting that the highest credit score borrowers have the lowest interest elasticity of demand for both GSE mortgages and overall.

In the appendix figure A.5, we report the estimates of an alternative event-study style regression, where we interact the dummy variable for credit scores below each threshold with the month fixed effects. We generally find parallel pre-trends for the number of loan originations, suggesting that our main estimates reflect the causal effects of the change in the LLPA.

Heterogeneous effects on the number of originations by income We also study the heterogenous effects of the g-fee change by income. Specifically, we split our sample into two groups depending on whether their household income relative to their MSA median income is above or below the median of the relative income distribution. Table 4 presents the semi-elasticity estimates by income. The relationship between household incomes and the elasticities is different across the credit score cutoffs. At the 680 cutoff, higher-income borrowers are more responsive to g-fees than lower-income borrowers (columns (7) and (8) of panel (a)). The semi-elasticity of the total home-purchase originations for above-median income borrowers is twice as large as that for below-median income borrowers. In contrast, at the 780 cutoff, the semi-elasticity of the total originations for higher-income borrowers is close to zero and statistically insignificant (column (7) of panel (d)), while that for lower-income borrowers is 15% (column (8) of panel (d)). At the 720 and 760 cutoffs, the semi-elasticities are similar between lower- and higher-income borrowers.

These results suggest that income characteristics of marginal borrowers are different across the credit score cutoffs. At the 680 cutoff, marginal borrowers are more likely to have higher

incomes, and lower-income borrowers are more like to lack downpayments and prefer FHA/ VA loans and thus are not very responsive to g-fee changes. At the 780 cutoff, marginal borrowers are more likely to have lower incomes, and higher-income borrowers do not reduce their home purchases significantly with g-fee changes.

These reduced-form elasticity estimates show that the effects of g-fee changes vary significantly with credit scores and incomes. They also suggest that a simple cross-subsidy may have unintended distributional consequences. For example, the cross-subsidy toward borrowers with low credit scores is more likely to benefit higher-income borrowers, at the expense of lower-income borrowers with high credit scores.

Although the reduced-form estimates are useful, examining both the aggregate and distributional effects of alternative g-fee pricing requires applying semi-elasticities across the entire credit score and income distributions. In the next section, we turn to a structural model for that purpose.

Table 3: Semi-elasticities of the number of home-purchase loan originations with respect to a 100 bps increase in g-fees

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	-0.392***	0.051*	-0.080	-0.155***
	(0.042)	(0.030)	(0.068)	(0.033)
Share	0.32	0.49	0.19	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.858	0.658	0.737	0.809

(a) Credit scores around 680

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	-0.267***	-0.022	-0.145*	-0.236***
	(0.052)	(0.144)	(0.078)	(0.025)
Share	0.50	0.20	0.30	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.820	0.645	0.757	0.839

(b) Credit scores around 720

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	-0.316***	0.029	-0.027	-0.167**
	(0.084)	(0.192)	(0.103)	(0.067)
Share	0.52	0.12	0.36	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.856	0.527	0.855	0.902

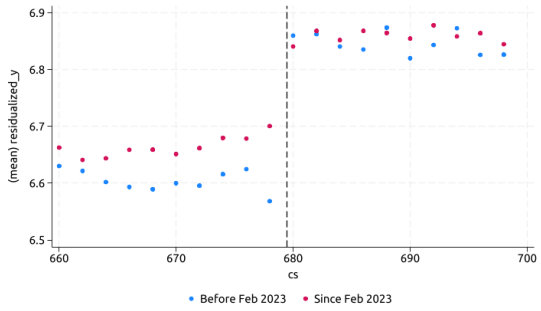
(c) Credit scores around 760

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	-0.185***	0.038	0.052	-0.065**
	(0.056)	(0.120)	(0.058)	(0.027)
Share	0.49	0.10	0.41	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.823	0.514	0.790	0.840

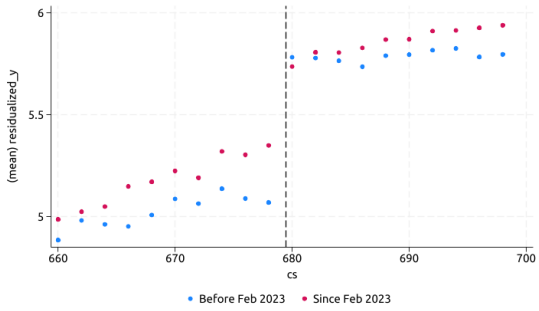
(d) Credit scores around 780

Note: this table presents Poisson regression estimates of equation (1) for mortgage number of home-purchase originations per 100 bps increase in g-fees. "Share" refers to the market share of each loan type in the sample. Standard errors are clustered by the credit score.

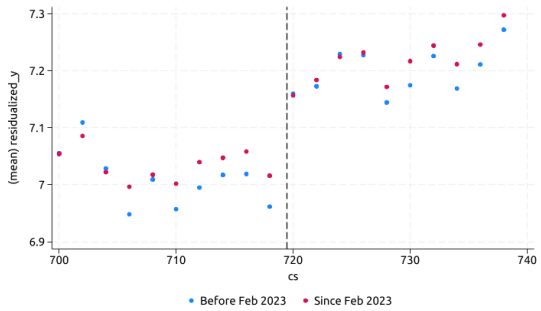
Figure 4: Number of home-purchase loan originations for credit scores around 680



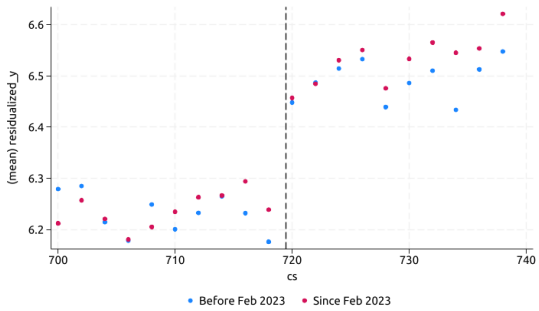
(a) All loans (credit score 680)



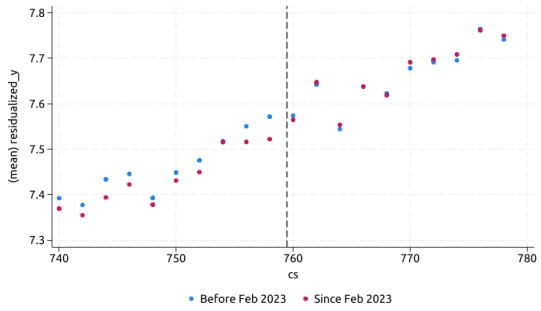
(b) GSE loans (credit score 680)



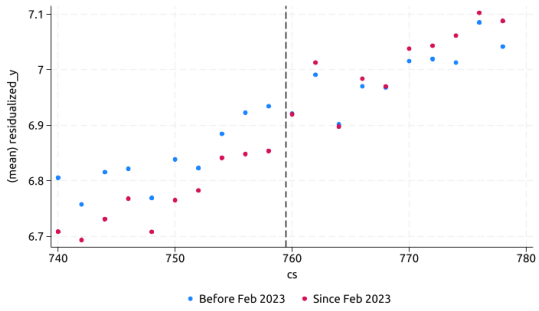
(c) All loans (credit score 720)



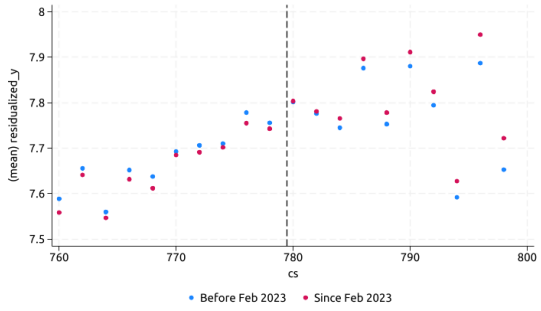
(d) GSE loans (credit score 720)



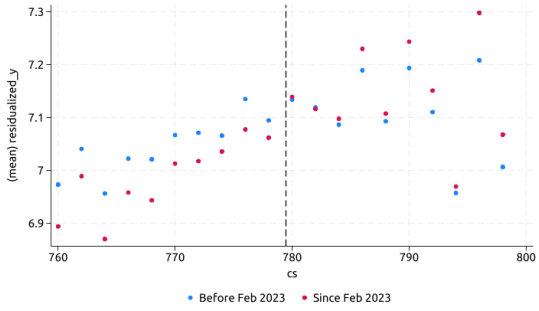
(e) All loans (credit score 760)



(f) GSE loans (credit score 760)



(g) All loans (credit score 780)



(h) GSE loans (credit score 780)

Note: this figure presents average log loan counts pre-and-post policy.

Table 4: Semi-elasticities of the number of home-purchase loan originations with respect to a 100 bps increase in g-fees by income

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.437***	-0.334***	0.073*	0.037	-0.165**	-0.009	-0.223***	-0.110***
	(0.041)	(0.079)	(0.039)	(0.043)	(0.071)	(0.078)	(0.026)	(0.041)
Share	0.38	0.28	0.37	0.58	0.24	0.15	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.752	0.783	0.431	0.579	0.647	0.552	0.727	0.680

(a) Credit scores around 680

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.292***	-0.213**	-0.185	0.084	0.098	-0.469***	-0.194***	-0.252***
	(0.091)	(0.085)	(0.195)	(0.137)	(0.107)	(0.114)	(0.053)	(0.059)
Share	0.49	0.51	0.15	0.26	0.37	0.24	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.691	0.737	0.445	0.554	0.692	0.536	0.770	0.714

(b) Credit scores around 720

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.274***	-0.332***	-0.118	0.119	-0.024	-0.121	-0.160***	-0.195
	(0.101)	(0.120)	(0.236)	(0.236)	(0.108)	(0.156)	(0.049)	(0.121)
Share	0.47	0.56	0.09	0.16	0.43	0.28	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.783	0.755	0.385	0.405	0.825	0.626	0.871	0.783

(c) Credit scores around 760

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.132*	-0.237***	0.304	-0.167	0.014	0.028	-0.029	-0.146**
	(0.080)	(0.072)	(0.207)	(0.126)	(0.076)	(0.083)	(0.036)	(0.059)
Share	0.43	0.56	0.08	0.13	0.49	0.31	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.771	0.724	0.392	0.377	0.759	0.598	0.813	0.743

(d) Credit scores around 780

Note: this table presents Poisson regression estimates of equation (1) for mortgage number of home purchases originations per 100 bps increase in g-fees by income group. "Share" refers to the market share of each loan type in the sample. Standard errors are clustered by the credit score.

5 Structural model

In order to study the effects of counterfactual g-fee designs, we need to apply our estimated semi-elasticity to the entire credit score distribution, rather than only at the four cut-offs we study. In this selection, we develop a model that allows us to interpolate between our estimated semi-elasticities across the credit score and income distribution in a principled way. We also use it to extrapolate our estimated semi-elasticities to the very low end of the credit score distribution, where FHA loans become more dominant. Our model has excellent fit in sample, and incorporates many realistic features of the mortgage market as studied in Jiang (2023); Buchak et al. (2024).

5.1 Setup

Let household i with credit score c and income category k make a choice between $\{$lender $j \times$ LTV category $l \times$ FHA versus conventional $f\}$. Lenders are differentiated by bank versus non-bank. We calibrate the number of bank lenders and non-bank lenders as the median number of bank lenders and non-bank lenders, respectively, within a Census tract, following Jiang (2023). Their utility from taking out a loan is given by Equation (3):

$$u_{ickjlf} = \max_{jlf} -\delta_c r_{ckjlf} + \gamma_{nb}\mathbb{1}(j \in \{\text{nonbank}\}) + \tilde{\gamma}_{f,i}\mathbb{1}(f = 1) + \xi_{cklf} + \epsilon_{ijt}. \quad (3)$$

where δ_c is the interest elasticity of demand, and r_{ckjlf} is the lender fee-adjusted interest rate on the mortgage for borrowers with credit score c, income k, lender type j, LTV l, and FHA choice f. The fee-adjusted interest rate is computed by multiplying the lender fees as a fraction of the loan amount by 0.2 and then adding it to the interest rates.[8] γ_{nb} is a preference for non-bank lenders which may include convenience of FinTech, underwriting practices, or broker relationships. $\tilde{\gamma}_{f,i} \sim Normal(0, \sigma_{\tilde{\gamma}_f})$ is a random coefficient indicating heterogeneous preference for FHA loans. Note that we set the mean of $\tilde{\gamma}_{f,i}$ to zero because any fixed preference

[8] This is between the 1/8 to 1/4 conversion rate between interest rate and fees as in the rule of thumb of Bartlett et al. (2021).

for FHA loans is already absorbed into the fixed effects ξ_{cklf}. We parameterize δ_c as:

$$\delta_c = \delta_0 + \delta_1 c_f, \tag{4}$$

where c_f is the residualized credit score of the borrower, defined as the credit score of the borrower minus 700, divided by a scale factor of 100. The δ_1 term allows us to capture the general decrease in interest elasticity of demand with respect to credit score as shown in Table 4.

Lastly, ξ_{cklf} indicates fixed effects for credit score $\times$ income $\times$ LTV $\times$ FHA. These fixed effects influence the average utility from different loan types for borrowers with different credit scores, incomes, and LTVs. The outside option of not choosing a mortgage at all is included in the choice set and set to a utility of 0. Its share is calibrated to 0.33 following Jiang (2023).

5.2 Estimation and fit

By construction, the model exactly fits the market shares of conventional and FHA mortgages by credit score, income, and LTV as well as the outside good market share, which are determined by ξ_{cklf}, via nested fixed point. For the remaining model parameters $\gamma_{nb}, \delta, \sigma_{\tilde{\gamma}}, \phi_{\tilde{\gamma}}$, we estimate the model via GMM, targeting the overall and FHA/VA home purchase volume semi-elasticities to g-fee changes by income group in Table 4. Specifically, these are the coefficient estimates in columns (3), (4), (7), and (8) of Table 4. We use the inverse of the covariance matrix of moments as the GMM weights. The parameter estimates are shown in Table 5.

Table 5: Model parameter estimates

Parameter	Estimate	GMM Standard Error
	Above-median income	
γ_{nb}	0.197***	0.009
δ_0	37.234***	2.723
δ_1	-4.694***	0.392
$\sigma_{\tilde{\gamma}}$	20.237***	1.647
	Below-median income	
γ_{nb}	0.334***	0.012
δ_0	18.535***	4.412
δ_1	-2.059***	0.617
$\sigma_{\tilde{\gamma}}$	22.993***	1.902

In terms of the parameter estimates, Table 5 shows a positive and statistically significant coefficient for non-bank lenders, γ_{nb} among both above-median income and below-median income borrowers. This is because of a high non-bank lender market share within our post-COVID sample period of 2022–2023 despite them charging on average higher lender fee adjusted interest rates, and potentially reflects the technological advantages of shadow banks leading to higher borrower demand over this time period (Buchak et al., 2018; Fuster et al., 2021).

Interestingly, our interest rate sensitivity parameter δ_0 is larger for above-median income borrowers compared to below-median income borrowers. The magnitude of this parameter can be interpreted in terms of the borrower's heterogeneous preference for FHA mortgages $\sigma_{\tilde{\gamma}_f}$. For above-median income borrowers, δ_0 is about two times higher than $\sigma_{\tilde{\gamma}_f}$, and suggests that a 1 percentage point lower rate on GSE mortgages will generate a shift from FHA mortgages by 1.9 standard deviations. For below-median income borrowers, δ_0 is smaller than above-median income borrowers, which suggests that a similar 1 percentage point lower interest rate on GSE mortgages will generate a shift from FHA mortgages by only 0.9 standard deviations. This difference suggests below-median borrowers who get FHA mortgages appear to have much more inelastic demand for them, which can be due to their greater liquidity constraints.

Finally, our negative δ_1 estimates suggests that, in general, higher credit score households

have lower interest elasticities of demand. This is consistent with their lower home purchase elasticities as shown in Table 4.

The fit of our estimated model is shown in Appendix Table **??**. In general, the model fits our estimated semi-elasticities well within sample. Since our model fits the semi-elasticities well, it can be viewed as a structured way in which we interpolate our estimated semi-elasticities across credit score bins, which then allows us to assess their effects under counterfactual upfront g-fee designs.

5.3 Estimating GSE risk

We next estimate the extent of the GSE cross-subsidy across credit score and LTV bins, which we obtain via a simple model of borrower default and prepayment. Suppose that borrowers default at a rate $\lambda_{d,t}$ and pay down their principal at a rate $\lambda_{p,t}$, where $\lambda_{p,t}$ would include both the regularly scheduled amortization pay down as well as prepayment. The loss given default is L_t. The upfront g-fee is g^u, and the on-going g-fee is g^o. The value of the mortgage to the GSEs with discount rate δ and capital costs k is then:

$$V^{GSE}(g^u, g^o) = g^u + E\sum_t \delta^t l_t(g^o - LGD(S_t)\lambda_d(S_t) - k) \tag{5}$$

where $l_t = l_{t-1}(1 - \lambda_p(S_t) + \lambda_d(S_t))$ is the fraction remaining of the balance of the mortgage at time t, and k is the capital cost. We use a two-state pricing model, where states $S_t = \{0, 1\}$ are whether the economy is in a housing crash. The default and principal paydown rates are then:

$$\lambda_p(S_t) = \lambda_p^0, \lambda_d(S_t) = \lambda_d^0, \text{ if } S_t = 0, \tag{6}$$

$$\lambda_p(S_t) = \lambda_p^1, \lambda_d(S_t) = \lambda_d^1, \text{ if } S_t = 1. \tag{7}$$

We calibrate the value of $\lambda_d(S_t), \lambda_p(S_t), LGD(S_t)$ by taking the mean of their respective values within each credit score bin and LTV group from the Fannie Mae Single-Family Performance Data from 2000 to 2019, where the housing crash years are taken to be 2008 to

2013 ($S_t = 1$), and the rest being non-housing crash years ($S_t = 0$). Notably, to compute the $LGD(S_t)$, we follow the steps in Fannie Mae's loss data analysis tutorial.[9] This procedure includes the effects of private mortgage insurance which reduces GSE losses at LTVs greater than 80% as well as the foregone interest that were covered by Fannie Mae to be paid to investors. While $S_t = 1$ occurred in 30% of the years in the data, we downweight the probability of being in a housing crash state going forward by assuming that $S_t = 1$ has a 10% chance of occurring.

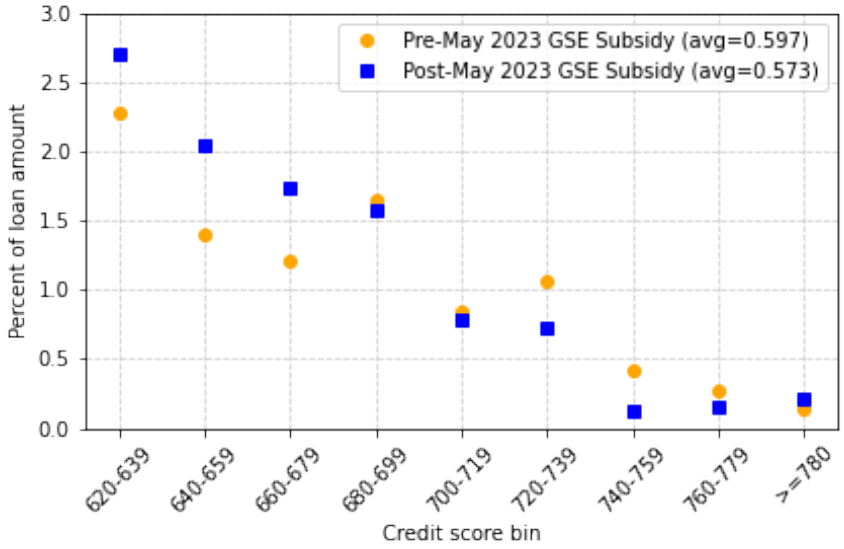
Finally, we obtain our estimate GSE capital cost k by taking the GSE retained capital levels by credit score bin and LTV from deRitis and Zandi (2014), and multiply it by a 10% capital cost, as per the return on equity of FDIC-insured institutions (deRitis and Zandi, 2014). We also assume a discount rate of $\delta = 0.96$, consistent with the risk-free rate over this time period. Notably, the estimates of both the costs of retained equity capital k as well as the discount rate δ are likely too low compared to what would be required of large systemically important financial institutions holding similar risks. Therefore, our estimate of the GSE subsidy, based on the GSEs' current capital requirements as well as funding costs, would understate the extent of the GSE subsidy from the social perspective.[10]

Our estimated GSE subsidy $-V^{GSE}(g^u, g^o)$ for each credit score, pre-and-post May 2023, is presented in Figure 5, where we present the average subsidy across LTV bins in the LLPA matrix taking into account the LTV distribution within each credit score bin. In general, we see significant cross-subsidy from high to low credit score borrowers and from low to high LTV borrowers, which has increased after May 2023. This cross-subsidy is consistent with estimates from FHFA in even non-crisis periods, as described in Gerardi (2017). The overall positive level of the subsidy reflects the fact that the GSEs are not earning the return on equity that FDIC-insured institutions earn on their retained capital, which can be viewed as a subsidy from their equity holders (i.e. the Treasury) to homeowners.

[9] Available HERE.

[10] For more discussion of GSE capital costs, see Ambrose and Warga (2002) and Richardson et al. (2017).

Figure 5: GSE subsidy by credit score, pre-and-post May 2023



Note: this figure presents the GSE-volume weighted estimated GSE subsidy across purchase mortgages by credit score bins, pre-and-post the May 2023 LLPA change. The raw estimated subsidies by credit score and LTV bins are shown in Appendix Table A.6.

5.4 Counterfactuals

Using the estimated model, we simulate the effects of three counterfactual changes in g-fees. The first two counterfactual simulations aim to shed light on the effects of potential g-fee changes that are likely to happen if the GSEs exit conservatorship. First, we simulate the effects of a uniform increase in g-fees across the LLPA grids of credit scores and LTVs. Second, we simulate the effects of removing the cross-subsidy in g-fees. Lastly, we simulate the effects of undoing the controversial LLPA change in May 2023.

5.4.1 Uniform increase in g-fees

This counterfactual simulation examines the effects of increasing g-fees uniformly for all borrowers. Raising g-fees is often discussed as an option for increasing the GSEs' capital to meet their capital standard. For example, some previous analyses suggest that the GSEs will

have to increase the average upfront g-fee by roughly 50 bps to meet the required capital they are required to hold under their capital standard adopted in 2020.[11]Thus, it is reasonable to expect that the GSEs' exit from conservatorship is likely to lead to an increase in g-fees unless the required minimum capital is sufficiently lowered.

Moreover, with the US Treasury's holding of senior preferred stock of the GSEs since 2008, increasing g-fees is often viewed as a way to generate additional tax revenue for the US Treasury. For example, the ongoing g-fee was raised by 10 bps to pay for the tax cut in the Temporary Payroll Tax Cut Continuation Act of 2011, and the Infrastructure Investment and Jobs Act in 2021 extended the 2011 g-fee increase. An increase in the g-fee is also being contemplated as one of the ways to pay for the proposed tax cut in the second Trump administration.

Figures 6(a) and 6(b) show that a uniform 50 bps increase in upfront g-fees will have very different effects across households with different credit scores and incomes. For credit score bins lower than 660, FHA mortgages are more important because they are not likely to have enough savings for larger payments. Thus, the effect of g-fees on home purchases is more muted. The effects on home purchases increase in credit score bins until the 700 bin, by more for households with above-median income. This result suggests that, among these households with near-prime credit scores, those with above-median incomes are more likely to prefer GSE loans over FHA loans. For credit score bins greater than 700, the elasticity of g-fees on home purchases decreases with borrower credit scores, but the number of households increases with credit scores, leading to relatively flat overall effects across credit score bins. However, the effects become increasingly different between above- and below-median income households. Specifically, the effects decrease in credit scores for above-median households but increase for below-median households because higher-income, higher-credit score borrowers are much less dependent on GSE loans.

The overall effect on home purchase is slightly regressive by income, with below median income borrowers losing about 10% more than above median income borrowers. However, the g-fee increase will hurt households with above-median incomes more among those with credit scores below 720, whereas it will hurt households with below-median incomes more among

[11]NYU Furman Center

those with credit scores above 720.

We further estimate how much the increase in g-fees will increase the GSEs' earning because g-fees may be raised to increase the GSEs' incomes and capital. We estimate the earning impact of the increase in g-fees as a percentage of the pre-policy loan amount by computing:

$$\Delta\pi = \sum_i V^{GSE}(g_i^u + 0.5, g^o) * s_i * (1 + e_i) - V^{GSE}(g_i^u, g^o) * s_i \tag{8}$$

where s_i is the share of GSE loans in a credit score $\times$ LTV category i, and e_i is the semi-elasticity of conventional mortgage volume with respect to a 50 bps increase in upfront g-fees. This implicitly assumes that within conventional mortgages, the GSE share is constant, which is reasonable because we do not detect statistically significant non-agency substitution for loans below the base conforming loan limit in Table 3.[12] The result of this calculation, at 0.539 percentage points of the loan amount, is shown in row (A) of Table 6. The reason that our estimate is slightly larger than 50 basis points is due to the volume response leading to a more favorable risk pool for the GSEs in aggregate. We further conduct a back-of-the-envelope calculation of the total dollar revenue impact of the such an increase by incorporating the total GSE origination volume in 2023,[13] with a resulting annual revenue impact of $3.3 billion shown in row (C) of Table 6.

Table 6: Annual revenue impact of a 50bps increase in upfront g-fees

	Estimate
(A) Revenue impact as a percent of the loan volume	0.539%
(B) Total GSE loan origination amount in 2023	$616 billion
(C) Annual revenue impact ((A)*(B))	$3.3 billion

Note: this table shows the estimated Treasury revenue increase as a result of a 50 basis points increase in GSE upfront g-fees. GSE total origination volume in 2023 is obtained from the FHFA's 2023 Annual Report to Congress.

[12] We do detect large non-agency substitution for high balance mortgages in Section A, but they are only about 1% of aggregate GSE volume.

[13] Available HERE.

5.4.2 Removing the GSE cross-subsidy

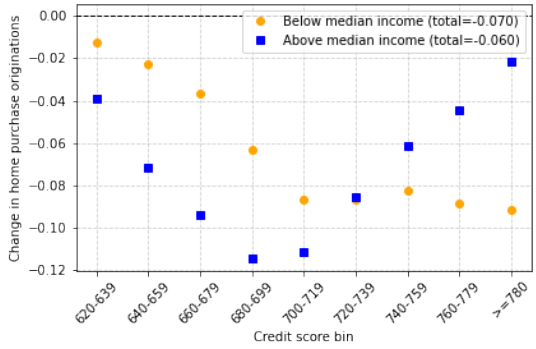
We now examine the effect of removing the GSE cross-subsidy across LLPA grids, which aligns pricing with default risk. It is reasonable to expect that the GSEs' exit from conservatorship will limit their ability to cross-subsidize high-risk borrowers because market forces, for example from their shareholders or competition with other financing sources, may lead the GSEs' to set g-fees appropriate for credit risk they take on for each borrower. Indeed, Fannie Mae's 2024 10-K states, *"Increasing our returns to a level sufficient to attract private equity investors may require increases in our pricing or changes in other aspects of our business ... including the level of support we provide to low- and moderate-income borrowers."*

In this simulation, we hold the average level of the GSE subsidy constant for this analysis to distinguish the effects of a cross-subsidy from the effects of reducing the average level of a GSE subsidy. As shown in Figure 5, the current LLPA policy provides a cross-subsidy from high-score to low-score borrowers. Indeed, we find that removing the GSE cross-subsidy will decrease home purchases among lower credit score borrowers and increase them among higher credit score borrowers, suggesting that the current LLPA policy is progressive in terms of credit score. Although households with very low credit scores less than 680 will have the largest increase in their g-fees, they do not have larger responses than households with credit scores in the 680 bin. That is because FHA loans are more important for these households with the very low credit scores.

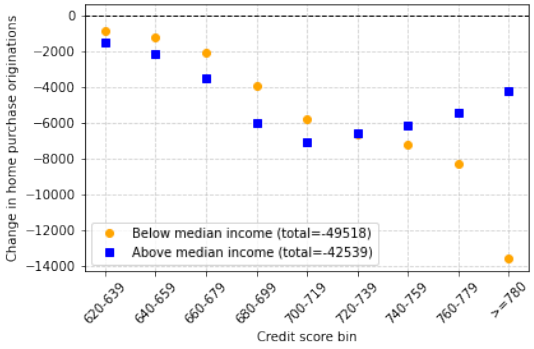
However, our finding also shows that above-median income borrowers benefit more from the cross-subsidy in the current LLPA policy than below-median income borrowers. Among households with lower credit scores of 680 or below, the negative effects of removing the cross-subsidy are larger among those with higher incomes, which is consistent with our reduced-form finding in Table 4. Among households in the highest credit score bin (780), removing the cross-subsidy will increase home purchases for below-median income borrowers. This is because higher-income borrowers with high credit scores can avoid the cost of the GSEs' cross-subsidy by choosing non-agency loans. Overall, the home purchase effects of removing the GSE cross-subsidy are more than 40% larger among above-median income households (-29,211) compared to below-median income households (-16,757). This result suggests that the cross-

subsidy in the current g-fee pricing policy is regressive in the income dimension, although the cross-subsidy increases the total home purchases.

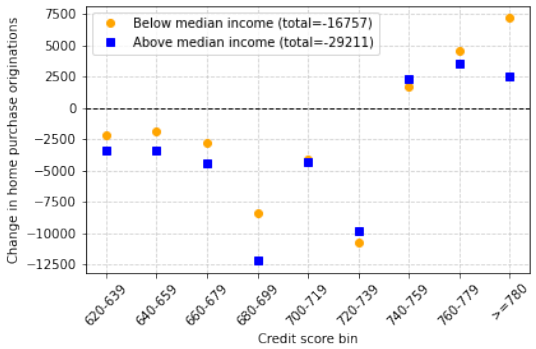
Figure 6: Model counterfactuals



(a) Semi-elasticities with respect to a uniform 50 bps increase in g-fees



(b) Changes in the number of originations with a uniform 50 bps increase in g-fees



(c) Removing the cross-subsidy by credit scores and LTVs



(d) Undoing the May 2023 g-fee change

Note: this figure presents our model counterfactuals in terms of the effect of alternative g-fee schedules on home purchases across the credit score distribution. Panel (a) eliminates the GSE cross-subsidy by credit scores and LTV, so that pricing is aligned with risk, while keeping the overall level of the GSE subsidy constant at pre-May 2023 levels. Panel (b) shows the effect of a uniform increase in g-fees of 50 basis points. Panel (c) shows the effect of un-doing the May 2023 g-fee change.

5.4.3 The effects of the May 2023 g-fee change

Finally, we simulate the effects of undoing the May 2023 g-fee change. This change was controversial because some viewed this change as providing a cross-subsidy to higher-risk

borrowers. Figure 6(d) presents the results for undoing the May 2023 g-fee change. Borrowers with higher credit scores (≥780 and 760–779 bins) experience limited changes in origination volume. Borrowers with middle credit scores, in the 720–759 credit score bins, show significant increase in home purchases, consistent with them bearing the cost of the May 2023 g-fee change. Lower credit score borrowers (620–679 bins) show significant decreases in home purchase origination volume, with higher income borrowers being more affected as consistent with our reduced-form findings in Table 4. The effect of on home purchases overall is relatively muted.

6 Discussion

GSE redistribution by borrower credit scores and LTV is controversial and generally nontransparent. In this paper, we make progress on estimating their real effects on home purchases by exploiting a set of recent g-fee changes and by using a novel difference-in-discontinuity analysis. We then apply our estimated semi-elasticities to estimate the effect of counterfactual g-fee pricing schedules across the borrower credit score and income distributions. We find that removing the GSE cross-subsidy by credit scores and LTV as well as undoing the May 2023 g-fee change, both of which would lead to better alignment of prices with risk, may not necessarily be in conflict with distributional goals.

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Internet Appendix

A Analysis of the Effects of G-fee Increases for High-Balance Loans

The second change to the LLPAs that we examine in this paper is the increased LLPAs that the GSEs placed on high-balance loans starting in April 2022. The Housing and Economic Recovery Act of 2008 (HERA) promulgated a permanent formula setting the national baseline CLL and higher county-specific loan limits for certain high-cost areas, where 115 percent of the local median home value exceeds the baseline CLL. For instance, in 2024, the baseline CLL was $766,550, while the highest cost areas had the loan limit of $1,149,825. The conventional loans that the GSEs purchased with loan balance between the national CLL and higher limits in high-cost areas are commonly known as high-balance loans, or super conforming.

Historically, GSEs charged an upfront g-fee of 25 basis points on the high balance loans. On January 5, 2022, the GSEs announced a set of changes to the LLPAs that include changes to the high balance loans. The updated LLPAs became effective for loans purchased on or after April 1st, 2022.[1] Figure A.1 shows the new LLPAs for high-balance loans due to the change. These were all higher than the 25 basis points prior to the change, and g-fees increased by up to 75 bps of the loan amount with larger increases for higher-LTV loans. We leverage off the LLPA changes for high-balance loans in Section A to examine high-balance borrowers' responses to GSE fees.

Figure A.1: April 2022 G-fee Changes, Home Purchase

Additional LLPAs by Loan Attribute Applicable to Hight Balance Loans									
Loan Feature	LTV Range								
	Applicable for all loans								
	< 30.00%	30.01 – 60.00%	60.01 – 70.00%	70.01 – 75.00%	75.01 – 80.00%	80.01 – 85.00%	85.01 – 90.00%	90.01 – 95.00%	>95.00%
Purchase or limited cash-out refinance	0.500%	0.500%	0.750%	0.750%	1.000%	1.000%	1.000%	1.000%	1.000%
Cash-out refinance	1.250%	1.250%	1.500%	1.500%	1.750%	NA	NA	NA	NA
ARM	0.750%	0.750%	0.750%	0.750%	1.500%	1.500%	1.500%	1.750%	1.750%

Note: Figure A.1 shows the changes in G-fees for home purchase high balance loans effective April 2022.

[1] See the announcement HERE.

A.1 Regression specifications

To examine the effect of a g-fee increase on high-balance loans, we use the same regression in equation (1), but with a different cutoff and a different running variable. Although a higher g-fee is applied based on loan size, we do not use a cutoff or a running variable based on loan size because the loan size choice is very endogenous. Many borrowers bunch right below the base CLL because of higher mortgage rates associated with high-balance loans (Huh and Kim, 2022).

Thus, as in previous papers that used a loan size cutoff (Kaufman, 2014; Fuster and Vickery, 2014; DeFusco and Paciorek, 2017; Huh and Kim, 2022; Adelino et al., 2025), we use the house price as the running variable. With the fact that many borrowers also bunch at LTV of 80%, we use the national CLL $\times$ 1.25 as the cutoff. In this setup, we compare transactions of homes that have to be financed with high-balance loans with LTV of 80% (house prices $>$ 1.25 $\times$ base CLL) and transactions of homes that can be financed with low-balance loans with LTV of 80%.

As our running variable for this analysis is the house price, an important identifying assumption is that borrowers do not sort into cheaper homes in response to to higher mortgage rates associated with high-balance loans. One way to test this assumption is whether the number of home transactions is smooth around the cutoff. Figure A.6 shows that histograms of mortgage originations with home prices around the cutoff of 1.25 $\times$ national CLL. Although there are bunching at house prices of multiples of \$5,000, the histograms do not exhibit discrete changes in the distribution around the cutoff before or after the g-fee increase for high-balance loans in April 2022.

Figure A.6(c) presents a scatter plot of log(number of originations) after residualizing it by the origination year$\times$month fixed effects as well as the fixed effects for home prices of multiple of \$5,000, \$10,000, ..., \$100,000. The figure does not show any clear sorting around the cutoff, and the format regression to estimate a potential jump at the cutoff also yields statistically insignificant estimates.

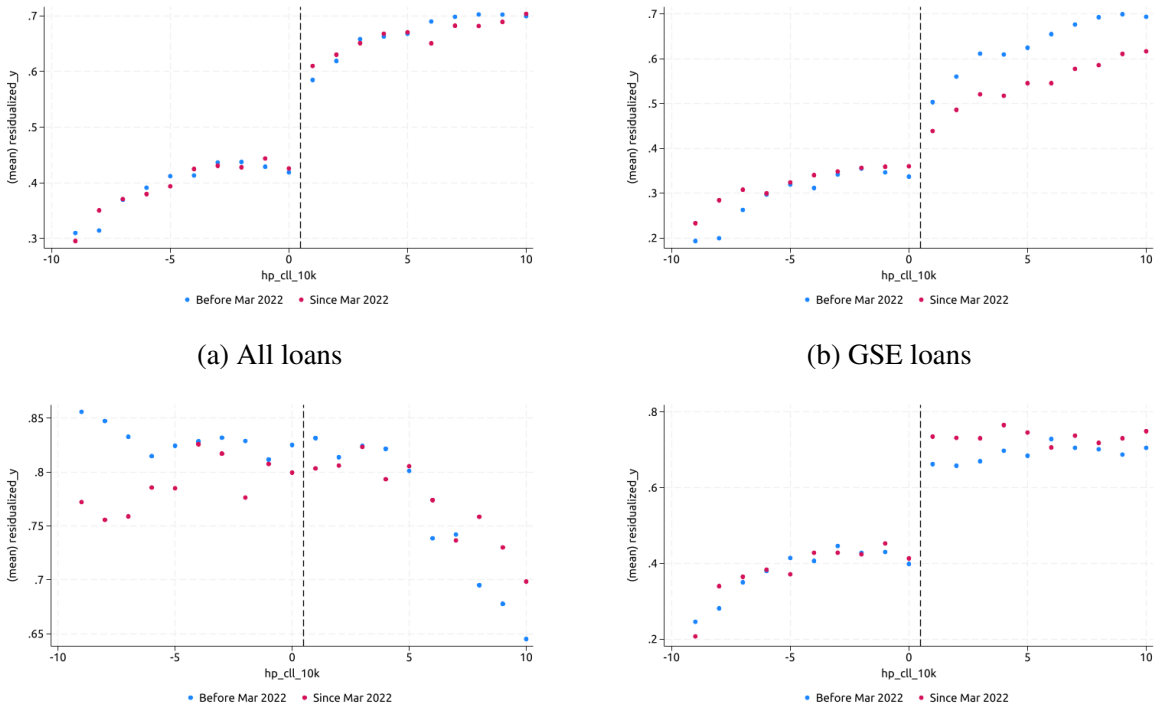
This result suggests that a higher g-fee for high-balance loans did not affect purchases of houses that are typically more likely to be financed with high-balance loans. In the rest of this section, we examine whether the g-fee increase affected the mortgage market in other margins.

High-balance loan share We now examine how the g-fee increase for high-balance loans affected the probability to originate high-balance loans. Figure A.2 and column (1) of Table A.1 shows that the overall share of high-balance loans did not change. However, the g-fee increase had a large effect on how high-balance loans are financed. Homes that are more likely to be purchased with high-balance loans are financed by non-agency loans instead of GSE loans.

Securitization channel share Table A.1 show that the increase in the g-fee for high-balance loans lead to a decline in the shares of loans GSEs above the cutoff. The decline in

the GSE share was entirely made up by an increase in the non-agency loans (either portflio or private securiziation).

Figure A.2: Share of high-balance loans by loan type



(a) All loans

(b) GSE loans

(c) FHA/VA loans

(d) Non-agency loans

Note: this figure presents average log loan counts pre-and-post policy are around the 1.25 × CLL cutoff.

Table A.1: Share of high balance loans and securitization channel share

	Share of high-balance loans				Securitization channel share		
	Total	GSE	FHA or VA	Non-agency	GSE	FHA or VA	Non-agency
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
1[HP > 1.25 × CLL] × Post	0.014	-0.072***	-0.033**	0.072***	-0.039***	0.000	0.039***
	(0.014)	(0.015)	(0.016)	(0.022)	(0.009)	(0.006)	(0.007)
Orig YM FE	Y	Y	Y	Y	Y	Y	Y
Credit score bin	Y	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y	Y
N. Obs.	218,728	131,130	29,070	58,506	218,728	218,728	218,728
Adj. R^2	0.18	0.20	0.41	0.21	0.10	0.25	0.09

Note: this table presents the local linear regression estimates of the December 2022 g-fee increase on the volume of high balance loans and on their securitization channel around the 1.25 × CLL cutoff.

B No Jumbo in the Sample

Table A.2: Effects of a 100 bps increase in g-fees on mortgage rates and net origination charges

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	0.135***	-0.003	0.017	-0.039**	0.392***	0.025	0.096*	0.097***
	(0.029)	(0.015)	(0.036)	(0.015)	(0.032)	(0.030)	(0.057)	(0.024)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	75,471	142,093	41,012	261,867	74,534	139,332	40,033	257,134
Adj. R^2	0.60	0.63	0.73	0.61	0.24	0.26	0.51	0.28

(a) Credit scores around 680

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	0.223***	0.089	0.100	0.072***	0.276***	-0.013	0.138	0.136***
	(0.030)	(0.055)	(0.064)	(0.024)	(0.035)	(0.068)	(0.082)	(0.028)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	182,613	91,770	88,744	366,577	179,880	89,886	86,732	360,043
Adj. R^2	0.64	0.63	0.73	0.64	0.21	0.25	0.47	0.27

(b) Credit scores around 720

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	0.204***	-0.041	-0.105**	0.103***	0.306***	-0.021	0.014	0.194***
	(0.050)	(0.114)	(0.042)	(0.029)	(0.065)	(0.117)	(0.045)	(0.031)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	310,313	74,687	154,924	543,194	305,211	73,165	151,556	533,240
Adj. R^2	0.66	0.63	0.72	0.65	0.19	0.21	0.42	0.25

(c) Credit scores around 760

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	0.105***	-0.099	0.088*	0.062**	0.211***	-0.190	0.078	0.112***
	(0.028)	(0.089)	(0.051)	(0.028)	(0.055)	(0.122)	(0.056)	(0.032)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	365,831	74,883	187,658	631,602	359,907	73,339	183,628	620,160
Adj. R^2	0.65	0.63	0.72	0.66	0.18	0.19	0.39	0.23

(d) Credit scores around 780

Note: The estimates of equation (1) for mortgage rates and net origination charges as percent of loan amount per 100 bps increase in g-fees for borrowers below each cutoff. All columns include origination year-month fixed effects, county fixed effects, and fixed effects for discrete grid of LTVs used in the LLPA. Standard errors are clustered by the credit score.

Table A.3: Semi-elasticities of the number of home-purchase loan originations with respect to a 100 bps increase in g-fees

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	-0.392***	0.051*	-0.042	-0.148***
	(0.042)	(0.030)	(0.087)	(0.035)
Share	0.33	0.50	0.17	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.858	0.658	0.687	0.798

(a) Credit scores around 680

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	-0.267***	-0.022	-0.199*	-0.249***
	(0.052)	(0.144)	(0.104)	(0.028)
Share	0.53	0.22	0.25	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.820	0.645	0.663	0.820

(b) Credit scores around 720

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	-0.316***	0.029	-0.097	-0.204***
	(0.084)	(0.192)	(0.143)	(0.065)
Share	0.57	0.14	0.29	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.856	0.527	0.743	0.878

(c) Credit scores around 760

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta \text{g-fee}}$	-0.185***	0.038	-0.036	-0.112***
	(0.056)	(0.120)	(0.051)	(0.036)
Share	0.56	0.12	0.32	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.823	0.514	0.668	0.822

(d) Credit scores around 780

Note: this table presents Poisson regression estimates of equation (1) for mortgage number of home-purchase originations per 100 bps increase in g-fees. "Share" refers to the market share of each loan type in the sample. Standard errors are clustered by the credit score.

Table A.4: Semi-elasticities of the number of home-purchase loan originations with respect to a 100 bps increase in g-fees by income

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.437***	-0.334***	0.073*	0.037	-0.083	-0.015	-0.206***	-0.111***
	(0.041)	(0.079)	(0.039)	(0.043)	(0.096)	(0.082)	(0.028)	(0.042)
Share	0.40	0.28	0.39	0.58	0.21	0.14	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.752	0.783	0.431	0.579	0.552	0.547	0.701	0.679

(a) Credit scores around 680

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.292***	-0.213**	-0.185	0.084	0.038	-0.453***	-0.229***	-0.248***
	(0.091)	(0.085)	(0.195)	(0.137)	(0.174)	(0.117)	(0.069)	(0.058)
Share	0.55	0.51	0.17	0.26	0.28	0.23	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.691	0.737	0.445	0.554	0.520	0.517	0.722	0.710

(b) Credit scores around 720

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.274***	-0.332***	-0.118	0.119	-0.112	-0.139	-0.209***	-0.201*
	(0.101)	(0.120)	(0.236)	(0.236)	(0.218)	(0.163)	(0.068)	(0.120)
Share	0.57	0.57	0.11	0.16	0.32	0.27	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.783	0.755	0.385	0.405	0.647	0.583	0.826	0.775

(c) Credit scores around 760

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.132*	-0.237***	0.304	-0.167	-0.097	-0.021	-0.080	-0.164***
	(0.080)	(0.072)	(0.207)	(0.126)	(0.071)	(0.079)	(0.052)	(0.059)
Share	0.55	0.57	0.10	0.13	0.35	0.30	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.771	0.724	0.392	0.377	0.565	0.545	0.779	0.736

(d) Credit scores around 780

Note: this table presents Poisson regression estimates of equation (1) for mortgage number of home purchases originations per 100 bps increase in g-fees by income group. "Share" refers to the market share of each loan type in the sample. Standard errors are clustered by the credit score.

C Additional Figures and Tables

Figure A.3: May 2023 LLPA Changes, Refinance Loans

Credit Score	LTV Range								
	Applicable for all loans with terms greater than 15 years								
	≤ 30.00%	30.01 – 60.00%	60.01 – 70.00%	70.01 – 75.00%	75.01 – 80.00%	80.01 – 85.00%	85.01 – 90.00%	90.01 – 95.00%	>95.00%
≥ = 780	0.000%	0.000%	-0.250%	-0.125%	0.000%	0.375%	0.250%	0.125%	-0.375%
760 – 779	0.000%	0.000%	-0.125%	0.125%	0.375%	0.750%	0.500%	0.375%	-0.125%
740 – 759	0.000%	0.000%	0.000%	0.500%	0.625%	1.125%	0.875%	0.750%	0.250%
720 – 739	0.000%	0.000%	0.250%	0.500%	0.875%	1.250%	1.000%	0.750%	0.250%
700 – 719	0.000%	0.000%	0.125%	0.250%	0.625%	1.125%	0.750%	0.625%	0.125%
680 – 699	0.000%	0.000%	0.375%	0.375%	0.500%	1.000%	0.875%	0.500%	0.250%
660 – 679	0.000%	0.125%	0.125%	-0.375%	-0.250%	0.250%	0.125%	-0.125%	-0.125%
640 - 659	-0.500%	-0.250%	0.125%	-0.625%	-0.125%	0.125%	0.125%	-0.250%	-0.250%
620 - 639	-0.500%	-0.125%	0.250%	-0.500%	0.500%	0.625%	0.375%	-0.750%	-1.000%
≤ 619[1]	-0.500%	-0.375%	0.000%	-0.875%	-0.250%	-0.375%	-0.625%	-1.000%	-2.000%

(a) Limited cash-out refinance

Credit Score	LTV Range				
	Applicable for all loans with terms greater than 15 years				
	≤ 30.00%	30.01 – 60.00%	60.01 – 70.00%	70.01 – 75.00%	75.01 – 80.00%
? = 780	0.000%	0.000%	-0.125%	-0.500%	-0.500%
760 – 779	0.000%	0.000%	0.125%	-0.125%	0.000%
740 – 759	0.000%	0.000%	0.250%	0.250%	0.500%
720 – 739	-0.125%	0.000%	0.250%	0.500%	0.750%
700 – 719	-0.250%	-0.125%	0.500%	1.000%	1.250%
680 – 699	-0.500%	-0.250%	0.500%	1.250%	1.750%
660 – 679	-0.500%	0.000%	1.000%	2.250%	2.750%
640 - 659	-0.500%	0.500%	1.250%	2.750%	3.000%
620 - 639	-0.500%	0.500%	1.500%	3.000%	3.000%
? 619[1]	-0.500%	0.500%	1.500%	3.000%	3.000%

(b) Cash-out refinance

Note: Figure A.3 shows the changes in G-fees for limited cash-out refinance and cash-out refinance loans effective May 2023. The values are in percentages of the loan amount. Green cells represent decreases in G-fees, while red cells represent increases.

Table A.5: Effects on borrowers with credit scores between 620 and 659

	Mortgage Rates (%)				Net Origination Charges (% of loan amount)			
	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total	(5) GSE	(6) FHA or VA	(7) Non-agency	(8) Total
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	0.240*	0.012	0.779**	0.123***	0.763***	0.047	0.156	0.176**
	(0.135)	(0.034)	(0.368)	(0.033)	(0.241)	(0.059)	(0.278)	(0.071)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	17,718	143,319	11,143	175,132	17,513	140,604	10,837	171,915
Adj. R^2	0.54	0.64	0.74	0.61	0.25	0.28	0.56	0.28

(a) Interest rates and net origination charges

	(1) GSE	(2) FHA or VA	(3) Non-agency	(4) Total
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.381**	-0.032	0.241	-0.054
	(0.175)	(0.060)	(0.252)	(0.057)
Share	0.12	0.80	0.08	1.00
Orig YM FE	Y	Y	Y	Y
N. Obs.	320	320	320	320
Pseudo R^2	0.683	0.675	0.533	0.774

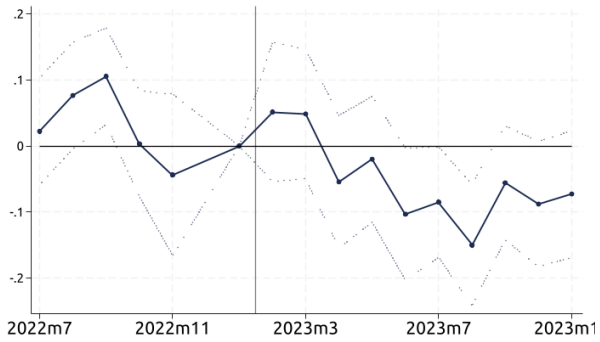
(b) Number of originations

	GSE		FHA or VA		Non-agency		Total	
	(1) Income > Median	(2) Income ≤ Median	(3) Income > Median	(4) Income ≤ Median	(5) Income > Median	(6) Income ≤ Median	(7) Income > Median	(8) Income ≤ Median
$\frac{\beta_{10}}{\Delta\text{g-fee}}$	-0.362*	-0.400*	-0.033	-0.039	-0.127	0.516*	-0.086	-0.050
	(0.200)	(0.236)	(0.123)	(0.095)	(0.253)	(0.301)	(0.118)	(0.082)
Share	0.18	0.09	0.71	0.84	0.11	0.06	1.00	1.00
Orig YM FE	Y	Y	Y	Y	Y	Y	Y	Y
N. Obs.	320	320	320	320	320	320	320	320
Pseudo R^2	0.558	0.536	0.427	0.608	0.388	0.390	0.606	0.689

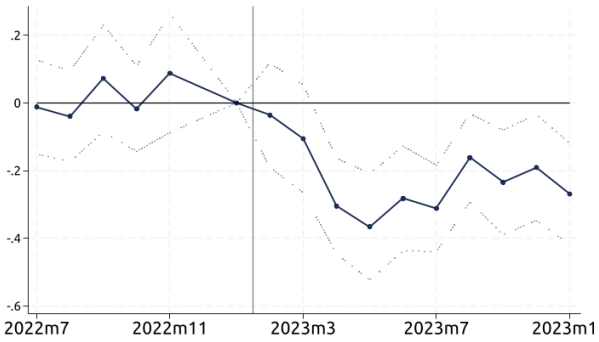
(c) Number of originations by income

Note: this table presents regression estimates of equation (1) for households with credit scores from 620 to 659.

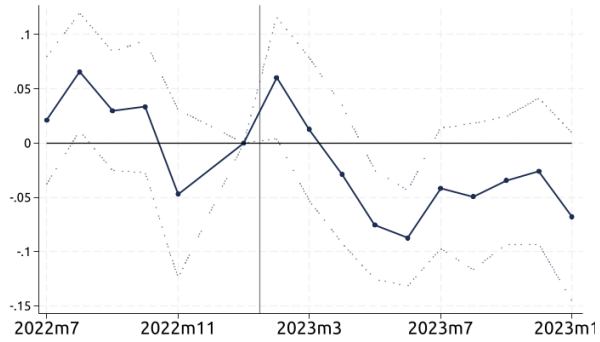
Figure A.4: Interest Rates and Net Origination Charges (event study)



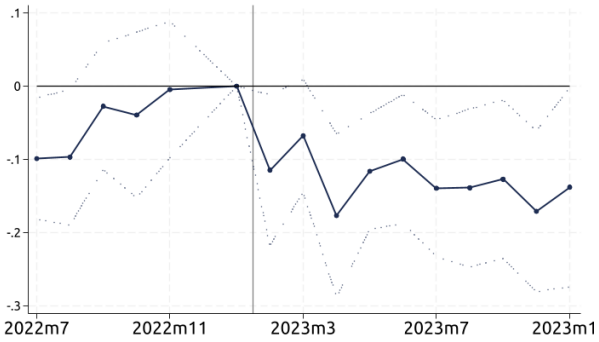
(a) Mortgage rates (credit score 680)



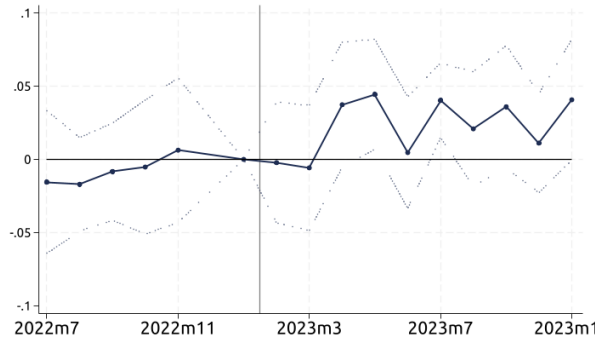
(b) Net origination charges (credit score 680)



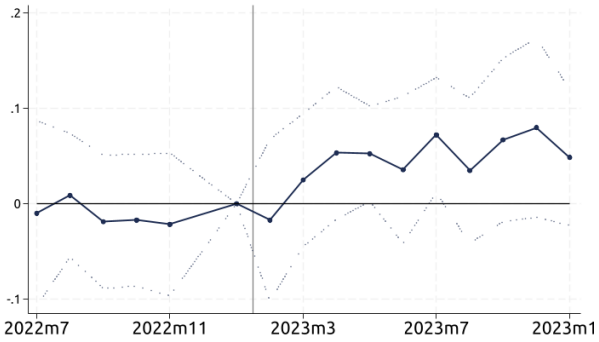
(c) Mortgage rates (credit score 720)



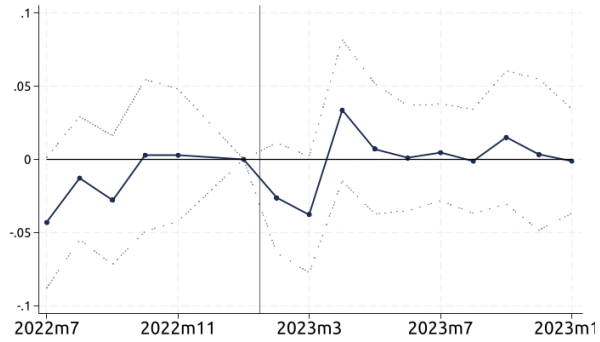
(d) Net origination charges (credit score 720)



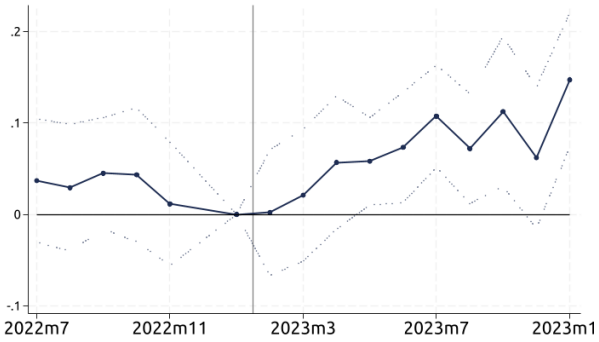
(e) Mortgage rates (credit score 760)



(f) Net origination charges (credit score 760)



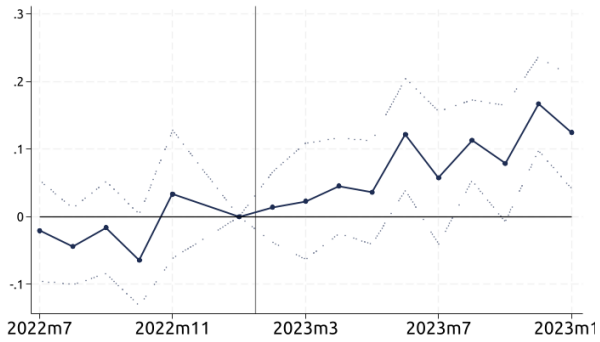
(g) Mortgage rates (credit score 780)



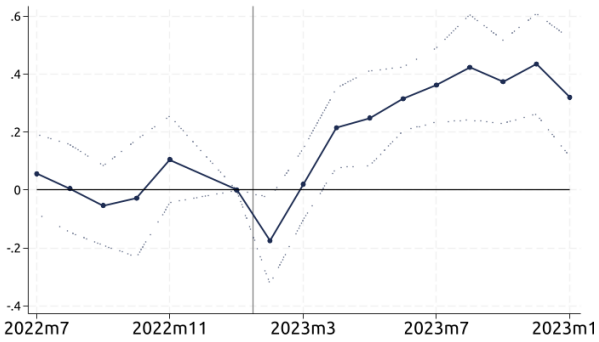
(h) Net origination charges (credit score 780)

Note: event-study regression with 2023:m1 as the omitted time period.

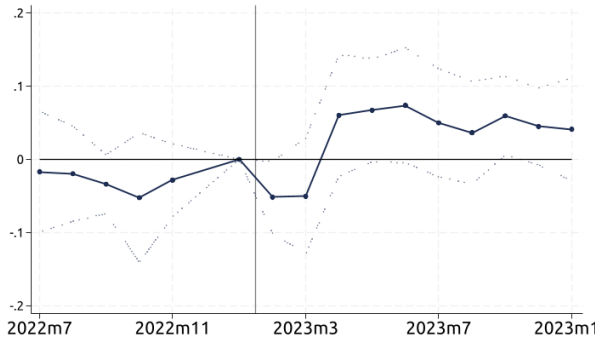
Figure A.5: Number of originations (event study)



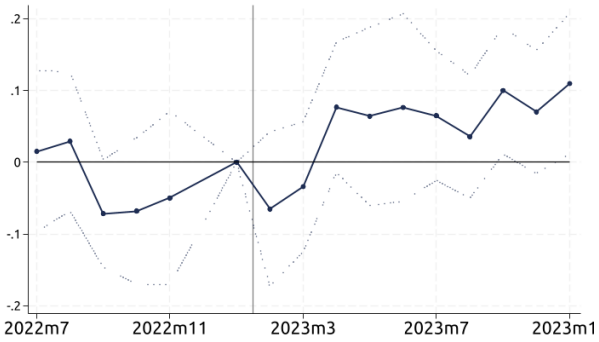
(a) Total loan originations (credit score 680)



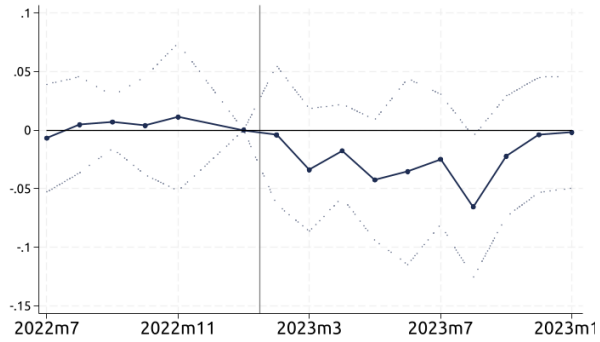
(b) GSE loan originations (credit score 680)



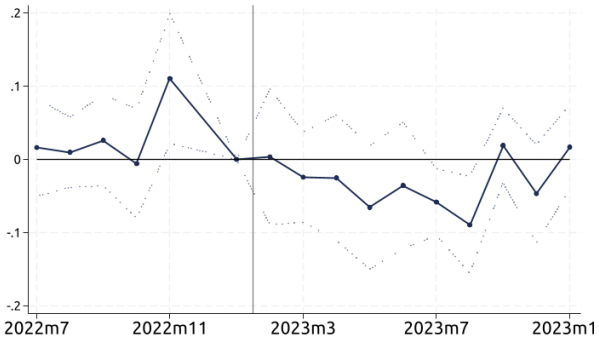
(c) Total loan originations (credit score 720)



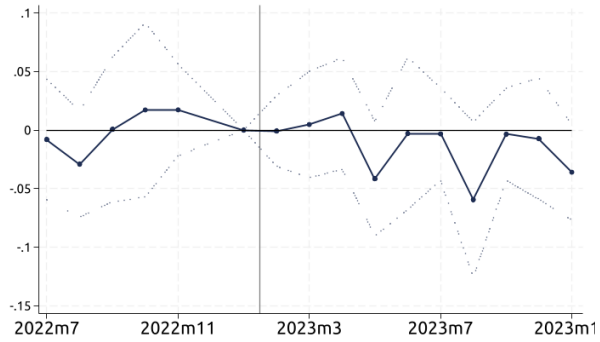
(d) GSE loan originations (credit score 720)



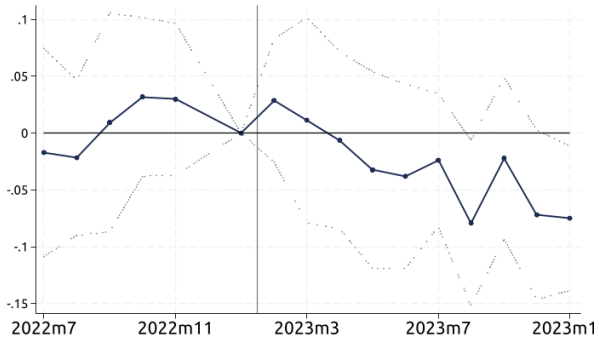
(e) Total loan originations (credit score 760)



(f) GSE loan originations (credit score 760)



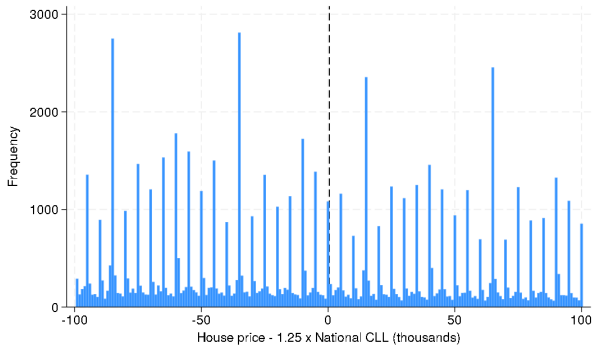
(g) Total loan originations (credit score 780)



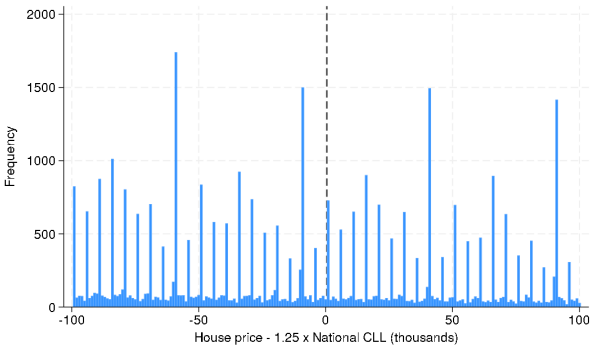
(h) GSE loan originations (credit score 780)

Note: event-study regression with 2023:m1 as the omitted time period.

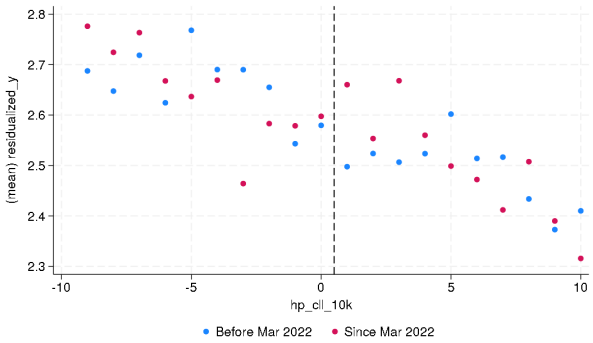
Figure A.6: Number of loan originations (high-balance loan g-fee change)



(a) Histogram of house prices (pre March 2022)



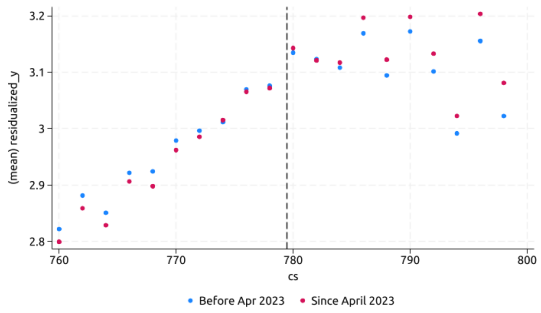
(b) Histogram of house prices (post March 2022)



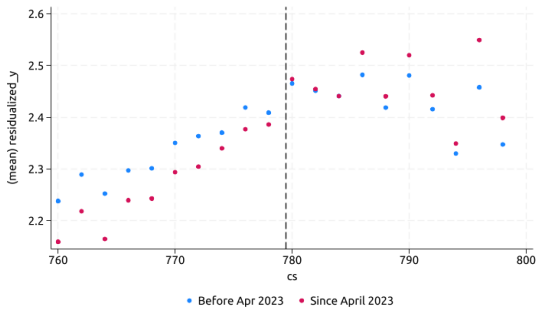
(c) log(number of originations), residualized

Note: this figure presents the histogram of house prices as well as the number of originations around the 1.25 × CLL cutoff.

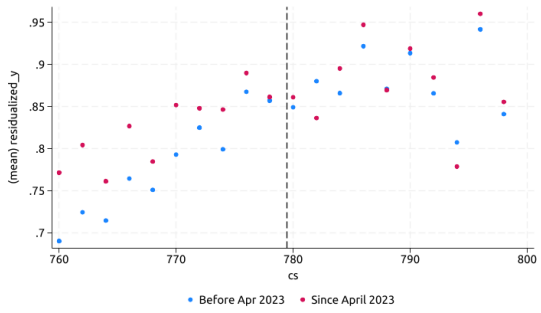
Figure A.7: Log of loan originations for credit score around 780 (above-median incomes)



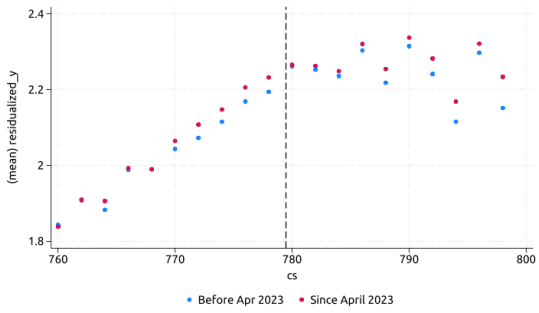
(a) All loans



(b) GSE loans



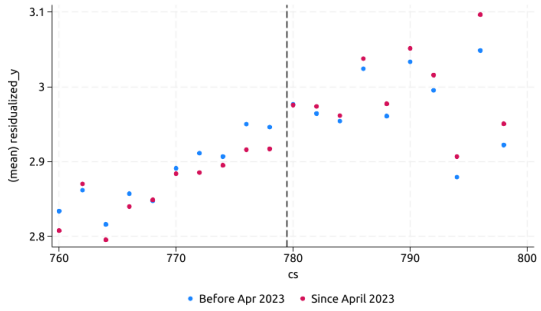
(c) FHA/VA loans



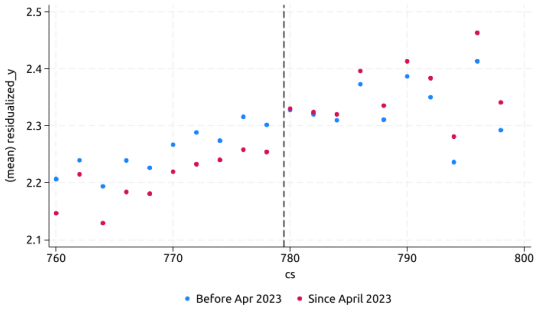
(d) Non-agency loans

Note: this figure presents average log loan counts pre-and-post policy are around the 780 credit score cut-off for the subsample of above-median income borrowers.

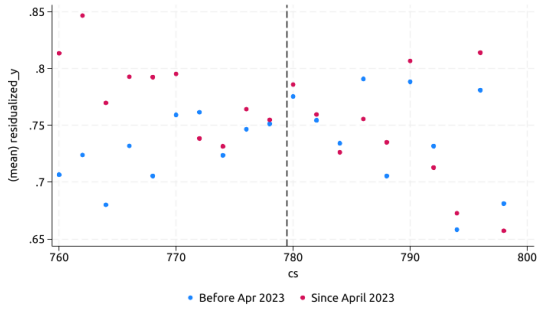
Figure A.8: Log of loan originations for credit score around 780 (below-median incomes)



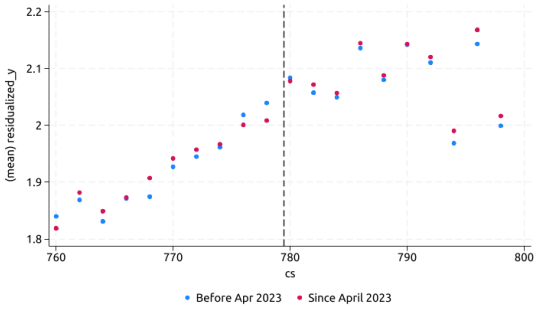
(a) All loans



(b) GSE loans



(c) FHA/VA loans



(d) Non-agency loans

Note: this figure presents average log loan counts pre-and-post policy are around the 780 credit score cut-off for the subsample of below-median income borrowers.

Table A.6: Estimated GSE subsidy by credit score and LTV, at current capital levels

credit score / LTV	≤60	60.01–70	70.01–75	75.01–80	80.01–85	85.01–90	90.01–95	> 95
≥ 780	-0.352	0.008	0.048	-0.146	0.617	0.634	0.688	0.295
760–779	-0.289	0.046	0.102	-0.098	0.682	0.695	0.708	0.379
740–759	-0.249	0.107	0.188	0.029	0.689	0.878	0.828	0.511
720–739	-0.075	0.828	0.746	0.608	1.397	1.522	1.537	1.386
700–719	0.012	0.684	0.440	0.278	1.186	1.368	1.344	1.386
680–699	0.288	1.742	1.316	1.052	1.888	2.133	2.301	2.720
660–679	0.458	1.573	0.780	0.493	0.992	1.777	2.033	2.989
640–659	0.181	2.080	0.792	0.848	1.497	2.116	2.722	3.560
620–639	1.134	3.084	2.068	1.967	2.967	2.595	4.146	5.867
max-min	1.486	3.075	2.116	2.113	2.350	1.961	3.457	5.572

(a) Pre-May 2023

credit score / LTV	≤60	60.01–70	70.01–75	75.01–80	80.01–85	85.01–90	90.01–95	> 95
≥ 780	-0.352	0.258	0.298	-0.021	0.492	0.634	0.688	0.920
760–779	-0.289	0.296	0.102	-0.223	0.307	0.445	0.458	0.879
740–759	-0.249	0.232	0.063	-0.346	-0.061	0.378	0.453	0.761
720–739	-0.075	0.828	0.496	0.108	0.647	1.022	1.162	1.636
700–719	0.012	0.809	0.565	0.153	0.686	1.118	1.219	2.011
680–699	0.288	1.617	1.441	1.052	1.513	1.883	2.176	3.095
660–679	0.458	1.823	1.655	1.368	1.617	2.277	2.658	3.989
640–659	0.681	2.205	2.042	1.598	2.247	2.866	3.597	4.810
620–639	1.509	3.084	2.943	2.217	3.342	3.220	5.146	7.617
max-min	1.861	2.826	2.880	2.563	3.404	2.775	4.458	6.697

(b) Post-May 2023

Note: this table presents the estimated GSE subsidy across purchase mortgages for different credit score/LTV bins, pre-and-post the May 2023 LLPA change.

Table A.7: Model fit

	Income > Median			Income ≤ Median		
Moment Label	Target	Model	Difference	Target	Model	Difference
Bank Type						
Nonbank	0.702	0.702	-0.000	0.737	0.737	0.000
Total						
680 Total	-0.223	-0.205	0.018	-0.110	-0.113	-0.003
720 Total	-0.194	-0.242	-0.048	-0.252	-0.240	0.012
760 Total	-0.160	-0.094	0.066	-0.195	-0.197	-0.002
780 Total	-0.029	-0.029	-0.000	-0.146	-0.126	0.020
FHA/VA						
680 FHA/VA	0.073	0.069	-0.004	0.037	0.036	-0.001
720 FHA/VA	-0.185	0.172	0.357	0.084	0.097	0.013
760 FHA/VA	-0.118	0.108	0.226	0.119	0.174	0.055
780 FHA/VA	0.304	0.045	-0.259	-0.167	0.139	0.306