Cost Pass-Through and Mortgage Credit: The Case of Guarantee Fees

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January 2024

Abstract

Fannie Mae and Freddie Mac charge lenders "guarantee fees" to insure mortgages against credit risk. Using changes in guarantee fees as quasi-exogenous variation, we show that lenders completely pass through cost shocks to borrowers, on average, primarily via interest rates rather than upfront fees. However, pass-through is both asymmetric and heterogeneous. Lenders fully pass through cost increases but only 70% of cost decreases. Moreover, pass-through varies significantly by market structure and borrower characteristics. This heterogeneity limits the effectiveness of using guarantee fees as a tool for redistributing costs among borrowers and leads to an underestimation of their cost impact.

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1 Introduction

Mortgages represent the largest category of household debt in the United States (Federal Reserve Bank of New York 2024). The cost of mortgage credit not only influences household borrowing and spending decisions (DeFusco and Paciorek 2017; Di Maggio et al. 2017), but it also plays a key role in the transmission of fiscal and monetary policy (Di Maggio, Kermani, and Palmer 2020; Agarwal et al. 2023). Lenders influence mortgage credit costs in many ways that extend beyond just risk-based pricing. In particular, they partly determine the extent to which various cost shocks, such as regulatory changes or macroeconomic shocks, are ultimately borne by consumers.

In this paper, we examine how lenders pass through mortgage production costs and subsidies to borrowers via pricing. We specifically focus on changes in guarantee fees charged by the government-sponsored enterprises (GSEs), Fannie Mae and Freddie Mac. The GSEs acquire and insure eligible mortgages from lenders, packaging them into agency mortgage-backed securities (MBS) in exchange for guarantee fees. These fees play a pivotal role in redistributing costs and wealth to and among mortgage borrowers. For instance, by allowing guarantee fees to depart from strict risk-based pricing, the GSEs typically earn much lower rates of return on riskier loans (e.g., those with lower credit scores and higher loan-to-value ratios) than on less risky loans, leading to substantial cross-borrower subsidies (Federal Housing Finance Agency 2022). Moreover, Hurst et al. 2016 show that guarantee fees often omit predictable credit risks that are priced in private MBS markets, resulting in lower insurance premiums than risk-based pricing would suggest.

The effectiveness of guarantee fees as a policy tool for redistributing costs and subsidizing mortgage borrowing ultimately depends on how lenders pass through cost shocks to borrowers. Complete pass-through ensures that any such policies will operate as designed, while significant rent extraction by lenders or behavioral responses by borrowers can distort the intended effects and undermine the policy. Yet, while most studies and policy discussions implicitly assume full pass-through of guarantee fees to borrowers (Congressional Budget

Office 2024), there is no strong economic rationale for this assumption. In fact, economic theory predicts that the pass-through rate should depend on numerous factors germane to the mortgage market, such as borrower characteristics, lender characteristics, and market structure (Weyl and Fabinger 2013).

To estimate price pass-through, we focus on a set of historically significant changes to guarantee fees that went into effect in May 2023. These changes drastically reduced guarantee fees for some types of mortgages while significantly raising them for others, creating a major cost shock for lenders. We estimate the impact of these changes on mortgage prices and quantities and document four main results. First, lenders pass through around 99% of guarantee fee changes to borrowers, on average, via mortgage prices. Second, this average effect masks significant asymmetry and heterogeneity. While lenders slightly overshift fee increases onto borrowers, they only pass through around 70% of fee decreases. Moreover, pass-through is lower for borrowers with more elastic credit demand and in less competitive credit markets. Third, accounting for heterogeneity in the pass-through rate significantly increases the estimated cost of the GSEs' guarantee fee changes relative to the Federal Housing Finance Agency's (FHFA) calculated benchmark. Finally, we show that lenders primarily pass through guarantee fee changes along the more salient interest rate margin rather than the less salient upfront fee margin.

Unlike other studies that examine how financing terms respond to cost shocks (Benmelech, Meisenzahl, and Ramcharan 2017), our unique setting allows us to highlight nuance in price incidence along two important dimensions. First, the simultaneous increase in guarantee fees for some types of mortgages and decrease for others enables us to estimate the pass-through rate as a function of the direction of the cost shock. While traditional economic theory predicts that the pass-through rate should be symmetric across cost increases and decreases, our findings are consistent with recent studies arguing that asymmetry may arise under different conditions like the presence of information asymmetry (Busse, Silva-Risso, and Zettelmeyer 2006) or convex supply / demand (Ritz 2015). Second, mortgage prices consist of both a salient interest rate component and a non-salient upfront fee component (Bhutta and Hizmo 2021), creating an opportunity for price shrouding (Gabaix and Laibson 2006). If borrowers are less price-sensitive to upfront fees than interest rates as found in Liu 2019 and elsewhere,[1] then it could be optimal for lenders to pass on cost increases via upfront fees and cost decreases via interest rates. Our findings are inconsistent with this prediction that lenders strategically adjust their upfront fees to limit the overall impact on demand.

Our analysis uses data on millions of mortgages from the GSEs and the Home Mortgage Disclosure Act (HMDA). The data contains the contract terms of each mortgage as well as numerous borrower, lender, and property characteristics. A key feature of the data is that we can observe each mortgage's interest rate and upfront fees, allowing us to construct an all-in measure of the mortgage price akin to an APR. In addition, we can precisely measure the guarantee fee for each mortgage, which is something that is usually not possible in other mortgage-related datasets such as credit bureau data.

Even with loan-level data, estimating the effect of guarantee fees on mortgage prices is difficult due to the presence of other confounding factors. For example, one component of the guarantee fee – called the loan-level price adjustment (LLPA) – is determined by a matrix of credit scores and loan-to-value ratios (LTVs). Riskier cells in this matrix, which command higher interest rates for numerous reasons, also tend to be assigned higher LLPAs and hence higher guarantee fees. To resolve this and other identification concerns, we use the GSEs' decision to adjust LLPAs in May 2023 as a source of quasi-exogenous variation in a difference-in-differences design.[2] Effectively, our model compares changes in mortgage prices across loans in different matrix bins with different changes in LLPAs (and hence guarantee fees). We provide evidence in support of the identification assumptions of our model in

1. From Buchak and Jorring 2024: "According to survey data from the 2020 National Survey of Mortgage Originations (NSMO), while 98% of borrowers considered the interest rate when choosing their mortgage, only 81% of borrowers considered fees".

2. We provide an extensive discussion of our natural experiment in Section 2.2. For now, it is sufficient to know that the GSEs increased their guarantee fees for some kinds of mortgages, reduced them for others, and left some unchanged.

Section 4, and we perform numerous robustness tests to address potential identification issues related to non-random assignment and strategic borrower responses in Section 6.

Using the above setting, we find that lenders pass through around 99% of guarantee fee changes to borrowers, on average. The magnitude of this effect is persistent over time and there is no evidence of differential pre-trends. We also find that around 69% of price pass-through comes from the interest rate margin while the remaining 31% comes from upfront fees, specifically mortgage discount points. This limited amount of pass-through along the upfront fee margin has two important implications. First, it suggests that studies that focus solely on interest rates and ignore upfront fees (e.g., van Binsbergen and Grotteria 2024) may significantly understate cost pass-through in the mortgage market. Second, when combined with our results below, it suggests that lenders do not strategically adjust their upfront fees to take advantage of the fact that borrowers may be less price-sensitive to them, in contrast to Liu 2019.

Although price pass-through is near-complete on average, we find that it is a highly asymmetric function of the cost shock. Lenders slightly overshift the costs associated with guarantee fee increases onto borrowers but pass through only 70% of the savings from guarantee fee decreases. In addition, we find that the asymmetry in pass-through is driven almost entirely by interest rates, not upfront fees. This finding is again consistent with upfront fees serving a non-strategic role in the mortgage price-setting process.[3]

From a policy evaluation standpoint, documenting asymmetric pass-through is important for several reasons. First, as discussed in Section 2.2, one of the main goals the May 2023 guarantee fee changes was to reduce the cost of mortgage financing for certain borrowers. While targeted borrowers did in fact experience reductions in their financing costs due to the guarantee fee changes, we find that a significant portion of the subsidies directed towards

3. Instead of this strategic view, our results are consistent with the practitioner view of upfront fees, which argues that lenders simply use upfront fees as "plugs" in their rate sheets to keep their expected profits constant regardless of the borrower's specific contract choice (Salomon Brothers 2001). Essentially, since the market convention is for mortgage interest rates to come in one-eighth percentage point increments, upfront fees serve as a tool for lenders to convert discrete interest rates into continuous prices.

them were ultimately captured by lenders, limiting the effectiveness of the policy.

In addition, understanding the drivers of asymmetric pass-through is important for evaluating alternative mortgage subsidization policies. For example, if asymmetric pass-through primarily arises because of asymmetric information about the cost shock, then it may be more efficient to directly allocate mortgage subsidies to borrowers instead of relying on lenders to pass them through (Busse, Silva-Risso, and Zettelmeyer 2006). However, we find that asymmetric pass-through was primarily driven by demand convexity (Ritz 2015), not asymmetric information about the cost shock, which suggests that the equilibrium effects of mortgage subsidies should be the same regardless of whether they are nominally directed to borrowers or lenders.

Finally, we explore cross-sectional heterogeneity in the pass-through rate across borrower characteristics and market structure. In general, we find that pass-through is slightly lower for borrowers who are more price-sensitive and in areas where there is less competition between lenders, albeit the latter form of heterogeneity is statistically insignificant. Notably, we find no economically or statistically significant heterogeneity across demographic characteristics such as race and gender.

Our paper contributes to three distinct strands of literature. First, a nascent but growing literature examines the pass-through of monetary policy shocks and changes in secondary market prices (e.g., 10-year swap rates) to mortgage interest rates (Scharfstein and Sunderam 2016; Huh and Kim 2022; Ahsin 2024; van Binsbergen and Grotteria 2024). These studies typically find near-complete pass-through during normal times, although there is some debate as to whether pass-through varies with factors such as local lender concentration and capacity constraints (Fuster, Lo, and Willen 2024). In contrast, we study how guarantee fees, which are a distinct and relatively more opaque component of mortgage production costs, get passed through to both interest rates and upfront fees. While we document near-complete pass-through on average, only 69% of it operates through interest rates, with 31% operating through upfront fees. Furthermore, we show that the pass-through rate is asymmetric across simultaneous cost increases and decreases, and that it varies across borrower characteristics and market structure.

Second, a handful of papers study how the GSEs influence the mortgage market via their subjective pricing of guarantee fees (Elenev, Landvoigt, and Van Nieuwerburgh 2016; Richardson, Van Nieuwerburgh, and White 2017). In particular, one of the main ways that the GSEs attempt to increase the affordability of mortgage credit for low-income and low-wealth borrowers is by letting their guarantee fees depart from strict risk-based pricing (Congressional Budget Office 2024). This opaque system of implicit subsidies is controversial for many reasons, including that it distorts borrower / lender incentives and attenuates the link between credit risk and loan prices. However, a key issue that is often overlooked in this discussion is whether these implicit subsidies, which are nominally directed towards lenders, actually make their way to borrowers via interest rates and upfront fees. We provide the first large-scale estimates of the extent to which guarantee fee increases and decreases get passed through to mortgage prices. We show that pass-through is highly asymmetric, with lenders completely passing through higher costs (i.e., "taxes") while capturing a significant portion of subsidies. Our results thus highlight the potential limitations of using guarantee fees as a policy tool for redistributing mortgage costs and subsidizing borrowing.

Third, our paper is related to the more general literature on cost pass-through, which includes important contributions in the areas of tax incidence (Chetty, Looney, and Kroft 2009), exchange rate and input price pass-through (Campa and Goldberg 2005; Nakamura and Zerom 2010), and the price incidence of trade policies (Amiti, Redding, and Weinstein 2019). Unlike prior studies, we examine a setting in which both prices are multi-dimensional and the cost shock varies across consumers. These features not only allow us to explore the importance of strategic pricing decisions by sellers, but they also allow us to examine the role of borrower- and market-specific factors in determining the pass-through rate.

2 Background and Economic Framework

2.1 The GSEs and Guarantee Fees

Fannie Mae and Freddie Mac are government-sponsored enterprises (GSEs) that acquire qualifying mortgages from lenders and package them into agency mortgage-backed securities (MBS). The GSEs ensure timely payment of principal and interest on these securities to investors, charging lenders fees in exchange for providing credit guarantees. Despite numerous policy initiatives to reduce their size and importance, Fannie Mae and Freddie Mac have only become more dominant since entering the conservatorship of the Federal Housing Finance Agency (FHFA) in 2008. Of the roughly $13 trillion in residential mortgages outstanding at year-end 2021, over 50% were funded by agency MBS guaranteed by the GSEs.[4]

The GSEs acquire qualifying mortgages through two channels. First, via the "cash window", lenders may deliver whole loans to the GSEs in return for direct cash payments. Alternatively, lenders may exchange entire pools of loans for agency MBS which can be subsequently sold to investors in the secondary mortgage market. Lenders have the option of delivering loans to either cash or MBS, but pricing is generally more favorable when delivering to MBS and lenders traditionally have been required to commit to one strategy with each GSE. In practice, larger lenders typically exchange pools of loans for agency MBS, whereas smaller lenders tend to deliver whole loans for cash (Federal Housing Finance Agency 2023).

The GSEs charge lenders guarantee fees to cover the expected credit losses, administrative costs, and cost of capital associated with insuring mortgages. There are two types of guarantee fees: ongoing and upfront. Ongoing fees are collected each month out of the interest rate and do not depend on borrower or loan characteristics. Upfront fees, also called loan-level price adjustments (LLPAs), depend on several risk attributes such as the credit

4. For the other 50% of mortgages, roughly 20% were funded by Ginnie Mae MBS, 3% were funded by private-label MBS, and the rest were funded by bank balance sheets (Kim et al. 2022). It is important to note that many mortgages that are held on bank balance sheets are still packaged into agency MBS and insured by the GSEs. Hence, Fannie Mae and Freddie Mac's footprint in the mortgage market is even larger than the 50% reported above. Moreover, our study specifically focuses on conforming mortgages, the vast majority of which (i.e., over 90%) are funded by agency MBS securitizations (Fuster et al. 2013).

score, loan-to-value ratio (LTV), loan purpose (e.g., purchase versus refinance), and total number of liens.[5] LLPAs are the primary mechanism through which the GSEs implement risk-based pricing. Loans with riskier attributes (e.g., lower credit scores and higher LTVs) typically have higher LLPAs than loans with less risky attributes.

The LLPA is quoted as a percentage of the outstanding loan amount and is charged to the lender upon the loan's delivery, which is usually one or two months after the loan is originated (Fuster, Lo, and Willen 2024). Lenders can either pay the entire LLPA on the delivery date or, more commonly, capitalize it over the loan's duration by opting for a higher ongoing fee (Bartlett et al. 2022). The latter option is called "buying up" the ongoing fee, and the GSEs frequently communicate "buy-up multiples" to lenders (but generally not to the public) so that they are aware of the current cost of this conversion.[6]

For reference, Federal Housing Finance Agency 2024 reports that in 2022 the average ongoing fee was 44 basis points and the average LLPA was 17 basis points (quoted in terms of an equivalent ongoing fee). These are the most recent figures as of the time of writing.

LLPAs consist of two components: the base LLPA and supplemental LLPAs. The base LLPA is solely determined by the borrower's credit score, the loan's purpose, and the LTV. Panel A in Figure 1 shows Fannie Mae's base LLPA matrix for purchase mortgages as of May 17, 2023. The matrix is split into 9 credit score bins and 9 LTV bins, for a total of 81 possible base LLPAs. Given a particular mortgage, determining its base LLPA is as simple as locating the relevant credit score × LTV cell in the matrix. For example, the base LLPA for a purchase mortgage delivered on June 1, 2023 with a credit score of 720 and an LTV of 80% would have been 1.25%, or $3,750 on a $300,000 loan. Upon delivering this loan to

5. LLPAs are distinct from private mortgage insurance (PMI), which is generally required for qualified mortgages with LTVs above 80%. In addition to ongoing guarantee fees and LLPAs, the GSEs also sometimes impose adverse market fees on particular types of mortgages during periods of market stress (Ahsin 2024) However, no adverse market fees were active during our sample period.

6. Similarly, there is a "buy-down multiple" that lenders can use to convert the guarantee fee into a higher LLPA. As noted in Fuster et al. 2013, the buy-up multiple is typically much lower than the buy-down multiple because buying up the guarantee fee allows lenders to shift the prepayment risk associated with excess servicing to the GSEs, thereby exposing them to adverse selection. There is also usually much greater demand for buy-ups than buy-downs, as buying up the guarantee fee effectively allows lenders to convert excess servicing cash flows that are subject to additional regulatory capital charges into cash.

one of the GSEs, the lender would have been given the choice of either providing the entire \$3,750 upfront or converting it into a 38 basis point higher ongoing fee, assuming a quoted buy-up multiple of 3.25 as in Section 3.

Supplemental LLPAs depend on various other risk factors such as whether the mortgage has a second lien or whether it is for a second home. Panel B in Figure 1 displays Fannie Mae's supplemental LLPA matrix for purchase mortgages as of May 17, 2023. For "vanilla" 30-year, conforming, fixed-rate, first-lien, purchase mortgages for single-family, owner-occupied, site-built homes, the supplemental LLPA is usually zero. However, for other types of mortgages, the supplemental LLPA can be substantial. For example, as of June 1, 2023, the supplemental LLPA for a purchase mortgage on a manufactured, second home with an LTV of 80% was 3.875% (= 0.50% + 3.375%), or \$11,625 on a \$300,000 loan.[7]

LLPAs are set administratively and do not purely reflect Fannie Mae and Freddie Mac's perceptions about credit risk. Indeed, the GSEs' charters specifically include statements allowing them to limit LLPAs on certain loans to fulfill various aspects of their affordable housing mission. However, since the FHFA still expects the GSEs to earn a minimum rate of return on their overall mortgage portfolios, these subsidies are implicitly paid for by less risky borrowers who get assessed higher LLPAs than strict risk-based pricing would otherwise warrant (Congressional Budget Office 2024). LLPAs also do not incorporate several sources of credit risk that are priced in private MBS markets, generating additional cross-subsidies. For instance, Hurst et al. 2016 show that LLPAs do not vary geographically despite there being significant predictable regional variation in default risk.[8]

Since the LLPA affects the lender's cost of delivering a loan to the GSEs, it should affect the price that the borrower pays to take out a mortgage. To see this, let R_0 denote the interest rate on a hypothetical mortgage with zero upfront fees (i.e., zero discount points,

7. Certain types of mortgages sometimes receive LLPA waivers or credits. We remove these types of mortgages, which account for a small fraction of loans, from our sample in Section 3.

8. Imperfect risk-based pricing does not cause the GSE market to unravel because there are other benefits associated with GSE securitizations, such as the implicit federal backstop and TBA market liquidity. See Elenev, Landvoigt, and Van Nieuwerburgh 2016, DeFusco and Paciorek 2017, and Huh and Kim 2022.

zero origination fees, and zero lender credits). We can deconstruct this rate as follows:

$$R_0 = G + L + C + F + S + \pi, \tag{1}$$

where G denotes the ongoing fee, L denotes the LLPA (expressed in terms of an equivalent ongoing fee), C denotes the par agency MBS coupon rate (i.e., the common funding cost that all lenders face), F denotes lender-specific funding and administrative costs, S denotes the amount of servicing income,[9] and π denotes the lender's non-servicing profits. If the LLPA rises (falls), then the interest rate must rise (fall) an equal amount or else the lender's profits will decline (rise). Alternatively, instead of adjusting the interest rate, the lender can adjust the amount of upfront fees that the borrower must pay at closing. While the precise degree to which LLPA changes are passed through to borrowers via interest rates and upfront fees is ultimately an empirical question, theory suggests that it should depend on several factors such as borrower characteristics, lender characteristics, and market structure. We discuss these concepts in greater detail in Section 2.3 below.

Industry reports suggest that lenders incorporate upcoming LLPA changes into their mortgage prices months in advance. To see this, Figure 4 displays the typical origination timeline for a conforming mortgage that eventually gets packaged into an agency MBS and sold to investors in the secondary market. On the rate lock date, which is usually 30 to 60 days before the loan closing date, the lender offers the borrower a menu of mortgage contracts with different interest rates and discount points, commonly referred to as a "rate sheet" (Fuster, Lo, and Willen 2024). After the borrower selects a contract from this menu, the lender determines when it will deliver the loan (along with many other loans) to the GSEs in exchange for an agency MBS, usually around one to two months after the closing date (Fuster et al. 2013). Simultaneously, the lender sells the agency MBS forward by shorting a

9. Fannie Mae and Freddie Mac require lenders to collect at least 25 basis points of servicing income, known as base servicing, to cover the operational costs associated with servicing the loan. While some lenders sell their servicing rights, others prefer to retain them due to the float income it provides and the inside track it offers to refinance the loan / cross-sell other financial products (Kim et al. 2022). The market price of excess servicing closely tracks the buy-up multiple offered by the GSEs, and vice versa.

to-be-announced (TBA) contract (Vickery and Wright 2013), effectively locking in the loan's price ahead of time. A key feature of the TBA contract is that, on the trade date, the buyer and seller only agree upon six characteristics of the agency MBS to be delivered but not the precise CUSIP.[10] Over the following months, the lender assembles the pool of loans and eventually delivers them to the GSEs in exchange for the agency MBS. Finally, the lender delivers the agency MBS to the TBA buyer on the contract expiration date and receives the previously agreed-upon price. The delivery of the agency MBS to the TBA buyer effectively closes out the lender's end of the transaction, eliminating all their exposure to the loan except for any retained servicing.

Thus, when constructing their rate sheets, lenders incorporate many pieces of forward-looking information. First, since lenders know the price that each loan will fetch in the TBA market, lenders incorporate these prices and any required margins into their rate sheets. Second, since future LLPA matrices are circulated by the GSEs months in advance, lenders know what each loan's LLPA will be on its rate lock date. As such, lenders should incorporate upcoming LLPA changes into their rate sheets before they take effect, starting with loans that are expected to close one to two months before the LLPA change date.[11]

2.2 The May 2023 LLPA Changes

In 2021, the FHFA launched a comprehensive review of Fannie Mae and Freddie Mac's single-family mortgage pricing (i.e., guarantee fee) framework. According to Federal Housing

10. Specifically, the buyer and seller only agree upon the MBS issuer (Fannie Mae or Freddie Mac), coupon rate (50 basis point increments), maturity (15-year or 30-year), amount, price, and delivery date. It is important to emphasize that only interest rate risk and prepayment risk matter for TBA / agency MBS pricing, as any loan-specific credit risk is borne entirely by the GSEs once the lender pays the LLPA. Moreover, investors cannot "pick and choose" which types of loans to purchase in the TBA market because (i) most loan-specific features (e.g., credit scores and LTVs) are not TBA contract parameters and (ii) agency MBS pools need to satisfy certain diversification criteria, among other things, to be considered TBA-eligible. Over 90% of agency MBS trading occurs via the TBA market (Fuster, Lucca, and Vickery 2022).

11. Mortgage lenders typically aim to preserve a specific profit margin while hitting a target quantity of loans. Lenders that fail to incorporate LLPA increases will see their margins shrink, and lenders that fail to incorporate LLPA decreases will be priced above the market and fail to make loans. Lenders are thus likely to rapidly incorporate LLPA changes into their prices, although the precise degree to which these changes get passed through to borrowers is ultimately an empirical question.

Finance Agency 2024, the objectives of this review included, "...increasing pricing support for many creditworthy homebuyers limited by wealth or income," and aligning guarantee fees, "...more closely with the risk factors utilized in the [newly-adopted] Enterprise Regulatory Capital Framework (ERCF) and the level of capital required by the ERCF."

Following this review, in January 2023 the FHFA announced major changes to LLPAs for most types of mortgages.[12] These changes, which applied to loans delivered after May 1, 2023, generally reduced base LLPAs for borrowers with low credit scores and high LTVs while raising them for borrowers with moderately higher credit scores and lower LTVs. Figure 2 displays Fannie Mae's base LLPA matrix for 30-year purchase mortgages just before and after May 1, 2023, and Figure 3 displays the change in base LLPAs for each cell in the matrix. Borrowers with credit scores below 680 / LTVs above 95% mostly saw their LLPAs decline, sometimes by up to 2 percentage points. In contrast, less risky borrowers with credit scores between 680 and 779 and LTVs in the 75% to 95% range mostly saw their LLPAs rise by amounts ranging between 0.125 and 0.75 percentage points.

While bad credit score borrowers continued to be assessed higher LLPAs than good credit score borrowers with similar LTVs after the policy change, the traditionally increasing relation between LLPAs and LTVs (holding the credit score fixed) became inverted for all LTVs above 80%. Further, after the policy change, there were a handful of surprising cases where very risky borrowers were now being assessed lower LLPAs than significantly less risky borrowers. For example, as of May 1, 2023, the base LLPA for a borrower with a credit score of 719 and an LTV of 76% was 1.375%, whereas the base LLPA for a riskier borrower with a credit score of 660 and a LTV of 97% was only 1.25%.

Major news outlets and prominent politicians reacted to the proposed LLPA changes with controversy. The editorial board of The Wall Street Journal wrote, "A new rule will raise mortgage fees for borrowers with good credit to subsidize higher-risk borrowers...This is the socialization of risk, and it flies against every rational economic model while encouraging

12. Fannie Mae and Freddie Mac previously adjusted their guarantee fees in 2011 and 2015. However, the 2023 changes that we study are significantly larger and were more controversial than these other changes.

housing market dysfunction and putting taxpayers at risk for higher defaults" (Wall Street Journal 2023c). Presidential candidate Nikki Haley echoed this negative view on Twitter, "Thanks to Joe Biden, starting May 1, your mortgage costs may go up. Buyers with good credit scores will pay even more to cover those with bad credit." House Financial Services Committee Chair Patrick McHenry pledged to repeal the proposed LLPA changes if they took effect, albeit his efforts were ultimately in vain (Wall Street Journal 2023b).

Sandra Thompson, director of the FHFA, initially defended the proposed changes by stating that they would not only, "...increase pricing support for purchase borrowers limited by income or wealth," but also, "...further the safety and soundness of the Enterprises, which will help them better achieve their mission" (Wall Street Journal 2023a). The FHFA later walked back this affordability angle by instead arguing that opponents of the changes, "...mistakenly assume that the prior pricing framework was somehow perfectly calibrated to risk – despite many years passing since that framework was reviewed comprehensively" and that the changes would, "...more accurately align pricing with the expected financial performance and risks of the underlying loans" (Federal Housing Finance Agency 2023). However, only after the media backlash took place did the FHFA try to link the LLPA changes to improved risk-based pricing and revised capital requirements under the ERCF.[13] Thus, our general reading of the policy is that it was originally intended to subsidize borrowers on the lower end of the credit score / down payment spectrum by reducing their LLPAs, funding these changes by charging moderately less risky borrowers slightly higher LLPAs.

For our sample of vanilla mortgages (see Section 3.3), the loan-weighted average increase in LLPAs was 29 basis points and the average decrease was -30 basis points. The overall average change in LLPAs was 4 basis points, with 45% of newly originated mortgages experiencing an LLPA increase, 31% experiencing a decrease, and 24% experiencing no change.

13. The FHFA made numerous other puzzling statements around this time. For example, despite clear evidence to the contrary, the FHFA explicitly stated that the recalibrated LLPA matrices, "...do not provide incentives for borrowers to make a lower down payment to benefit from lower fees" and that, "...higher credit score borrowers are not being charged more so that lower credit score borrowers can pay less".

2.3 Economic Framework

We are generally interested in measuring the extent to which LLPA changes get passed through to borrowers via mortgage prices. To highlight the basic economic intuition behind our empirical analysis, we start by considering a perfectly competitive mortgage market wherein lenders make \$1 loans to a homogeneous pool of borrowers at a uniform interest rate r. For simplicity, we assume that lenders do not charge upfront fees, and that each loan is immediately securitized and sold in the secondary mortgage market after it is originated. For a loan with an interest rate r, investors in the secondary market are willing to pay $p(r)$, where the pricing function p is exogenous and maps one-to-one to the interest rate.[14] Thus, without loss of generality, we can assume that lenders make loans at prices p, and we can directly work with mortgage prices instead of interest rates.

To sell a loan in the secondary market, the lender needs to convert the loan into an agency MBS that has been stripped of credit risk. The GSEs charge the lender a fee of L to perform this service, where L is the LLPA discussed in the previous section. The lender's net proceeds from selling a loan in the secondary market are $p - L$, so that the LLPA can be thought of as an excise tax imposed on the lender. Therefore, if lender i produces q_i loans each at price p, then its profits are $q_i \cdot (p - L - 1) - c(q_i)$, where $c(\cdot)$ is the cost function associated with producing loans.

Let D and S denote the market demand and supply curves, respectively. In equilibrium, the loan price p equates demand and supply:

$$D(p) = S(p - L). \tag{2}$$

We are primarily interested in how the LLPA affects the equilibrium price p. Let $\rho := \mathrm{d}p/\mathrm{d}L$ denote the so-called pass-through rate, which measures how the equilibrium loan

14. In practice, the secondary market price of a loan is determined by the coupon rate of the MBS that it is pooled into, not simply its interest rate. However, since loans with similar interest rates and risk attributes typically get pooled into the same MBS coupon, we write the loan price as a function of the interest rate for simplicity.

price changes in response to an infinitesimal change in the LLPA. By the implicit function theorem, the pass-through rate is:

$$\rho = \frac{1}{1 + (\epsilon_D/\epsilon_S)}, \tag{3}$$

where $\epsilon_D := -D' \cdot (p/Q)$ is the (negative) elasticity of demand, $\epsilon_S := S' \cdot (p/Q)$ is the elasticity of supply, and $Q := D(p) = S(p - L)$ is the equilibrium quantity of loans.

Equation 3, which is a classical result from tax theory, states that the more inelastic side of the market bears more of the cost shock. Specifically, it states that the pass-through rate rises as lenders become more price-sensitive relative to borrowers, and vice versa. In the extreme case of perfectly elastic supply, the pass-through rate is 1 and borrowers bear the full burden of the cost shock. Conversely, in the extreme case of perfectly elastic demand, the pass-through rate is 0 and lenders absorb the full impact of the cost shock.[15]

While useful for highlighting the basic economic intuition behind our analysis, the above framework is simplified in the sense that it does not consider many important features of the mortgage market. For starters, the mortgage market is not usually thought of as being perfectly competitive (Scharfstein and Sunderam 2016), as studies have found evidence of local market power in mortgage lending (Buchak and Jorring 2024). Weyl and Fabinger 2013 derive a formula for the pass-through rate in imperfectly competitive markets with n symmetrically differentiated firms. Their formula, which is directly applicable to the above setting, states that:

$$\rho = \frac{1}{1 + \frac{\theta}{\epsilon_\theta} + \frac{\epsilon_D - \theta}{\epsilon_S} + \frac{\theta}{\epsilon_M}}, \tag{4}$$

where ϵ_M is the curvature of log-demand, θ is the conduct parameter that measures the degree of competition in the market (e.g., $\theta = 0$ under perfect competition, $\theta = 1/n$ under

15. Figure IA.1 in the Internet Appendix shows a stylized example of how an LLPA increase affects the market equilibrium when the demand and supply curves are linear. An increase in the LLPA shifts the supply curve inward, causing the equilibrium loan price to rise, but by less than the amount of the LLPA change because of borrowers' behavioral responses to higher prices. In this example, the pass-through rate is less than 1, and borrowers and lenders share the economic burden of the cost shock.

Cournot competition, and $\theta = 1$ under monopoly), and ϵ_θ is the elasticity of the conduct parameter to the quantity produced.

As noted in Genakos and Pagliero 2022, it is common for empirical studies to assume that θ is constant, at least in the short run. Under this assumption, the pass-through rate can be written as an interpolation between the case of perfect competition (with weight $1 - \theta$) and monopoly (with weight θ):

$$\rho = \frac{1}{(1-\theta)\frac{\epsilon_D}{\epsilon_S} + \theta\left(\frac{\epsilon_D - 1}{\epsilon_S} + \frac{1}{\epsilon_M}\right)}. \tag{5}$$

For many classic models (e.g., Cournot competition), the above formula predicts that higher competition will lead to higher pass-through. However, in general, the relation between pass-through and competition is theoretically ambiguous, as it depends on the interaction of several factors including the relative elasticities of demand and supply and the curvature of demand.[16] For instance, if lenders have market power and demand is sufficiently convex, then the pass-through rate can exceed 100%, and the cost shock may be "overshifted" onto borrowers (Pless and van Benthem 2019).[17]

To summarize, the above framework predicts that the level of competition as well as demand and supply heterogeneity should be important determinants of the pass-through rate. Less (more) elastic demand and more (less) elastic supply should be associated with higher (lower) pass-through, and stronger (weaker) competition should usually be associated with higher (lower) pass-through but not always. Before we proceed, we reiterate that there are many other features of the mortgage market that may also affect the pass-through rate. Furthermore, several of these features could specifically cause the pass-through rate to be

16. Empirical studies commonly find both positive and negative relations between pass-through and competition, sometimes even within the same market. For example, while Genakos and Pagliero 2022 find a positive relation in the gasoline market, Doyle and Samphantharak 2008 find the opposite.

17. Overshifting is a common finding in the empirical pass-through literature. For example, Besley and Rosen 1999 study how taxes are passed through to consumer prices for a wide variety of goods and find overshifting for more than half of them, including goods with relatively competitive markets such as bananas, bread, milk, shampoo, and soda. See also Barzel 1976, Barnett, Keeler, and Hu 1995, Delipalla and O'Donnel 2001, Kenkel 2005, Marion and Muehlegger 2011, Pless and van Benthem 2019, and Stolper 2021.

asymmetric across LLPA decreases and increases. For example, since lenders are generally more informed about LLPA changes than borrowers, lenders may be able to capture a larger share of LLPA decreases while bearing a smaller portion of LLPA increases.[18] In addition, if the market demand or supply curves are convex, then the pass-through rate may be asymmetric simply due to the discrete (i.e., non-infinitesimal) nature of the LLPA changes we study (Ritz 2015).[19] Our tests in Section 4 explore the role of several of these factors, many of which are novel to the empirical pass-through literature.

3 Data and Sample

We conduct our analysis using loan-level data from Fannie Mae and the Home Mortgage Disclosure Act (HMDA).[20] Below, we describe these data in detail, as well as how we combine them to construct our main sample.

3.1 Fannie Mae Data

The Fannie Mae Single-Family Loan Performance Data covers the vast majority of single-family conforming mortgages guaranteed by Fannie Mae since the early 2000's (Buchak et al. 2018). For each mortgage, the data contains information about its type and purpose; its original loan amount, maturity, interest rate, and LTV; the type, location, and occupancy status of its underlying property; and a handful of borrower characteristics such as the credit score and debt-to-income ratio (DTI). Importantly, the credit score and LTV values reported

18. The game-theoretic bargaining literature predicts that a negotiating party with incomplete information will obtain a smaller share of the surplus than if they were better informed. Consistent with this prediction, Busse, Silva-Risso, and Zettelmeyer 2006 find that consumers that purchase a new car receive 70-90% of manufacturer-supplied cash rebates when the rebates are nominally directed to them, but only 30-40% of cash rebates when they are nominally directed to car dealers.

19. Although we believe that the supply curve is likely locally linear in our setting due to low mortgage volumes, it is common to assume that the supply curve is locally convex when mortgage demand is high and lenders are near their capacity constraints (Fuster, Lo, and Willen 2024).

20. While loan-level data is also available from Freddie Mac, this data does not include a field for the loan origination date, which is necessary for imputing the LLPA. As such, we exclude Freddie Mac data from our main analysis. Table IA.1 shows that our main results are robust to incorporating Freddie Mac data using one month before the first payment date as a proxy for the loan origination date.

in the data are precisely the ones that Fannie Mae uses to assign LLPAs.[21] Therefore, our imputed LLPAs should be precisely measured, which is crucial to ensure because the magnitudes of our pass-through estimates are of interest, not just their signs.

We focus on vanilla 30-year, fixed-rate, purchase mortgages that were originated within six months of the May 2023 LLPA change date and were only assessed a base LLPA and not any supplemental LLPAs. Specifically, we start by restricting our sample to 30-year, fixed-rate, first-lien, purchase mortgages for single-family, owner-occupied, site-built homes with origination dates between November 2022 and November 2023. To ensure that each mortgage was not assigned any supplemental LLPAs and did not receive any LLPA waivers / credits, we further remove mortgages with subordinate financing; PMIs below Fannie Mae's standard coverage requirement (when applicable); original loan amounts above the national conforming loan limit or below $50,000; LTVs above 97%; mortgages with exotic features such as interest-only payments or prepayment penalties; mortgages originated under the HomeReady, Home Relocation, or High LTV Refinance programs; and mortgages provided to buyers in rural areas or first-time homebuyers whose incomes fall below Fannie Mae's location-specific median income thresholds. We note that the filters used in our analysis are similar to the ones used in other studies, including Bhutta, Hizmo, and Ringo 2023, Gerardi, Willen, and Zhang 2023, and Buchak and Jorring 2024.

We impute each mortgage's LLPA using Fannie Mae's historical LLPA matrices.[22] To do so, we map each mortgage to its designated LLPA cell (c) based on its credit score (s), LTV ratio (r), and the LLPA matrix that was active on its delivery date, which is usually one month after its origination date ($d := t+1$).[23] This gives us the mortgage's LLPA expressed as a percentage of its loan amount, which we then convert into an equivalent ongoing fee using an estimated Fannie Mae buy-up multiple of M. That is, if the upfront LLPA is $U_{c,d}$,

21. Other datasets do not contain this information. For example, credit bureau data typically only reports the Vantage score, which is different than the particular FICO score Fannie Mae uses to determine the LLPA.

22. Current LLPA matrices can be found on Fannie Mae's website. Historical LLPA matrices are not actively surfaced by Fannie Mae but can be found on the Internet Archive using the Wayback Machine.

23. Recall that there is typically a one month lag between when a mortgage is originated and when it is delivered to Fannie Mae. Also, the LLPA is assessed upon the loan delivery date, not the origination date.

then the flow-equivalent LLPA is:

$$L_{c,d} = \frac{U_{c,d}}{M}, \tag{6}$$

where $M = 3.25$, on average, during our sample period (see below).[24]

Since Fannie Mae does not make their buy-up multiple M publicly available, we estimate it using TBA coupon prices from Bloomberg. As noted in Fuster et al. 2013, the implied buy-up multiple from a par TBA coupon swap should closely track the Fannie Mae buy-up multiple. Figure 5 displays the behavior of our estimated buy-up multiple over the sample period. The average multiple is roughly 3.25, and there is little time-series variation.[25]

Table IA.2 in the Internet Appendix reports descriptive statistics for the 303,214 mortgages in our Fannie Mae sample. The average mortgage has a loan amount of $342,669, LTV of 81%, and interest rate of 6.71%. The average borrower has a credit score of 754 and DTI of 37%. The average upfront LLPA is 0.59% of the loan amount ($1,995), or 0.17% (= 0.59% / 3.25) when quoted in terms of an equivalent ongoing fee.

3.2 HMDA Data

The Static National Loan Level Dataset from HMDA covers the near-universe of mortgage originations in the United States. In addition to the numerous variables that it shares with the Fannie Mae data, the HMDA data contains several unique variables that we use to supplement our main analysis. In particular, the HMDA data contains contains detailed information on upfront mortgage fees such as discount points and lender credits. These fees are crucial to observe because mortgage prices are multi-dimensional (Bhutta and Hizmo 2021), and lenders can respond to cost shocks by adjusting not only their interest rates but also their upfront fees (Liu 2019). Another unique feature of the HMDA data is that it

24. Another way to think about the buy-up multiple is in terms of mortgage discount points. Effectively, a buy-up multiple of 3.25 assumes that receiving one discount point will increase a mortgage's interest rate by 31 basis points, consistent with historical estimates of this relation (Yang 1992; Brueckner 1994; Agarwal, Ben-David, and Yao 2017; Fuster, Lo, and Willen 2024). Many other studies use (or find) multiples in the 3 to 5 range, including Fuster et al. 2013, Ahsin 2024, and Fuster, Lo, and Willen 2024.

25. We confirmed with an industry source that our estimated buy-up multiple is similar to what Fannie Mae was quoting lenders during our sample period.

reports the income, age, gender, race, and ethnicity of each borrower. These variables allow us to investigate whether pass-through varies across demographic groups.

The HMDA data contains four upfront fee-related variables: total loan costs, origination charges, discount points, and lender credits. Total loan costs are defined as the sum of origination charges – which are the sum of discount points and non-point loan fees such as application and underwriting fees – and charges paid to third parties such as home inspectors and title insurance companies. Lender credits are equivalent to negative discount points. The difference between origination charges and lender credits measures the net amount of upfront fees paid to the lender (hereafter, net upfront fees or just upfront fees). Further, the difference between total loan costs and origination charges measures the amount of upfront fees paid to third parties (hereafter, third-party fees), which are outside the lender's control.

We apply the same filters to the HMDA data as we did to the Fannie Mae data. In addition, we restrict the data to mortgages that were delivered to Fannie Mae by the calendar year-end HMDA reporting date (Begley and Srinivasan 2022). Table IA.3 reports descriptive statistics for the 1,030,703 mortgages in our HMDA sample. The average borrower paid \$3,062 in net upfront fees (0.88% of the loan amount), which was split between \$2,252 in discount points (0.65%), \$1,233 in non-point loan origination fees (0.35%), and \$423 in lender credits received (0.12%). Approximately 65% of borrowers are below the age of 45, 37% are female, and 26% are non-white. An additional 6% of borrowers have missing gender data and 15% have missing racial data.

Using the lender crosswalk file from Robert Avery and the classification procedure in Buchak et al. 2018, we classify each lender in our HMDA sample as either a bank or a non-bank. We find that approximately 26% of loans in our HMDA sample were originated by banks and 74% were originated by non-banks. We find similar results if we classify lenders as banks or non-banks based on whether they have non-missing assets data in the HMDA Public Panel File (Benson, Kim, and Pence 2024; Bhutta, Fuster, and Hizmo 2024).

3.3 Merging the Fannie Mae and HMDA Data

Our main analysis focuses on the intersection of the Fannie Mae and HMDA samples, which we call our "merged Fannie-HMDA sample". By focusing on the intersection of these samples, we can accurately measure each mortgage's LLPA as well as multiple aspects of its price.[26]

To merge the Fannie Mae and HMDA samples, we use a modified version of the two-step procedure outlined in Cuesta et al. 2023 and Buchak and Jorring 2024. In the first step, we match loans based on location,[27] lender name,[28] origination year, original loan amount, interest rate, DTI, and LTV.[29] For around 35% of the loans in our Fannie Mae sample, this first step produces at least one match; however, around 2% of these matches are non-unique. Thus, in the second step of the procedure, we remove loans with duplicate observations in the matched dataset. The final sample consists of 84,685 mortgages with unique matches between the Fannie Mae and HMDA samples.

Table 1 reports descriptive statistics for our merged Fannie-HMDA sample. Unsurprisingly, the merged sample is similar to both the Fannie Mae and HMDA samples along most dimensions.[30] The average mortgage has a loan amount of $359,972 and LTV of 82%. The

26. While the Fannie Mae data contains the information needed to calculate LLPAs, it does not contain any information on upfront fees. Conversely, while the HMDA data contains information on upfront fees, it does not contain information on credit scores, which are necessary for calculating LLPAs. A further limitation of the public version of the HMDA data is that it only reports the year that each mortgage was originated, whereas our empirical strategy requires knowing both the precise year and the month.

27. In the Fannie Mae data, the most granular unit of geography is the three-digit ZIP code, whereas in the HMDA data it varies between the census tract and county. Given this mismatch, we use the following waterfall procedure to match on locations. First, if the most granular units of geography in the Fannie Mae and HMDA data completely overlap, then we match them using the USPS ZIP crosswalk. Second, for the remaining unmatched locations, we match them using MSAs, which are reported in both datasets.

28. One challenge here is that the Fannie Mae data only reports the names of lenders that had at least a one percent origination market share in the reporting period. To work around this issue, we match on lender names using the following waterfall procedure. First, if the lender name is surfaced in the Fannie Mae data, then we match it to its the relevant Legal Entity Identifiers (LEIs) in the HMDA data. Second, if the lender name is not surfaced, then we match it to the remaining set of unmatched HMDA lenders.

29. For some of these loan characteristics (e.g., the loan amount), the Fannie Mae data reports the variable at a more granular level than the HMDA data. In such cases, we bucket the values in the Fannie Mae data to match the level of detail reported in the HMDA data.

30. Table IA.4 shows that there are no economically significant differences between loans in the Fannie Mae sample that have unique matches in the HMDA sample and loans in the Fannie Mae sample that do not have unique matches in the HMDA sample.

average borrower has a credit score of 757, household income of $162,536, and DTI of 34%. The average upfront LLPA is 0.58% of the loan amount ($2,066), or 0.18% when quoted in terms of an equivalent ongoing fee.

As mentioned above, mortgage prices are multi-dimensional, consisting of both an interest rate component and upfront fees. Therefore, to measure the extent to which the LLPA changes were passed through to mortgage prices, we construct an all-in mortgage price P akin to an APR:

$$P = R + \frac{N}{A \cdot M}, \tag{7}$$

where R is the interest rate, N is the net amount of upfront fees paid to the lender (= discount points + non-point loan fees − lender credits), A is the original loan amount, and $M = 3.25$ is the estimated Fannie Mae buy-up multiple. As shown in Table 1, the average loan in our sample has an interest rate of 6.73%, flow-equivalent net upfront fees of 0.34%, and all-in mortgage price of 7.07%.

4 Price Pass-Through

We begin by examining the extent to which the May 2023 LLPA changes were passed through to mortgage prices. Let i denote a mortgage, c its LLPA cell, and d its delivery month. We estimate the following model:

$$P_{i,c,d} = \alpha + \rho \cdot L_{c,d} + \delta_c + \delta_d + \varepsilon_{i,c,d}, \tag{8}$$

where $P_{i,c,d}$ is the all-in mortgage price, $L_{c,d}$ is the flow-equivalent LLPA, δ_c are LLPA cell fixed effects, and δ_d are delivery month fixed effects. The coefficient of interest, ρ, measures the average pass-through rate. Standard errors are double-clustered at the LLPA cell and delivery month levels to match the assignment of treatment.

Column 1 in Table 2 reports the coefficient estimates from the model. On average, the pass-through rate is 99%, with a 95% confidence interval of 81% to 116%. Column 2 shows that the magnitude of the average pass-through rate is insensitive to including additional control variables in the model, such as lender × month fixed effects, DTI decile × month fixed effects, and loan amount decile × month fixed effects. Thus, across both specifications, we find that lenders pass through a substantial portion of LLPA changes to borrowers via mortgage prices, and we cannot reject the hypothesis of complete pass-through at the 10% level.

We next examine whether lenders distribute the costs of LLPA changes across multiple price margins. To do so, we separately estimate Equation 8 with interest rates and upfront fees as the outcome variable. Columns 3 through 6 in Table 2 report the coefficient estimates from the models. We find that around 69% of price pass-through comes from the interest rate margin (= 0.68 / 0.99), with the remaining 31% coming from upfront fees (= 0.31 / 0.99).

As mentioned in Section 3.2, upfront fees consist of three components – discount points, non-point loan fees, and lender credits – which differ in terms of how salient they are to borrowers. Whereas discount points and lender credits are directly quoted to borrowers on the rate lock date, non-point loan fees are usually not revealed until closer to the closing date. To examine the relative importance of these fee components, we separately estimate Equation 8 with discount points, lender credits, and non-point loan fees as the outcome variable. Table 3 shows that pass-through via upfront fees was almost entirely driven by changes in discount points. There were no economically significant changes in lender credits or non-point loan fees following the May 2023 LLPA changes.

Combined, the results in Tables 2 and 3 have two important implications. First, they suggest that studies that focus solely on interest rates and ignore upfront fees (e.g., van Binsbergen and Grotteria 2024) may significantly understate cost pass-through in the mortgage market. This is closely related to the findings in Buchak and Jorring 2024, which shows that upfront fees, but not interest rates, are higher in areas where there is less competition among lenders.

Second, our results suggest that lenders do not strategically adjust their upfront fees to take advantage of borrowers' differential price sensitivities. If borrowers are less sensitive to upfront fees than interest rates as argued in Liu 2019 and elsewhere, then strategically-behaving lenders would pass on more of a cost increase via upfront fees to limit the overall impact on demand (Chen and Juvenal 2016). However, we find no evidence of such behavior. Not only do upfront fees account for less than one-third of overall pass-through, but pass-through via upfront fees primarily comes from discount points, which are by far the most salient upfront fees.[31] Thus, our results are more in-line with the practitioner-oriented view of upfront fees described in Salomon Brothers 2001 and Fuster et al. 2013. This view argues that lenders use discount points as "plugs" in their rate sheets to keep their expected profits constant regardless of which contract the borrower ultimately chooses.[32]

To supplement the pooled analysis above, we also examine time-series heterogeneity in the pass-through rate. We do so by estimating the following dynamic (reduced-form) version of Equation 8:

$$\begin{aligned} P_{i,c,d} = \alpha &+ \sum_{\tau=-5}^{7} \Gamma_\tau \cdot 1\left(\Delta L_c < 0\right) \cdot D_{d,\tau} + \sum_{\tau=-5}^{7} \beta_\tau \cdot 1\left(\Delta L_c > 0\right) \cdot D_{d,\tau} \\ &+ \delta_c + \delta_d + \varepsilon_{i,c,d}, \end{aligned} \tag{9}$$

where $D_{d,\tau}$ is equal to one if delivery month d is τ months from the treatment date, and zero otherwise; $1\left(\Delta L_c < 0\right)$ is equal to one if the LLPA in cell c decreased on the treatment date, and zero otherwise; and $1\left(\Delta L_c > 0\right)$ is equal to one if the LLPA in cell c increased on the treatment date, and zero otherwise. We exclude the first delivery month of the

31. Technically, the relevant strategic response would involve lenders raising their upfront fees in response to cost increases but lowering their interest rates in response to cost decreases. However, we find no evidence of such asymmetric effects in Section 5.1.

32. Since the market convention is for mortgage interest rates to be quoted in one-eighth percentage point increments, lenders use discount points as a tool to convert discrete prices to continuous prices. For each interest rate offered on the rate sheet, lenders set the number of discount points on the contract to achieve their target profit margins, which fluctuate with market conditions.

sample period ($\tau = -5$, or December 2023) as the reference month. Therefore, the Γ_τ (β_τ) coefficients capture the average difference in mortgage prices between cells with LLPA increases (decreases) and cells with no LLPA changes as of delivery month τ, relative to the same difference as of the first delivery month of the sample period.

Figure 6 plots the coefficient estimates from Equation 9. We find that mortgage prices reacted immediately to the LLPA changes and that the effects were persistent. The absence of economically significant pre-trends suggests that neither borrowers nor lenders strategically timed their mortgage originations to coincide with the LLPA changes.[33] Overall, both the static and dynamic specifications suggest lenders pass through a substantial portion of LLPA changes to borrowers via mortgage prices.

While the pass-through of LLPA changes to loan prices is important, so is the effect on loan quantities (DeFusco and Paciorek 2017). We thus estimate the following intensive margin loan demand model:

$$\log A_{i,c,d} = \alpha + \mu \cdot L_{c,d} + \delta_c + \delta_d + \varepsilon_{i,c,d}, \tag{10}$$

where $\log A_{i,c,d}$ is the natural logarithm of the loan amount. Since the pass-through rate in Table 2 is close to 100%, the reduced-form model above will produce similar results as an instrumental variables regression with loan price on the right-hand side.

Column 1 in Table 4 reports the coefficient estimates. We find a small, negative relation between LLPAs and loan quantities. Our estimates imply an intensive margin loan demand elasticity of -0.01, which is economically and statistically indistinguishable from perfectly inelastic demand. This inelastic demand estimate helps justify the near-complete pass-through rate observed in Table 2, among other things.

33. Two other pieces of evidence are inconsistent with strategic borrower or lender sorting. First, our sample is limited to purchase mortgages whose closing dates are difficult to precisely manipulate due to moving-related reasons. Second, the magnitudes of our estimates are stable throughout the post-period, whereas strategic sorting would predict some reversion in the effects.

5 Heterogeneous Pass-Through

So far, we have shown that price pass-through is high on average and is met with minimal demand-side responses. We next explore whether price pass-through varies across both the direction of the cost shock and across borrowers.

5.1 Asymmetric Pass-Through

We begin by examining whether the pass-through rate is symmetric across LLPA increases and decreases. To do so, we estimate the following model:

$$P_{i,c,d} = \alpha + \theta \cdot L_{c,d} + \phi \cdot L_{c,d} \cdot 1\,(\Delta L_c < 0) + \delta_c + \delta_d + \varepsilon_{i,c,d}, \quad (11)$$

where all the terms are defined as before. Column 1 in Table 5 reports the coefficient estimates from the model. We find that the pass-through rate is highly asymmetric, with lenders capturing a significant portion of mortgage subsidies intended for borrowers. Specifically, while lenders slightly overshifted the costs associated with LLPA increases onto borrowers ($\hat{\theta}$ = 129%; 95% CI = 111% to 147%), they only passed through 70% of the savings associated LLPA decreases.

To better understand the drivers of this asymmetry, we separately estimate Equation 11 with interest rates and upfront fees as the outcome variable. As shown in columns 2 and 3 in Table 5, we find that asymmetric pass-through is driven almost entirely by interest rates, not upfront fees. Columns 4 through 6 additionally document no significant asymmetry for any components of upfront fees. Combined, these results are consistent with the view that upfront fees do not play a strategic role in the mortgage price-setting process, similar to our findings from before.[34]

From a policy evaluation standpoint, documenting asymmetric pass-through is important

34. An alternative view of our results is that lenders do adjust their fees strategically but that borrowers are more sensitive to fees than interest rates (i.e., the opposite of Liu 2019). However, if this view were true, we would expect lenders to pass through more of a cost decrease via upfront fees, which we do not find.

for several reasons. One of the FHFA's main goals for the May 2023 LLPA changes was to reduce the cost of mortgage financing for borrowers "...limited by income or wealth" (Wall Street Journal 2023c). While these borrowers did in fact experience reductions in their financing costs due to the LLPA changes, we find that a significant portion of the subsidies directed towards them were ultimately captured by lenders, limiting the overall effectiveness of the policy. Moreover, lenders were able to completely pass through the "taxes" that were supposed to pay for these subsidies to moderately less risky borrowers. Thus, from the average lender's perspective, intermediating the May 2023 LLPA changes was likely a profitable endeavor, as highlighted in our cost calculations below.

Documenting asymmetric pass-through is also important for assessing the average cost of the May 2023 LLPA changes. To see this, suppose one incorrectly calculated the average cost per loan as the product of the average pass-through rate from Table 2 ($\hat{\rho} = 0.99$) and the average dollar change in guarantee fees ($\overline{\Delta U} = \$185$):[35]

$$\overline{\Delta U} \cdot \hat{\rho} = \$183, \tag{12}$$

Doing so would result in a cost estimate that is approximately 30% as large as an estimate that accounts for pass-through asymmetry:

$$N^{-1} \sum_{i=1}^{N} \Delta U_{i,c} \cdot \left(\hat{\theta} + \hat{\phi} \cdot 1\left(\Delta L_c < 0\right) \right) = \$591. \tag{13}$$

where $\hat{\theta} = 1.29$ and $\hat{\phi} = -0.59$ are the pass-through estimates from Table 5.

It is important to note that the reason the above cost difference is larger than the degree of asymmetry is because smaller loans were more likely to receive LLPA decreases. Thus, in dollar terms, the amount of taxes raised that were directed back to borrowers was even smaller than the average pass-through rate suggests, and lenders captured an even larger amount of the difference via higher per loan profits.

35. Here, $\overline{\Delta U} = N^{-1} \sum_{i=1}^{N} \Delta U_i$, where ΔU_i is how much mortgage i's LLPA changed due to the policy.

Is there a more effective way of delivering mortgage subsidies to borrowers? Answering this question requires a better understanding of the drivers of asymmetric pass-through. For example, if asymmetric pass-through primarily arises because of asymmetric information about the cost shock, then it may be more efficient to directly allocate mortgage subsidies to borrowers instead of relying on lenders to pass them through (Busse, Silva-Risso, and Zettelmeyer 2006). However, if asymmetric pass-through is simply a byproduct of the discrete nature of the cost shock and convexity in the demand and supply curves (Ritz 2015), then the equilibrium pass-through rate would be the same regardless of whether mortgage subsidies were nominally directed to borrowers or lenders. Below, we empirically examine several potential drivers of asymmetric pass-through and discuss their policy implications.

5.1.1 What Drives Asymmetric Pass-Through?

One potential driver of asymmetric pass-through is asymmetric information about the cost shock. If, as was likely the case, borrowers were less informed about the May 2023 LLPA changes than lenders, then lenders may have been able to pass through less of the savings from LLPA decreases and more of the costs from LLPA increases (Busse, Silva-Risso, and Zettelmeyer 2006). While earlier theories of pass-through predict that the economic incidence of a cost shock does not depend on its statutory incidence, more recent studies argue that this may not be the case in the presence of information asymmetry (Tappata 2009) or borrower optimization frictions (Chetty, Looney, and Kroft 2009).

To empirically assess the relevance of this asymmetric information channel, we use two proxies for how well-informed borrowers were about the LLPA changes. The first proxy is whether the borrower used a mortgage broker to obtain their loan. Mortgage brokers were likely well-informed about the LLPA changes and thus might have had more negotiating power when it came to the division of the resulting costs / benefits. If asymmetric information about the cost shock drives our results, then we should expect that borrowers that used a mortgage broker should have received a larger share of the benefits from LLPA decreases and shouldered less of the costs from LLPA increases.

We divide borrowers into two subsamples based on whether their LLPA cells experienced an LLPA increase or decrease on the treatment date. Next, we separately estimate the following model for each subsample:

$$P_{i,c,d} = \alpha + \rho \cdot L_{c,d} + \pi \cdot L_{c,d} \cdot \text{Brokered}_i + \delta_{\text{Brokered},d} + \delta_c + \delta_d + \varepsilon_{i,c,d}, \tag{14}$$

where Brokered_i is equal to one if mortgage i was obtained through a mortgage broker, and zero otherwise. For both subsamples, we include loans from cells that did not experience an LLPA change as additional control observations. The coefficient of interest is π, which measures the differential pass-through rate for broker-intermediated mortgages relative to mortgages that were obtained directly from lenders.

Columns 1 and 3 in Table 6 report the coefficient estimates from Equation 14. Consistent with the information asymmetry channel, we find that a relatively greater portion of LLPA decreases were passed through to borrowers that used a mortgage broker. However, we also find that a larger share of LLPA increases were passed through to these same borrowers, suggesting that borrowers that use a mortgage broker may just be less price-sensitive in general and hence may just have naturally higher pass-through rates.

Our second proxy for how well-informed borrowers were about the LLPA changes is whether they were first-time homebuyers. Since first-time homebuyers never obtained a mortgage before, they might have been less aware of the May 2023 LLPA changes than more experienced homebuyers (e.g., real estate investors). Therefore, if the information asymmetry channel drives our results, then we should expect to find that first-time homebuyers received a smaller share of the savings from LLPA decreases and shouldered a larger portion of the costs from LLPA increases.

To test this hypothesis, we replace the Brokered_i variable in Equation 14 with First_i, which is equal to one for first-time homebuyers, and zero otherwise. We then separately estimate this model for the same two subsamples used in our previous test. Columns 2 and 4 in Table 6 report the coefficient estimates. For both LLPA decreases and increases, we find no significant heterogeneity in the pass-through rate across first-time homebuyer status. Overall, the results in Table 6 provide mixed evidence, at best, for the asymmetric information channel.

One important feature of the May 2023 LLPA changes is that they were not randomly assigned. While borrowers with lower credit scores and higher LTVs were more likely to receive LLPA decreases, borrowers with moderately higher credit scores and lower LTVs were more likely to receive LLPA increases. Thus, another potential explanation for asymmetric pass-through could be that the types of borrowers who received LLPA decreases may simply be less price-sensitive than the types of borrowers who received LLPA increases.[36]

To test the above explanation, we start by separately estimating Equation 11 for borrowers with above-median and below-median credit scores. Columns 1 and 2 in Table 7 report the coefficient estimates. Inconsistent with differential borrower price sensitivities driving our results, we find that the pass-through rate is asymmetric within both subsamples. Columns 3 and 4 repeat the test after splitting the sample based on LTVs instead of credit scores. We continue to find evidence of asymmetric pass-through, albeit the interaction coefficient is statistically insignificant for the below-median LTV subsample.

Finally, the discrete – i.e., non-infinitesimal – nature of the LLPA changes we study could have led to asymmetric pass-through if mortgage demand or supply is sufficiently convex (Ritz 2015).[37] It is common to assume that mortgage supply is locally convex during periods in which loan demand is high and lenders are operating near their capacity constraints (Fuster, Lo, and Willen 2024). However, our sample period was characterized by rising interest rates and relatively low loan demand, making locally linear supply seem like a

36. The auto loan literature typically finds that borrowers with lower credit score are less sensitive to financing costs, not more sensitive (e.g., Attanasio, Goldberg, and Kyriazidou 2008). If this finding also applies to the mortgage market, then our asymmetric pass-through estimates should be attenuated, if anything.

37. Equation 3 shows that the theoretical pass-through rate is symmetric for infinitesimal cost shocks. However, most real-world cost shocks are discrete, not infinitesimal, and this seemingly innocuous difference generates asymmetries if the market demand or supply curves are sufficiently non-linear.

more reasonable assumption. To test whether the mortgage demand curve is convex, we re-estimate Equation 10 after adding a squared LLPA term to the right-hand side (Pless and van Benthem 2019). As shown in column 2 in Table 4, we find a large, positive coefficient on the squared term, consistent with borrowers having convex mortgage demand.

In summary, our results suggest that asymmetric pass-through may have been driven by technical features of the pass-through rate and not differential price sensitivities or asymmetric information about the cost shock. Knowing this information is important for the design of mortgage subsidies, as it suggests that the equilibrium effects on prices and quantities should be the same regardless of whether they are nominally allocated to borrowers or lenders. In contrast, if the asymmetric information channel was driving our results, then it would be more efficient to allocate mortgage subsidies directly to borrowers, as the economic incidence of these subsidies would depend on the their statutory incidence under this channel.

5.2 Mortgage Market Competition

In addition to the direction of the cost shock, economic theory predicts that the pass-through rate may depend on market structure and competition. In particular, Weyl and Fabinger 2013 show that the relation between pass-through and competition is theoretically ambiguous, and that it depends on several factors such as how widespread the cost shock is and the shapes of the market demand and supply curves. In our setting, the cost shock was mostly market-wide since the vast majority of qualifying mortgages are eventually delivered to the GSEs. For a cost shock of this type, a wide range of models predict that pass-through will be increasing as the level of competition rises (Genakos and Pagliero 2022).

One challenge that arises when examining whether pass-through varies across competition is that most mortgage lenders face similar competitive environments. The Federal Reserve has historically viewed the United States mortgage market as national in scope (Federal Reserve System 2008), with most of the largest mortgage lenders having significant market share nationwide. However, Scharfstein and Sunderam 2016 and Buchak and Jorring 2024 document significant local components of lender concentration that affect mortgage prices. These differences in local lender concentration, in turn, may provide us with meaningful variation in mortgage market competition.

Following the above studies, we use the Herfindahl–Hirschman index (HHI) as an inverse measure of mortgage market competition. We construct our HHIs at the county level based on pre-treatment HMDA lender market shares. We then assign mortgages to two groups based on the median county-level HHI and estimate the following model:

$$\begin{aligned} P_{i,c,d,f} = \alpha + \rho \cdot L_{c,d} + \pi \cdot L_{c,d} \cdot \text{Low Competition}_f \\ + \delta_c + \delta_d + \delta_{\text{Low Competition},t} + \varepsilon_{i,c,d,f}, \end{aligned} \tag{15}$$

where Low Competition$_f$ is equal to one if county f has an above-median HHI (i.e., below-median competition), and zero otherwise.

Column 1 in Table 8 reports the coefficient estimates from the model. Consistent with the predictions above, we find that pass-through is slightly lower in less competitive mortgage markets ($\hat{\rho} + \hat{\pi} = 89\%$) than more competitive markets ($\hat{\rho} = 100\%$). However, since the interaction coefficient is statistically insignificant at the 10% level, we are wary to conclude that mortgage market competition has a strong influence on the pass-through rate.

It is important to note that the difference in the pass-through rate across more-versus-less competitive mortgage markets might be attenuated due to limited variation in lender concentration around the median. Table IA.6 re-estimates Equation 15 within the tails of the competition distribution and documents some evidence of this, albeit the interaction coefficients are still statistically insignificant at the 10% level.

5.3 Borrower Characteristics

Economic theory also predicts that lenders will find it easier to pass on cost shocks when borrowers are relatively less price-sensitive. To test this prediction, we start by proxying for relative credit demand elasticities using DTI ratios, as higher DTI ratios should be indicative of tighter financial constraints and perhaps higher price sensitivities. We then split our sample into two groups based on the median DTI ratio and estimate the following regression model:

$$P_{i,c,d} = \alpha + \rho \cdot L_{c,d} + \pi \cdot L_{c,d} \cdot \text{High DTI}_i + \delta_c + \delta_d + \delta_{\text{High DTI},t} + \varepsilon_{i,c,d} \tag{16}$$

where High DTI_i is equal to one if mortgage i has an above-median DTI ratio, and zero otherwise.

Column 2 in Table 8 reports the coefficient estimates from the model. Consistent with the predictions above, we find that the pass-through rate is slightly lower for borrowers with higher DTI ratios ($\hat{\pi} = -0.05$). However, this DTI-based heterogeneity is substantially weaker than the pass-through asymmetry in Table 5, which is not overly surprising given the highly inelastic average demand elasticity in Table 4.

It is also important to understand whether pass-through varies across demographic groups. To investigate this potential source of heterogeneity, we re-estimate Equation 16 after replacing the High DTI_i variable with indicators for whether the primary borrower is (i) non-white and (ii) female. Columns 3 and 4 in Table 8 report the coefficient estimates from the models. We find no economically or statistically significant heterogeneity in the pass-through rate across race and gender.

6 Alternative Explanations and Robustness

The May 2023 LLPA changes might have affected borrower and lender behavior in many ways, including by encouraging borrowers to make lower down payments or changing lenders' loan retention decisions. Below, we investigate several alternative explanations for our results but find that none are supported by the data.

6.1 Strategic Borrower Sorting on LTVs

One potential concern is that certain types of borrowers may have strategically made lower down payments and sorted into higher LTV cells to take advantage of the May 2023 LLPA changes.[38] For example, if unobservably more price-sensitive borrowers were more likely to sort into higher LTV cells than less price-sensitive borrowers, then the subsequent change in the composition of borrowers across the LTV distribution could cause us to overstate the degree of pass-through asymmetry (but perhaps not the average pass-through rate).

We conduct two tests to examine whether borrowers strategically sorted into higher LTV cells following the May 2023 LLPA changes. First, in Figure IA.2, we plot the before-and-after change in the share of mortgage originations in each LLPA cell against the change in each cell's LLPA. If borrowers responded to the May 2023 LLPA changes by sorting into "riskier" cells, then we should expect to find that larger reductions in LLPAs were followed by larger increases in mortgage origination shares, and vice versa. However, we find no systematic evidence of this relation, consistent with the highly inelastic loan demand documented in Table 4.

Second, Figure IA.3 plots the average LTV within each credit score bin (i.e., each row of the LLPA matrix) before and after the LLPA changes. If borrowers strategically sorted into higher LTV cells to reduce their LLPAs, then we should expect to find that LTVs increased, on average, within most credit score bins. However, we find the opposite in the data. For every credit score bin, average LTVs for newly originated mortgages are lower after the LLPA change than before, with the overall average LTV declining from 82.65% to 81.44%.[39]

38. By inverting the traditionally increasing relation between LLPAs and LTVs for LTVs above 80%, the May 2023 LLPA changes encouraged liquidity-constrained borrowers to sort into higher LTV cells. However, they did not encourage borrowers to sort into lower credit score cells, as lower credit scores were associated with higher LLPAs both before and after the change date. It is important to note that it is generally not possible for borrowers to precisely sort into higher credit score cells (Agarwal, Ben-David, and Yao 2017) and that liquidity constraints prevent most borrowers from precisely sorting into lower LTV cells.

39. To supplement this test, Figure IA.4 plots the histogram of mortgage originations across LTV bins, before and after the May 2023 LLPA changes. Strategic borrower sorting would imply that the histogram of mortgage originations should shift to the right for LTVs above 80% (i.e., the region where it is advantageous to do so). However, we find that the histogram of mortgage originations was stable during our sample period, inconsistent with strategic borrower sorting driving our results.

It is likely that the average borrower did not reduce their down payment following the May 2023 LLPA changes because they were unaware of the benefits of doing so. LLPAs are opaque components of mortgage prices which are usually not communicated by lenders to borrowers. To get a rough idea of their LLPA, a borrower would not only have to estimate their tri-bureau credit score, but they would also have to search Fannie Mae's website for the active LLPA matrix. Borrowers would also have to actively follow mortgage-related news to understand how the relation between LLPAs and down payments changed after May 2023. While it is possible that informed intermediaries such as mortgage brokers might have steered borrowers towards the down payment that minimizes their LLPA (subject to liquidity constraints), we continue to find no evidence of strategic borrower sorting for broker-intermediated loans in Figure IA.5

6.2 Changes in Credit and Prepayment Risk

Another potential concern is that differential changes in credit or prepayment risk across LLPA cells might be driving our results. To address this concern, we re-estimate Equation 8 with indicators for whether a loan defaulted or was prepaid within 6 months of its origination date as the outcome variable. Table IA.7 reports the coefficient estimates from the models. Inconsistent with this alternative explanation, we find that the May 2023 LLPA changes were not followed by any significant differential changes in credit or prepayment risk.

In addition to lacking empirical support, the above explanation is at odds with several institutional details. First, by paying the LLPA, lenders are effectively removing credit risk from their loans. Hence, loan-specific credit risk should not affect lenders' primary market pricing once the LLPA has been accounted for (Bartlett et al. 2022).[40] Second, since

40. While paying the LLPA essentially converts loan-specific credit risk into prepayment risk from the perspective of the owner of the loan, default-related prepayment risk is small relative to non-default-related prepayment risk (Scharfstein and Sunderam 2016). Moreover, we find no differential changes in combined credit and prepayment risk. Bhutta and Hizmo 2021 similarly discuss the reasons that loan-specific credit risk should not affect mortgage pricing in the FHA market: "Because FHA loans are fully insured by the U.S. government and sold into government guaranteed securities, mortgage originators and investors are exposed to little or no credit risk and thus have limited incentives to price risk. As such, omitted credit risk variables

most qualifying mortgages are packaged into agency MBS which are subsequently sold in the TBA market, the relevant secondary market price for these mortgages is the price of the best-execution TBA coupon, not the prices of the loans themselves. As a result, loan-specific prepayment risk should also not affect lenders' primary market pricing beyond the common TBA funding cost (and the value of servicing rights), which is mostly controlled for by our time fixed effects. It is also important to remember that investors in the TBA market cannot "pick and choose" which types of loans to purchase, and hence they cannot bid up or down the prices of specific types loans. On the trade date, the TBA buyer and seller only agree upon a few key characteristics of the agency MBS to be delivered but not the precise CUSIP. Partly because of this feature, most agency MBS pools delivered in the TBA market are well-diversified and consist of thousands of qualifying mortgages across the distribution of credit scores and LTVs.[41]

Finally, it is unlikely that the GSEs changed their LLPA matrices in May 2023 because they expected credit or prepayment risk to be different in the future (i.e., reverse causality should not be a concern). Despite significant changes in credit and prepayment risk between 2013 and 2022, Fannie Mae and Freddie Mac only updated their LLPA matrices once for purchase mortgages during this period. The GSEs let their LLPAs depart from pure risk-based pricing partly to accomplish their affordable housing mandate, and they do not incorporate many predictable sources of credit risk into their LLPAs (Hurst et al. 2016).

6.3 Non-Random Assignment of LLPA Changes

One lingering issue is that the May 2023 LLPA changes were not randomly assigned. Lower credit score and higher LTV mortgages were more likely to receive LLPA decreases, whereas moderately higher credit score and lower LTV mortgages were more likely to receive LLPA

should not pose a serious threat to identification".

41. See Vickery and Wright 2013. Effectively, the TBA market concentrates agency MBS trading into a small number of contracts, thereby improving liquidity at the expense of adverse selection. Huh and Kim 2022 find that TBA eligibility reduces primary market mortgage rates by 7 to 28 basis points, with the effect being larger for mortgages with higher prepayment risk.

increases. Although the institutional details in Section 6.2 help alleviate this concern, it is still possible that our results might be capturing the effect of a time-varying omitted factor that is correlated with credit scores or LTVs, as opposed to the causal effect of the LLPA changes per se.

We perform two robustness tests to address this concern. First, we re-estimate Equation 8 with credit score bin × month and LTV bin × month fixed effects to control for the direct time-varying effects of credit scores and LTVs on mortgage prices. Table IA.9 reports the coefficient estimates from the models. Despite the more limited source of variation, we find that a substantial portion of LLPA changes were passed through to borrowers, similar to our baseline estimates.

Second, we conduct a placebo test using FHA and VA mortgages that were delivered to Ginnie Mae. Similar to how the GSEs charge guarantee fees to insure qualified mortgages against credit risk, Ginnie Mae provides credit guarantees for FHA and VA mortgages in exchange for upfront and annual mortgage insurance premiums.[42] However, while Fannie Mae and Freddie Mac made significant changes to their LLPA matrices in May 2023, Ginnie Mae did not adjust its mortgage insurance premiums during our sample period. The basic idea behind our placebo test is to assign each Ginnie Mae-backed loan a "pseudo LLPA" based on its credit score, LTV, and the Fannie Mae LLPA matrix that was active during the month it was delivered. If our previous results capture the causal effect of the LLPA changes and not a correlated omitted variable, then we should find no significant relation between pseudo LLPAs and mortgage prices for FHA and VA loans.

To implement our placebo test, we use loan-level data from the Ginnie Mae MBS Disclosure File. We clean the data using the same filters (whenever possible) as in Section 3.1, and we assign each mortgage a pseudo LLPA using the method outlined above. We then re-estimate Equation 8 after replacing the flow-equivalent LLPA with the flow-equivalent pseudo LLPA, and we report the coefficient estimates from the model in Table IA.8. In

42. These premiums vary only slightly by LTV, loan size, and loan maturity. They do not vary by credit score or other loan-specific risk factors such as DTI. See Bhutta and Hizmo 2021.

general, we find no consistent relation between pseudo LLPAs and mortgage prices. For VA mortgages the relation is positive, for FHA mortgages it is negative, and for all specifications the effect size is economically insignificant.[43]

6.4 Lender Characteristics and Retention Decisions

It is also possible that the GSEs may have either undone or amplified the effects of the LLPA changes by changing their cash window pricing. This alternative explanation seems unlikely though, as competition between Fannie Mae and Freddie Mac for cash window volume typically keeps cash window pricing closely tied to MBS pricing. Nevertheless, we also explicitly test this alternative explanation by re-estimating Equation 8 using only the ten largest lenders in our sample. These lenders usually deliver to MBS instead of the cash window. As shown in Table IA.10, the pass-through rate for these ten lenders is similar to the pass-through rate for our full sample, inconsistent with differential changes in cash window pricing driving our results.

Finally, bank lenders may have been able to partially undo LLPA increases by holding more whole loans on their balance sheets (Elenev, Landvoigt, and Van Nieuwerburgh 2016). To rule out this concern, we re-estimate Equation 8 on just the subsample of non-bank lenders, which usually securitize the overwhelming majority of mortgages that they originate. Table IA.11 reports the coefficient estimates from the model. Inconsistent with changes in lender retention decisions driving our results, the pass-through rate for the subsample of non-bank lenders is similar to the pass-through rate for our full sample.

7 Conclusion

The cost of mortgage credit influences a range of outcomes including household borrowing and spending decisions as well as the transmission of fiscal and monetary policy. Beyond

43. In some sense, the economically small effect size in Table IA.8 can be used as a measure of the omitted variable bias in our baseline estimates.

risk-based pricing, lenders shape mortgage credit costs through mechanisms like determining how various types of costs are passed on to consumers. In this paper, we study how lenders pass through mortgage production costs and subsidies to borrowers, focusing specifically on changes in guarantee fees charged by the GSEs.

In May 2023, the GSEs drastically reduced their guarantee fees for some types of mortgages while raising them for others, creating a major cost shock for lenders. We use this event as a natural experiment and ask four specific questions. First, to what extent do lenders pass through guarantee fees to mortgage prices? Second, do lenders concentrate price increases along less salient margins, such as upfront fees? Third, is pass-through symmetric across cost increases and decreases? Fourth, does pass-through vary across borrower characteristics and market structure according to the predictions of economic theory?

Using loan-level data from the GSEs and HMDA, we show that lenders pass through approximately 99% of guarantee fee changes to borrowers, on average. However, this average effect is somewhat misleading because pass-through is highly asymmetric and heterogeneous. While lenders slightly overshift cost increases onto borrowers, they only pass-through 70% of cost decreases. Further, there is heterogeneity in the pass-through rate across market structure and borrower characteristics. We show that ignoring heterogeneous pass-through leads to significant underestimates of the cost of recent guarantee fee changes. We also show that lenders primarily pass through guarantee fee changes via interest rates, not upfront fees, inconsistent with lenders strategically adjusting their prices along non-salient margins to limit the overall impact on demand. Our results highlight the limits to the effectiveness of using guarantee fees as a tool for redistributing costs and subsidies among borrowers.

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Table 1: Descriptive Statistics for Merged Fannie-HMDA Sample

	Mean (1)	SD (2)	P10 (3)	P25 (4)	P50 (5)	P75 (6)	P90 (7)
Total Loan Price (%)	7.07	0.63	6.26	6.62	7.06	7.50	7.89
Interest Rate (%)	6.73	0.61	5.99	6.38	6.75	7.12	7.50
Net Upfront Fees (%)	0.34	0.29	0.05	0.11	0.27	0.50	0.75
Net Upfront Fees ($)	3,626.26	3,571.34	533.22	1,252.50	2,523.00	5,178.30	8,188.28
Discount Points ($)	2,402.47	3,452.08	0.00	0.00	974.46	3,629.93	6,660.84
Non-Point Loan Fees ($)	1,581.64	2,561.26	0.00	995.00	1,295.00	1,590.00	3,200.00
Lender Credits ($)	357.86	1,257.67	0.00	0.00	0.00	20.00	819.89
Loan Amount ($)	359,972.27	157,261.65	172,000.00	240,000.00	336,000.00	465,000.00	597,000.00
Loan-to-Value Ratio (%)	81.82	15.03	60.00	80.00	80.00	95.00	95.00
Credit Score	757.12	40.29	700.00	733.00	765.00	789.00	802.00
Debt-to-Income Ratio (%)	33.76	9.20	22.00	27.00	34.00	41.00	46.00
Household Income	162,536.05	122,536.34	79,000.00	103,000.00	139,000.00	191,000.00	261,000.00
Co-Signed? (1/0)	0.58	0.49	0.00	0.00	1.00	1.00	1.00
Upfront LLPA (%)	0.58	0.52	0.00	0.25	0.50	0.75	1.25
Flow LLPA (%)	0.18	0.16	0.00	0.08	0.15	0.23	0.38
Upfront LLPA ($)	2,066.10	2,102.95	0.00	732.50	1,510.00	2,750.00	4,565.00
Is Bank? (1/0)	0.29	0.45	0.00	0.00	0.00	1.00	1.00
Is Below 35? (1/0)	0.39	0.49	0.00	0.00	0.00	1.00	1.00
Is Above 65? (1/0)	0.06	0.23	0.00	0.00	0.00	0.00	0.00
Is Female? (1/0)	0.35	0.48	0.00	0.00	0.00	1.00	1.00
Is Missing Gender? (1/0)	0.06	0.24	0.00	0.00	0.00	0.00	0.00
Is Hispanic? (1/0)	0.10	0.30	0.00	0.00	0.00	0.00	0.00
Is American Indian? (1/0)	0.01	0.08	0.00	0.00	0.00	0.00	0.00
Is Asian? (1/0)	0.06	0.23	0.00	0.00	0.00	0.00	0.00
Is Black? (1/0)	0.03	0.17	0.00	0.00	0.00	0.00	0.00
Is Pacific Islander? (1/0)	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Is Missing Race? (1/0)	0.14	0.35	0.00	0.00	0.00	0.00	1.00

NOTE.—This table presents descriptive statistics for our merged Fannie-HMDA sample of 84,685 mortgages. Descriptive statistics are as of each mortgage's origination date.

Table 2: Average Pass-Through Rate

	Total Loan Price		Interest Rate		Net Upfront Fees	
	(1)	(2)	(3)	(4)	(5)	(6)
Flow LLPA	0.99***	0.97***	0.68***	0.65***	0.31***	0.32***
	(0.09)	(0.07)	(0.07)	(0.06)	(0.02)	(0.02)
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender × Month FE		Yes		Yes		Yes
DTI × Month FE		Yes		Yes		Yes
Loan Amount × Month FE		Yes		Yes		Yes
N	84,685	84,685	84,685	84,685	84,685	84,685
R^2	0.50	0.69	0.46	0.59	0.06	0.31

NOTE.—This table reports coefficient estimates from Equation 8. The model is estimated on our merged Fannie-HMDA sample of 84,685 mortgages. The outcome variable is either the all-in mortgage price, the interest rate, or the net amount of upfront fees. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Pass-Through to Upfront Fee Components

	Net Upfront Fees		Discount Points		Non-Point Loan Fees		Lender Credits	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Flow LLPA	0.31***	0.32***	0.24***	0.24***	0.06***	0.07***	-0.01	-0.00
	(0.02)	(0.02)	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lender × Month FE		Yes		Yes		Yes		Yes
DTI × Month FE		Yes		Yes		Yes		Yes
Loan Amount × Month FE		Yes		Yes		Yes		Yes
N	84,685	84,685	84,685	84,685	84,685	84,685	84,685	84,685
R^2	0.06	0.31	0.04	0.25	0.01	0.26	0.00	0.19

NOTE.—This table reports coefficient estimates from Equation 8 for the 84,685 mortgages in the merged Fannie-HMDA sample. The outcome variable is either net upfront fees, discount points, non-point loan origination fees, or lender credits. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Loan Demand

	log Loan Amount	
	(1)	(2)
Flow LLPA	-0.06	-0.29**
	(0.06)	(0.09)
Flow LLPA		0.35**
		(0.10)
Cell FE	Yes	Yes
Month FE	Yes	Yes
$\%\Delta\bar{L} = \Delta\bar{L}/\bar{L}_{\text{Pre-perod}}$	5.5%	5.5%
$\widehat{\%\Delta A} = \widehat{\beta}_1\Delta\bar{L} + \widehat{\beta}_2\Delta\bar{L}^2$	-0.06%	-0.29%
Implied Elasticity ($= \widehat{\%\Delta A}/\%\Delta\bar{L}$)	-0.01	-0.05
N	84,685	84,685
R^2	0.12	0.12

NOTE.—This table reports coefficient estimates from a regression of log loan amounts on flow LLPAs, flow LLPAs squared, and LLPA cell and delivery month fixed effects. The model is estimated on our merged Fannie-Mae sample of 84,685 mortgages. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Asymmetry of Pass-Through

	Total Loan Price (1)	Interest Rate (2)	Net Upfront Fees (3)	Discount Points (4)	Non-Point Loan Fees (5)	Lender Credits (6)
LLPA Flow	1.29***	0.94***	0.35***	0.23***	0.11**	-0.01
	(0.09)	(0.09)	(0.04)	(0.04)	(0.04)	(0.01)
LLPA Flow × LLPA Decreased	-0.59***	-0.51***	-0.08	0.01	-0.09	0.00
	(0.18)	(0.17)	(0.07)	(0.06)	(0.06)	(0.01)
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
N	84,685	84,685	84,685	84,685	84,685	84,685
R^2	0.50	0.47	0.06	0.04	0.01	0.00

NOTE.—This table reports coefficient estimates from Equation 11. The model is estimated on our merged Fannie-HMDA sample of 84,685 mortgages. The outcome variable is either the all-in mortgage price, interest rate, net upfront fees, discount points, non-point loan origination fees, or lender credits. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Heterogeneity Across Information Environment

	Total Loan Price			
	LLPA Decrease		LLPA Increase	
	(1)	(2)	(3)	(4)
LLPA Flow	0.65***	0.66***	1.28***	1.33***
	(0.18)	(0.18)	(0.12)	(0.12)
LLPA Flow × Broker Loan	0.15***		0.14***	
	(0.04)		(0.04)	
LLPA Flow × First Home		0.01		-0.03
		(0.02)		(0.02)
Cell FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Broker Loan × Month FE	Yes		Yes	
First Home × Month FE		Yes		Yes
N	46,332	46,332	58,273	58,273
R^2	0.51	0.51	0.48	0.48

NOTE.—This table reports coefficient estimates from Equation 14. The model is estimated on two subsamples of our merged Fannie-HMDA sample of 84,685 mortgages. The first subsample, in columns 1 and 2, consists of mortgages in cells that experienced an decrease in their LLPAs or no change. The second subsample, in columns 3 and 4, consists of mortgages in cells that experienced an increase in their LLPAs or no change.The outcome variable is the all-in mortgage price. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: Asymmetry Within Credit Score and LTV Subsamples

	Total Loan Price			
	(1)	(2)	(3)	(4)
LLPA Flow	1.28**	1.43***	1.01***	1.40***
	(0.11)	(0.22)	(0.11)	(0.09)
LLPA Flow × LLPA Decreased	-0.60***	-0.68*	-0.21	-0.73***
	(0.11)	(0.34)	(0.20)	(0.22)
Subsample	Low Score	High Score	Low LTV	High LTV
Cell FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
N	42,343	42,342	42,342	42,343
R^2	0.49	0.46	0.50	0.49

NOTE.—This table reports coefficient estimates from Equation 11. In column 1, the sample is restricted to mortgages with below-median credit scores. In column 2, the sample is restricted to mortgages with above-median credit scores. In column 3, the sample is restricted to mortgages with below-median LTVs. In column 4, the sample is restricted to mortgages with above-median LTVs. The outcome variable is the all-in mortgage price. Variable definitions are provided in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8: Heterogeneity Across Market Structure and Borrower Characteristics

	Total Loan Price			
	(1)	(2)	(3)	(4)
LLPA Flow	1.00***	1.01***	0.98***	1.00***
	(0.09)	(0.08)	(0.09)	(0.09)
LLPA Flow × Low Competition	-0.11			
	(0.15)			
LLPA Flow × High DTI		-0.05**		
		(0.02)		
LLPA Flow × Non-White			0.01	
			(0.02)	
LLPA Flow × Female				-0.03
				(0.03)
Cell FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Low Competition × Month FE	Yes			
High DTI × Month FE		Yes		
Non-White × Month FE			Yes	
Below Age 45 × Month FE				Yes
N	84,644	84,685	84,685	84,685
R^2	0.50	0.50	0.50	0.50

NOTE.—This table reports coefficient estimates from Equations 15 and 16. The models are estimated on our merged Fannie-HMDA sample of 84,685 mortgages. The outcome variable is the all-in mortgage price. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Figure 1: Fannie Mae LLPA Matrices for Purchase Mortgages as of May 2023

(a) Base LLPA Matrix

Purchase Money Loans – LLPA by Credit Score/LTV Ratio

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%	SFC
≥ = 780	0.000%	0.000%	0.000%	0.000%	0.375%	0.375%	0.250%	0.250%	0.125%	N/A
760 – 779	0.000%	0.000%	0.000%	0.250%	0.625%	0.625%	0.500%	0.500%	0.250%	N/A
740 – 759	0.000%	0.000%	0.125%	0.375%	0.875%	1.000%	0.750%	0.625%	0.500%	N/A
720 – 739	0.000%	0.000%	0.250%	0.750%	1.250%	1.250%	1.000%	0.875%	0.750%	N/A
700 – 719	0.000%	0.000%	0.375%	0.875%	1.375%	1.500%	1.250%	1.125%	0.875%	N/A
680 – 699	0.000%	0.000%	0.625%	1.125%	1.750%	1.875%	1.500%	1.375%	1.125%	N/A
660 – 679	0.000%	0.000%	0.750%	1.375%	1.875%	2.125%	1.750%	1.625%	1.250%	N/A
640 - 659	0.000%	0.000%	1.125%	1.500%	2.250%	2.500%	2.000%	1.875%	1.500%	N/A
≤ 639[1]	0.000%	0.125%	1.500%	2.125%	2.750%	2.875%	2.625%	2.250%	1.750%	N/A

(b) Supplemental LLPA Matrix

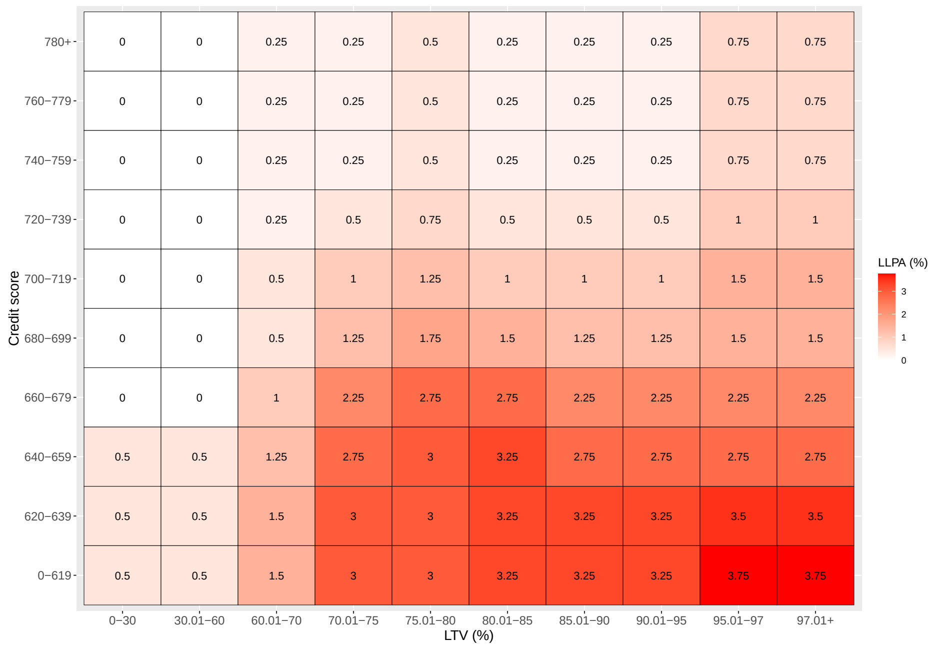
Additional LLPAs by Loan Attribute Applicable to Purchase Money Loans

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%	SFC
Adjustable-rate mortgage	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.250%	0.250%	N/A
Condo[2]	0.000%	0.000%	0.125%	0.125%	0.750%	0.750%	0.750%	0.750%	0.750%	N/A
Investment property	1.125%	1.125%	1.625%	2.125%	3.375%	4.125%	4.125%	4.125%	4.125%	N/A
Second home	1.125%	1.125%	1.625%	2.125%	3.375%	4.125%	4.125%	4.125%	4.125%	N/A
Manufactured home[3]	0.500%	0.500%	0.500%	0.500%	0.500%	0.500%	0.500%	0.500%	0.500%	235
Two- to four-unit property	0.000%	0.000%	0.375%	0.375%	0.625%	0.625%	0.625%	0.625%	0.625%	N/A
High-balance fixed-rate	0.500%	0.500%	0.750%	0.750%	1.000%	1.000%	1.000%	1.000%	1.000%	808
High-balance ARM	1.250%	1.250%	1.500%	1.500%	2.500%	2.500%	2.500%	2.750%	2.750%	808
Subordinate financing[4]	0.625%	0.625%	0.625%	0.875%	1.125%	1.125%	1.125%	1.875%	1.875%	N/A

NOTE.——This figure displays Fannie Mae's base LLPA matrix (Panel A) and supplemental LLPA matrix (Panel B) for 30-year purchase mortgages as May 2023. The LLPA is quoted in terms of percent of the outstanding loan amount and is assessed to the seller when a mortgage is delivered to Fannie Mae.

Figure 2: Base LLPAs for Purchase Mortgages Before and After May 2023

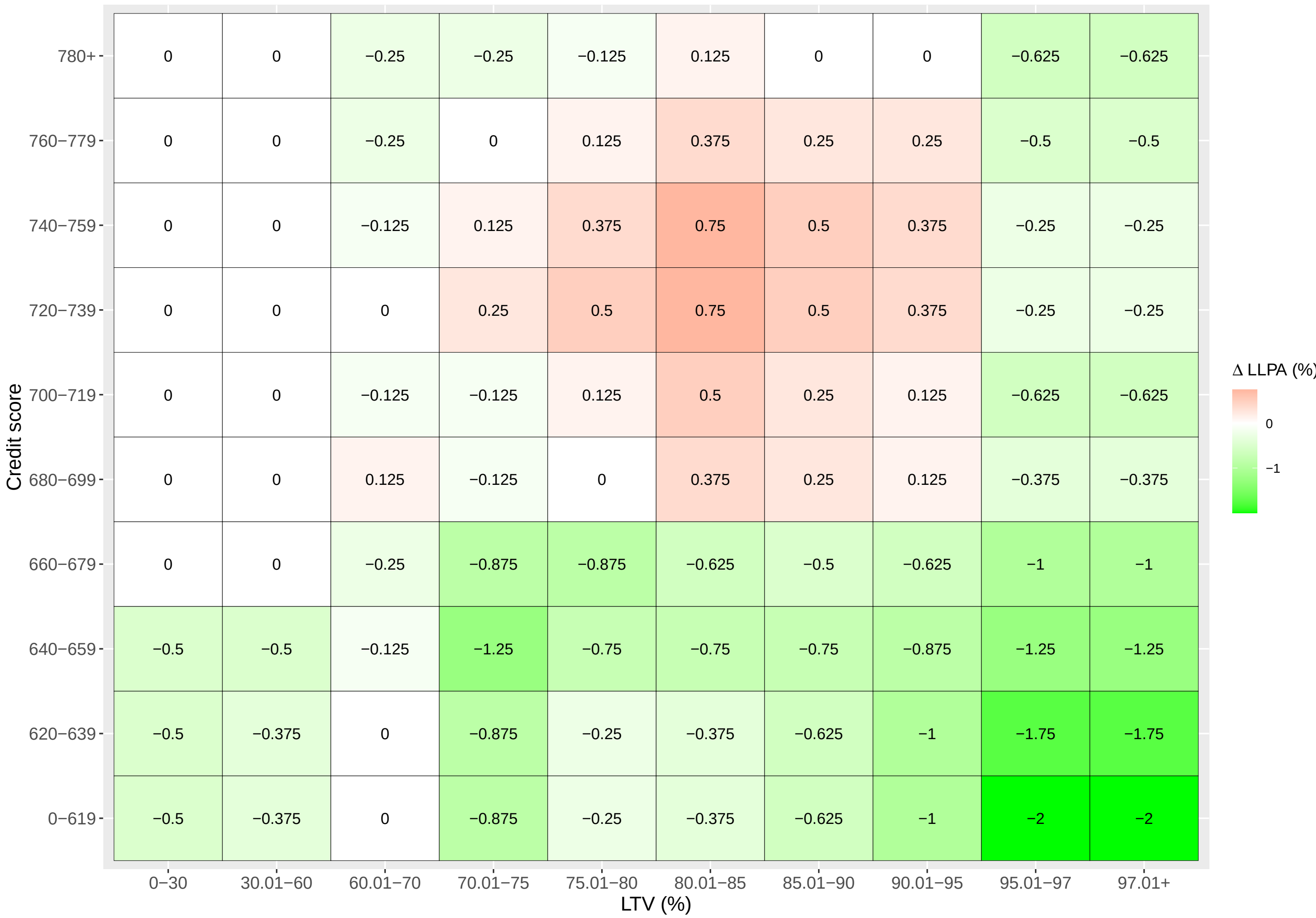
(a) Prior to May 1, 2023



(b) May 1, 2023 and After

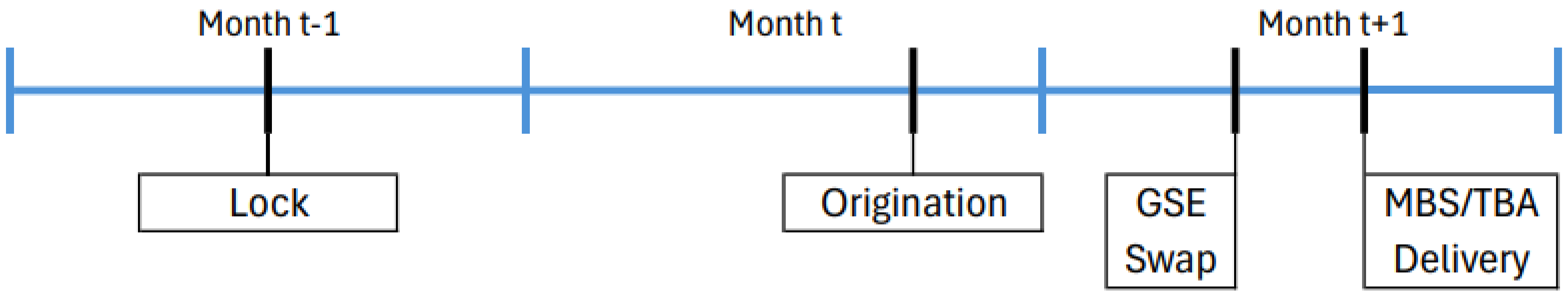
NOTE.——This figure displays heat map representations of Fannie Mae's base LLPA matrices for 30-year purchase mortgages before and after May 1, 2023. The LLPA is quoted in terms of percent of the outstanding loan amount and is assessed to the seller when a mortgage is delivered to Fannie Mae.

Figure 3: Change in Base LLPAs for Purchase Mortgages After May 2023



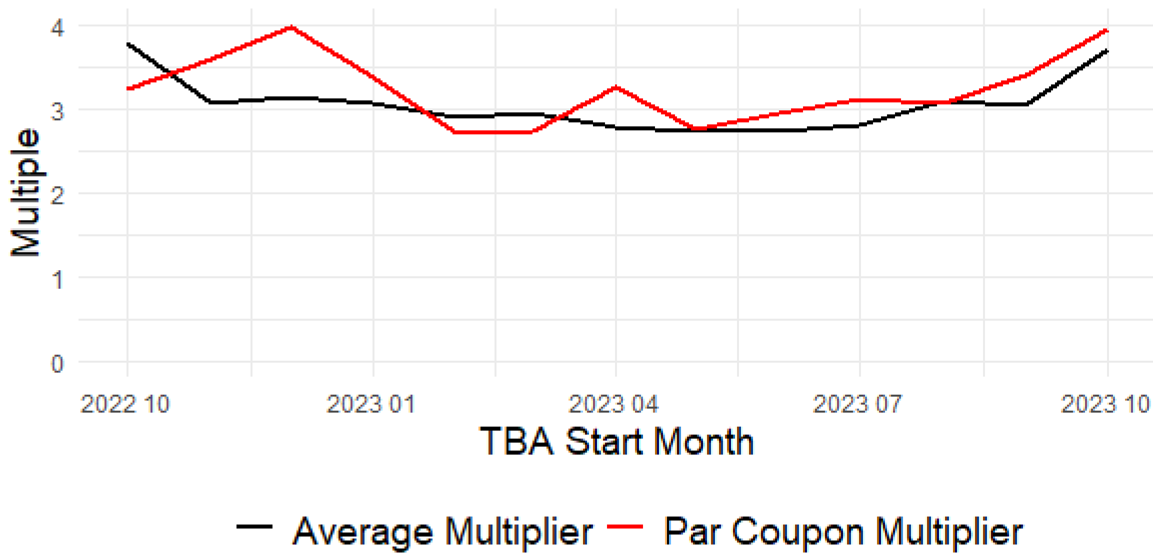
NOTE.——This figure displays a heat map representation of the change in base LLPAs for 30-year purchase mortgages before-and-after May 1, 2023. The LLPA is quoted in terms of percent of the outstanding loan amount and is assessed to the seller when a mortgage is delivered to Fannie Mae.

Figure 4: Origination, Securitization, and Delivery Timeline



NOTE.——This figure displays a hypothetical origination timeline for a conforming mortgage that is eventually securitized into an agency MBS and delivered to investors in the TBA market. In month $t-1$, the lender enters into a rate-lock agreement with the borrower and sells the loan forward by shorting a TBA contract. In month t, the lender originates the loan. In month $t+1$, the lender pools the loan with other conforming mortgages and delivers them to Fannie Mae or Freddie Mac in exchange for an agency MBS. Shortly afterwards, the lender delivers the agency MBS to the long side of the TBA contract.

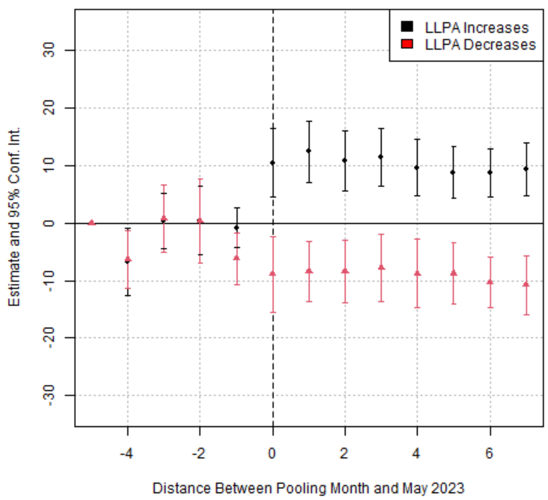
Figure 5: Estimated Buy-Up Multiples During Sample Period



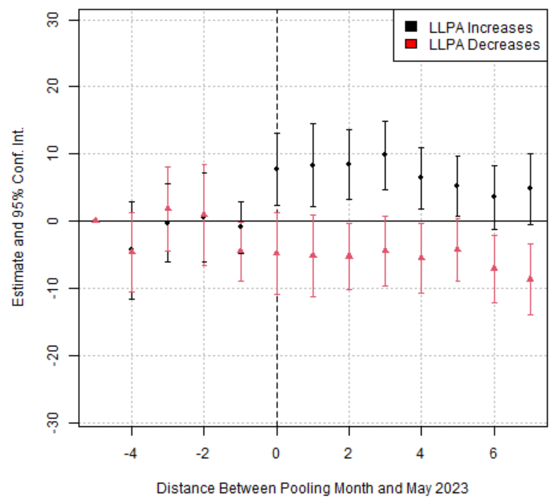
NOTE.——This figure plots the estimates of the average and par rate strip multiple over the sample period. These values are calculated using the method described in Fuster et al. 2013 using TBA swaps. TBA prices come from Bloomberg. Swap values are computed on a daily basis using the two-month forward TBA contract, since this corresponds to the most likely delivery, and the average is taken for the month before being assigned to individual loans. The swap value is for 50 basis points of stripped rate and so is multiplied by two in order to get the multiple for a point. The Par Coupon Multiplier is from the swap where the long leg of the swap is closest to par. The Average Multiplier is weighted by loan amount for the sample, where each loan is assigned to the swap value where the long leg of the swap corresponds to the second highest TBA execution to which the loan is deliverable. For example, if the loan could be delivered to 3.0, 3.5, adn 4.0 TBAs, then it would be assigned to the swap where the long leg was the 3.5 TBA.

Figure 6: Level Effects on Loan Prices, Interest Rates, and Net Upfront Fees

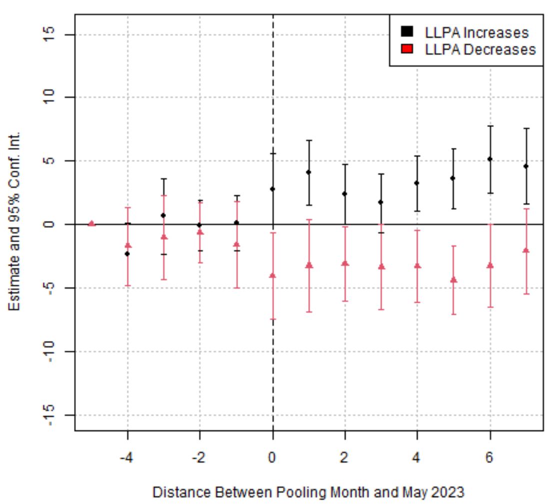
(a) Total Loan Price



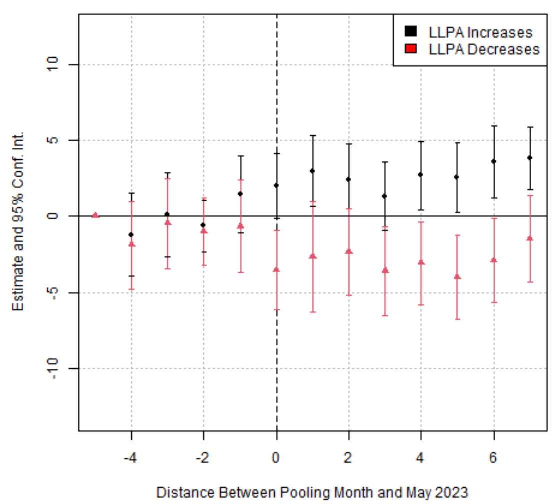
(b) Interest Rate



(c) Net Upfront Fees



(d) Discount Points



NOTE.——This figure plots coefficient estimates from Equation 9. The model is estimated on our merged Fannie-Mae sample of 84,685 mortgages. Variable definitions are in Table IA.12. The x-axis corresponds to the number of months between a mortgage's delivery date and May 2023. The dashed vertical line corresponds to May 2023. The circles correspond to the coefficient estimates, and the vertical bars correspond to 95% confidence intervals. Black corresponds to estimates for LLPA increases, and red corresponds to estimates for LLPA decreases. The reference delivery month (origination month) is December 2022 (November 2022). Standard errors are double-clustered at the LLPA cell and origination month levels.

Internet Appendix

Table IA.1: Freddie Mac Data: Average Pass-Through Rate

	Total Loan Price		Interest Rate		Net Upfront Fees	
	(1)	(2)	(3)	(4)	(5)	(6)
Flow LLPA	1.06***	0.99***	0.70***	0.66***	0.36***	0.33***
	(0.08)	(0.07)	(0.05)	(0.05)	(0.05)	(0.06)
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender × Month FE		Yes		Yes		Yes
DTI × Month FE		Yes		Yes		Yes
Loan Amount × Month FE		Yes		Yes		Yes
N	77,201	77,201	77,201	77,201	77,201	77,201
R^2	0.52	0.67	0.46	0.54	0.07	0.30

NOTE.—This table reports coefficient estimates from Equation 8. The model is estimated on the merged Freddie-HMDA sample of 77,201 mortgages, which follows the same sample construction procedure as the merged Fannie-HMDA sample in Section 3. The outcome variable is either the all-in mortgage price, the interest rate, or the net amount of upfront fees. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IA.2: Descriptive Statistics for Fannie Mae Sample

	Mean (1)	SD (2)	P10 (3)	P25 (4)	P50 (5)	P75 (6)	P90 (7)
Interest Rate (%)	6.71	0.61	5.99	6.25	6.63	7.12	7.50
Loan Amount ($)	342,669.43	160,980.66	150,000.00	220,000.00	317,000.00	447,000.00	584,000.00
Loan-to-Value Ratio (%)	81.24	15.81	59.00	77.00	80.00	95.00	95.00
Credit Score	754.01	41.40	695.00	728.00	762.00	787.00	801.00
Debt-to-Income Ratio (%)	37.17	9.09	24.00	31.00	39.00	45.00	48.00
Co-Signed? (1/0)	0.53	0.50	0.00	0.00	1.00	1.00	1.00
Upfront LLPA (%)	0.59	0.55	0.00	0.25	0.50	0.88	1.25
Flow LLPA (%)	0.17	0.16	0.00	0.07	0.14	0.25	0.36
Upfront LLPA ($)	1,994.91	2,133.47	0.00	637.50	1,417.50	2,680.00	4,515.00

NOTE.—This table presents descriptive statistics for our Fannie Mae sample of 303,214 mortgages. Descriptive statistics are as of each mortgage's origination date.

Table IA.3: Descriptive Statistics for HMDA Sample

	Mean (1)	SD (2)	P10 (3)	P25 (4)	P50 (5)	P75 (6)	P90 (7)
Interest Rate (%)	5.65	1.25	3.75	4.88	5.88	6.62	7.12
Origination Fees Less Credits (%)	0.30	0.30	0.00	0.09	0.22	0.46	0.72
Origination Fees Less Credits ($)	3,061.99	3,545.94	0.00	1,036.40	1,933.75	4,412.33	7,421.04
Discount Points ($)	2,251.65	3,568.83	0.00	0.00	742.50	3,215.57	6,391.70
Non-Point Loan Fees ($)	1,233.26	2,826.20	0.00	875.00	1,266.00	1,535.00	2,465.00
Lender Credits ($)	422.98	1,344.30	0.00	0.00	0.00	58.75	1,055.03
Loan Amount ($)	348,139.10	164,113.39	155,000.00	225,000.00	325,000.00	445,000.00	575,000.00
Loan-to-Value Ratio (%)	81.17	16.23	57.80	75.99	83.00	95.00	95.96
Household Income ($)	131,216.17	88,7914.18	53,000.00	75,000.00	109,000.00	156,000.00	218,000.00
Co-Signed? (1/0)	0.47	0.50	0.00	0.00	0.00	1.00	1.00
Is Bank? (1/0)	0.26	0.44	0.00	0.00	0.00	1.00	1.00
Is Below 35? (1/0)	0.39	0.49	0.00	0.00	0.00	1.00	1.00
Is Above 65? (1/0)	0.08	0.27	0.00	0.00	0.00	0.00	0.00
Is Female? (1/0)	0.37	0.48	0.00	0.00	0.00	1.00	1.00
Is Missing Gender? (1/0)	0.06	0.24	0.00	0.00	0.00	0.00	0.00
Is Hispanic? (1/0)	0.12	0.32	0.00	0.00	0.00	0.00	1.00
Is American Indian? (1/0)	0.01	0.08	0.00	0.00	0.00	0.00	0.00
Is Asian? (1/0)	0.09	0.29	0.00	0.00	0.00	0.00	0.00
Is Black? (1/0)	0.05	0.22	0.00	0.00	0.00	0.00	0.00
Is Pacific Islander? (1/0)	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Is Missing Race? (1/0)	0.15	0.35	0.00	0.00	0.00	0.00	1.00

NOTE.—This table presents descriptive statistics for HMDA sample of 1,030,703 mortgages. Descriptive statistics are as of each mortgage's origination date.

Table IA.4: Comparison of Fannie Mae Sample and Merged Fannie-HMDA Sample

	Mean (1)	SD (2)	P10 (3)	P25 (4)	P50 (5)	P75 (6)	P90 (7)	Matched (8)	Unmatched (9)	Difference (10)
Interest Rate (%)	6.71	0.61	5.99	6.25	6.62	7.12	7.50	6.73	6.70	0.03
Loan Amount ($)	342,678	160,983	150,000	220,000	317,000	447,000	584,000	359,972	335,976	23,997
Loan-to-Value Ratio (%)	81.24	15.81	59.00	77.00	80.00	95.00	95.00	81.82	81.02	0.80
Credit Score	754.02	41.40	695.00	728.00	762.00	787.00	801.00	757.12	752.81	4.31
Debt-to-Income Ratio (%)	37.17	9.09	24.00	31.00	39.00	45.00	48.00	33.76	38.50	-4.74
Co-Signed? (1/0)	0.53	0.50	0.00	0.00	1.00	1.00	1.00	0.58	0.51	0.06
Upfront LLPA (%)	0.59	0.55	0.00	0.25	0.50	0.88	1.25	0.58	0.59	-0.01
Flow LLPA (%)	0.18	0.17	0.00	0.08	0.15	0.27	0.38	0.18	0.18	-0.00
Upfront LLPA ($)	1,994.89	2,133.54	0.00	637.50	1,417.50	2,680.00	4,515.00	2,066.10	1,967.30	98.81

NOTE.—This table compares the 84,685 mortgages in the Fannie Mae sample that have a unique match in the HMDA sample to the 218,529 mortgages in the Fannie Mae sample without a unique match. Columns 1 through 7 repeat the descriptive statistics in Table IA.2. Columns 8 through 10 are defined as follows: *Matched* is the mean for mortgages in the Fannie Mae sample with a unique match in the HMDA sample, *Unmatched* is the mean for mortgages in the Fannie Mae sample without a unique match in the HMDA sample, and *Difference* is the difference in means between matched and unmatched mortgages.

Table IA.5: Interest Rate Pass-Through for Fannie Mae Sample

	Interest Rate	
	(1)	(2)
Flow LLPA	0.65***	0.58***
	(0.05)	(0.05)
Cell FE	Yes	Yes
Month FE	Yes	Yes
Lender × Month FE		Yes
DTI × Month FE		Yes
Loan Amount × Month FE		Yes
N	303,214	303,214
R^2	0.44	0.48

NOTE.—This table reports coefficient estimates from Equation 8 for the 303,214 mortgages in the Fannie Mae sample. The outcome variable is the interest rate. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IA.6: Tails of the Competition Distribution

	Total Loan Price	
	(1)	(2)
LLPA Flow	1.05***	1.05***
	(0.09)	(0.13)
LLPA Flow × Low Competition	-0.12	-0.20
	(0.11)	(0.12)
Competition Subsample	Quartiles 1 and 4	Deciles 1 and 10
Cell FE	Yes	Yes
Month FE	Yes	Yes
Low Competition × Month FE	Yes	Yes
N	42,322	16,929
R^2	0.51	0.51

NOTE.—This table reports coefficient estimates from Equation 15. In column 1, the model is estimated on the subsample of mortgages in the first and fourth quartiles of competition distribution. In column 2, the model is estimated on the subsample of mortgages in the first and tenth deciles of competition distribution. The outcome variable is the all-in mortgage price. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IA.7: Defaults and Prepayments

	Defaulted?		Prepaid?	
	(1)	(2)	(3)	(4)
Flow LLPA	-0.003	-0.006	0.005	0.007
	(0.003)	(0.004)	(0.005)	(0.007)
Cell FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Lender × Month FE		Yes		Yes
DTI × Month FE		Yes		Yes
Loan Amount × Month FE		Yes		Yes
N	84,683	84,683	84,683	84,683
R^2	0.01	0.10	0.01	0.09

NOTE.—This table reports coefficient estimates from Equation 8. The model is estimated on our merged Fannie-HMDA sample of 84,685 mortgages. The outcome variable in columns 1 and 2 is equal to 1 if the mortgage was 90 or more days past due on its payments within 6 months of its origination date, and zero otherwise. The outcome variable in columns 3 and 4 is equal to 1 if the mortgage was prepaid in full within 6 months of its origination date, and zero otherwise. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IA.8: Placebo Test: Ginnie Mae Sample

	Interest Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Flow LLPA	0.06	0.03	-0.15***	-0.08***	-0.07**	-0.04**
	(0.04)	(0.04)	(0.03)	(0.02)	(0.03)	(0.02)
Loan Type	VA	VA	FHA	FHA	Both	Both
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender × Month FE		Yes		Yes		Yes
DTI × Month FE		Yes		Yes		Yes
Loan Amount × Month FE		Yes		Yes		Yes
Loan Type FE					Yes	Yes
N	63,283	63,283	131,488	131,488	200,698	200,698
R^2	0.22	0.38	0.23	0.40	0.26	0.41

NOTE.—This table reports coefficient estimates from Equation 8. In columns 1 and 2, the model is estimated on the sample of VA mortgages. In columns 3 and 4, the model is estimated on the sample of FHA mortgages. In columns 5 and 6, the model is estimated on the sample of FHA and VA mortgages. The outcome variable is the interest rate. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IA.9: Additional Fixed Effects for Credit Score and LTV Bins

	Total Loan Price		Interest Rate		Net Upfront Fees	
	(1)	(2)	(3)	(4)	(5)	(6)
Flow LLPA	0.94***	0.95***	0.65***	0.68***	0.29***	0.27***
	(0.12)	(0.12)	(0.11)	(0.10)	(0.09)	(0.09)
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Credit Score Bin × Month FE	Yes	Yes	Yes	Yes	Yes	Yes
LTV Bin × Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender × Month FE		Yes		Yes		Yes
DTI × Month FE		Yes		Yes		Yes
Loan Amount × Month FE		Yes		Yes		Yes
N	84,685	84,685	84,685	84,685	84,685	84,685
R^2	0.50	0.69	0.47	0.59	0.06	0.32

NOTE.—This table reports coefficient estimates from Equation 8 after including credit score bin × month fixed effects and LTV bin × month fixed effects. The model is estimated on our merged Fannie-HMDA sample of 84,685 mortgages. The outcome variable is either the all-in mortgage price, the interest rate, or the net amount of upfront fees. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IA.10: Pass-Through for Ten Largest Lenders

	Total Loan Price		Interest Rate		Net Upfront Fees	
	(1)	(2)	(3)	(4)	(5)	(6)
Flow LLPA	0.95***	0.93***	0.65***	0.61***	0.30***	0.32***
	(0.11)	(0.09)	(0.11)	(0.10)	(0.04)	(0.02)
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender × Month FE		Yes		Yes		Yes
DTI × Month FE		Yes		Yes		Yes
Loan Amount × Month FE		Yes		Yes		Yes
N	39,952	39,952	39,952	39,952	39,952	39,952
R^2	0.56	0.64	0.49	0.53	0.07	0.22

NOTE.—This table reports coefficient estimates from Equation 8. The sample is restricted to mortgages from the ten largest lenders in terms of loan originations. The outcome variable is either the mortgage price, the interest rate, or the net amount of upfront fees. Variable definitions are in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IA.11: Pass-Through for Non-Bank Lenders

	Total Loan Price		Interest Rate		Net Upfront Fees	
	(1)	(2)	(3)	(4)	(5)	(6)
Flow LLPA	0.93***	0.94***	0.63***	0.62***	0.31***	0.32***
	(0.08)	(0.07)	(0.07)	(0.07)	(0.03)	(0.01)
Cell FE	Yes	Yes	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Lender × Month FE		Yes		Yes		Yes
DTI × Month FE		Yes		Yes		Yes
Loan Amount × Month FE		Yes		Yes		Yes
N	60,349	60,349	60,349	60,349	60,349	60,349
R^2	0.49	0.66	0.45	0.56	0.07	0.27

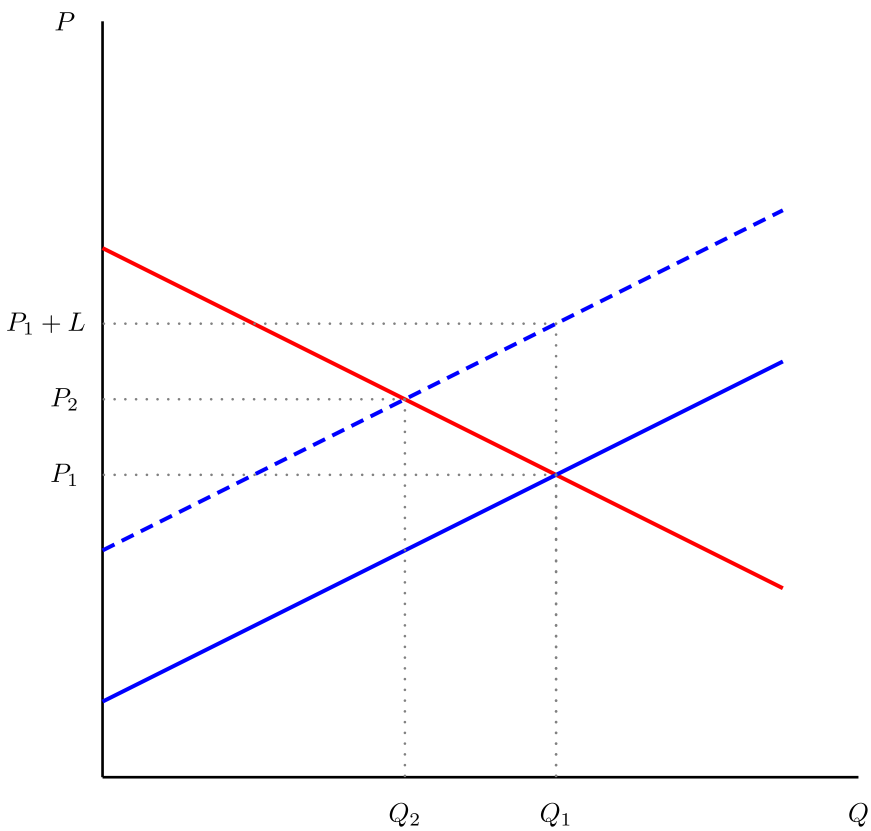
NOTE.—This table reports coefficient estimates from Equation 8. The sample is restricted to mortgages from non-bank lenders. The outcome variable is either the mortgage price, the interest rate, or the net amount of upfront fees. Variable definitions are provided in Table IA.12. Standard errors, reported below the coefficient estimates, are double-clustered at the LLPA cell and origination month levels. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table IA.12: Variable Definitions

Variable (1)	Data Source (2)	Formula (3)
Flow LLPA (%)	Fannie Mae	$\frac{\text{Upfront LLPA (\%)}}{\text{LLPA Multiple}}$
Interest Rate (%)	Fannie Mae	
Net Upfront Fees (%)	HMDA	$\frac{\text{Origination Charges (\$)} - \text{Lender Credits (\$)}}{\text{Loan Amount} \times \text{LLPA Multiple}}$
Total Loan Price (%)	Fannie Mae and HMDA	Interest Rate (%) + Net Upfront Fees (%)
Discount Points (%)	HMDA	$\frac{\text{Discount Points (\$)}}{\text{Loan Amount} \times \text{LLPA Multiple}}$
Non-Point Loan Fees (%)	HMDA	$\frac{\text{Origination Charges (\$)} - \text{Discount Points (\$)}}{\text{Loan Amount} \times \text{LLPA Multiple}}$
Lender Credits (%)	HMDA	$\frac{\text{Lender Credits (\$)}}{\text{Loan Amount} \times \text{LLPA Multiple}}$

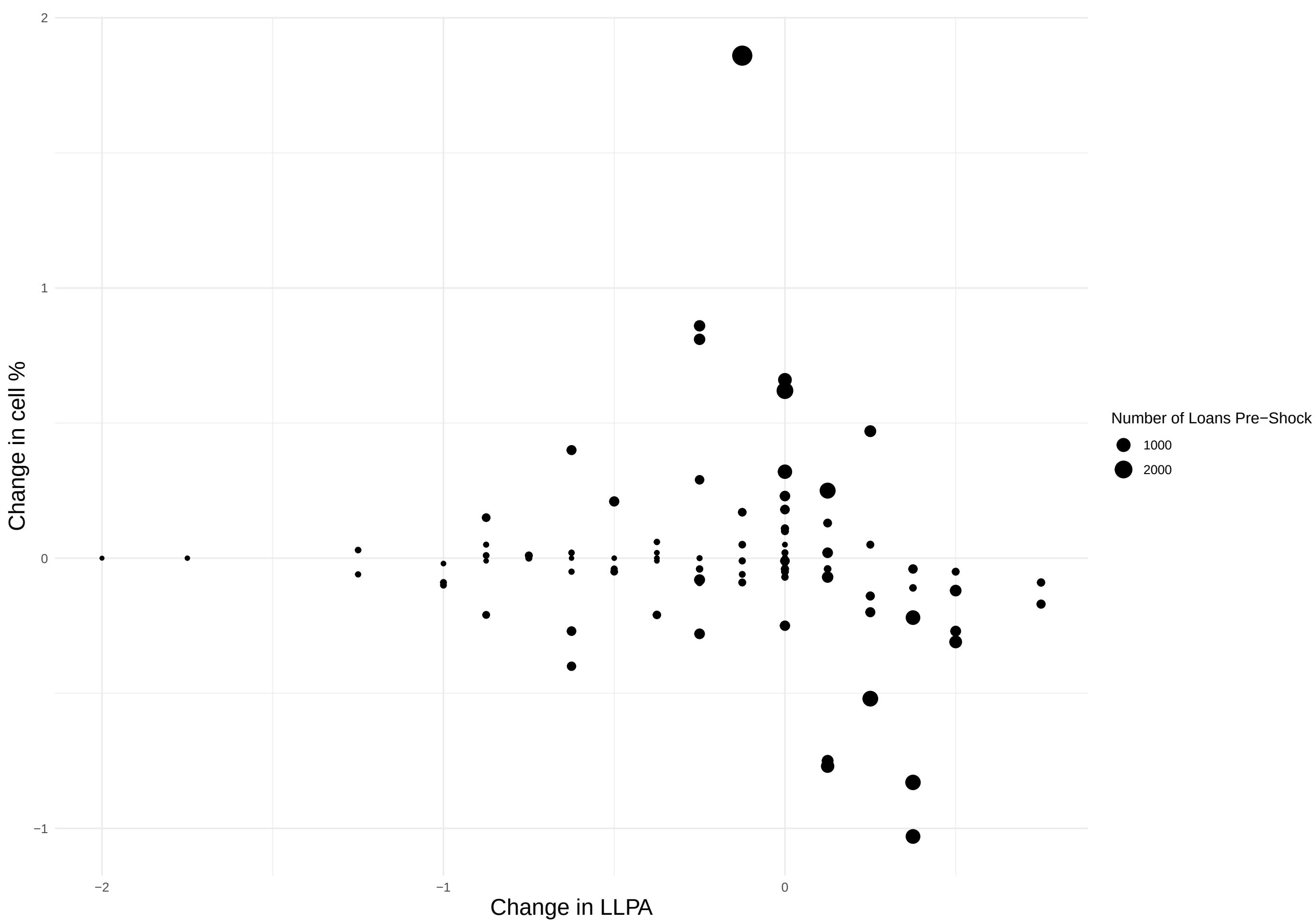
NOTE.—This table defines the main variables used in our analysis.

Figure IA.1: Effect of LLPA Increase on Market Equilibrium



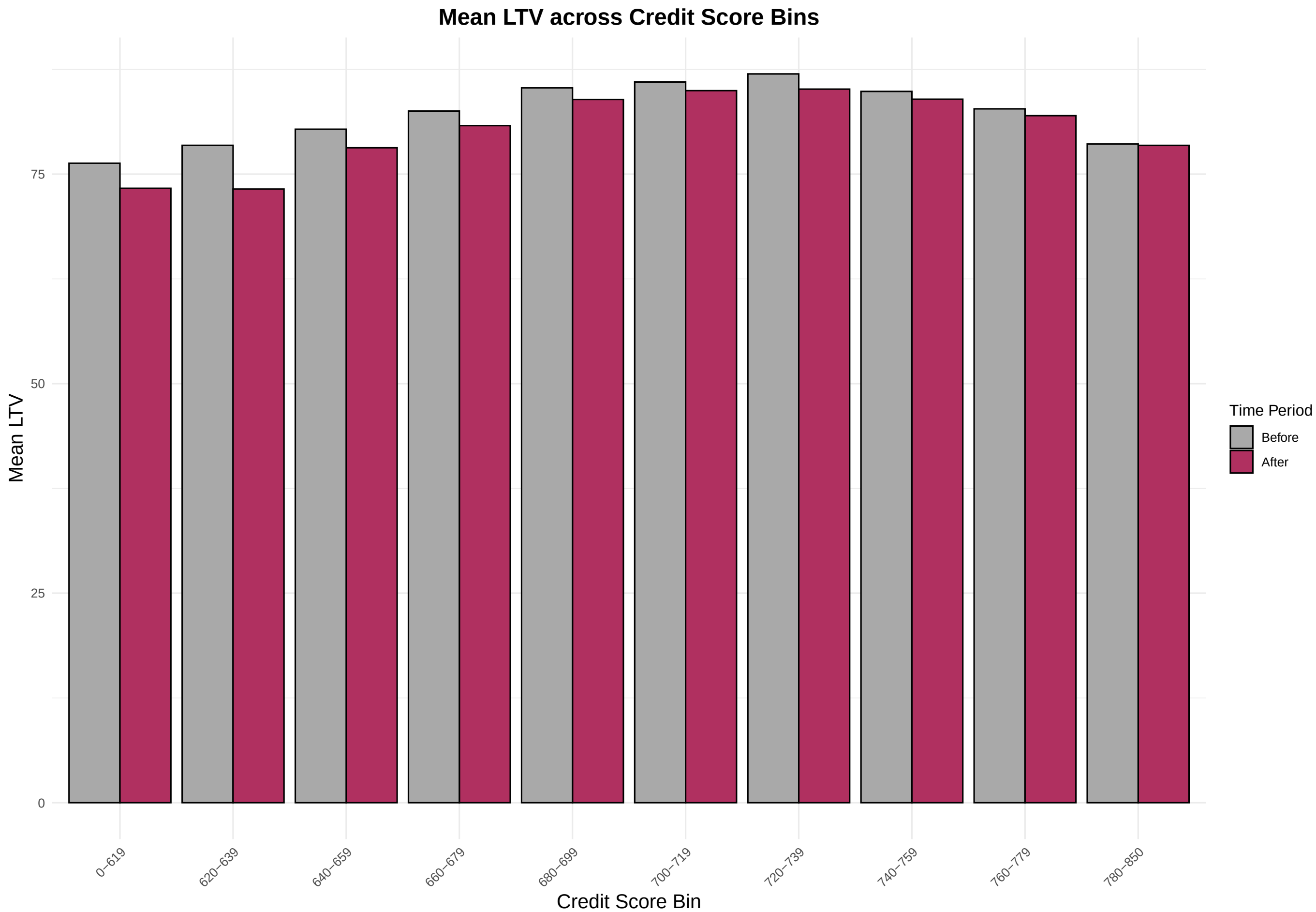
NOTE.——This figure displays an example of how the market equilibrium may change when an LLPA of $L > 0$ is introduced. For simplicity, we assume that the market is perfectly competitive and that the demand and supply curves are linear. The x-axis corresponds to the number of loans originated, and the y-axis corresponds to the secondary market loan price. The solid red line corresponds to the demand curve, the solid blue line corresponds to the original supply curve before the LLPA is introduced, and the dashed blue line corresponds to the new supply curve after the LLPA is introduced. The original equilibrium is characterized by a price of P_1 and a quantity of Q_1. The new equilibrium is characterized by a price of P_2 and a quantity of Q_2, where $P_2 > P_1$ and $Q_2 < Q_1$. The pass-through rate ρ is equal to $(P_2 - P_1)/L$, which is less than 1 in this example.

Figure IA.2: Change in the Percent of Loans in Each Base LLPA Cell



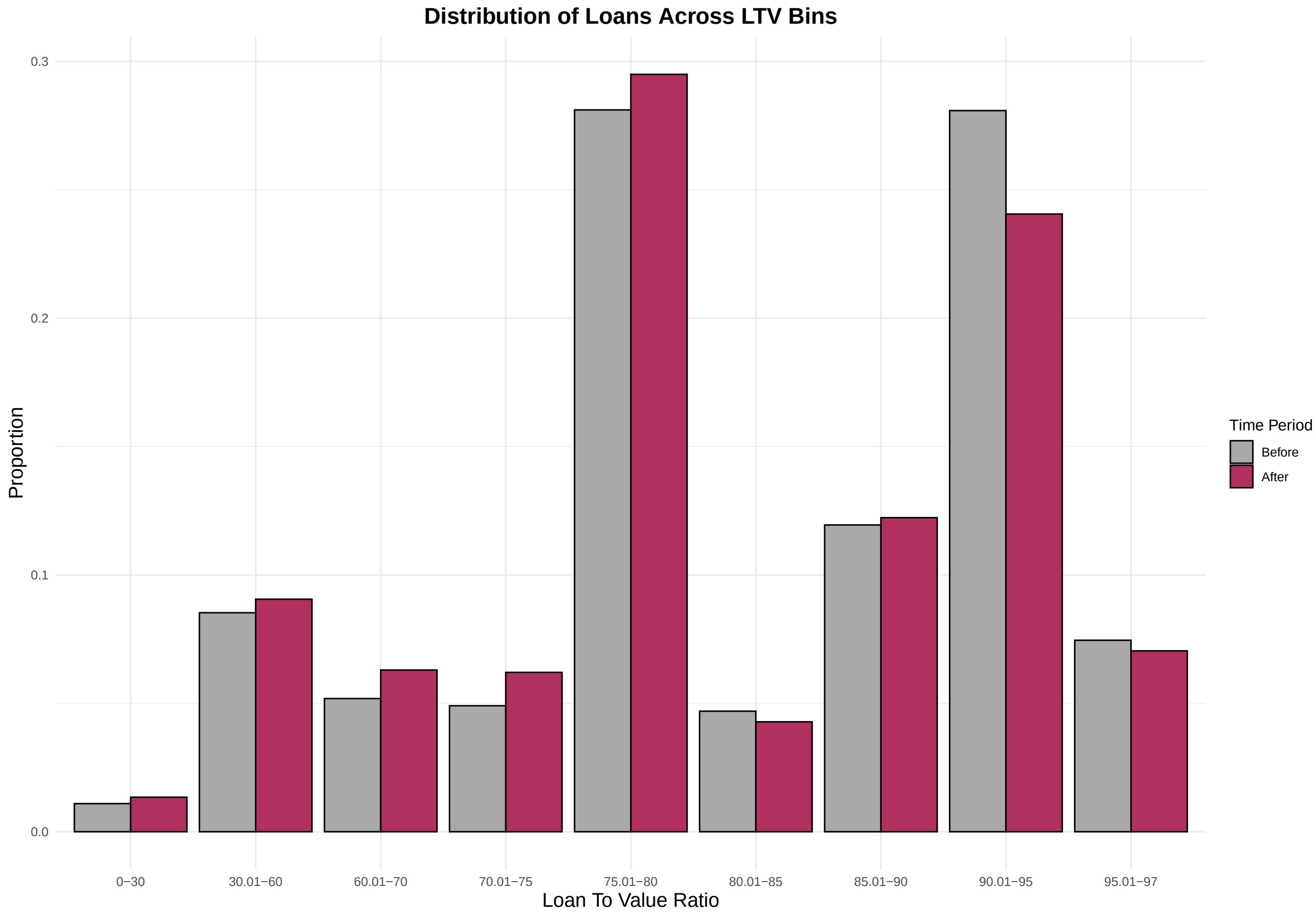
NOTE.——This figure displays a scatterplot representation of the change in the percent of loans in each cell versus the change in LLPAs. (% in cell after change - % in cell before change). For example, if a cell contained 9% of loans before the LLPA change and 10% after, the change would be “1”. Larger dots represent cells with more loans in the sample in the period prior to the change in LLPAs.

Figure IA.3: Change in the Percent of Loans in Each Base LLPA Cell



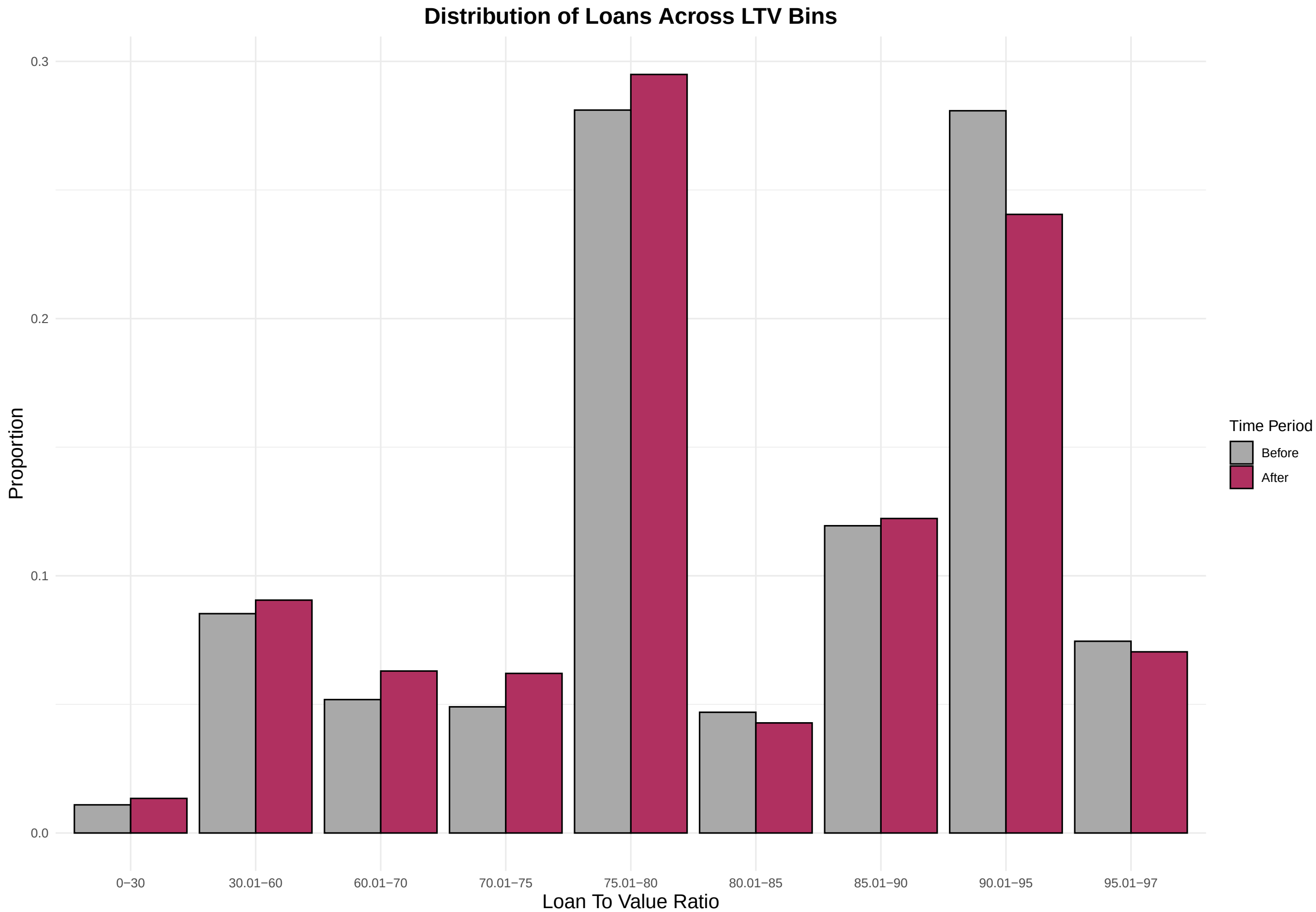
NOTE.——This figure displays the pre-treatment and post-treatment average LTVs for newly originated mortgages within each credit score bin. The x-axis corresponds to credit score bins from the LLPA matrix. The y-axis corresponds to the average LTV within each credit score bin. Average LTVs are calculated separately for the pre-treatment period (gray bars) and the post-treatment period (red bars) using our merged Fannie-HMDA sample of 84,685 mortgages.

Figure IA.4: Distribution of Loans Across LTV Bins Before and After May 2023



NOTE.——This figure displays the pre-treatment and post-treatment distribution of loans across LTV bins for our merged Fannie-HMDA sample of 84,685 mortgages. The x-axis corresponds to LTV bins from the LLPA matrix. The y-axis corresponds to the proportion of loans. Proportions are calculated separately for the pre-treatment period (gray bars) and the post-treatment period (red bars).

Figure IA.5: Distribution of Broker-Intermediated Loans Across LTV Bins Before and After May 2023



NOTE.——This figure displays the pre-treatment and post-treatment distribution of loans across LTV bins for the subsample of broker-intermediated mortgages. The x-axis corresponds to LTV bins from the LLPA matrix. The y-axis corresponds to the proportion of loans. Proportions are calculated separately for the pre-treatment period (gray bars) and the post-treatment period (red bars).