Competition with Multi-Dimensional Prices: Theory and Evidence from U.S. Mortgage Markets*

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Abstract

How do lenders with market power set markups across multiple pricing dimensions? We develop a theory where lenders allocate markups across upfront fees and interest rates by trading off gains from backloading payments against prepayment risk. Using exogenous variation in refinancing costs and market concentration in the U.S. mortgage market, we show that the effect of concentration shifts from fees to rates as prepayment risk falls. We estimate a structural model to study counterfactual contract design. Rate caps reduce borrower welfare by shifting markups toward socially inefficient fees, while fee caps increase borrower welfare because prepayment risk dampens rate increases.

Keywords: Mortgages, market structure, local competition, bank merger policy, contract design.
JEL Classification Codes: G2, L5

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1 Introduction

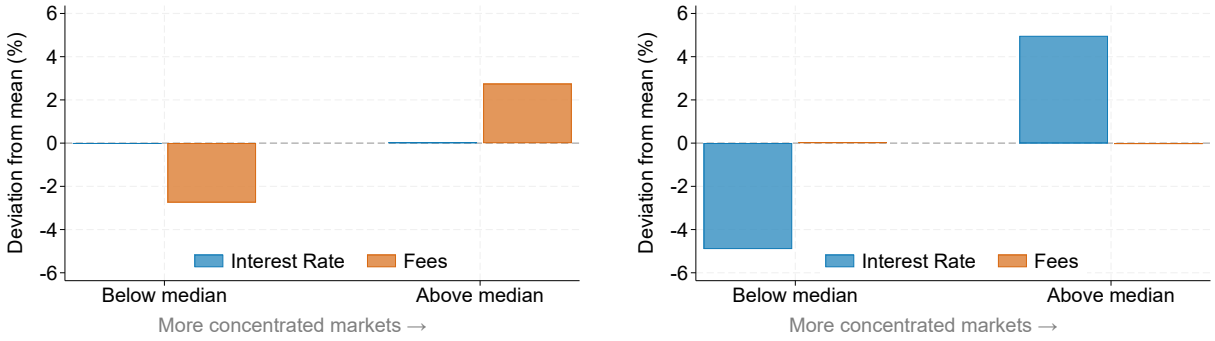
In many markets, firms compete using multidimensional contracts rather than a single price (Oi, 1971; Tirole, 1988). Firms with market power can shift markups across pricing components that consumers and firms may value and respond to differently. However, the empirical literature on market concentration and its implications for prices and markups typically treats products as having a single price, abstracting from multidimensional contracts (Autor et al., 2020; De Loecker, Eeckhout and Unger, 2020; Barkai, 2020). This raises the question: how does market concentration affect pricing when contracts are multidimensional?

We study this question in the context of the U.S. mortgage market, where contracts include both upfront origination fees and recurring interest payments. Despite this multidimensional structure, prior academic and policy work focuses almost exclusively on the interest rate margin. In particular, the Federal Reserve, which regulates mortgage market competition through merger approvals, has found little to no relationship between local mortgage market concentration and interest rates on standard fixed-rate mortgages without prepayment restrictions. Consequently, it regards the market as national in scope.[1] However, focusing exclusively on rates abstracts from a central insight in the theoretical literature: multidimensional contracts can affect how firms extract surplus (DellaVigna and Malmendier, 2004; Gabaix and Laibson, 2006; Bordalo, Gennaioli and Shleifer, 2013).

A simple stylized fact motivates our study. Figure 1 plots average deviations in residualized interest rates and upfront fees by below- and above-median lender concentration. Panel A shows that among standard prepayable mortgages, interest rates exhibit almost no variation with lender concentration. Based on this rate-only evidence, the Federal Reserve's conclusion that mortgage markets are national in scope would appear justified. Yet upfront fees are markedly higher in more concentrated counties, indicating that concentration is reflected in pricing even when rates are flat. Panel B shows that the relationship between concentration and pricing also depends on contract form. Among mortgages with prepayment penalties, interest rates are higher in more concentrated counties, while fees show little variation. This contrast between the rate-only assessment of standard mortgages and

[1] Prior to 2008, the Federal Reserve considered mortgage markets to be geographically local. However, with the approval of Bank of America's acquisition of Countrywide, it declared the mortgage market to be "national in scope" (Federal Reserve System, 2008). The Fed reaffirmed this position in a later analysis of interest rates, stating: "we test for an empirical relationship between the local concentration of mortgage lending and changes in mortgage rates and find essentially no correlation," concluding that "local mortgage markets appear too unconcentrated ... for the participants to have market power and the individual ability to affect prices" (Amel et al., 2018).

Figure 1: Mortgage Pricing and Local Concentration



A: Standard Prepayable Mortgages

B: Mortgages with Prepayment Penalties

Note: This figure shows the variation in interest rates and upfront fees comparing loans in markets with above- and below-median lender concentration. Panel A includes standard prepayable mortgages, while Panel B restricts the sample to loans with prepayment penalties. Each bar reports the average deviation from the sample mean in percent (controlling for origination date, lender and county fixed effects, and loan characteristics) and market concentration is the previous year's market concentration. The datasource is the 2018-2023 HMDA & GSE data.

the broader pricing patterns across margins and contract types motivates the analysis that follows, in which we examine how concentration affects multidimensional mortgage pricing.

Our main result is that local concentration affects mortgage pricing, but the margin on which concentration affects pricing depends on refinancing risk. When refinancing risk is high, such as in standard prepayable mortgages, higher concentration is reflected primarily in upfront fees rather than interest rates. When refinancing risk is low, such as in mortgages with prepayment penalties, the pattern reverses and concentration is reflected in higher interest rates. A rate-only assessment, therefore, understates the relationship between concentration and pricing and can lead to misleading conclusions about the scope of mortgage markets.

We begin our analysis with a simple theoretical model of multidimensional mortgage pricing. A lender offers an infinite-horizon loan characterized by an upfront fee and a recurring interest payment to a borrower who has an outside option that captures local competition. The borrower can exit early by refinancing, and both parties internalize his incentive to do so. Two assumptions drive the analysis. First, the lender discounts future payments less than the borrower does, generating intertemporal gains from trade through interest payments. Second, the borrower is more likely to exit when the contracted rate is higher, reflecting the greater gains from refinancing from a higher rate.

A key insight from the model is that upfront fees and interest payments are not perfect substitutes. A dollar collected through an upfront fee is received immediately and does not affect borrower behavior, whereas a dollar collected through interest is received over time and increases the borrower's incentive to refinance. Because lenders and borrowers discount future payments differently, and because interest affects exit risk, lenders must trade off intertemporal gains from trade against higher prepayment risk when determining the optimal contract.

Crucially, the choice of optimal contract reduces to choosing the optimal interest rate, with the fee adjusting to any slack in the borrower's participation constraint. The optimal unconstrained rate trades off greater intertemporal gains from trade against the risk of early exit and is independent of competition. This yields two pricing regimes. When refinancing costs are low, the unconstrained rate is feasible, and the lender extracts surplus through the fee margin; fees vary with competition, while rates do not. When refinancing costs are high, the unconstrained rate is infeasible and the optimal rate is pinned down by competition; in this regime, rates vary with concentration, while fees do not. The model therefore delivers a sharp prediction: competition affects fees, but not rates when refinancing costs are low, and rates but not fees when refinancing costs are high.

We next turn to the empirical analysis and present new facts on market concentration and multidimensional pricing in mortgage markets. Extending the stylized fact in Figure 1 to a regression framework, we estimate the relationship between local concentration and both interest rates and upfront lender fees. Consistent with prior work and the Federal Reserve's rate-based assessment, concentration is not systematically related to interest rates for standard prepayable mortgages. In contrast, concentration is strongly and economically meaningfully related to upfront lender fees in the same contracts. The pattern reverses for mortgages with prepayment penalties, where higher concentration is reflected in higher interest rates and not in upfront fees. These patterns hold across multiple measures of concentration, when comparing observationally similar loans, and when including lender, county, and origination-date fixed effects.

Both contract choice and local market structure are endogenous, so we next exploit exogenous variation in refinancing frictions and market concentration. To isolate the role of refinancing incentives, we use the New York mortgage recording tax, which raises the cost of refinancing and materially reduces refinancing activity. In reduced-form estimates, the relationship between concentration and pricing shifts toward the interest-rate margin in New York and away from the fee margin, consistent with the model's prediction that higher re-

financing frictions reallocate the expression of market power across pricing instruments. To address the endogeneity of concentration itself, we implement two independent instrumental variables strategies: an incidental merger instrument that exploits bank mergers affecting counties unlikely to have motivated the transaction, and a failed-lender-share instrument that uses counties' 2007 exposure to lenders that failed in 2008. Although these instruments generate very different sources of variation in local concentration, they produce similar estimates, with instrumented increases in concentration raising upfront fees but not interest rates for standard mortgages.

The economic magnitudes are substantial and the results are robust across identification strategies and specifications. A one standard deviation increase in local concentration raises upfront lender fees by 20 basis points—equivalent to approximately $6 billion in additional annual fees—and although the two instrumental variables designs generate very different sources of variation in local concentration, they produce almost identical estimates. The findings are robust to a battery of alternative specifications, samples, and measurement choices. As a placebo test, we decompose upfront fees into lender-controlled and third-party components and show that concentration is strongly related to lender-controlled charges, such as origination fees and discount points, but unrelated to third-party fees including appraisal and title services. The results are also not driven by sorting along the rate–points menu: they hold when restricting the sample to loans with zero points and within points categories. Finally, when aggregating rates and fees into an imputed expected present value of mortgage revenue, higher concentration remains associated with higher total lender revenue, reinforcing the interpretation that the results reflect market power.

To evaluate these results quantitatively in the context of the U.S. mortgage market, we build and estimate a dynamic structural model of multidimensional mortgage pricing with endogenous prepayment. The model takes the theoretical framework as its starting point and makes it quantitatively realistic in three ways. First, we microfound borrower refinancing behavior through a dynamic refinancing game. Second, we incorporate lender marginal origination and financing costs. Third, we move from a stark outside option to a competitive environment with multiple differentiated lenders.

The key parameters governing the model concern borrower refinancing behavior. This behavior is summarized by the empirical "s-curve," which relates the differential between the contracted rate and the prevailing market rate to the probability of refinancing. A steeper s-curve implies that borrowers are more responsive to rate differentials, making the interest rate a more competitive pricing margin. In the model, the slope of the s-curve is disciplined

by the fixed cost of refinancing and borrowers' rate sensitivity. We estimate these parameters by matching the model-implied refinancing hazard to the empirical s-curve, which the model replicates closely. Remaining demand parameters are taken from the literature and mortgage-shopping data, and lender marginal costs are recovered from the model's first-order pricing conditions.

The calibrated model reconciles two facts that appear in tension in the data: the presence of markups on both pricing dimensions and the concentration sensitivity of only one. When calibrated to match standard U.S. prepayable mortgages with low refinancing frictions, the model generates positive markups in both interest rates and upfront fees (consistent with the literature documenting markups in the national mortgage market; e.g., Bhutta, Fuster and Hizmo, 2026; Buchak et al., 2024; Fuster, Lo and Willen, 2024), and only fee markups vary with local concentration. Interest-rate markups are disciplined by their effect on refinancing and therefore remain largely invariant to local market structure. In contrast, when refinancing frictions are high, as with mortgages carrying prepayment penalties, rate markups are no longer constrained by exit risk. In this regime, local concentration raises interest rates while leaving fees largely unchanged.

We evaluate two counterfactual regulatory policies. Consider first an interest rate cap, a common regulatory tool (Cuesta and Sepúlveda, 2021; Cherry, 2024). By capping rates at marginal funding costs, the policy eliminates rate markups that generate intertemporal gains from trade and induces lenders to shift markups into upfront fees instead. Because fee markups do not trigger prepayment in the same way, refinancing falls, effective markups remain roughly unchanged, and borrower welfare declines. In contrast, a policy that caps fees at marginal origination costs lowers upfront fees by roughly 75 basis points and leads lenders to reallocate markups toward interest rates, increasing rates by about 20 basis points. This shift is welfare-improving because rate markups operate on the more competitive margin: higher rates raise refinancing incentives. As a result, annual refinancing probabilities rise by roughly 2 percentage points, effective lender markups fall by about 12 percent relative to baseline, and consumer welfare increases by approximately $250 per loan.[2]

In the final part of our paper, we evaluate the political and regulatory implications of our results. In the U.S. mortgage market, the Federal Reserve has direct influence over local lender concentration through its authority to approve or deny bank mergers. Our analysis

[2]Our welfare calculation is only on the intensive margin of lending and likely understates the effect due to changes in the extensive margin of period-one lending. As the policy leads to lower effective price (in utility terms), and the quantity effect can be large even for small changes in prices, as shown by Defusco, Johnson and Mondragon (2019), the all-in effect could be even larger.

shows that local lender concentration is a significant determinant of mortgage pricing, enabling large transfers from borrowers to lenders. These findings imply that policymakers should treat local mortgage concentration as a first-order object of regulatory attention.

At present, however, local mortgage concentration is largely neglected in merger review and related oversight. One reason is the prevailing view, informed by a rate-focused literature on standard prepayable mortgages, that local concentration has little effect on mortgage pricing. Our results show that this conclusion is incomplete because mortgage pricing is multidimensional and the pass-through of market power depends on the contract's prepayment risk. A second reason is the assumption that deposit-market concentration is a sufficient proxy for mortgage-market concentration due to product bundling (Federal Reserve System, 2021). While this may have been reasonable in earlier decades, we show that local deposit and mortgage markets have diverged and are now largely unbundled. Taken together, these findings point to an important academic and regulatory gap: local mortgage concentration *does* affect mortgage pricing, but along margins that conventional assessments overlook.

Relationship to the Literature

Our paper contributes to the literature studying the implications of rising market concentration (Autor et al., 2020; De Loecker, Eeckhout and Unger, 2020; Barkai, 2020).[3] We study this question by combining two longstanding insights from the theoretical IO and finance literatures: firms deploy multidimensional prices (Oi, 1971; Tirole, 1988), and ongoing interest payments affect borrower behavior and ultimately loan value (Dunn and McConnell, 1981; Stanton, 1995). Together, our paper provides evidence for the idea that multidimensional contracts can shape how firms with market power extract rents from consumers (DellaVigna and Malmendier, 2004; Gabaix and Laibson, 2006; Bordalo, Gennaioli and Shleifer, 2013).

We study this question in the context of the U.S. mortgage market, where recent papers have documented that national lenders exercise market power when setting mortgage interest rates; see, e.g., Bhutta, Fuster and Hizmo (2026), Buchak et al. (2024), and Fuster, Lo and Willen (2024). However, while there appear to be lender markups on interest rates *in aggregate*, as noted earlier, *local variation in concentration* is seen by regulators and policy makers as largely irrelevant in contributing to mortgage lenders' market power. Specifically, the Federal Reserve considers mortgage markets to be national in scope because they find little to no relationship between local concentration and interest rates (Federal Reserve

[3]The recent literature builds on a longstanding body of work studying the relationship between market structure and pricing outcomes (Bain, 1951; Demsetz, 1973; Bresnahan, 1989).

System, 2008; Amel et al., 2018). The assumption that mortgage markets are national in scope aligns with prior work in the academic literature on standard prepayable mortgages, where estimates of the relationship between local concentration and interest rates range from no effect to a small, positive relationship.[4]

Our central contribution, and departure from prior work, is to move beyond interest rates and examine how lenders use upfront fees to exert market power—and how the choice between pricing margins varies with prepayment risk. The data necessary to examine fees at large scale in the U.S. mortgage market has only recently become available, so few papers have addressed this topic. Two related papers, those of Liu (2019) and Benetton, Gavazza and Surico (2025), examine lender pricing strategies across both fees and rates in the U.K. mortgage market. These papers, like ours, find a non-trivial tradeoff in setting rates and fees, although due to the structure of the U.K. market, they do not specifically tackle the effects of local market concentration and prepayment risk on pricing margins.

In addition to its effect on prices and markups, a growing literature studies how market structure affects cost pass-through (Drechsler, Savov and Schnabl, 2017; Scharfstein and Sunderam, 2016) and, more broadly, whether market power influences the transmission of monetary policy (Xiao, 2020; Wang et al., 2022). Consistent with the findings of our calibrated model, recent work by Adelino and Ahsin (2025) studies locked rate sheets and find differential responses by national lender size but not by local concentration.[5]

Our theoretical model connects several strands of literature in industrial organization and financial economics. Traditional two-part tariff models in industrial organization (e.g., Tirole, 1988) characterize pricing strategies in which a monopolist extracts surplus through a combination of fixed and variable charges, but abstract from dynamic contract risk and

[4]For example, Fuster et al. (2013) study the gap between primary and secondary mortgage rates and argue that national concentration alone seems unlikely to explain profits; Scharfstein and Sunderam (2016) have found that increased local concentration leads to reduced pass-through of MBS rates to origination rates, while Amel et al. (2018) argue that there are no differences. Bhutta, Fuster and Hizmo (2026) study a sample of *locked* mortgages and find a positive relationship when interacting concentration with a measure of sophistication, suggesting that local competition is helpful primarily for sophisticated borrowers. Fuster, Lo and Willen (2024) study rate sheet data and find that, within a specific market, interest rates do not vary with time-series variation in local concentration. In contrast, Ratnadiwakara and Yerramilli (2020) argue that local concentration does matter for interest rates. Relatedly, Hurst et al. (2016) show that interest rates for conforming loans do not vary with regional differences in credit risk and Granja and Paixão (2019) find that banks price deposits uniformly across branches.

[5]Another strand of the literature has examined the interaction between market concentration and non-price attributes and outcomes; see, e.g., Ho and Ishii (2011) (branch networks), Sharpe and Sherlund (2016) (capacity constraints), Favara and Giannetti (2017) (debt liquidation), Di Maggio, Kermani and Korgaonkar (2019) (penalty terms), Begley and Purnanandam (2021) (product quality), Saidi and Streitz (2020) (product markets), and Yannelis and Zhang (2021) (loan screening).

early termination. In credit markets, the mortgage and consumer lending literature studies borrower prepayment risk (e.g., Stanton, 1995; Agarwal, Ben-David and Yao, 2017), but focuses primarily on interest rate adjustments and does not endogenize the composition of upfront fees and periodic charges. Models of switching costs and lock-in (Klemperer, 1987) examine related dynamics, but largely in static or post-contractual settings. Our contribution is to bring these elements together by showing how early termination risk and borrower impatience jointly determine a lender's markup strategy, generating distinct preferences over upfront fees and ongoing charges.

Our empirical and theoretical analyses show that prepayment risk plays a central role in determining the margin—rates or fees—along which lenders exercise market power. This finding builds on a growing literature demonstrating that variation in mortgage design can influence both borrower behavior and broader macroeconomic dynamics. For example, Mayer, Piskorski and Tchistyi (2013) show that prepayment penalties can improve welfare for risky borrowers by lowering interest rates and reducing defaults, while Beltratti, Benetton and Gavazza (2017) document how prepayment penalties affect prepayment, pricing, and borrower selection in the Italian mortgage market.[6]

Finally, while our findings are not driven by the rate–point menu, prior work—including Stanton and Wallace (1998), Bhutta and Hizmo (2020), Willen and Zhang (2022), and Zhang (2024)—has shown that this margin plays an important role in shaping borrower outcomes and distributional effects.

Our paper proceeds as follows. Section 2 begins with a simple theoretical framework linking competition and prepayment risk to multidimensional pricing. Then, Section 3 presents the datasets and provides institutional background on the U.S. mortgage market. In Section 4, we present the empirical analysis testing the model's predictions. Section 5 presents the results from the fully calibrated model and explore how borrower welfare changes under counterfactual regulatory regimes. Section 6 concludes with implications for policy.

[6]In addition to contractual differences, prepayment risk is often related to the borrowers' (lack of) financial sophistication (Woodward and Hall, 2012; Agarwal, Rosen and Yao, 2016; Keys, Pope and Pope, 2016; Agarwal, Ben-David and Yao, 2017; Andersen et al., 2020; Jørring, 2024), and a set of recent papers illustrates how firms across various financial markets often tailor their products to exploit consumers' lack of financial sophistication (Gurun, Matvos and Seru, 2016; Agarwal, Chomsisengphet and Lim, 2017; Célérier and Vallée, 2017; Egan, 2019). (We capture this effect in our model by allowing for differential salience of rates and fees.) Relatedly, a number of recent papers study the effect of competition and consumer sophistication in the auto-loan market (Low et al., 2020; Hankins, Momeni and Sovich, 2023; Momeni, 2024).

2 Theoretical Framework

We begin with a theoretical framework linking competition to multidimensional pricing. We outline the setup, solve the model, and derive comparative statics that guide the empirical analysis in Section 4. The model then serves as the basis for our quantification and counterfactuals in Section 5.

2.1 Model specification

Setup. In period 0, lender l offers an infinite-period loan to borrower b. The loan contract is characterized by two pricing instruments: an upfront fee $f \geq 0$, and a per-period interest payment $i \geq 0$. The borrower can terminate the loan early (e.g., refinance), stopping the interest payments. The loan's per-period survival probability, $s(i) \in (0,1)$, is (in the stylized model) a model primitive that depends on the interest payment.[7]

The lender and borrower discount future payments by β_l and β_b, respectively. The present values of loan repayments from their perspectives are:

$$P_l(f,i) = f + i\underbrace{\sum_{t=1}^{\infty}\beta_l^t s(i)^t}_{PV_l(i)} \qquad P_b(f,i) = f + i\underbrace{\sum_{t=1}^{\infty}\beta_b^t s(i)^t}_{PV_b(i)}. \tag{1}$$

$PV_j(i)$ is the present value of one unit of interest payment for agent $j \in \{l,b\}$. For notational convenience, we will often use $P_j(i) \equiv iPV_j(i) = P_j(0,i)$ to refer to the interest-only portion. The borrower has an outside option with present-value cost $C > 0$ and accepts the offered loan if and only if $P_b(f,i) \leq C$. C therefore parameterizes competition, with a lower C corresponding to more competition. The lender's problem is to maximize the expected present value from lending, subject to the borrower's participation constraint:

$$\max_{f\geq 0,\, i\geq 0} P_l(f,i) \qquad \text{s.t.} \quad P_b(f,i) \leq C. \tag{2}$$

Key assumptions. We maintain the following assumptions:

(i) *Discounting*: $1 > \beta_l > \beta_b > 0$

[7] Exit corresponds to refinancing into a new loan. Because refinancing involves frictions such as search costs, origination fees, and potential prepayment penalties, borrowers do not exit immediately. We endogenize this refinancing decision in the structural model.

(ii) *Exit interest rate sensitivity*: $s : \mathbb{R}_+ \to (0, 1)$ is twice differentiable and has $s'(i) < 0$.

(iii) *Limiting behavior*: $\lim_{i\to\infty} i \cdot s(i) = 0$.

Assumption (i) means thet borrower values current relative to future cash flows more than the lender does and generates a lending motive. Assumption (ii) captures the idea that the borrower is more likely to exit when its current rate is higher because a higher contracted rate makes refinance (or default) more desirable. Assumption (iii) ensures the lender does not charge arbitrarily high interest payments with a vanishingly small chance that the borrower will survive.

Before proceeding, we flag three simplifications that we enrich in the quantitative model. First, the quantitative model derives $s(i)$ as an endogenous refinancing choice in a dynamic refinancing problem. Second, as we omit marginal origination and funding costs in the stylized model, f and i should be interpreted as markups in excess of marginal costs. In particular, $f = 0$ corresponds to zero markups in fees, rather than no fees at all. The quantitative model introduces and estimates these production costs. Third, the quantitative model features strategic competition among differentiated lenders, rather than the stark outside option loan C. While relevant for the quantification, these simplifications do not meaningfully affect the economic forces we highlight here.

2.2 Solution

To preview results, because the lender can always extract slack in the borrower's participation constraint by charging a higher fee, the multidimensional pricing problem reduces to choosing a feasible interest payment i, with the fee $f^*(i)$ pinned down by the participation constraint. The reformulated problem has the lender attempting to set an interest payment that maximizes joint welfare, while using the fee to extract the remaining surplus. When such an interest payment is feasible, pricing falls into a *positive-fee markup regime*, with $f^* > 0$ and $i^* > 0$. When the participation constraint rules out this rate, pricing falls into a *no-fee markup regime*, with $f^* = 0$ and $i^* > 0$. In the *positive-fee markup* regime, increasing competition leads to lower fees (and does not impact rates), while in the *no-fee markup regime*, competition impacts rates and not fees. Finally the *no-fee markup* regime is more likely to arise under higher refinancing frictions.

2.2.1 Reducing the problem to a single pricing dimension

The problem reduces to a single-dimensional pricing problem over interest payments:

Proposition 2.1 (Reduction to single-dimension)**.** *The lender's problem* (2) *is equivalent to*

$$i^* \in \arg\max_{i \geq 0} \; i\Delta(i), \qquad s.t.\; P_b(i) \leq C, \qquad f^* = C - P_b(i) \tag{3}$$
$$with\ \Delta(i) \equiv PV_l(i) - PV_b(i).$$

Proof. See Proof B.1 in Internet Appendix B. □

$\Delta(i)$ is the difference in valuation for a dollar of interest payments between lender and borrower. It represents the per-dollar intertemporal gains from trade. The lender's problem is to choose an interest payment to maximize total intertemporal gains from trade, $i\Delta(i)$, subject to the interest-only portion of the contract satisfying the borrower's participation constraint. The optimal fee, which must be non-negative, extracts the remaining slack in the participation constraint.[8] Much of the problem's logic runs through $\Delta(i)$, which has the following two properties:

Proposition 2.2 (Properties of the present value wedge)**.**

$$\Delta(i) > 0 \qquad\qquad \Delta'(i) < 0. \tag{4}$$

Proof. See Proof B.2 in Internet Appendix B. □

$\Delta(i) > 0$ implies that there are always intertemporal gains from trade from interest payments. These gains arise out of differences in discount factors. In particular, because the lender values future payments more than the borrower, delaying payments is surplus-enhancing. $\Delta'(i) < 0$ implies that as the level of interest payments increase, the per-dollar gains from trade diminish, because higher interest payments induce early contract termination.

2.2.2 Two pricing regimes

First, a baseline result is that i^* is strictly positive. The intuition, formalized in Proof B.3, illustrates the importance of discount rate-induced gains from trade: Around $i = 0$, the

[8] This logic parallels the classic insight of Oi (1971), who shows that introducing a fixed fee alongside a per-unit price both restores efficiency and allows the seller to extract the full surplus.

lender can feasibly reduce the fee and increase the interest payment by a PV-equivalent amount. The lender and borrower value the fee reduction equivalently, but owing to discount rate differences, the lender values the interest payment increase more than the borrower does, which allows the lender to increase profits.

Beyond this, the lender's optimal pricing strategy falls into either a *positive-fee markup* regime with $f^* > 0$, or a *no-fee markup* regime with $f^* = 0$, depending on whether the interest-only participation constraint, $P_b(i) \leq C$, binds.

Proposition 2.3 (Two pricing regimes)**.** *Let* $\mathbf{i}^U$ *denote the set of local maximizers of* $i\Delta(i)$ *with* $i > 0$ *and* $P_b(i) < C$*, and let* $\mathbf{i}^C$ *denote the set of interest rates with* $i > 0$ *and* $P_b(i) = C$*. The optimal interest rate* i^* *exists and is in* $\mathbf{i}^U$ *or* $\mathbf{i}^C$*.*

- *If* $i^* \in \mathbf{i}^U$*,* $f^* > 0$ *(Positive-fee markup regime).*
- *If* $i^* \in \mathbf{i}^C$*,* $f^* = 0$ *(No-fee markup regime).*

Proof. See Proof B.4 in Internet Appendix B. □

An illustrative case is one where $i\Delta(i)$ is single peaked with maximizer, i^u. If i^u is strictly feasible, then that is the optimal interest payment, and the lender extracts the remaining slack with a positive fee. If i^u is not feasible, the optimal interest payment occurs at a rate i^c satisfying $P_b(i^c) = C$, and the fee is identically zero. Figure 2 illustrates the two regimes. In Panel A, i^u is feasible, so $i^* = i^u$ and $f^* = C - P_b(i^U)$. In Panel B, i^u is infeasible, so $f^* = 0$ and $i^* = i^c$ with $P_b(i^c) = C$.

2.2.3 Regime-specific effects of competition

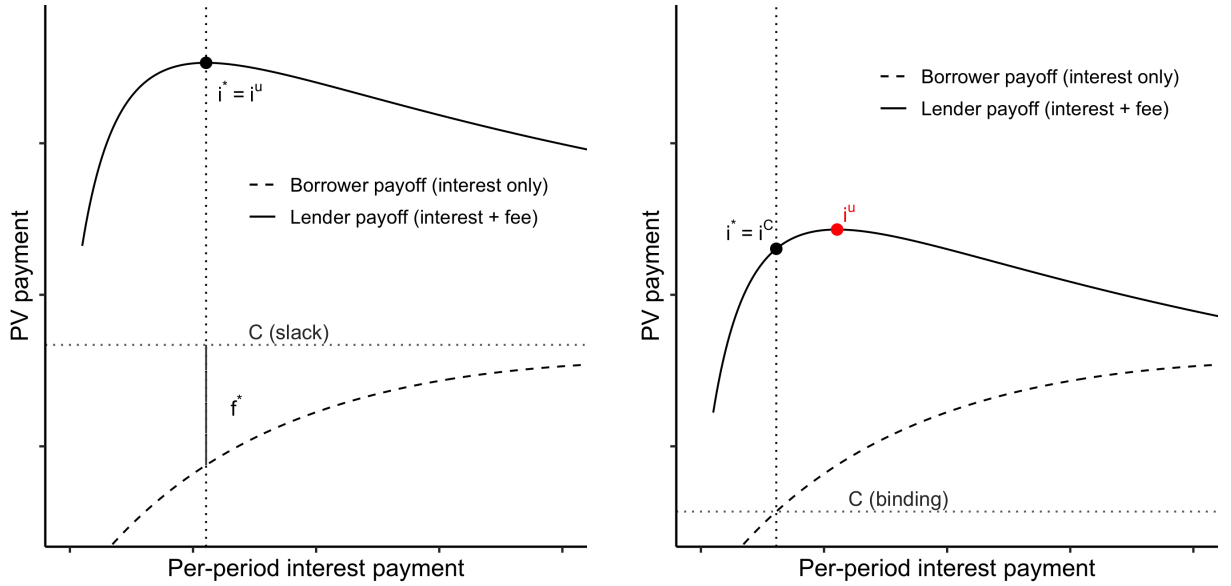
Comparative statics with respect to competition C depend on the fee regime, summarized in the following proposition:

Proposition 2.4 (Competition and pricing)**.** *An increase in* C *(decrease in competition) changes optimal pricing as follows:*

1. *Positive-fee markup regime* ($f^* > 0$)*.*

$$\frac{\partial i^*}{\partial C} = 0, \qquad \frac{\partial f^*}{\partial C} = 1.$$

Figure 2: Optimal Interest Payments and Fees



A: *Positive-fee markup regime* B: *No-fee markup regime*

2. No-fee markup regime ($f^* = 0$).

$$\frac{\partial i^*}{\partial C} > 0, \qquad \frac{\partial f^*}{\partial C} = 0.$$

Proof. See Proof B.5 in Internet Appendix B. □

In the *positive-fee markup regime*, the first-order condition, $i\Delta'(i) + \Delta(i) = 0$, pins down the interest payment. This equation illustrates lender's tradeoff between capturing additional intertemporal gains from trade, $\Delta(i) > 0$, and reducing the gains from trade on inframarginal interest payments, $i\Delta'(i) < 0$, by inducing early exit.[9] A lender in this regime sets interest payments to balance this tradeoff, which importantly does not depend on the level of competition C. Rather, C determines how much remaining surplus can be taken up by fees, and so increases in C translate one-to-one with increases in fees. Returning to Figure 2 Panel A, which illustrates the *positive-fee markup regime*, observe that increasing C (the

[9]This condition exactly mirrors standard monopoly pricing. Defining the elasticity of surplus per unit of interest with respect to the interest rate as

$$\varepsilon_\Delta(i) \equiv -\frac{i\Delta'(i)}{\Delta(i)},$$

the unconstrained optimal interest rate satisfies $\varepsilon_\Delta(i^*) = 1$.

horizontal dotted line) does not impact i^*, but allows the lender to raise f^*, as indicated by the vertical dashed line between the borrower's present value cost and C.

In contrast, in the *no-fee markup regime*, the interest payment is set directly by the constraint $P_b(i) = C$, and so changes in C must change the interest payment. As we show in the proposition's proof, the optimal i^* in this regime occurs when $P_b(i^*)$ is upward sloping, and so increases in C translate into increases in i^*. As the optimal fee markup in this regime is $f^* = 0$, changes in C do not alter f^*. Returning to Figure 2, observe that increasing C increases the interest payment at which the participation constraint binds, causing i^* to increase.

2.3 Refinancing frictions and the endogenous pricing regime

Finally we introduce refinancing frictions through a parameter θ that raises the probability of loan survival at a given interest rate. Formally, the survival probability becomes $s(i, \theta)$ with $\partial s(i, \theta)/\partial\theta > 0$. For example, low or high θs correspond to a mortgage without or with prepayment penalties. The following proposition summarizes relationships between θ and key model objects:

Proposition 2.5 (Refinancing frictions)**.** *The addition of refinancing frictions implies*

(i) Refinance frictions increase effective present value: $\partial PV_j(i, \theta)/\partial\theta > 0$.

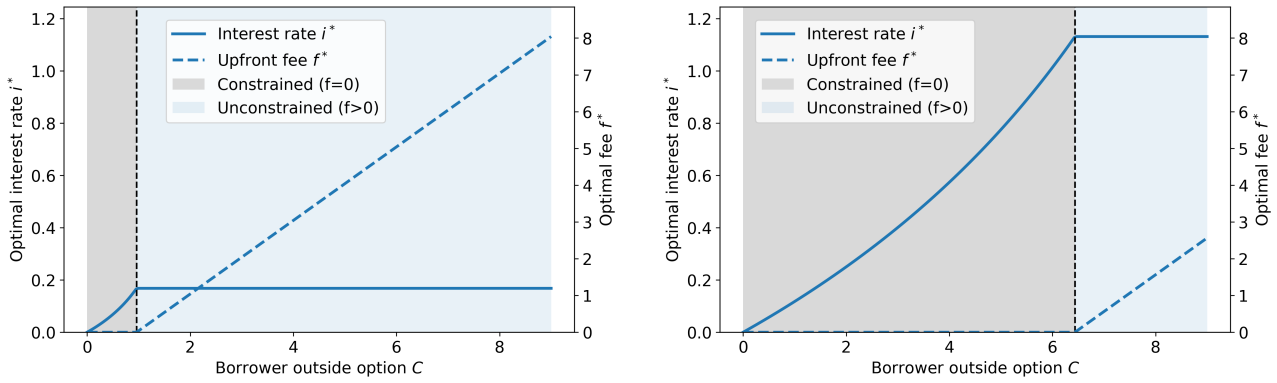
(ii) Refinance frictions shrink the set of feasible interest payments: Let $\iota(\theta)$ *denote the set of feasible rates,* $\iota(\theta) = \{i \mid iPV_b(i, \theta) \leq C\}$. *Then* $\theta_2 > \theta_1 \implies \iota(\theta_2) \subset \iota(\theta_1)$.

(iii) Refinance frictions increase the present value wedge: $\partial\Delta(i, \theta)/\partial\theta > 0$.

Proof. See Proof B.6 in Internet Appendix B. □

(i) states that when refinance is less likely, the expected present value of a given stream of interest payments higher. (ii) states that in consequence, fewer potential interest rates satisfy the borrower's participation constraint. (iii) shows that as the expected duration of the contract expands due to a lower exit rate, the per-dollar present value wedge between lender and borrower expands because more backloaded contract payments are likely to occur. These results are significant because they imply that refinance frictions simultaneously lead the lender to want to charge higher interest payments while also shrinking the set of feasible interest payments. This tends to make the constrained *no-fee markup regime* and associated comparative statics more likely.

Figure 3: Refinancing Frictions and the Margin of Price Adjustment



Panel A: Low refinancing frictions

Panel B: High refinancing frictions

Figure 3 illustrates this mechanism. Panel A depicts a case with low refinancing frictions. The regime threshold separating the *no-fee markup regime* (gray-shaded) region where $f^* = 0$ from the *positive-fee markup regime* (light-shaded) region lies far to the left, and lenders compete mainly through the upfront fees: f^* rises with C while i^* stays flat. Panel B shows the high-refinancing frictions case. The regime boundary shifts rightward, expanding the *no-fee markup regime* region in which lenders set $f^* = 0$ and increases in competition only affects the interest rate. Thus, higher refinancing frictions shift the competitive margin of adjustment from the fee to the interest rate. In Internet Appendix B, we provide two natural parameterizations of $s(i) \mapsto s(i, \theta)$ and show formally that greater refinancing frictions necessarily make the *no-fee markup regime* more likely.

2.4 Summary of Empirical Predictions

We conclude by summarizing the model's empirical predictions for the effects of competition on both dimensions of pricing. There are two pricing regimes, a *positive-fee markup regime*, which tends to arise when there are low frictions to refinance, and a *no-fee markup regime*, which tends to arise when there are high frictions to refinance. In the *positive-fee markup regime* associated with low refinancing frictions, competition pins down the fee, and consequently greater competition lowers fees but does not affect rates. In the *no-fee markup regime*, competition pins down the interest rate, and consequently greater competition lowers rates but does not affect fees. Table 1 summarizes these results.

In mortgage markets, these predictions imply that competition operates through different pricing margins depending on refinancing frictions. The cleanest example is the comparison

Table 1: Pricing regimes and empirical predictions

Refi frictions	Regime	Interest markup i^*	Fee markup f^*	Effect of higher C
Low	*Positive-fee markup*	Interior, surplus-maximizing	> 0	i^* unchanged, f^* increases
High	*No-fee markup*	Constrained by $P_b(i^*) = C$	$= 0$	i^* increases, f^* unchanged

between mortgages with no prepayment penalties (low refinancing frictions) and mortgages that do have prepayment penalties (high refinancing frictions). The model's prediction is that among mortgages without prepayment penalties, competition should impact fees and not rates, while among mortgages with prepayment penalties, competition should impact rates and not fees. Similarly, regulations that make refinancing more difficult should shift the pricing margin of competition.[10] We test these empirical predictions in the next sections.

3 Data & Institutional Background

This section presents the datasets used in the empirical analysis and reviews two institutional features of U.S. mortgage markets that connect directly to the model. First, mortgage contracts include both upfront fees and per period interest payments. Second, the likelihood that a borrower refinances increases with their interest rate.

3.1 Data

Home Mortgage Disclosure Act: Our main data source is the mortgage-level application and acceptance data collected under the Home Mortgage Disclosure Act (HMDA), which covers the near universe of U.S. mortgage applications. The HMDA data, used extensively in the literature, includes lender identification, application outcome, and loan type, purpose, size, year of origination, and location at the census tract level. Since 2018, HMDA has recorded several further variables that are key in our analysis: loan interest rate, upfront fees (including origination charges, discount points, and lender credits), loan-to-value (LTV) ratio, and debt-to-income (DTI) ratio. Consequently, most of our study centers on the years

[10] The same logic applies to other lending and non-financial markets in which contracts combine an upfront charge with a recurring payment, and similar pricing structures arise outside of finance, where industries such as telecommunications, software-as-a-service, and membership clubs combine activation, onboarding, or initiation fees with recurring payments for ongoing service. Examples in the literature studying multi-dimensional pricing in lending markets include bank credit lines with commitment fees and spreads (Sufi, 2009), syndicated loans with upfront and recurring charges (Berg, Saunders and Steffen, 2016), credit cards with annual fees and interest charges (Nelson, 2025), and auto loans with origination fees and monthly installments (Grunewald et al., 2023).

2018 to 2023.[11]

Table 2: Summary Statistics

Panel A: Loan-level variables

	N	Mean	Std. dev.	10%-tile	90%-tile
Loan amount ($)	3,013,640	314,750.75	158,369.78	134,000.00	528,000.00
Interest rate (percent)	3,013,637	4.22	1.26	2.88	6.12
Total loan costs ($)	3,004,349	5,031.10	4,634.03	2,096.15	8,918.21
Total loan costs (pct.)	3,004,349	1.85	1.26	0.68	3.39
Lender fees ($)	3,005,091	1,868.15	2,895.57	-60.15	4,908.19
Lender fees (pct.)	3,005,091	0.69	0.88	-0.02	1.82
Origination charge ($)	3,005,091	2,349.02	2,772.89	0.00	5,590.00
Origination charge (pct.)	3,005,091	0.84	0.82	0.00	2.01
Discount points ($)	1,315,825	2,486.19	2,924.55	255.47	5,761.60
Discount points (pct.)	1,315,825	0.83	0.79	0.12	1.94
Lender credits ($)	1,146,029	1,263.68	2,228.76	15.00	3,731.96
Lender credits (pct.)	1,146,029	0.41	0.63	0.00	1.21
Third-party fees ($)	3,005,091	2,676.06	3,503.05	1,198.00	4,262.85
Third-party fees (pct.)	3,005,091	1.00	0.66	0.41	1.70
Income ($ thousands)	2,982,040	113.83	87.09	46.00	197.00
Combined loan-to-value ratio (pct.)	3,013,640	83.14	46.90	63.93	96.87
Debt-to-income ratio (pct.)	3,012,752	35.63	9.81	25.00	47.00
FICO	2,986,139	753.70	42.81	692.00	803.00

Panel B: County-year statistics

	N	Mean	Std. dev.	10%-tile	90%-tile
Mortgage lenders	19,040	52.76	66.37	5.00	136.50
Herfindahl-Hirschman Index (HHI)	18,991	0.10	0.10	0.03	0.19
Market share for top 4 (CR4)	18,991	0.47	0.18	0.26	0.72
Unemployment rate	18,940	4.54	2.05	2.50	7.20

Note: This table reports the number of observations, the mean and standard deviation, and the 10th and 90th percentiles. Panel A gives summary statistics for loan-level variables for the matched HMDA-GSE dataset and Panel B gives summary statistics for the county-year variables. Table G.1 in the Online Appendix gives summary statistics for the unmatched HMDA dataset.

Fannie Mae and Freddie Mac single-family loan origination and performance data: Fannie Mae and Freddie Mac provide information on the GSEs' portfolios of 30-year single-family conforming fixed-rate mortgages. As with the HMDA sample, we restrict the

[11] In our baseline sample, we follow the literature and restrict attention to 30-year, conventional, first-lien mortgages originated for the purchase of owner-occupied single-family homes. We exclude government-insured loans—such as FHA, VA, FSA, and RHS mortgages—as well as mortgages with "exotic" features, including reverse mortgages, open-end lines of credit (e.g., HELOCs), interest-only structures, introductory-rate periods, balloon payments, or other non-amortizing terms. These restrictions ensure that our sample is comparable to those used in prior studies.

sample to 30-year mortgages originated for purchases of owner-occupied homes. These loans are fully amortizing, prepayable, and have full documentation. The loan-level origination dataset provides interest rates, FICO scores, LTVs, and DTIs, as well as loan size, type, purpose, and location. It also identifies the originator that sold the loan to the GSE in cases where the originator had sufficiently high origination market share in the reporting period.

We merge the HMDA dataset with the GSE dataset using the following conservative procedure. We first restrict the GSE loans to those matching the criteria listed above for the HMDA loans (i.e., loans for the purchase of owner-occupied homes, etc.). We then match loans on location (state, metropolitan statistical area, and ZIP Code), the exact loan amount and interest rate, and the purchaser type (i.e., Fannie Mae or Freddie Mac). To ensure the highest-quality match, we exclude all loans with duplicate observations, and we match without replacement. Table 2 presents high-level summary statistics.

Black Knight McDash Analytics: Black Knight is a private company that has created a loan-level mortgage dataset covering loans serviced by the ten largest mortgage servicers in the United States. This dataset is similar to the GSE dataset in content (it includes similar loan-level origination and performance variables). The Black Knight dataset complements the HMDA and GSE datasets chiefly by providing borrower FICO scores and performance measures for markets beyond conforming agency loans. Specifically, for our analysis it complements the GSE dataset by providing data on mortgages with prepayment penalties.

Supplemental data: We supplement the datasets on mortgages with a number of additional data sources that are commonly used in the literature. At the county-year level, we collect demographic variables, unemployment rates, and conforming mortgage loan limits from the American Community Survey, the Bureau of Labor Statistics, and the Federal Housing Finance Agency, respectively. At the lender-year level, we collect RSSD lender identifiers from the Federal Reserve Board, bank branch deposit data from the FDIC's Summary of Deposits, and bank merger data from the Federal Financial Institutions Examination Council. Finally, we use spatial crosswalks provided by the Department of Housing and Urban Development.

Concentration: As our measure of lender concentration, we consider two standard indices: the Herfindahl–Hirschman Index (HHI) and the concentration ratio of the top four lenders (CR4). Markets are defined at the county-year level, with HHI and CR4 given by equations (5)–(6) where $J(c,t)$ is the set of lenders that originated a loan in county c in year

t, and $J^4(c,t)$ is the set of the top four lenders by origination market share.

$$HHI_{ct} = \sum_{j \in J(c,t)} s_{jct}^2, \tag{5}$$

$$CR4_{ct} = \sum_{j \in J^4(c,t)} s_{jct}. \tag{6}$$

Table 2, Panel B, shows summary statistics at the market level. County-level mortgage markets exhibit substantial dispersion: the average HHI is about 10 percent and the average CR4 is about 48 percent.[12] As we show in Appendix Section A.I, geographical concentration is fairly stable over time, and does not reflect an urban-rural divide.

3.2 Mortgage Pricing

Mortgage lenders in the U.S. charge two types of prices: interest rates and upfront fees. The interest rate determines how much a borrower pays over time on the loan balance, while upfront fees—including origination charges, discount points, application fees, and lender credits—are paid at closing.

Interest Rates: The mortgage interest rate is the contractual percentage applied to the outstanding loan balance that determines the interest component of payments in an amortized loan with fixed monthly payments. This variable is available in the HMDA data beginning in 2018. (In the Internet Appendix Section C.I, we report the unconditional and residualized distributions of interest rates.)

Upfront fees: The HMDA dataset includes data on multiple sources of fees that borrowers pay up front as part of the closing process. This data is collected on a standardized form, mandated by the Consumer Financial Protection Bureau (CFPB), that lenders must fill out after loan origination. Figure A2 in the Appendix shows an example of the CFPB form. Specifically, the dataset provides four variables from the form: total loan costs, origination charges, discount points, and lender credits.[13]

[12] Across counties, the 10th to 90th percentile ranges are 3 to 19 percent for HHI and 26 to 72 percent for CR4.

[13] The HMDA dataset also includes a fifth variable, called "Total Points and Fees," which appears to be a legacy variable unrelated to the standard CFPB closing cost disclosure form. We have excluded this variable from the analysis, because it is missing from more than 99.7% of the observations.

Total loan costs: The total loan cost is the sum of all borrower-paid upfront non-interest costs associated with the mortgage. It is the sum of origination charges (which accrue to the lender) and fees to third-party institutions. (In the CFPB form, fees to third-party institutions are broken down according to whether or not they represent services that the borrower shopped for. This decomposition, however, is not available in the HMDA dataset.)

Origination charges: Origination charges are a part of the total loan cost; they comprise discount points, application fees, and underwriting fees.

Discount points: Money paid for discount points is a subset of the origination charges. Borrowers pay for discount points in exchange for lower interest rates. Figure F.2 in the Internet Appendix shows an example of the pricing-menu of discount points and interest rates.

Lender credits: Lender credits are essentially negative discount points. They enable the lender to pay cash to the borrower in exchange for a higher interest rate. (On the disclosure form, lender credits appear in Section J and not as part of the origination charges.)

Variable construction: From this set of variables, we construct a measure of upfront *lender fees*—the upfront fee that flows directly to the originating lender—as follows:

$$\text{lender fees} = \text{origination charges} - \text{lender credits}. \tag{7}$$

This captures the upfront non-interest fees that accrue directly to the lender; in what follows, we will refer to lender fees simply as "fees." Similarly, we define the part of the upfront fees accruing to third parties (such as appraisers, home inspectors, and title insurance companies) as follows:

$$\text{third-party fees} = \text{total loan costs} - \text{origination charges}. \tag{8}$$

3.3 The Mortgage Prepayment Option

A distinctive institutional feature of the U.S. mortgage market is that the vast majority of residential mortgages are *long-term, fixed-rate loans with a free prepayment option.* Prepayment risk rises with the interest rate on the mortgage: borrowers with higher rates have stronger incentives to refinance when market rates fall, shortening expected duration and

reducing the marginal value of the higher interest rate to investors (Hanson, 2014).[14] This positive relationship between a loan's interest rate and its refinancing probability is a central mechanism in our theoretical framework (captured by Assumption (ii)), and confirmed in our quantitative analysis.[15]

Both contractual features and state-level policies generate substantial heterogeneity in borrowers' refinancing probabilities. On the contractual side, prepayment penalties raise the cost of prepayment, attenuating borrowers' responses to falling interest rates. On the policy side, state anti–predatory lending laws limit the use of such penalties, and variation in mortgage recording taxes—especially New York's—further alters refinancing incentives (Bostic et al., 2012; Fuster, Lucca and Vickery, 2023). Our empirical analysis exploits these differences.

4 Empirical Analysis

This section presents our empirical analysis. We first show correlative evidence relating market concentration to multidimensional mortgage pricing. We then present our causal identification strategy and results, and conclude with robustness and placebo tests.

4.1 New Facts on Mortgage Pricing

We compare observationally similar loans by regressing interest rates and upfront lender fees on measures of concentration at the loan level as follows:

$$Y_{ibct} = \beta Concentration_{ct-1} + \eta' X_i + \mu' X_{ct} + \gamma_b + \gamma_c + \gamma_t + \epsilon_{ibct}, \tag{9}$$

where $Concentration_{ct-1}$ is the one-year lagged county-year measure of concentration, either $CR4_{ct-1}$ or HHI_{ct-1}.

Table 3 shows the results. Columns (1)–(4) report the results on the full sample, and, consistent with the existing literature, we find no relationship between local concentration and interest rates. Across specifications, the estimated coefficients are small in magnitude and statistically indistinguishable from zero. Interpreting the point estimates, increasing

[14] In more recent work, Chernov, Dunn and Longstaff (2017) find that prepayment risk carries a significant risk premium, and Boyarchenko, Fuster and Lucca (2019), who study MBS spreads, show that non-interest-rate prepayment risk (such as prepayment risk related to house prices) contributes to a pricing smile.

[15] See Figure A4.

Table 3: Market Concentration and Mortgage Pricing

	Full sample				Standard Mortgages		Prepayment Penalties	
	(1) Rates	(2) Fees	(3) Rates	(4) Fees	(5) Rates	(6) Fees	(7) Rates	(8) Fees
CR4	-0.01	0.12***			-0.01	0.14***	1.21***	-0.17
	(0.02)	(0.03)			(0.02)	(0.03)	(0.30)	(0.19)
HHI			0.02	0.19***				
			(0.02)	(0.05)				
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
Orig. date FE	✓	✓	✓	✓	✓	✓	✓	✓
N	3,011,841	3,003,332	3,011,841	3,003,332	2,986,574	2,980,075	24,915	22,905
R^2	0.92	0.28	0.92	0.28	0.93	0.28	0.81	0.39

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the relationship between market concentration and mortgage pricing. The table shows the results from equation (9) where the sample includes either all mortgages (Columns (1)-(4)), standard prepayable mortgages (Columns (5) and (6)), or mortgages with prepayment penalties (Columns (7) and (8)). In the odd columns, the dependent variable is the interest rate, and in the even columns, the dependent variable is upfront lender fee. Standard errors clustered at the local market level (in parentheses).

concentration from 0 to 1 implies a 1 basis point decline in interest rates when measured by $CR4$ and a 2 basis point increase when measured by HHI. These magnitudes are economically negligible relative to typical variation in mortgage rates.[16]

However, while there is essentially no relationship between concentration and interest rates, we find a large and statistically significant relationship between concentration and fees. The coefficients in Columns (2) and (4) imply that increasing concentration from 0 to 1 increases fees by 12 basis points when concentration is measured by $CR4$, and by 19 basis points when concentration is measured by HHI.

What accounts for the stark contrast in how concentration relates to interest rates versus upfront fees? According to our model, lenders strategically allocate markups across pricing instruments as a function of the contract's inherent refinancing risk. As a first descriptive assessment of this mechanism, we split the sample into standard prepayable mortgages and

[16]Our findings mirror the range of results in the existing literature, which varies from no effect of local concentration on interest rates (Amel et al., 2018; Fuster, Lo and Willen, 2024), to a small positive effect (Ratnadiwakara and Yerramilli, 2020), to effects that only appear for specific borrowers (Bhutta, Fuster and Hizmo, 2026).

mortgages with prepayment penalties. Columns (5)–(8) of Table 3 report the results. For standard mortgages, concentration is unrelated to interest rates but positively related to upfront fees. For mortgages with prepayment penalties, the pattern reverses: local concentration is positively related to interest rates, while the relationship with upfront fees is negative and statistically indistinguishable from zero.

However, mortgages with prepayment penalties are endogenously chosen and relatively rare in the 2018–2023 sample. This exercise therefore provides descriptive evidence consistent with the mechanism, but it does not identify a causal effect.

4.2 Policy-Driven Variation in Refinancing Risk

To address the endogeneity of contract choice, we exploit a policy-driven source of variation in refinancing risk. In particular, we use the New York State mortgage recording tax (MRT), which raises the cost of refinancing and generates exogenous differences in effective refinancing incentives across otherwise similar mortgages.[17]

We first verify that the New York MRT materially reduces refinancing activity in standard prepayable mortgages. Columns (1) and (4) of Table 4 report regressions where the dependent variable is an indicator for whether a mortgage refinances within two years of origination. Across specifications, mortgages originated in New York are less likely to refinance. Column (1) reports the results on the sample that includes all states. New York mortgages are 10 percentage points less likely to refinance within two years relative to mortgages originated in other states, compared to a mean refinancing rate of 21 percent. In Column (4), we restrict the sample to New York and bordering states (Pennsylvania, New Jersey, Connecticut, Massachusetts, and Vermont), which face similar regional economic conditions but are not subject to the New York MRT. We find a similar pattern, with a 7 percentage point reduction in New York relative to a mean refinancing rate of 16 percent.

To examine how refinancing risk modifies the relationship between concentration and pricing, we estimate the following reduced-form specification:

$$\begin{aligned} Y_{ibct} \;&= \beta_1 \,\text{Concentration}_{ct-1} \;+\; \beta_2 \,\text{Concentration}_{ct-1} \times \mathbb{1}\{\text{NY}_i\} \\ &\quad +\; \eta' X_i \;+\; \mu' X_{ct} \;+\; \gamma_b \;+\; \gamma_c \;+\; \gamma_t \;+\; \epsilon_{ibct}, \end{aligned} \tag{10}$$

[17] The New York MRT is levied on the principal amount of a newly recorded mortgage and must be paid again upon refinancing when the new mortgage is recorded. With a statutory rate of at least $1.00 per $100 of mortgage debt, this tax represents a meaningful refinancing friction. See https://www.tax.ny.gov/pit/mortgage/mtgidx.htm.

Table 4: Policy-driven Variation in Prepayment Risk

	All states			NY & bordering states		
	(1) Refi'd in 2 years	(2) Rates	(3) Fees	(4) Refi'd in 2 years	(5) Rates	(6) Fees
NY	-0.10***			-0.07***		
	(0.01)			(0.01)		
CR4		-0.04	0.16***		-0.35***	0.27**
		(0.03)	(0.04)		(0.08)	(0.12)
CR4 × NY		0.91***	-0.58***		0.80***	-0.68***
		(0.24)	(0.17)		(0.17)	(0.18)
Loan controls	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓
County FE		✓	✓		✓	✓
Orig. date FE	✓	✓	✓	✓	✓	✓
N	2,985,046	2,984,503	2,978,006	411,343	411,338	410,646
R^2	0.24	0.93	0.28	0.23	0.94	0.30

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table examines policy-driven variation in refinancing risk using the New York mortgage recording tax (MRT). Columns (1)–(3) use the full national sample, while Columns (4)–(6) restrict the sample to New York and bordering states. In Columns (1) and (4), the dependent variable is an indicator for whether the mortgage refinances within two years of origination. Columns (2), (3), (5), and (6) show the results from equation (10), where the dependent variable is the interest rate in Columns (2) and (5), and the dependent variable is the upfront lender fee in Columns (3) and (6). Clustered standard errors are reported in parentheses.

where $\mathbb{1}\{\text{NY}_i\}$ is an indicator for mortgages originated in New York. The interaction coefficient β_2 captures the differential association between local market concentration and mortgage pricing in New York relative to other states.[18]

Columns (2)–(3) of Table 4 report estimates for the full national sample. Outside New York, concentration has little relationship with interest rates, but is positively related to upfront fees. This mirrors the pattern documented in Table 3. The coefficient on the interaction term $CR4 \times NY$ is positive for interest rates and negative for upfront lender fees, implying that the relationship between concentration and pricing is significantly more tilted toward the interest-rate margin and away from the fee margin in New York. Both patterns align with the model's prediction that higher refinancing frictions shift the incidence of

[18]Because we include county fixed effects, time-invariant differences between New York and other counties are absorbed. The interaction therefore captures how the relationship between concentration and pricing differs within counties in New York relative to elsewhere.

market power from fees toward rates.[19]

Columns (5)–(6) restrict the sample to New York and bordering states. This restriction comes at the cost of a smaller sample and, accordingly, the estimated relationships are more variable. Nevertheless, the interaction terms remain economically large and statistically significant, reinforcing the conclusion that the concentration–pricing relationship in New York is shifted toward rates and away from fees.

4.3 Exogenous Variation in Market Concentration

It is important to emphasize that concentration itself remains endogenous in these specifications. The coefficients on $CR4$ reflect equilibrium correlations between local market structure and pricing and therefore do not isolate the causal effect of competition. To address the endogeneity in market structure, we exploit two sources of variation in local mortgage-market concentration. Our first source of variation exploits bank mergers as an instrument for market concentration. The IV specification is:

$$Y_{ibct} = \beta \widehat{Concentration}_{ct-1}^{Merger} + \eta' X_i + \mu' X_{ct} + \gamma_b + \gamma_c + \gamma_t + \epsilon_{ibct}. \tag{11}$$

Because merger decisions are endogenous and reflect lenders' strategic objectives, we follow the procedure of Dafny, Duggan and Ramanarayanan (2012) and Scharfstein and Sunderam (2016) to construct a sample of counties that have been affected by bank mergers, but that are unlikely to have been the key motivation for the mergers.[20] In total, we identify 144 counties where a merger incidentally increased concentration. For these counties, we estimate the difference in fees and rates before and after the merger, as a function of the change in concentration (conditional on other observable characteristics). See Internet Appendix Section D.I for an illustrative example.

Table 5 reports the results for standard prepayable mortgages. Column (1) presents the first stage: incidental mergers raise concentration by 4 percentage points, and the Kleiber-

[19] In unreported results, restricting the sample to loans with zero discount points yields similar estimates, mitigating concerns that the results are driven by upfront cost differences rather than refinancing incentives.

[20] We use bank merger data from the National Information Center and restrict attention to mergers in which the predecessor transferred all assets to the successor, excluding government-assisted failures. For each merger between mortgage-originating institutions, we identify counties where both banks had positive market shares prior to the merger. Following Scharfstein and Sunderam (2016), we focus on counties where each bank accounted for more than 1% of local originations, but where the county represented no more than 2% of either bank's total originations. This isolates mergers that increased local concentration incidentally rather than as a primary motivation. In Section D, we show our results are robust to alternative threshold choices.

gen–Paap F-statistic of 20 indicates a strong instrument. Columns (2) and (3) show that higher concentration has no statistically significant effect on interest rates but significantly increases upfront fees. The magnitude implies that moving from a county with CR4 equal to 0 to 1 raises fees by 108 basis points, consistent with the model's prediction that, for prepayable mortgages, market power is expressed through fees rather than rates.[21]

The incidental merger IV generates within-county variation in concentration that is plausibly uncorrelated with local cost or demand shocks. At the same time, it inherits the standard LATE interpretation and is implemented on a limited set of merger-affected counties, which together may constrain external validity. We therefore complement the merger IV with a second instrument that is novel to the literature and uses counties' 2007 market share of lenders that failed in 2008 to instrument for concentration. The IV specification is:[22]

$$Y_{ibct} = \beta \widehat{Concentration}_{ct-1}^{Failed\ Share} + \eta' X_i + \mu' X_{ct} + \gamma_b + \gamma_t + \gamma_s + \epsilon_{ibct}. \tag{12}$$

The failed lender instrument is relevant because the market shares of *other* lenders are highly sticky. Although many of the failed lenders were eventually acquired by competitors, their failures led to sustained changes in local market shares, consistent with substantial inertia in lender presence. The identifying assumption is that the economic forces that drove the 2008 failures are unlikely to be systematically related to unobserved borrower selection or lender cost differences during our later sample period. Given the dramatic structural changes in credit provision following the crisis, such as the collapse of private-label securitization, these induced differences in lender concentration are unlikely to be correlated with unobserved borrower characteristics a decade later. Indeed, we find that the 2007 failed lender shares are uncorrelated with contractual features typical of pre-crisis mortgage origination in our sample period.[23]

[21] In Table G.2 in the Internet Appendix, we replicate the baseline OLS specifications from Table 3 across the full sample, standard mortgages, and prepayment-penalty mortgages, but instrument concentration using the Merger IV. The IV estimates mirror the OLS patterns: for standard mortgages, higher instrumented concentration increases fees but has no statistically significant effect on rates, while for mortgages with prepayment penalties, higher concentration raises rates and has no significant effect on fees, consistent with the model.

[22] Because the failed lender share is time-invariant within a county, we cannot include county fixed effects and instead include state fixed effects.

[23] See Figures F.4, F.5, and F.6 for correlations across the three failed lenders, and see Section D.II for robustness tests showing that the estimates are consistent across varying thresholds and specifications. To further address potential concerns that failed-lender shares may be correlated with unobserved borrower characteristics, we replicate the results using only the 2007 market share of a single institution: Wachovia. As documented by Mondragon (2020), Wachovia was a healthy lender before the crisis that failed due to

Table 5: Instrumenting for Concentration

	Incidental Mergers			Failed Lenders			F.L. × New York	
	(1) CR4	(2) Rates	(3) Fees	(4) CR4	(5) Rates	(6) Fees	(7) Rates	(8) Fees
Merger	0.04***							
	(0.01)							
CR4		-0.40	1.08**		0.03	1.14***	0.03	1.40**
		(0.32)	(0.50)		(0.07)	(0.21)	(0.18)	(0.66)
Share				-0.62***				
				(0.09)				
CR4 × New York							0.55**	-1.43
							(0.28)	(0.88)
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓
Orig. date FE	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓					
State FE				✓	✓	✓	✓	✓
N	215,744	215,576	214,576	2,658,867	2,658,867	2,653,257	400,940	400,262
R^2	0.93	0.00	0.03	0.38	0.01	0.07	0.01	0.07
F-statistics								
KP rk Wald	20			50				
SW: level							15	15
SW: interaction							14	14
Effect in New York								
CR4 coefficient							0.59	-0.03
Standard error							0.19	0.52
P-value							0.00	0.96

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports IV estimates of equations (11) and (12). Columns (1)–(3) use incidental mergers as an instrument for concentration, with Column (1) reporting the first stage and Columns (2)–(3) reporting second-stage effects on interest rates and upfront fees. Columns (4)–(6) use the 2007 market share of failed lenders as an instrument, with Column (4) reporting the first stage and Columns (5)–(6) reporting second-stage pricing effects. Columns (7)–(8) interact instrumented concentration with an indicator for New York to examine differential pass-through under the New York MRT. The second panel reports Kleibergen–Paap and Sanderson–Windmeijer first-stage F-statistics. The third panel reports the implied CR4 effects in New York. Standard errors are reported in parentheses.

provisions and expected losses from the acquisition of Golden West Financial Corporation—a lender with a large portfolio of toxic option adjustable-rate mortgages (ARMs). Consistent with the predictions of Mondragon (2020), we find no correlation between Wachovia's 2007 market share and the share of high-

Table 5 Columns (4)-(6) show the results. In Column (4), we report the first stage and see that a one-unit increase in the 2007 failed-lender share reduces CR4 by 0.62, and the Kleibergen–Paap first-stage F-statistic of 50 confirms that the instrument strongly predicts local concentration. The IV estimates for pricing, reported in Columns (5) and (6), closely mirror the Merger IV results: higher instrumented concentration has no statistically significant effect on interest rates but significantly increases upfront fees. The magnitude implies that moving from a county with CR4 equal to 0 to 1 raises fees by 114 basis points, consistent with the model's prediction that, for prepayable mortgages, market power is expressed through fees rather than rates.

A one standard deviation increase in local concentration raises upfront fees by 19 basis points under the Incidental Merger IV and by 21 basis points under the Failed Lender Share IV. The close alignment of these magnitudes across two distinct sources of exogenous variation reinforces the interpretation that the pricing effect reflects market power rather than the particulars of any single identification strategy. Moreover, the fact that two instruments operating through distinct economic channels yield nearly identical estimates mitigates concerns that the results are driven by instrument-specific violations of the exclusion restriction.

Finally, Columns (7) and (8) interact instrumented concentration with an indicator for New York. These specifications combine exogenous variation in concentration, from failed-lender exposure, with exogenous variation in refinancing incentives generated by the New York MRT. In the states bordering New York, the results mirror those in the full sample: higher instrumented concentration has no statistically significant effect on interest rates but significantly increases upfront fees. Moving from a county with CR4 equal to 0 to 1 raises fees by 140 basis points. In New York, by contrast, the pricing margin shifts toward rates. The fee effect is -0.03, while the corresponding rate effect is 0.59, indicating that when refinancing incentives are altered by the New York MRT, market power is passed through into interest rates rather than fees.[24]

Discussion of OLS vs. IV coefficients. It is instructive to compare the OLS and IV coefficients. Across designs that instrument for local concentration, the estimated effect of

risk borrowers in that year—and, importantly for our identification strategy, no correlation with high-risk borrower shares during our sample period. Finally, to ensure that our results are not driven solely by Wachovia, we construct the Failed Lender IV using only the two other failed institutions, Countrywide and Washington Mutual, and find similar results. (In contrast with Wachovia, both Countrywide and Washington Mutual failed after significant exposure to riskier loan products.)

[24] We cannot interact the Merger IV with the New York indicator because there are no incidental mergers in New York during our sample.

concentration on mortgage pricing is larger in magnitude than in the corresponding OLS specifications. This pattern is consistent with equilibrium forces that induce a negative correlation between concentration and unobserved determinants of prices, attenuating OLS estimates toward zero.

One possible source of attenuation is borrower sorting across counties. If large urban counties attract younger and more mobile borrowers with more complex or costly underwriting needs, while also attracting more lenders due to scale, these markets could exhibit low concentration but high prices. Such borrower sorting would induce a negative correlation between concentration and unobserved cost determinants of prices, biasing OLS toward zero.

A related possibility operates through lender heterogeneity. If legacy banks anchored in smaller counties earn relationship rents on bundled retail products and charge lower standalone mortgage markups, while specialized online lenders concentrate in larger markets and recover more revenue directly from mortgages (Buchak et al., 2018), concentration could again be negatively correlated with prices for reasons unrelated to market power. This mechanism would similarly attenuate OLS relative to IV.

4.4 Additional Robustness and Placebo Tests

The empirical relationships described above are robust across a range of samples, variable definitions, and regressions specifications, and do not appear to be driven by other plausible mechanisms.

Endogenous sorting of borrowers across the rate–points menu. A well-documented feature of mortgage pricing is that borrowers can pay discount points, or receive lender credits, in exchange for lower or higher interest rates, respectively (Stanton and Wallace, 1998; Bhutta and Hizmo, 2020; Willen and Zhang, 2022; Zhang, 2024). However, this tradeoff does not appear to drive our findings. As we show in Appendix A.II.1, across the entire rate-points schedule, borrowers in more concentrated counties pay higher points for the same interest rate. We provide additional evidence in Online Appendix Table G.5, where we regress fees on local concentration while controlling for the interest rate.

Additionally, we obtain similar estimates when restricting the sample to loans with exactly zero points and credits, as recommended by Bhutta, Fuster and Hizmo (2026), as when we include loans with non-zero points (Table G.3). In the full sample, which includes points and credits, the relationship between fees and interest rates is mechanically negative. In contrast, in the restricted sample where points and credits are fixed at zero, this relation-

ship is positive. Crucially, the relationship between fees and local concentration is virtually unchanged when controlling for interest rates, suggesting that our results are not driven by endogenous sorting across the rate–points menu.

Third-party fees. An alternate mechanism could be that, despite the IVs, concentration remains correlated with local demand conditions or borrower composition that reduce sensitivity to upfront charges (which could, by construction, account for the fee differences in standard mortgages with low refinancing frictions but not the reversal observed when refinancing frictions are high). To assess this possibility, we compare charges set by the lender to fees determined by third parties. In Appendix A.II.2 and Appendix Table A1, we show that local market concentration is strongly related to lender-controlled charges, including origination fees, discount points, and lender credits. In contrast, we find no relationship between concentration and third-party fees such as appraisal, inspection, and title insurance charges. If our estimates were driven by broader local or borrower-specific determinants of upfront costs, a similar relationship should also appear for third-party fees. It does not. The evidence therefore points to lender-controlled pricing as the source of the fee results.

Sample selection. In Online Appendix Section C.I, we show that the results hold both in the full HMDA sample, which does not include credit score controls, and in the merged HMDA–GSE sample, which does (Table G.3). We further show that the relationships between rates, fees, and concentration are not driven by spurious nonlinearities or outliers (Figure F.3) and that the differential effect of concentration is statistically significant (Table G.4). Another potential concern is that mortgages with prepayment penalties are relatively rare in our 2018–2023 sample, raising questions about statistical power and the stability of the estimated relationship. Motivated by this concern, we complement our baseline analysis with the Black Knight McDash dataset, which covers the period from 1990 to 2017 and provides a substantially larger and more historically representative sample of loans. In the Black Knight data, we again find no statistically significant relationship for standard prepayable mortgages. In contrast, for mortgages with prepayment penalties, concentration is strongly positively related to interest rates (results reported in Table G.6). The drawback of this data is that we do not observe fees, and therefore can only test rates.

Robustness of IV analysis. To assess the robustness of the IV analysis, we conduct a series of additional checks examining the strength and implementation of the identification strategies, with a detailed discussion in Online Appendix D. We begin by establishing strong first-stage relationships across all IV designs and showing that the IV estimates are unchanged when controlling directly for interest rates, as documented in Online Appendix

Tables G.7 and G.9. We then examine the robustness of the failed-lender design in Online Appendix D.II. There, we show that the results are robust to alternative definitions of failed lenders and to alternative sample restrictions, with estimates reported in Online Appendix Tables G.10 and G.11. Online Appendix D.II and Online Appendix D.III study the sensitivity of both the failed-lender and incidental-merger designs to alternative threshold and filter choices used in instrument construction, with the corresponding estimates summarized in Online Appendix Table G.12. Finally, Online Appendix D.IV provides additional IV evidence using cross-state variation in anti-predatory lending laws (Bostic et al., 2012), showing that stronger refinancing frictions amplify the effect of concentration on interest rates.

Total lender revenue. While the empirical analysis shows that concentration affects the composition of mortgage pricing across interest rates and upfront fees, a related question is whether it raises total expected lender revenue. To address this, we aggregate interest rates and upfront fees into an imputed expected present value of mortgage payment revenue. As described in Online Appendix C.IV and reported in Online Appendix Table G.13, we construct a back-of-the-envelope measure based on observed fees, interest rates, and an average prepayment horizon, and then repeat the OLS and IV analyses using it as the outcome. This exercise shows that the positive relationship between concentration and expected mortgage revenue persists when fees and interest rates are combined into a single measure, consistent with the interpretation that the results reflect market power.

5 Quantitative Model and Counterfactuals

A natural policy question is whether price ceilings on one pricing dimension can enhance borrower welfare in a market with imperfect competition and multidimensional contracts. In a standard model with a single price, if firms charge markups above marginal cost, a price ceiling that reduces prices toward marginal cost can increase borrower welfare. However, in markets with multidimensional contracts, firms may respond by endogenously adjusting other (potentially unobserved) contract dimensions, and the overall effect on welfare is ambiguous. Our setting allows us to model this endogenous response, disciplined by our empirical estimates, and quantify its implications for borrower welfare.

We extend our theoretical model in Section 2 in three ways to facilitate realistic quantification. First, we endogenize the borrower's survival probability $s(i)$ with a dynamic stochastic refinance decision, which we estimate directly from data on mortgage refinancing. Second, we allow for non-zero marginal funding costs and marginal origination costs

for the lender. Third, we enrich the competitive environment by modeling multiple lenders competing in a differentiated Bertrand setting, which we can map directly to our empirical measures of lender concentration. We then estimate the model and validate it out-of-sample with our earlier reduced form results. Finally, we explore the equilibrium impact of various price caps.

5.1 Model description

In the initial period, a borrower chooses among J differentiated lenders, each offering a (nominally) perpetual, fixed rate, prepayable mortgage characterized by an interest rate and a one-time origination fee. In subsequent periods, the borrower can refinance to a new mortgage, and may do so repeatedly. The rate to which he can refinance is stochastic, and the borrower incurs a fixed cost each time he refinances. The J period-one lenders engage in differentiated Bertrand competition, choosing rates and fees to maximize lifetime expected profits while anticipating competition from other lenders and future refinancing.[25] As our setting primarily concerns GSE-guaranteed mortgages, the lender (and implicitly, the purchaser of the originated mortgage) faces prepayment risk, but not credit risk. Thus, default has the same payoff for the lender as early exit due to refinance.

We first solve the borrower's problem before characterizing the lender's period-one pricing problem. Online Appendix Section E shows derivations of key equations.

5.1.1 Borrower's problem

The borrower is risk neutral, lives forever, discounts the future at $\beta_b \in (0, 1)$, and obtains an infinite-maturity, fixed-rate, prepayable mortgage. All monetary amounts are expressed as a share of (exogenous) mortgage principal. We work backwards from the refinancing decision.

Period two+ refinancing decision: The borrower enters each period after the first with interest rate i_0. With probability μ he prepays or exits for non-rate reasons (e.g., moving or a cash-out refinance) and exits the model. Otherwise, with probability ϕ he considers refinancing, and with probability $1-\phi$ he pays i_0 and continues to the next period. $\phi < 1$ captures behavioral reasons for not considering refinance, such as a lack of attention.[26]

[25] We do not explicitly consider lender entry/exit, but in robustness checks we show that this margin is unlikely to be quantitatively important in our results.

[26] This captures the "woodhead" behavior often referenced in the refinance literature, e.g., Campbell (2006), and broadly follows Andersen et al. (2020).

Flow utility from paying i_0 is $-\alpha i_0$, where $\alpha > 0$ measures sensitivity to rate payments.

If he considers refinancing, the borrower draws an exogenous rate $i \sim di(i)$ to which he can refinance. If he refinances, his contract rate becomes i, and he incurs a utility cost c, which encompasses both origination charges and any non-monetary costs of the refinance process such as search costs or inconvenience.[27] Finally, he incurs an idiosyncratic utility shock ϵ_r, which captures time-borrower specific costs of refinancing, such as how busy the borrower is. If he declines to refinance, he pays i_0 and draws ϵ_n, another idiosyncratic utility shock. The indirect utilities are

$$u_r(i) = -\alpha i - c + \beta_b Eu(i) + \epsilon_r \tag{13}$$

$$u_n(i_0) = -\alpha i_0 + \beta_b Eu(i_0) + \epsilon_n. \tag{14}$$

$Eu(i)$ denotes the continuation value given contracted rate i. The borrower takes the action with higher indirect utility. His beginning-of-period utility, before the shocks realize, is

$$\begin{aligned} Eu(i_0) =& (1-\mu)\left[\underbrace{(1-\phi)\left(-\alpha i_0 + \beta_b Eu(i_0)\right)}_{\text{does not consider refinance}} + \underbrace{\phi \int_{\epsilon,i} \max\left\{u_r(i), u_n(i_0)\right\} d\epsilon di}_{\text{considers refinance}}\right] \\ &+ \underbrace{\mu \times 0}_{\text{exogenous exit}} \end{aligned} \tag{15}$$

The integral runs over the idiosyncratic shocks and the draw of the new potential rate. Equation (15) implicitly defines the value function $Eu(i_0)$. The surival probability $s(i_0)$, i.e., one minus the probably of exit, given i_0 is,

$$1 - s(i_0) = \underbrace{\mu}_{\text{exogenous refi}} + \underbrace{(1-\mu)\left[\phi \int_{i,\epsilon} \mathbf{I}(u_r(i) > u_n(i_0)) d\epsilon di\right]}_{\text{rate-driven refi}}. \tag{16}$$

Period one borrowing decision: In period one, the borrower receives offers $j \in \{1, \ldots, J\}$, each with fee f_j, rate i_j, and an idiosyncratic borrower–lender shock ϵ_j. The shock reflects non-price factors observed by the borrower but not by the lender (distance to the branch, advertising exposure, and so on). The borrower pays the fee upfront and starts

[27] We do not directly model the market structure that gives rise to i or c, which includes an origination fee. It is sufficient for the model to match an empirical refinance probability $P(i_0)$, a function of the contracted interest rate i_0. A deeper microfoundation would increase complexity without altering our conclusions.

period two with rate i_j, after which the refinancing game begins. Indirect utility from offer j is

$$u_j(f, i) = -\gamma f_j + \beta E u(i_j) + \epsilon_j. \tag{17}$$

Parameter γ measures fee disutility. While a natural benchmark has $\gamma = \alpha$, implying equal weight on fees and interest, we allow but do not impose $\gamma \neq \alpha$ to capture behavioral differences. The borrower must obtain a loan, so there is no outside option. He picks the offer with the highest indirect utility. From the lender's view, the probability of being chosen is

$$d_j(f, i) = \int_\epsilon \mathbf{I}(u_j(f_j, i_j) > u_k(f_k, i_k) | \forall k) d\epsilon, \tag{18}$$

where f and i are a vector of all lenders' fees and rates. Finally, the borrower's ex-ante expected utility is

$$E u_0(f, i) = \int_\epsilon \max \left\{ u_j(f, i) \right\}_j d\epsilon. \tag{19}$$

Observe that $E u_0(f, i)$ corresponds to $P_b(f, i)$ in the theoretical model, and is in units of utils rather than present value dollars.

5.1.2 Lender's problem

In period one, the J differentiated lenders set fees and rates in Bertrand competition to maximize profit given other lenders' prices. Loan origination carries an upfront origination cost mc_f and a per-period funding cost mc_i until it is refinanced. Conditional on making the loan, the lender's net income per dollar lent is

$$\mathcal{V}(f, i) = f - mc_f + (i - mc_i) \underbrace{\sum_{t=1}^{\infty} \left[\beta_l s(i)\right]^t}_{\equiv PV_l(i)}. \tag{20}$$

Here, $f - mc_f$ captures the fee income net of origination costs, and $PV_l(i)$ is the net present value per unit of net interest income adjusted for refinancing. The lender discounts the future by β_l. Interpreting this in an originate-to-distribute setting, $(i - mc_i)PV_l(i)$ reflects

the price that an outside investor would pay for the future cash flows.[28] Total profit is

$$P_l(f,i) = d_j(f,i)\mathcal{V}(f,i). \tag{21}$$

We require that $f \geq mc_f$ and $i \geq mc_i$ so fees cover origination costs and rates cover funding costs.[29] With these restrictions, the lender solves

$$\max_{f \geq mc_f, i \geq mc_i} P_l(f,i). \tag{22}$$

Note that this corresponds exactly to the lender's problem in the theoretical model with (1) the incorporation of marginal origination and funding costs, and (2) the replacement of the borrower's participation constraint with the borrower's downward-sloping demand curve $d_j(f,i)$.

5.1.3 Equilibrium

In equilibrium: (i) borrowers refinance optimally, satisfying (16); (ii) borrowers choose loans optimally in period 1 as in (17)–(18); and (iii) lenders pick f, r to solve (22). Additionally, we impose a symmetric equilibrium where all lenders pick the same f, i. Solving the lender's problem yields three candidate profit-maximizing regimes:

$$f > mc_f, \quad i > mc_i, \quad \frac{\partial P_l(f,i)}{\partial f} = 0, \quad \frac{\partial P_l(f,i)}{\partial i} = 0 \qquad \text{("Fee and rate markup")}$$

$$f > mc_f, \quad i = mc_i, \quad \frac{\partial P_l(f,i)}{\partial f} = 0, \quad \frac{\partial P_l(f,i)}{\partial i} < 0 \qquad \text{("Fee markup only")}$$

$$f = mc_f, \quad i > mc_i, \quad \frac{\partial P_l(f,i)}{\partial f} < 0, \quad \frac{\partial P_l(f,i)}{\partial i} = 0 \qquad \text{("Rate markup only")}$$

We label these cases "fee and rate markup," "fee-only markup," where rates are set to the marginal funding cost, and "rate-only markup," where fees are set to the marginal origination cost, and analyze them in the next sections.

[28] In the case of the lender selling the originated mortgage to an MBS investor, we are implicitly assuming that prepayment risk is reflected in the price of the loan. This is consistent with Gabaix, Krishnamurthy and Vigneron (2007), who show that prepayment risk is priced in the MBS market. In more recent work, Chernov, Dunn and Longstaff (2017) find that prepayment risk caries a significant risk premium, and Boyarchenko, Fuster and Lucca (2019), who study MBS spreads, show that non-interest-rate prepayment risk (such as prepayment risk related to house prices) contribute to a pricing smile.

[29] $i < mc_i$ essentially means that the "borrower" is lending money to the "lender," and so we rule this out. A microfounded financial constraint would give rise to this restriction.

5.2 Model estimation

We begin by making standard functional form assumptions, and then discuss the identification of the model's underlying parameters.

Functional form assumptions. First, we assume the ϵ shocks follow a Type-1 extreme-value distribution, giving closed-form choice probabilities and expected utilities (see Online Appendix E). This assumption yields quasi–closed-form first-order conditions, up to borrower expected utilities and refinance probabilities $Eu(i)$ and $1 - s(i)$:

$$\mathcal{V}(f,i) = \left(\frac{1}{\gamma}\right)\left(\frac{1}{1-d(f,i)}\right) \qquad \text{(Fee FOC)}$$

$$\mathcal{V}(f,i) = \left(\frac{1}{\tilde{\alpha}}\right)\left(\frac{1}{1-d(f,i)}\right)\left(\frac{\partial}{\partial i}(i - mc_i)PV_l(i)\right); \quad \tilde{\alpha} \equiv \alpha\left(\frac{\beta_b s(i)}{1-\beta_b s(i)}\right) \qquad \text{(Rate FOC)}$$

The interior fee condition is the usual logit markup: markups fall with fee sensitivity and rise period-one market share. The rate condition incorporates two extra features. First, it shows that *future* competition enters through $\frac{\partial}{\partial i}(i - mc_i)PV_l(i)$, which reflects the tradeoff of higher per-period payments versus a lower survival probability. Second, it incorporates the borrower's *effective* interest rate sensitivity $\tilde{\alpha}$, reflecting the discounted value of future expected interest payments. Through the possibility of future refinancing, a lender setting rates is disciplined through competition with current lenders and through the threat of future refinance.

Given these functional form assumptions, the following parameters remain: On the *borrower side*: α (rate sensitivity), γ (fee sensitivity), β_b (borrower discount factor), c (refinance cost), ϕ (refinance-consideration probability), and μ (exogenous prepayment probability). On the *lender side*: mc_f, mc_i (origination and funding costs), β_l (lender discount factor), and J (number of symmetric lenders). We assume that the refinance rate follows $i \sim \mathcal{N}(\mu_i, \sigma_i^2)$. Table 6 summarizes these parameters.

Estimation. For discount rates, following Iacoviello (2005),[30] we set $\beta_l = 0.96$ and $\beta_b = 0.92$ on an annualized basis. For the rate process over our time period, the historical 30-year mortgage rates have $\mu_i = 4.31$ and $\sigma_i = 1.34$. For the market structure, our baseline scenario has $J = 9$ symmetric lenders, matching our observed CR4.[31] We recover α, c, ϕ, and μ by matching the empirical "s-curve," which relates the prepayment propensity to the difference between the contracted and current market rate to which a borrower could

[30] Which in turn cites Lawrance (1991).

[31] The average CR4 is 0.47. With equal shares CR4$= 4/J$, so $J \approx 4/0.47 \approx 9$.

refinance. As shown in Appendix A.III, our estimated model fits the empirical s-curve almost exactly.

Fee sensitivity γ measures the utility cost of paying upfront fees. A frictionless benchmark sets $\gamma = \alpha$, treating a dollar of fees like a dollar of interest. Empirical work, however, rejects this symmetry. Benetton, Gavazza and Surico (2025) show that mortgage applicants react less to fees than to rates, implying $\gamma < \alpha$. Guided by their finding, we write $\gamma = \omega\alpha$ and estimate ω from the National Survey of Mortgage Originations (NSMO). We take the share of borrowers who report being "very" familiar with closing costs and divide by the share "very" familiar with rates; the ratio is 0.86. Hence we set $\omega = 0.86$, so borrowers value a fee dollar about 14% less than an interest dollar.[32] With borrower parameters in hand we back out lender costs from observed equilibrium pricing, obtaining $mc_i = 4.24\%$ and $mc_f = 1.06\%$. Table 6, panel B, reports these estimates with bootstraped standard errors.

5.3 Mechanisms and external validation

The central prediction from the theoretical model, and the central finding in our reduced form analysis, is that when the refinancing cost is low, lenders mark up both rates and fees, but only fee markups vary with local competition. In contrast, when the refinancing cost is high, rate markups vary with local competition. As we show in Figure 4 and serving as model validation, our estimated model delivers these predictions and helps illustrate the economics underlying them.

Panels A and B show the optimal fee and rate as a function of refinance cost, with the vertical dashed line indicated the estimated refinance costs. The solid red lines show pricing if the lender could only mark up rates, the dashed blue lines show pricing if the lender could only mark up fees, and the dotted black line shows pricing when the lender is free to mark up both pricing dimensions. Under rate-only markups, a higher refinance cost causes the lender to reduce rates, because borrowers expect to have to pay them longer and are therefore more sensitive ex-ante. However, when the lender can mark up both rates and fees, the choice is more complex. For very low refinance costs, it is optimal to mark up the fee rather than the rate. As refinance costs rise and refinance becomes less likely, the lender shifts some of the markup from fees to rates. Eventually, all markups are placed on rates, and rates again decrease in the refinance cost.

Panels C and D trace equilibrium rates and fees as market concentration changes. We

[32] See Online Appendix E.IV for more discussion.

plot three refinance-cost scenarios which correspond to different regions in Panels A and B: baseline (black, estimated c), high cost $c = 15$ (red, prepayment-penalty loans), and low cost $c = 0$ (blue). In the baseline, fees rise with concentration while rates stay flat.[33]

Table 6: Structural estimation

Panel A: Externally Calibrated Parameters

Parameter	Description	Value	Source
Borrower parameters			
β_b	Borrower discount factor	0.92	Iacoviello (2005)
Lender parameters			
β_l	Lender discount factor	0.96	Iacoviello (2005)
Rate process			
μ_i	Rate mean	4.31	Data 2018-2023
σ_i	Rate volatility	1.34	Data 2018-2023

Panel B: Parameters estimated through SMM

Parameter	Description	Estimate	SE	Source
Borrower parameters				
α	Rate sensitivity	1.279	(0.180)	S-curve
γ	Fee sensitivity	1.105	(0.155)	Fee/rate familiarity
c	Refi cost	3.005	(0.354)	S-curve
ϕ	Refi consideration	0.340	(0.070)	S-curve
μ	Exogenous prepayment	0.059	(0.008)	S-curve
Lender parameters				
mc_f	Origination cost	1.063	(0.236)	Lender FOC
mc_i	Funding cost	4.241	(0.014)	Lender FOC

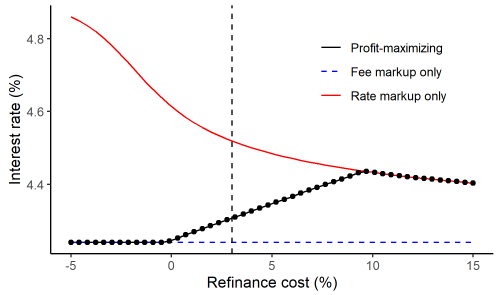
Panel C: SMM target moments

Moment	Data	Model moment
S-curve	See Figure A4	
Average rate	4.31	4.31
Average fee	1.84	1.84

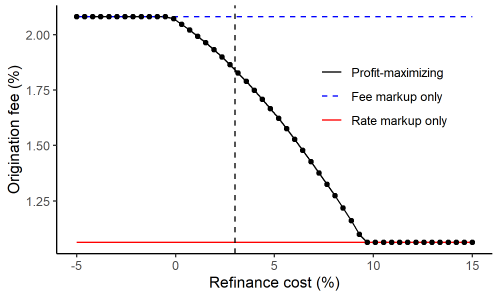
Note: This table provides the details of the structural estimation. Panel A shows the externally calibrated parameters, which are calibrated from a combination of papers in the literature as well as a direct estimation of the interest rate process. Panel B shows the parameters estimated through the simulated method of moments, where the first column shows the parameter, the second column describes the parameter, the third column shows the estimate, the fourth column shows the bootstrapped standard error, and the last column describes what identifies the parameter. Panel C shows the target moments. Note that there are four parameters calibrated with 12 separate moments from the s-curve (the rate incentive curve plotted in Figure A4).

[33]Observe that by combining Equations (Fee FOC) and (Rate FOC), which both hold in this interior region, one observes immediately that rate dependence on local market share immediately drops out, leaving rates to depend only upon future refinance probability.

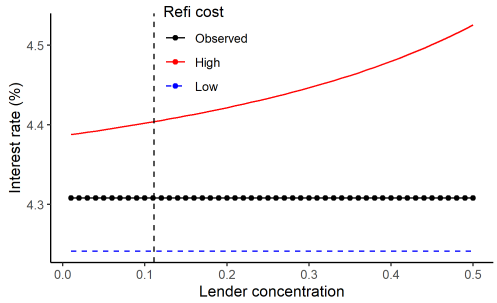
Figure 4: RATES, FEES, REFINANCE COSTS, AND COMPETITION



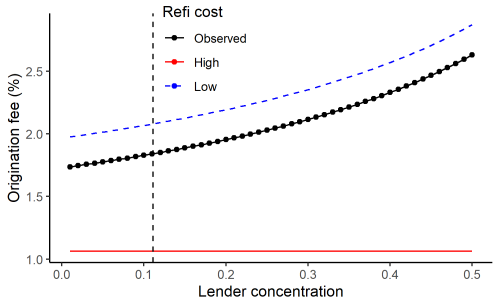
Panel A: Interest rates versus refinance cost



Panel B: Fees versus refinance cost



Panel C: Interest rates versus lender concentration



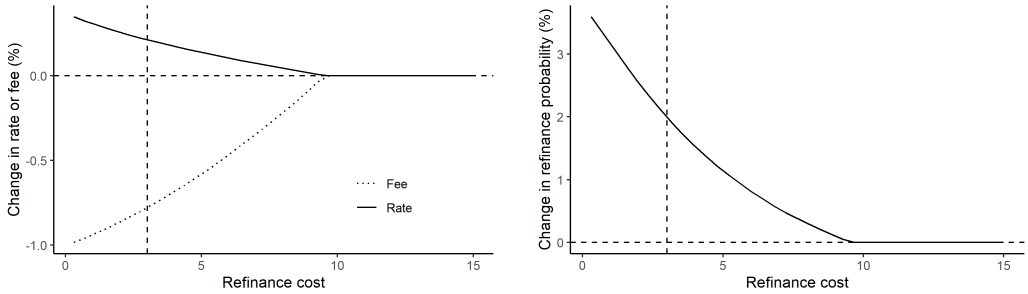
Panel D: Fees versus lender concentration

Note: This figure shows how rates, Panels A and C, and fees, B and D, vary with the hedonic refinance cost c, A and B, and lender concentration $1/J$, C and D. In panels A and B, the red line is the equilibrium interest rate or fee when lenders can markup rates but must set fees equal to the marginal cost of origination. The dashed blue line is the equilibrium interest rate or fee when lenders can markup fees but must set rates equal to the marginal cost of origination. The dotted black line is the lender's optimal pricing strategy given the choice of marking up rates only, fees only, or both under the constraint that rates and fees exceed their respective marginal costs. The dashed vertical line is the estimated refinance cost. In panels C and D, the dotted black line is the rate or fee when refinance costs are set to the estimated value, $c = 3.005$. The dashed blue line corresponds to low refi costs, $c = 0$, and the red line corresponds to high refi costs, $c = 15$. In these panels, the lender is following the profit-maximizing fee and rate strategy. The dashed vertical line is the calibrated market concentration.

An important takeaway from this exercise is that *both* rates and fees are marked up over marginal costs, but the markups in rates are not econometrically detectable by using local variation in concentration.

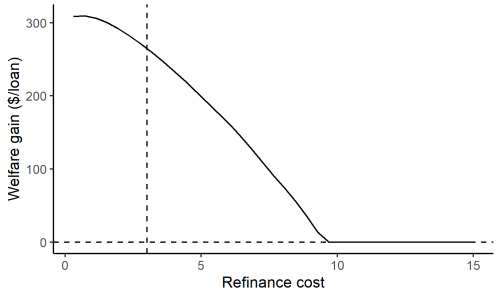
In the high-cost scenario, pricing follows the rate markup regime, and consistent with the reduced form results on loans with prepayment penalties or origination taxes, rates increase with concentration while fees do not. Finally, in the low-cost scenario, pricing follows the fee markup regime, with fees again increasing with concentration and rates remaining constant, albeit lower at a lower level, than the mixed-markup regime.

Figure 5: Counterfactual: Capping fees

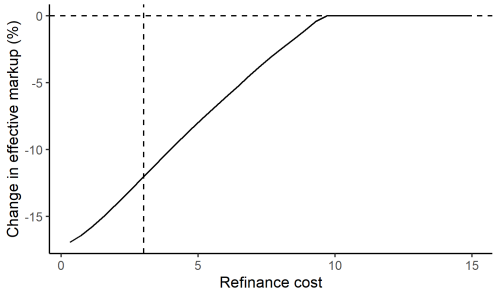


Panel A: Rates and fees

Panel B: Refinance probability



Panel C: Borrower welfare



Panel D: Lender markups

Note: This figure studies the impact of a counterfactual where lenders are forced to set fees equal to the marginal cost of origination, mc_f, and only impose markups through rates. Each panel compares outcomes in the counterfactual "rate markup only" scenario to the estimated "profit-maximizing" scenario. These panels show the counterfactual impact versus the hedonic refinance cost c, with the dashed vertical line indicating the estimated value. Panel A shows the change in rates (solid) and fees (dotted). Panel B shows the change in annual refinance probability. Panel C shows the change in welfare, measured in dollar utility for a loan of average size. Panel D shows the change in lender markups, inclusive of net fee and rate income.

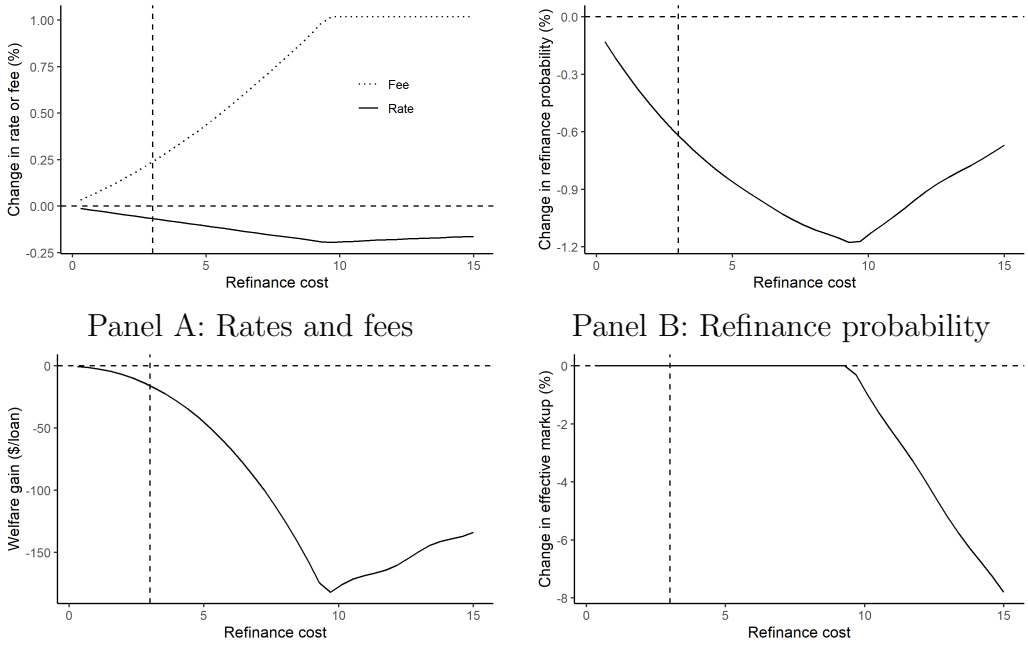
5.4 Counterfactual mortgage contract design

We finally use the model to evaluate the equilibrium impact of counterfactually restricting lenders to a *single* pricing dimension. We first consider capping fees at marginal origination cost (allowing rate markups), and then consider capping rates at marginal funding costs (allowing only fee markups).[34] Figure 5 imposes *rate-only* markups, and Figure 6 imposes *fee-only* markups.

Consider the rate-only scenario in Figure 5. Panel A plots the change in rates and fees, B the change in refinance probabilities, C the change in borrower surplus, and D the change

[34]Interest rate caps are a common regulatory tool across financial markets (Cuesta and Sepúlveda, 2021; Cherry, 2024).

Figure 6: Counterfactual: Capping rates



Panel A: Rates and fees

Panel B: Refinance probability

Panel C: Borrower welfare

Panel D: Lender markups

Note: This figure studies the impact of a counterfactual where lenders are forced to set rates equal to the marginal cost of funding, mc_i, and only impose markups through fees. Each panel compares outcomes in the counterfactual "rate markup only" scenario to the estimated "profit-maximizing" scenario. These panels show the counterfactual impact versus the hedonic refinance cost c, with the dashed vertical line indicating the estimated value. Panel A shows the change in rates (solid) and fees (dotted). Panel B shows the change in annual refinance probability. Panel C shows the change in welfare, measured in dollar utility for a loan of average size. Panel D shows the change in lender markups, inclusive of net fee and rate income.

in effective lender markups, inclusive of net fee and rate income, all against the refinance cost c (where the vertical dashed line corresponds to the estimated c). When c is low or moderate, rates rise and fees fall because lenders shift their otherwise positive fee markups into higher rates. At the estimated c, the model predicts a rate increase of roughly 20 bps and a fee decline of roughly 75 bps.[35] Higher rates raise the incentive to refinance, and as Panel B shows, refinance probabilities rise by roughly 2 pps annually at the estimated c. Panel C shows borrower welfare gains of about $250 per average loan. The counterfactual shows that forcing lenders to only compete on rates raises borrower welfare because it exposes their pricing decisions to both current competition and also the threat of future refinance. In

[35]For high c there is no impact because the profit-maximizing outcome already places the markup on rates.

consequence, they reduce effective markups by roughly 12% relative to the profit-maximizing baseline, shown in Panel D.

The fee-only policy (Figure 6) mechanically lowers rates, and lenders respond by raising fees. With lower rates, refinance becomes less likely. Borrower welfare drops by roughly $20 per loan at the estimated c, even though effective lender markups are unchanged. This policy reduces borrower welfare for a given level of lender markup, because lenders extract the markup through a dimension of pricing that neither generates gains from trade via different discount rates, nor exposes lenders to the threat of future refinance.

Our counterfactuals illustrate several important points when imposing a price cap on one price dimension of a multi-dimensional contract. First, there is some *leakage* in the sense that the seller responds to a price cap on one dimension by raising the price on another other dimension. Second, this is not an innocuous dollar-for-dollar substitution when the prices rather alter consumer behavior after the contract is initiated: there are real impacts on consumer welfare and firm profits. Third, whether the price caps raise or lower consumer welfare is ambiguous and depends critically on the market context. In this context, caps on fee markups are preferable because they channel pricing towards a dimension that is both more competitive and also by its nature generates gains from trade.

6 Conclusion

The findings in this paper point to two main implications for public policy. First, in markets with multidimensional prices, market power need not be reflected uniformly across all pricing margins. The margin that reflects market power depends on the contract environment and how consumers respond to different pricing dimensions, so focusing on a single price can lead to incorrect conclusions about the degree of competition. Second, regulatory interventions can have asymmetric effects, as capping one pricing margin induces firms to shift markups toward other margins.

Regarding the U.S. mortgage market in particular, prior work has concluded that it is national in scope based on the weak relationship between local concentration and interest rates for standard conforming loans. Our results show that this conclusion is incomplete. Mortgage contracts have multidimensional pricing, and the margin that reflects market power depends on refinancing risk. For standard prepayable loans, local concentration appears in upfront fees rather than rates, while for contracts with higher refinancing frictions, the relationship shifts toward rates. Focusing only on interest rates and on conforming mortgages

therefore understates the role of local market power.

The Federal Reserve does consider local *deposit* market concentration in merger reviews, and historically this may have served as a proxy for mortgage market concentration (Federal Reserve System, 2021). However, as banking has become less bundled, this relationship has weakened. Deposit concentration is no longer a reliable proxy for mortgage market concentration, so a regulatory framework centered on deposit markets can miss the local markets where lenders exert market power.[36]

Taken together, our results highlight a regulatory gap. By overlooking upfront fees and refinancing risk, the regulators ignore the less competitive dimensions of mortgage pricing and regards the mortgage markets as national in scope. Our findings suggest that once fees and refinancing risks are accounted for, local market concentration plays a critical role in shaping borrower outcomes, as it enables lenders to extract markups more effectively.

Finally, these insights extend beyond the U.S. mortgage market to a broad class of industries with multidimensional pricing. Many financial contracts, including consumer as well as commercial and corporate loans, combine upfront fees with ongoing payments and embed options such as prepayment or callability. More broadly, across non-financial industries, from leasing contracts to subscription services, firms set both an upfront and a recurring price, and higher recurring prices can increase the likelihood of consumer exit. Our results imply that researchers and policymakers must examine fees and other one-time charges in addition to ongoing prices when assessing markups. Ignoring the multidimensional nature of pricing risks missing the margin in which market power is expressed.

[36] In Apendix A.IV, we document the decoupling of deposit and mortgage concentration over time, showing that their correlation has declined substantially since the 1990s.

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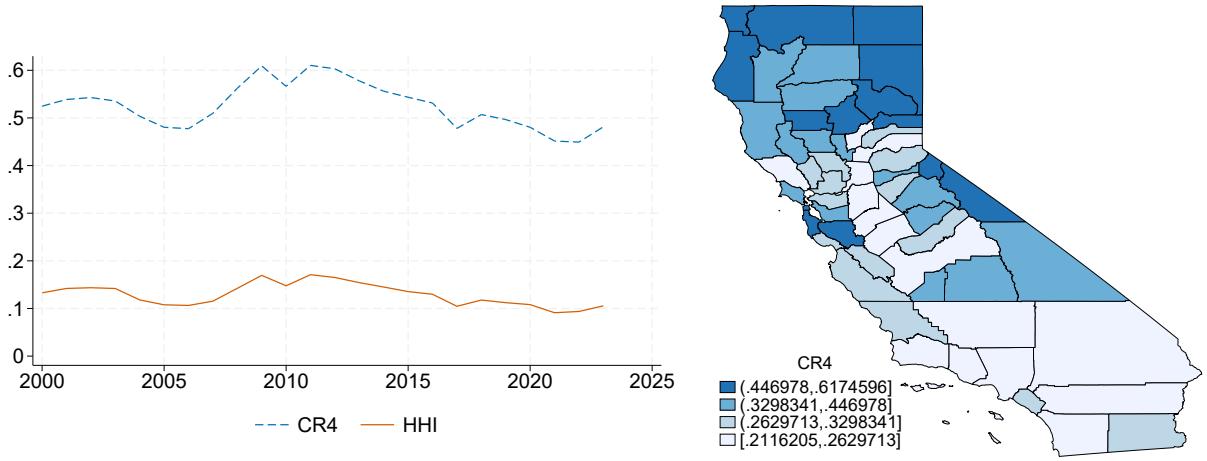
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A Appendix

A.I The distribution of lender concentration

Figure A1, Panel A, shows the averages of CR4 (dotted blue) and HHI (solid orange) between 2000 and 2023. Both measures of concentration have been fairly stable across these three decades, with a slight increase in average mortgage concentration from 2006 to 2009, and a reversal from 2011 to 2023. Apart from time-series variation, there is also substantial cross-sectional variation in concentration, as shown in Panel B of Figure A1.[37]

Figure A1: Local Mortgage Concentration



A: Local mortgage concentration over time

B: Concentration in California

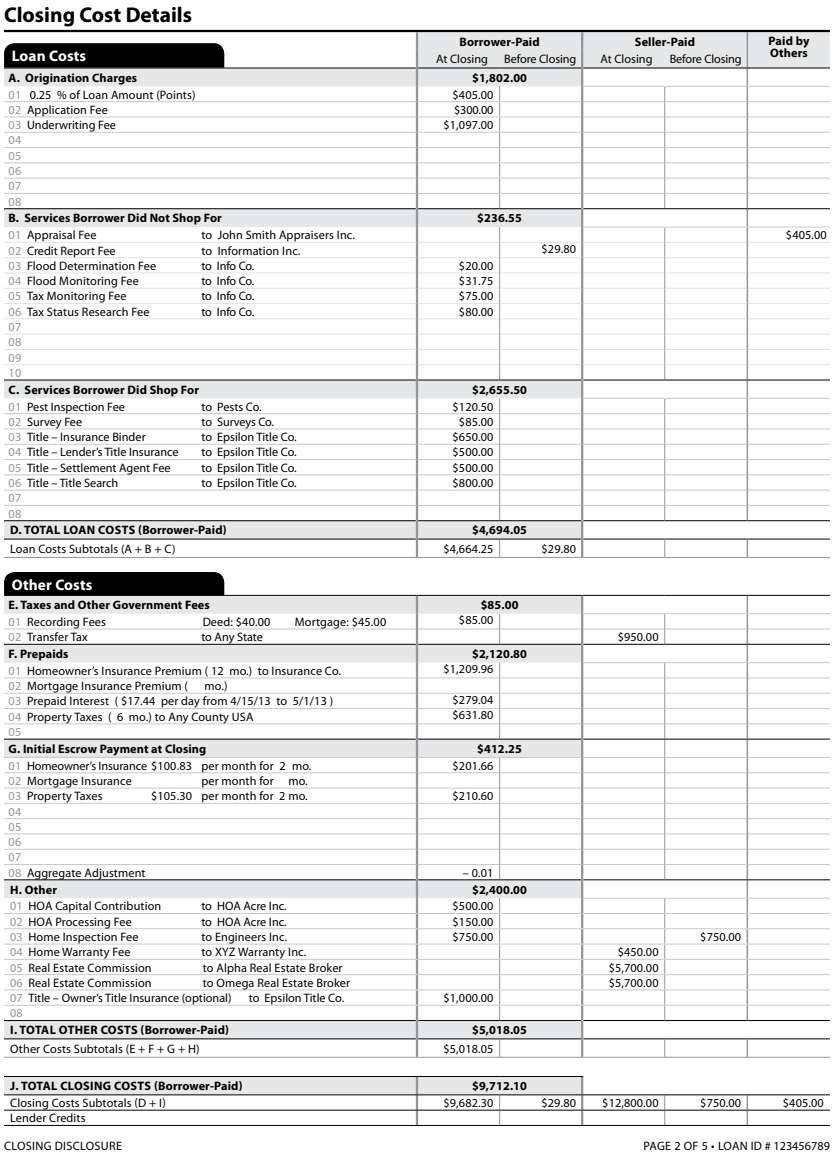
Note: This figure shows the distribution of local concentration across time and space. The data source is the HMDA dataset. Panel A shows the average county-level CR4 (dotted blue line) and HHI (solid orange line) for originated mortgages. Panel B shows the 2018 distribution of county-level mortgage market CR4 in California.

A.II Main robustness checks for empirical analysis

This section contains the main robusntess checks of our empirical analysis. Further robustness analyis around the OLS and IV analysis can be found in Internet Appendices C and D, respectively.

[37] In California in 2018, urban counties span the full concentration distribution: Los Angeles and San Diego fall in the bottom quartile of CR4, while Santa Clara and San Francisco fall in the top quartile. Rural counties also span the distribution, with Alpine in the top quartile and Yuba in the bottom quartile.

Figure A2: CFPB Mortgage Closing Cost Disclosure Form



Closing Cost Details

Loan Costs	Borrower-Paid At Closing	Borrower-Paid Before Closing	Seller-Paid At Closing	Seller-Paid Before Closing	Paid by Others
A. Origination Charges	**$1,802.00**				
01 0.25 % of Loan Amount (Points)	$405.00				
02 Application Fee	$300.00				
03 Underwriting Fee	$1,097.00				
04					
05					
06					
07					
08					
B. Services Borrower Did Not Shop For	**$236.55**				
01 Appraisal Fee to John Smith Appraisers Inc.					$405.00
02 Credit Report Fee to Information Inc.		$29.80			
03 Flood Determination Fee to Info Co.	$20.00				
04 Flood Monitoring Fee to Info Co.	$31.75				
05 Tax Monitoring Fee to Info Co.	$75.00				
06 Tax Status Research Fee to Info Co.	$80.00				
07					
08					
09					
10					
C. Services Borrower Did Shop For	**$2,655.50**				
01 Pest Inspection Fee to Pests Co.	$120.50				
02 Survey Fee to Surveys Co.	$85.00				
03 Title – Insurance Binder to Epsilon Title Co.	$650.00				
04 Title – Lender's Title Insurance to Epsilon Title Co.	$500.00				
05 Title – Settlement Agent Fee to Epsilon Title Co.	$500.00				
06 Title – Title Search to Epsilon Title Co.	$800.00				
07					
08					
D. TOTAL LOAN COSTS (Borrower-Paid)	**$4,694.05**				
Loan Costs Subtotals (A + B + C)	$4,664.25	$29.80			

Other Costs					
E. Taxes and Other Government Fees	**$85.00**				
01 Recording Fees Deed: $40.00 Mortgage: $45.00	$85.00				
02 Transfer Tax to Any State			$950.00		
F. Prepaids	**$2,120.80**				
01 Homeowner's Insurance Premium (12 mo.) to Insurance Co.	$1,209.96				
02 Mortgage Insurance Premium (mo.)					
03 Prepaid Interest ($17.44 per day from 4/15/13 to 5/1/13)	$279.04				
04 Property Taxes (6 mo.) to Any County USA	$631.80				
05					
G. Initial Escrow Payment at Closing	**$412.25**				
01 Homeowner's Insurance $100.83 per month for 2 mo.	$201.66				
02 Mortgage Insurance per month for mo.					
03 Property Taxes $105.30 per month for 2 mo.	$210.60				
04					
05					
06					
07					
08 Aggregate Adjustment	– 0.01				
H. Other	**$2,400.00**				
01 HOA Capital Contribution to HOA Acre Inc.	$500.00				
02 HOA Processing Fee to HOA Acre Inc.	$150.00				
03 Home Inspection Fee to Engineers Inc.	$750.00			$750.00	
04 Home Warranty Fee to XYZ Warranty Inc.			$450.00		
05 Real Estate Commission to Alpha Real Estate Broker			$5,700.00		
06 Real Estate Commission to Omega Real Estate Broker			$5,700.00		
07 Title – Owner's Title Insurance (optional) to Epsilon Title Co.	$1,000.00				
08					
I. TOTAL OTHER COSTS (Borrower-Paid)	**$5,018.05**				
Other Costs Subtotals (E + F + G + H)	$5,018.05				

J. TOTAL CLOSING COSTS (Borrower-Paid)	**$9,712.10**				
Closing Costs Subtotals (D + I)	$9,682.30	$29.80	$12,800.00	$750.00	$405.00
Lender Credits					

CLOSING DISCLOSURE PAGE 2 OF 5 • LOAN ID # 123456789

Note: Figure shows page 2 of the CFPC example closing cost disclosure form. Source: https://files.consumerfinance.gov/f/201311_cfpb_kbyo_closing-disclosure.pdf.

A.II.1 The Menu of Interest Rates vs. Discount Points

In this Section, we analyze the heterogeneous relationship between interest rates and two specific components of fees: discount points and lender credits (which combined make up just less than one quarter of total upfront fees). Since discount points and lender credits

are paid (received) by the borrower in exchange for lower (higher) interest rates, there is a mechanical relationship between discount points, lender credits, and interest rates. To study how local concentration affects this relationship in detail, we follow Bhutta and Hizmo (2020) and regress the interest rate spread on the net amount of discount points (discount points minus lender credits) using the matched HMDA–GSE dataset.[38]

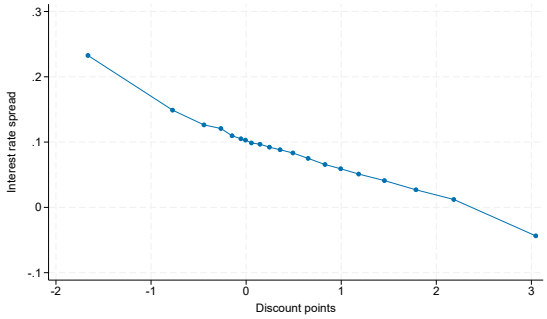
Figure A3, Panel A, illustrates the relationship with a plot of predicted values from the regression. We see a negative relationship between the revenue that the lender receives over time (the interest rate minus funding costs) and one part of the revenue that the lender receives up front (the discount points minus lender credits). Next, we analyze this relationship relative to concentration. We find that, the relationship between interest rates and points and credits differs significantly between low- and high-concentration markets. Figure A3, Panel B, presents graphical evidence of this difference, recreating the rate–point menu of Panel A for subsets of the data corresponding to high- and low-concentration markets. We plot the predicted values from a regression of interest rate spreads on discount points deciles interacted with quartiles of the one-year lagged county-level CR4.

We find that at each part of the schedule, borrowers in more concentrated counties pay higher interest rates for the same amount of points. The rate-points schedule for high-concentration markets (those in the top quartile by CR4) is shifted upward relative to the menu for low-concentration markets (those in the bottom quartile by CR4). In other words, obtaining the same interest rate through discount points costs at least 50 basis points more in a top-quartile market than in a bottom-quartile market, and often more. This result highlights that our main result is not simply driven by borrowers in some counties choosing a different point on the menu. Rather, we find that lenders with market power increase the amount of points and decrease the amount of lender credits they offer given the prevailing interest rate.

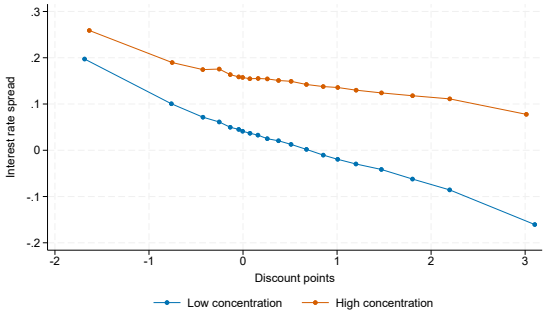
In a recent paper, Willen and Zhang (2022) build a structural model using pairwise domination that tests for racial discrimination in menus contracts. They recommend that researchers study the relationship in two ways, both 'natural' and with 'flipped' axis; i.e., using both rates and points on the y-axis (and points and rates on the x-axis, respectively.) They show, theoretically, that in some cases, a dominant relationship using one variable as the dependent variable will not survive when using the other variable as the dependent

[38]Only discount points and lender credits are offered as a menu relative to interest rates. Other fees, for example origination charges are not. The interest rate spread is calculated as the interest rate relative to the prime mortgage rate reported in Freddie Mac's weekly Primary Mortgage Market Survey, and we control for LTV and DTI-FICO bins.

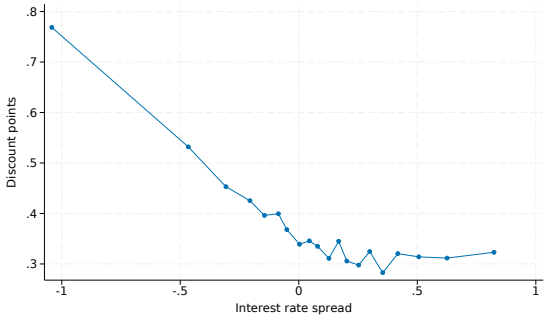
Figure A3: Discount points menu



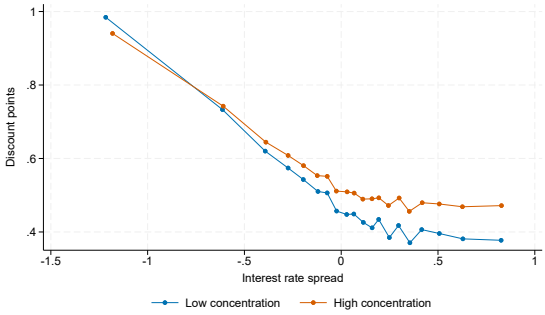
Panel A: Interest rates versus discount points



Panel B: Rates versus points (by concentration)



Panel C: Discount points versus interest rates



Panel D: Points versus rates (by concentration)

Note: The figure plots the relationship between discount points and interest rates. The data source is the merged HMDA-GSE dataset. Panel A plots a binned scatter plot of predicted values from a regression of interest rate spreads on loan-to-value and debt-to-income times FICO bins. Panel B plot predicted values from the same regression interacted with quartiles of the one-year lagged county-level CR4. Only the top and bottom quartile are included in Panel B. Interest rate spreads are calculated as the interest rate relative to the prime mortgage rate reported in Freddie Mac's weekly Primary Mortgage Market Survey (PMMS) and we exclude observations with more than a 1-percentage point positive spread. Panels C and D flip the x- and y-axis.

variable. Following their suggestion, we repeat our analysis, regressing net points on the interest rate, and here we also find that low-concentration counties have dominating menus across the entire range. We plot this result in Figure A3 Panels C and D.

A.II.2 Third party fees

As a placebo test, we decompose the effect of local concentration by the type of fees. If the main results are indeed driven by lender's market power, it is natural to expect that only fees controlled by the originating lenders are sensitive to local concentration. In this subsection, we investigate this insight and decompose the effects of concentration on fees

Table A1: Placebo Test: Heterogeneity by Types of Fees

Panel A: Effect of Concentration by Types of Fees

	(1) Origination charges	(2) Discount points	(3) Lender credits	(4) Third-party fees
CR4	0.235***	0.544***	-0.153***	0.053
	(0.038)	(0.097)	(0.025)	(0.039)
Loan controls	✓	✓	✓	✓
County controls	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓
County FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
N	12,274,206	4,874,455	4,716,313	12,274,206
R^2	0.28	0.20	0.16	0.26

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results from the placebo analysis. The table shows the results from equation (9). In Column (1), the outcome variable is origination charges. In Column (2) and (3), the outcome variable is money paid for discount points and money received for lender credits, respectively. In Column (4), the outcome variable is third-party fees. Clustered standard errors in parentheses. The dataset is the 2018-2023 HMDA data.

into the different components of fees.

We begin by analyzing the effect of changes in concentration on different types of fees set by the originating lender. Columns (1)–(3) of Table A1 Panel A show the effects of concentration on each of the three components: origination charges, discount points, and lender credits. We find that higher concentration is associated with higher revenue for lenders in every category. That is, it is associated with larger amounts paid for origination charges and discount points (which are borrower expenses) and smaller amounts paid for lender credits (which are lender expenses).

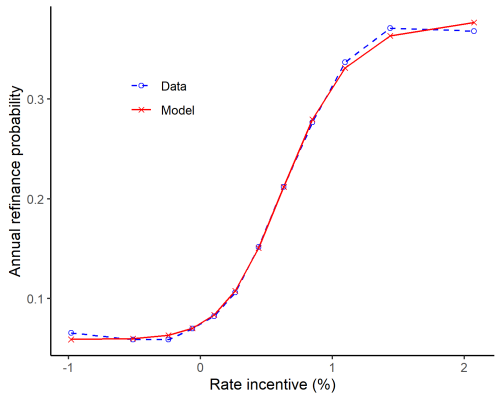
In comparison, as a placebo exercise, we analyze how concentration relates to fees that are not determined by the originating lender, such as appraisal, inspection, and title insurance fees. Column (4) reports the results. We do not find any statistically significant correlation between these fees and concentration; the coefficient is not statistically different from zero and it is substantially smaller than the coefficients for the fee types considered in Columns (1)–(3). This indicates that our main results are not driven by spurious geographic or borrower-specific variation that leads to higher fees across the board.

A.III Estimation of refinance propensity from the S-Curve

We recover α, c, ϕ, and μ by matching the empirical "s-curve." The s-curve relates the rate incentive, i.e., the difference between the borrower's current rate and a hypothetical refinance rate given current market conditions, to the probability of refinancing. While the estimation is done simultaneously, for expositional clarity we provide intuition around which parts of the s-curve identify which parameters. The rate of refinancing given no rate incentive pins down the exogenous exit rate, μ, yielding $\mu = 5.9\%$. The refinance cost c controls the rate incentive at which point the borrower begins to respond: a lower c means smaller rate differentials induce refinance. We estimate that $c = 3.00\%$. Average observed fees are 1.84%, so our estimate implies a modest hedonic cost of refinancing above the refinancing fee.

Rate sensitivity α governs the slope of the curve; we obtain $\alpha = 1.28$, similar to estimates in the literature.[39] Finally, ϕ is identified by the refinancing rate when the rate incentive is very high. We estimate $\phi = 34\%$, consistent with other frictions such as LTV or income limits. As Figure A4 shows, our model closely reproduces the empirical s-curve.

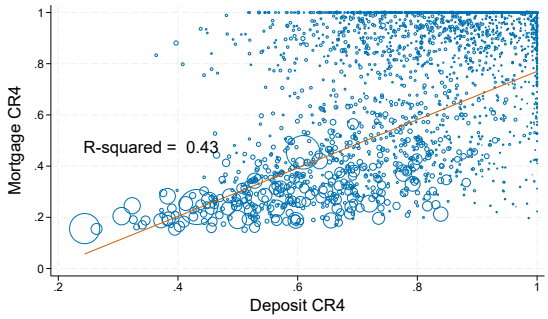
Figure A4: Empirical and model-implied s-curve



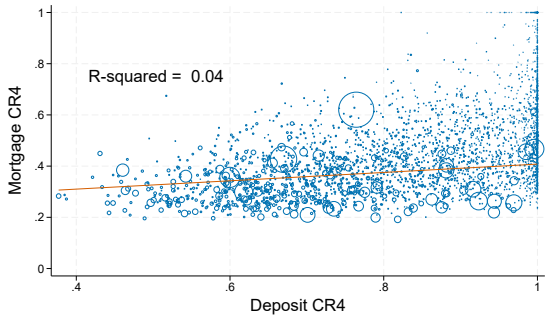
Note: This figure shows the empirical (blue) and model-implied (red) "s-curve." The x-axis is the rate incentive, i.e., the difference between a mortgage's current rate and prevailing rates at the time of observation. The y-axis is the annualized probability of refinancing.

[39] Buchak et al. (2024) estimate an average borrower's rate sensitivty as $\alpha = 1.65$. This α corresponds to our $\tilde{\alpha}$, as our α represents the structural per-period sensitivity to rate payments and their α represents the sensitivity to interest rates payments capitalized over the life of the mortgage. Accounting for the refinance probability and discount rate, their per-period sensitivity to rate payments is approximately 1.15, which is closely in line with our estimate.

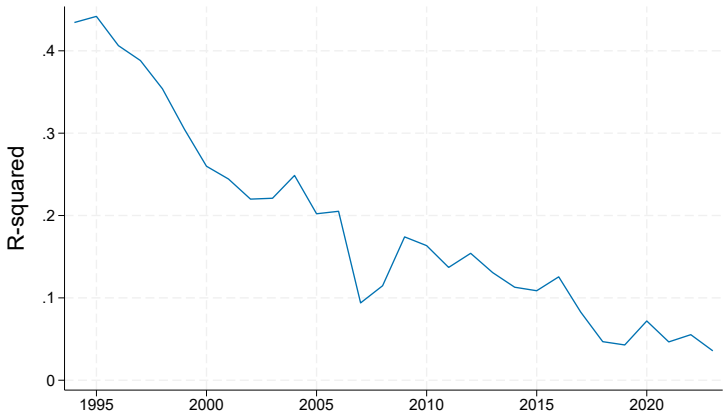
Figure A5: Deposit vs. Mortgage Concentration



Panel A: Market correlation in 1994



Panel B: Market correlation in 2023



Panel C: R^2 over time

Note: This figure shows cross-sectional correlation between county-level concentration in deposit markets and mortgage markets across time. The data sources are the 1994–2023 Summary of Deposits dataset and the 1994–2023 HMDA dataset. Panels A and B show scatterplots of local deposit market CR4 and local mortgage market CR4. Each circle represents a county in 1994 (Panel A) or 2023 (Panel B). The size of each circle is scaled by the amount of deposits in the county, the solid line represents the linear predicted values, and the R^2 is displayed. Panel C shows, for each year from 1994 to 2023, the R^2 from a univariate regression of local mortgage market CR4 on local deposit market CR4 (where each observation is weighted by the amount of deposits in the county-year).

A.IV The Decoupling of Deposit and Mortgage Concentration

Mortgage markets and deposit markets have decoupled over the past 30 years. In Figure A5, we document this divergence. Panel A shows a scatterplot of local deposit market concentration and local mortgage market concentration in 1994. Here, the cross-sectional correlation between deposit and mortgage concentration is 0.66, and the R^2 value from a

univariate regression using deposit concentration to predict mortgage concentration is 0.43. In other words, in 1994, the counties with high deposit concentration were on average the same as those with high mortgage concentration, so the bundling assumption was valid.[40]

By contrast, in the data for 2023 (shown in Panel B), this relationship is almost completely gone: the correlation is now 0.19, and the univariate R^2 is only 0.04. The bundling assumption is therefore no longer valid: regulatory decisions focusing on deposit concentration are likely to miss the markets with high mortgage concentration. In Panel C, we document how the relationship between deposit concentration and mortgage concentration has unraveled since 1994. The plot shows the R^2 value of mortgage CR4 regressed on deposit CR4, for each year from 1994 to 2023. The values are much lower in the 2010s and 20s than in the mid-1990s. This confirms that, to the extent that high mortgage market concentration enables lenders to exert market power, this market power can no longer be effectively curtailed by regulatory decisions based on deposit market concentration.

[40]We thank João Granja for suggesting this analysis. The starting point of the analysis is 1994, since the Summary of Deposits dataset only goes back to 1994 (while the HMDA dataset goes back to 1990).

Internet Appendix (for online publication only)

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B Results and proofs for the stylized model

B.I Proofs

Proof B.1 (Proof of Proposition 2.1)**.** *The lender's original problem is*

$$\max_{f\geq 0,\, i\geq 0} P_l(f,i) \qquad s.t.\ P_b(f,i)\leq C.$$

First, suppose that $P_b(i)+f<C$. Then $f'=C-P_b(i)>f$ is feasible and gives a higher payoff to the lender. Thus, whenever $P_b(i)<C$ the optimal fee f^* given i must satisfy $f^*(i)=C-P_b(i)>0$. The lender's objective function becomes $P_l(f,i)=f^*(i)+P_l(i)=C+P_l(i)-P_b(i)=C+i\Delta(i)$. The participation constraint together with the non-negativity constraint on f requires that $P_b(i)\leq C$. Finally, since C is a constaint, the maximizer for $C+i\Delta(i)$ is the same as the maximizer for $i\Delta(i)$. This establishes the claimed equivalence.

Proof B.2 (Proof of Proposition 2.2)**.** *Using the definition of $\Delta(i)$,*

$$\begin{aligned}\Delta(i)=PV_l(i)-PV_b(i)&=s(i)\left[\frac{\beta_l}{1-\beta_l s(i)}-\frac{\beta_b}{1-\beta_b s(i)}\right]\\&=s(i)\left[\frac{\beta_l-\beta_b}{(1-\beta_l s(i))(1-\beta_b s(i))}\right]>0,\end{aligned}$$

where the last inequality follows because $\beta_l>\beta_b$. Next, viewing Δ as a function of survival directly,

$$\frac{\partial\Delta(s)}{\partial s}=\frac{\partial}{\partial s}\left[\frac{(\beta_l-\beta_b)s}{(1-\beta_l s)(1-\beta_b s)}\right]=\frac{(\beta_l-\beta_b)(1-\beta_l\beta_b s^2)}{[(1-\beta_l s)(1-\beta_b s)]^2}>0,$$

where the last inequality follows from $\beta_l>\beta_b$ and β_l, β_b, and s each between 0 and 1. Finally, because $s'(i)<0$, it follows that $\partial\Delta(i)/\partial i<0$.

Proof B.3 (Proof that $i^*>0$)**.** *Since $C>0$, $i>0$ is feasible in a small neighborhood to the right of $i=0$. The derivative of the lender's objective function evaluated at $i=0$ is*

$$\begin{aligned}\frac{\partial}{\partial i}\left[i\Delta(i)\right]\Big|_{i=0}&=\left[i\Delta'(i)+\Delta(i)\right]\Big|_{i=0}\\&=0\cdot\Delta'(0)+\Delta(0)=\Delta(0)>0,\end{aligned}$$

where the last line follows from $s(0)>0$. In consequence, there is a small positive deviation

above $i = 0$ that gives the lender a higher payout, and thus i^* must be greater than zero.

Proof B.4 (Proof of Proposition 2.3)**.** *Recall that $\mathbf{i}^u$ is the set of local maximizers of $i\Delta(i)$ satisfying $i > 0$ and $P_b(i) < C$, and $\mathbf{i}^C$ is the set of interest payments satisfying $P_b(i) = C$. KKT implies that the optimal interest payment lies in one of these sets. We must show therefore that the sets are non-empty.*

First, we establish that an unconstrained maximizer of $i\Delta(i)$ exists. We look for the maximizer of $i\Delta(i)$ on $[0, \infty)$. Note that $0 \cdot \Delta(0) = 0$. Note also that

$$\begin{aligned}\lim_{i\to\infty} i\Delta(i) &= \lim_{i\to\infty} is(i)\left[\frac{\beta_l - \beta_b}{(1-\beta_l s(i))(1-\beta_b s(i))}\right] \\ &= 0,\end{aligned}$$

because by Assumption (iii), $is(i) \to 0$, and the term inside the brackets is a finite number. Finally, as shown in Proof B.3, $\partial i\Delta(i)/\partial i|_{i=0} > 0$. Since s (and therefore $i\Delta(i)$) is continuous, $i\Delta(i)$ starts at zero, increases, and approaches zero as $i \to \infty$, it attains a (not necessarily unique) maximum on $(0, \infty)$.

Now, consider the unconstrained maximizer (or one of the unconstrained maximizers, if multiple exist) of $i\Delta(i)$, i^u. If i^u is strictly feasible, i.e., $P_b(i^u) < C$, this is the solution to the problem, and $f^*(i^u) = C - P_b(i^u) > 0$. If i^u is exactly feasible, this is thet solution to the problem and $f^* = C - P_b(i^u) = 0$ is a knife-edge case. If i^u is infeasible, then $P_b(i^u) > C$. by the continuity of $s(i)$, there is some i satisfying $P_b(i) = C$, i.e., $\mathbf{i}^C$ is non-empty. Thus an optimal solution exists. Note, however, that even if i^u is infeasible, the optimum could still be an unconstrained local maximizer of $i\Delta(i)$.

Proof B.5 (Proof of Proposition 2.4)**.** *Positive-fee regime. In this regime, Proposition 2.3 implies that the equilibrium interest rate i^* is a local maximizer of $i\Delta(i)$. Since $i\Delta(i)$ does not depend on C, the optimal interest rate is invariant to changes in C, so $\partial i^*/\partial C = 0$. The optimal fee satisfies $f^* = C - P_b(i^*)$. Differentiating yields*

$$\frac{\partial f^*}{\partial C} = 1.$$

No-fee regime. In the no-fee regime, the optimal interest rate satisfies $i^* PV_b(i^*) = C$. We first show that among all candidate i^C satisfying $i^C PV_b(i^C) = C$, i^* is the smallest one. This then allows us to sign the derivative of $iPV_b(i)$ around i^*, which finally pins down the desired comparative static.

i^* is the lowest i^C satisfying $i^C PV_b(i^C) = C$: In the no-fee regime when $f^* = 0$, the interest rate is pinned down by the participation constraint, $iPV_b(i) = C$. Recall that the lender's objective function is,

$$i\Delta(i) + C = i\left[PV_l(i) - PV_b(i)\right] + C = iPV_l(i) = C\frac{PV_l(i)}{PV_b(i)} = C\frac{\beta_l}{\beta_b}\frac{1-\beta_b s(i)}{1-\beta_l s(i)}$$

Take the derivative with respect to i:

$$\frac{\partial}{\partial i}\left[C\frac{\beta_l}{\beta_b}\frac{1-\beta_b s(i)}{1-\beta_l s(i)}\right] = C\frac{\beta_l}{\beta_b}\left[\frac{\beta_l - \beta_b}{(1-\beta_l s(i))^2}\right]s'(i) < 0,$$

where the last inequality follows from $s'(i) < 0$ and $\beta_l > \beta_b$. Because the lender's value is strictly decreasing in i along the constraint, the lender's objective function is maximized at the lowest constrained value.

Signing $\partial i PV_b(i)/\partial i|_{i=i^*}$: Observe the following:

- $0 \cdot PV_b(0) = 0 < C$.
- *The optimal rate i^* is the smallest value satisfying $i\,PV_b(i) = C$.*
- *The function $i\,PV_b(i)$ is twice differentiable.*

Since i^* is the smallest root and $i\,PV_b(i)$ is continuous, the function must approach C from below as $i \uparrow i^*$, implying that the derivative of $i\,PV_b(i)$ at $i = i^*$ is weakly non-negative. If the derivative were strictly negative, then for $i < i^*$ sufficiently close to i^* we would have $i\,PV_b(i) > C$, and as i decreased towards $i = 0$ there would be another crossing point, contradicting the minimality of i^*. If instead the derivative is zero, then increasing C cannot lead to a lower optimal rate: the new intersection must occur to the right of i^* (possibly via a non-local jump), or the unconstrained maximizer i^u becomes feasible. Otherwise, if for some $C' > C$ the smallest solution to $i\,PV_b(i) = C'$ were $i' < i^*$, then since $0 < i' < i^*$ and

$$0 \cdot PV_b(0) = 0 < C < C' = i'PV_b(i'),$$

continuity of $i\,PV_b(i)$ implies by the Intermediate Value Theorem that there exists $j \in (0, i')$ such that $j\,PV_b(j) = C$, contradicting that i^* is the smallest root.

Signing the comparative static: $iPV_b(i)|_{i=i^*}$ is weakly increasing in i. If it is strictly increasing, then i^* strictly increasing in C follows immediately. If it is flat, the previous

section of the proof shows that the new intersection of $iPV_B(i)$ with $C' > C$ must occur at a higher value of of i.

Proof B.6 (Proof of Proposition 2.5)**.** *We check each claim in turn:*

1. *$\partial PV_j(i,\theta)/\partial\theta > 0$:*

$$PV_j = \frac{\beta_j s(i;\theta)}{1-\beta_j s(i;\theta)}$$
$$\frac{\partial PV_j}{\partial s} = \frac{(1-\beta_j s)\beta_j + \beta_j^2 s}{(1-\beta_j s)^2} = \frac{\beta_j}{(1-\beta_j s)^2} > 0.$$

   Because $\partial s(i,\theta)/\partial\theta > 0$, the claim follows.

2. *$\theta_2 > \theta_1 \implies \imath(\theta_2) \subset \imath(\theta_1)$:*

   Fix C. Suppose $i \in \imath(\theta_2)$. By definition, $iPV_b(i,\theta_2) \leq C$. Since $\theta_2 > \theta_1$ implies $PV_b(i,\theta_2) > PV_b(i,\theta_1)$, $iPV_b(i,\theta_1) < iPV_b(i,\theta_2) \leq C$. In consequence, $i \in \imath(\theta_1)$. The same approach shows that for i satisfying $iPV_b(i,\theta_1) = C$, $iPV_b(i,\theta_2) > C$, so $i \notin \imath(\theta_2)$. Thus $\imath(\theta_2)$ is strictly contained in $\imath(\theta_1)$.

3. *$\partial\Delta(i,\theta)/\partial\theta > 0$:*

$$\frac{\partial\Delta(i,\theta)}{\partial s} = \frac{\beta_l}{(1-\beta_l s)^2} - \frac{\beta_b}{(1-\beta_b s)^2} = \frac{(\beta_l-\beta_b)(1-\beta_l\beta_b s^2)}{(1-\beta_l s)^2(1-\beta_b s)^2} > 0$$

   Because $\partial s(i,\theta)/\partial\theta > 0$, the claim follows.

B.II Parameterizations of $s(i,\theta)$

We provide both an explict parameterization of $s(i,\theta)$, as well as a parameterized map from $s(i) \mapsto s(i,\theta)$ for an arbitrary $s(i)$ such that in both cases, $\theta_2 > \theta_1$ makes the zero-fee regime more likely.

Throughout this subsection, we retain the definition from the main text that

$$\Delta(i,\theta) \equiv PV_l(i,\theta) - PV_b(i,\theta)$$

is the per-dollar present-value wedge. We also define total gains from trade from interest payments as

$$\widetilde{\Delta}(i,\theta) \equiv i\Delta(i,\theta).$$

The lender's rate-choice problem is therefore to maximize $\widetilde{\Delta}(i,\theta)$ subject to feasibility.

B.II.1 An explicit parameterization of $s(i,\theta)$

We now introduce refinancing frictions through a parameter θ that raises the probability a loan survives at any given interest rate. Formally, the survival probability becomes

Notice that higher refinancing frictions raise the present value of interest payments and tighten the borrower's rate-only participation constraint. Formally, let $\imath(\theta) = \{i \geq 0 \mid P_b(i,\theta) \leq C\}$ denote feasible interest rates. Then for any $\theta_2 > \theta_1$, $\imath(\theta_2) \subseteq \imath(\theta_1)$. Holding the unconstrained optimum fixed, this contraction of the feasible set makes the constrained (zero-fee) regime weakly more likely. In the Appendix, we provide sufficient conditions on $s(i,\theta)$, monotonicity, normalization, and a wedge-scaling property, under which this conclusion continues to hold even when the unconstrained optimum is allowed to vary.

To illustrate this effect, consider the following parameterization of the survival probability (which, as with the previous simplifying assumptions, will be endogenized in the structural model):

$$s(i,\theta) = \exp\left(-\frac{i}{\theta}\right). \tag{23}$$

Proposition B.1 (Refinancing frictions and pricing regimes)**.** *An increase in refinancing frictions θ makes the constrained zero-fee regime weakly more likely. Specifically, there exists a cutoff $\bar{\theta} \in (0,\infty]$ such that:*

1. *if $\theta < \bar{\theta}$, the equilibrium lies in the positive-fee regime; and*
2. *if $\theta \geq \bar{\theta}$, the equilibrium lies in the zero-fee regime.*

Equivalently, if the equilibrium is in the zero-fee regime at some θ_1, then it is also in the zero-fee regime for all $\theta_2 > \theta_1$.

Proof B.7. *We begin with some useful lemmas.*

Lemma B.2 (Scaling under $s(i,\theta) = \exp(-i/\theta)$)**.** *Let $s(i,\theta) = \exp(-i/\theta)$ and define $x \equiv i/\theta$. Then for each $j \in \{b, l\}$,*

$$P_j(i,\theta) = i\frac{\beta_j s(i,\theta)}{1-\beta_j s(i,\theta)} = \theta\, x\frac{\beta_j e^{-x}}{1-\beta_j e^{-x}}.$$

Consequently, there exist functions $H(\cdot)$ and $B(\cdot)$ (independent of θ) such that

$$\widetilde{\Delta}(i,\theta) = \theta\, H(x) \quad \text{and} \quad P_b(i,\theta) = \theta\, B(x),$$

where

$$H(x) \equiv x\left(\frac{\beta_l e^{-x}}{1-\beta_l e^{-x}} - \frac{\beta_b e^{-x}}{1-\beta_b e^{-x}}\right), \qquad B(x) \equiv x\frac{\beta_b e^{-x}}{1-\beta_b e^{-x}}.$$

Proof B.8 (Proof of Lemma B.2)**.** *With $s(i,\theta) = e^{-i/\theta} = e^{-x}$, we have*

$$P_j(i,\theta) = i\frac{\beta_j e^{-x}}{1-\beta_j e^{-x}} = \theta x\frac{\beta_j e^{-x}}{1-\beta_j e^{-x}},$$

which proves the stated representation for $P_j(i,\theta)$ and hence for

$$\widetilde{\Delta}(i,\theta) = P_l(i,\theta) - P_b(i,\theta).$$

Lemma B.3 (Unconstrained maximizer scales linearly in θ)**.** *Under $s(i,\theta) = \exp(-i/\theta)$, let $x^U \in \arg\max_{x\geq 0} H(x)$ and define $i^U(\theta) \equiv \theta x^U$. Then $i^U(\theta) \in \arg\max_{i\geq 0} \widetilde{\Delta}(i,\theta)$. Moreover, the associated rate-only valuation at the unconstrained optimum satisfies*

$$P_b(i^U(\theta),\theta) = \theta\, B(x^U),$$

which is strictly increasing in θ whenever $B(x^U) > 0$.

Proof B.9 (Proof of Lemma B.3)**.** *By Lemma B.2, for $i = \theta x$ we have $\widetilde{\Delta}(i,\theta) = \theta H(x)$. Since $\theta > 0$ is a multiplicative constant, maximizing $\widetilde{\Delta}(i,\theta)$ over $i \geq 0$ is equivalent to maximizing $H(x)$ over $x \geq 0$. If x^U maximizes H, then $i^U(\theta) = \theta x^U$ maximizes $\widetilde{\Delta}(\cdot,\theta)$. The formula for $P_b(i^U(\theta),\theta)$ follows from Lemma B.2. If $x^U > 0$, then $B(x^U) > 0$ and the expression is strictly increasing in θ.*

Finally, the main proof. Assume the survival probability takes the form $s(i,\theta) = \exp(-i/\theta)$, so that Lemmas B.2 and B.3 apply. For each $\theta > 0$, let $i^U(\theta)$ denote an unconstrained maximizer of $\widetilde{\Delta}(i,\theta)$.

By Lemma B.3, there exists x^U independent of θ such that $i^U(\theta) = \theta x^U$ and

$$P_b(i^U(\theta), \theta) = \theta B(x^U),$$

where $B(x^U) \geq 0$. The unconstrained maximizer is feasible if and only if $\theta B(x^U) < C$.

If $B(x^U) > 0$, define the cutoff $\bar{\theta} = C/B(x^U)$. For $\theta < \bar{\theta}$, the unconstrained maximizer satisfies the participation constraint and the equilibrium lies in the positive-fee regime. For $\theta \geq \bar{\theta}$, the unconstrained maximizer is infeasible, and Proposition 2.3 implies that the equilibrium lies in the zero-fee regime. If $B(x^U) = 0$, then the unconstrained maximizer is feasible for all θ, and the cutoff may be taken to be infinite.

Since $P_b(i^U(\theta), \theta)$ is weakly increasing in θ, once the unconstrained maximizer becomes infeasible at some θ_1, it remains infeasible for all $\theta_2 > \theta_1$. Hence higher refinancing frictions make the constrained zero-fee regime weakly more likely.

B.II.2 A parameterized map $s(i) \mapsto s(i, \theta)$

Finally, we provide a natural parameterization of a map $s(i) \mapsto s(i, \theta)$ such that $\theta_2 > \theta_1$ makes the zero-fee regime more likely. In the body of the paper we do not specify how refinance costs enter the survival function $s(i, \theta)$ aside from the assumption that $\partial s(i, \theta)/\partial \theta > 0$. This section provides a natural parameterization that satisfies the following properties:

1. $\partial s(i, \theta)/\partial \theta > 0$ (monotonicity)
2. $s(i, 1) = s(i)$ (normalization)
3. $\Delta(i, \theta) = \theta \Delta(i)$ (wedge scaling)

Property (1) simply captures the idea that making refinance costlier makes it less likely. Property (2) is a normalization. Property (3) requires that the refinance cost not differentially change the shape of the PV wedge across values of i but rather that it stretches it uniformly. Note that because we require $s(i, \theta) < 1$, validity requires that

$$\theta \Delta(s(i)) < \Delta(1) \quad \text{for all } i.$$

A sufficient condition is $\theta < 1/\max s(i)$, which ensures this inequality holds. While this bound is convenient and easy to verify, it is not tight, and the true domain of validity may be larger.

Under this parameterization, increasing refinancing costs make the *no-fee regime* (and its accompanying comparative statics in C) more likely: Because $s(i,\theta)$ is increasing in θ, as shown previously, the set of interest payments that allow for positive fees shrinks. Then, because $\Delta(i,\theta) = \theta\Delta(i)$, it follows that

$$\widetilde{\Delta}(i,\theta) = i\Delta(i,\theta) = \theta\, i\Delta(i) = \theta\widetilde{\Delta}(i),$$

so the lender's objective function is scaled by a constant without altering the set of local maxima. Thus, it is possible for previously feasible local maxima to become infeasible, but it is not possible for a new feasible local maximum to appear.

To show that such a parameterization exists, we provide the following construction. Define the transformed survival probability $s_\theta(i)$ implicitly as,

$$\Delta(s_\theta(i)) = \theta\Delta(s(i)).$$

Since $\Delta(s)$ is strictly increasing (See Proof B.2), it is invertable. Therefore, solve for $s_\theta(i)$ as,

$$s_\theta(i) = \Delta^{-1}(\theta\Delta(s(i))).$$

This transformation has the desired properties: $s_{\theta=1}(i) = s(i)$ follows immediately from the construction when $\theta = 1$. $s_\theta(i)$ is strictly increasing in θ because $\Delta(i) > 0$ and and Δ^{-1} is strictly increasing in s. Finally, $\Delta(s_\theta(i)) = \theta\Delta(s(i))$ is immediate from the definition.

C Robustness Tests for OLS Analysis

C.I Additional descriptive statistics

Interest Rates: Figure F.1, Panel A, shows a histogram of interest rates for 2018 through 2023. The raw values in Figure F.1 show significant variation; however, this could arise from differences in funding costs across time or from differences in lenders' marginal costs—for example, the costs of collecting documents for income verification might vary across borrowers. We therefore residualize interest rates with the following specification:

$$Y_{ibct} = \eta' X_i + \mu' X_{ct} + \gamma_b + \gamma_c + \gamma_t + \epsilon_{ibct}, \tag{24}$$

where Y_{ibct} is the interest rate (in percent) for loan i originated by lender b in county c in year t; X_i is a vector of loan-level controls; X_{ct} is a vector of county-year-level controls; and γ_b, γ_c, and γ_t are lender, county, and origination date fixed effects. The loan-level controls include the loan amount and bins for FICO score, LTV and DTI ratios, and the county-year-level controls include unemployment levels. This regression removes differences in interest rates that can be attributed, for example, to differences explainable by fixed loan type, time, or geographical factors. We plot the residualized interest rates in Figure F.1, Panel B. The plot shows that even after differences due to risk are removed, there remains significant dispersion in interest rates, which itself is suggestive of variation in market power (Bhutta, Fuster and Hizmo, 2026).

Lender fees: Figure F.1, Panel C, shows a histogram of lender fees as a fraction of the loan amount. The raw values in Figure F.1 show significant variation. However, as with interest rates, this variation could arise from differences in lenders' marginal costs. We therefore residualize fees using equation (24). Figure F.1, Panel D, shows a plot of the residualized fees. As in the case of interest rates, the plot shows that even after differences due to observable characteristics are removed, there remains significant dispersion in fee amounts.

In part of the analysis, we follow Bhutta, Fuster and Hizmo (2026) and restrict our sample by only studying fees for loans with zero discount points and zero lender credits. Figure F.1, Panels E and F show plots of the raw and residualized origination charges (for loans with zero points and credits), respectively.

Binned Scatter Plots: Figure F.3 shows the main result for standard mortgages in binned scatter plots. This figure shows the distribution of residualized interest rates and fees relative to local mortgage market concentration. The y-axis gives the interest rate residual in Panels A (for all loans, including those with non-zero discount points) and B (for only loans with zero discount points). Similarly, Panels C and show the fees residual. In all four panels, the x-axis gives lagged market concentration residual.

Both panels show a binned scatterplot of either interest rates (Panels A and B) or fees (Panels C and D) residualized from Equation (24), where both variables are regressed on loan and county characteristics, and year, county, and lender fixed effects. In Panels A and C the sample includes all loans while in Panels B and D, the sample only includes loans with zero discount points and zero lender credits. In each panel, the dots represent 20 equal-sized bins based on the residualized one-year lagged county-level CR4. The solid line is a linear regression on the entire dataset, the transparent bars represent the 95% confidence interval, and the coefficients are displayed. The standard errors (in parentheses) are clustered at the county level.

We see that neither the lack of relationship between rates and concentration nor the positive relationship between fees and concentration are driven by any spurious non-linearities or outliers.

C.II Controlling for interest rates

Our results on the relationship between local concentration and fees for standard prepayable loans do not appear to be driven by borrower's with high fees endogenously having lower interest rates. We provide evidence for this in Table G.5, where we regress fees on local concentration while also controlling for the interest rate. In the full sample, which includes points and credits, the relationship between fees and rates is (mechanically) negative. Interestingly, in the restricted sample where points and credits are fixed at zero, the relationship between fees and rates is positive. Crucially, the relationship between fees and local concentration remains virtually unchanged when we include the interest rate as a control, suggesting that our results are not driven by the endogenous sorting of borrowers across the rate–points menu.

C.III Testing for Statistical Difference in the Differential Effect of Concentration

Table G.4 extends the analysis by jointly estimating the effect of market concentration for mortgages with and without prepayment penalties, allowing the pass-through of concentration into pricing to differ by refinancing risk. Unlike the results presented in the paper, which focuses on sub-sampling the data by whether the loan has a prepayment penalty or not, this table includes both contract types and identifies how the relationship between concentration and pricing differs across them through an explicit interaction term.

The interaction terms reveal a clear reallocation of markups across pricing dimensions when refinancing is costly. In the interest rate regressions, the interaction between concentration and a prepayment penalty is positive and statistically significant across both concentration measures and estimation approaches, indicating that increases in concentration raise interest rates more for mortgages with prepayment penalties than for standard prepayable mortgages.

In contrast, in the fee regressions, the interaction between concentration and a prepayment penalty is negative and statistically significant, indicating that the same increase in concentration leads to a smaller increase in upfront fees for mortgages with prepayment penalties relative to prepayable mortgages. Taken together, these interaction effects imply that when refinancing is costly, lenders shift markups away from upfront fees and toward interest rates.[41]

C.IV Expected Present Value

In this subsection, we conduct a back-of-the-envelope calculation to impute the expected present value of the revenue from each mortgage. We then estimate the relationship between local concentration and the expected present value of payment revenue.

The expected present value of future payments depends on several factors including the expected payments, the expected path of discount rates, and the future opportunity cost of capital (which may or may not be different than the future discount rate). To simplify calculations, we make the following simplifying assumption. We impute the expected present

[41] Note that, as in Table 5, the IV interaction estimates are larger than the corresponding OLS estimates, consistent with the borrower selection and lender segmentation mechanisms discussed in the paper.

value of payments as

$$E[PV(\text{payments})] = \text{fee} + \sum_{t=1}^{T} \frac{\text{interest rate}}{(1+r)^t} \tag{25}$$

We set $T = 5$ years as the average prepayment period. This is based on the average prepayment frequency, which we calculate in the HMDA-GSE dataset, were the average number of months before prepayment is 61 months (and the median is 38 months). This is consistent with the average Conditional Prepayment Rate (CPR) reported by the FHFA. For example, in their Prepayment Monitoring Report from the First Quarter of 2023,[42] the FHFA reports that during our sample period the CPR fluctuates between 5% and 35%. A CPR of 15% means that over half of the MBS portfolio has been prepaid after five years: $(1 - 15\%)^5 = 44\%$. We assume a constant discount rate of 5%.

For each mortgage in the sample, we impute the expected present value of payments using equation (25). Next, we repeat the OLS and IV analysis. Table G.13 report the results. Specifically, the table shows the results from a modified version of the OLS and IV specifications that includes an imputed expected present value as the dependent variable. Columns (1) and (2) show the OLS coefficients for HHI and CR4, respectively. Columns (3) and (4) show the first stage results for the Failed Lender IV. Finally, Columns (5) and (6) show the second stage results (equation 12), again for HHI and CR4, respectively.

As the expected present value imputed in equation (25) is simply a weighted average of the fee and the interest rate, the coefficients from the OLS and IV analyses are also consistent with the results from the main analysis. For example, we see that in both the OLS and IV analysis the coefficient on HHI and CR4 are positive and statistically significant at the 1-% level, and the IV coefficients are larger than the OLS coefficients, consistent with the borrower selection and lender path-dependence discussed in the paper.

D Robustness Tests for IV Analysis

In this section, we provide additional robustness analysis of the IV results. First, mirroring the OLS analysis, Table G.9 reports IV estimates that control directly for the interest rate. As before, the results are virtually unchanged, highlighting that our findings are not driven by the endogenous sorting of borrowers across the rate–points menu.

[42] See https://www.fhfa.gov/AboutUs/Reports/ReportDocuments/Prepayment-Monitoring-Report_2023Q1.pdf.

D.I Example of Incidental Merger IV

How does the Incidental Merger instrument work? Figure F.7 provides an illustrative example. In 2020, Cambridge Bancorp—the parent of Cambridge Trust, a mortgage lender in Cambridge, Massachusetts—completed its merger with Wellesley Bancorp Inc., another mortgage lender in Massachusetts. The figure presents a hypothetical situation in which Cambridge Trust is primarily active in Middlesex County, while Wellesley Bank is primarily active in Norfolk County. The assumption behind our IV analysis is that the economic motivation for Cambridge Trust's purchase is to expand its presence in Norfolk County. However, since both Cambridge Trust and Wellesley Bank are also active in Plymouth County, the market concentration in Plymouth County increases following the merger. That is, the merger incidentally increases concentration in overlapping markets that are not central to either party in the merger.

D.II Robustness of Failed Lender IV

In the baseline specification for the failed lender IV, we use Wachovia's market shares as the instrument. In Table G.10, we show that the results are robust to using the market shares of Countrywide and Washington Mutual instead or using the combined markets shares of all three lenders as well.

In Panels A–C in Figures F.5 and F.6, we report the correlations between 2007 borrower characteristics and the market shares of Countrywide and Washington Mutual, respectively, and we find indeed strong positive correlations with 2007 mortgage lending patterns, and we confirm that this correlation has vanished by 2017. While Countrywide and Washington Mutual's 2007 market shares appear unrelated to differences in borrower characteristics, we nevertheless use Wachovia's shares as our primary instrument out of an abundance of caution. Nonetheless, in robustness checks, we find that including either Wachovia alone, Countrywide and Washington Mutual, or all three lenders together deliver similar results.

Next, to ensure that our results are not driven by features unique to Wachovia that may limit external validity, we replicate the Failed Lender IV using two other large lenders that failed during the financial crisis: Countrywide and Washington Mutual. Results are reported in Table G.10. Given Countrywide's substantial market share in 2007, the resulting first-stage F-statistics are very large (448 and 463). The estimated effect on fees is smaller in magnitude than when using Wachovia alone, but is interestingly very close to the estimates obtained using the Merger IV. Then, in Table G.11, we show that the IV results are consistent

when using more granular sample restrictions, and in Table G.12, we demonstrate that our findings are robust to a range of sample restrictions and, in the case of the Incidental Mergers IV, to alternative definitions of what constitutes an incidental merger.

Specifically, in Table G.12 Panel A, we report the results from five alternative specifications. Specifically, the table reports the results from estimating the failed lender IV under different sample filters. Columns (1)–(5) present the first stage results and Columns (6)–(10) present the second stage results. In Columns (1) and (6) we do not filter the sample at all. That is, relative to the baseline sample, we include even counties where the failed lenders did not originate any mortgages. In Columns (2) and (7) we include only counties where the failed lender share is between 0 and 5%. In Columns (3) and (8) we include only counties where the failed lender share is between 0 and 10%. In Columns (3) and (8) we include only counties where the failed lender share is between 0 and 10%. In Columns (4) and (9) we include only counties where the failed lender share is between 0 and 15%. In Columns (5) and (10) we include only counties where the failed lender share is between 0 and 20%.

Across all the specifications, we find strong first stages with F-stats between 186 and 1,895. The second stage coefficients vary between 0.3 and 1.4. For all five of the alternative specifications, the second stage coefficient is statistically significant at the 1%-level.

D.III Robustness of Incidental Merger IV

When constructing the incidental merger IV, we follow Scharfstein and Sunderam (2016) and employ two filters. Under the first filter ("Filter 1"), we keep only counties where each of the lenders involved in the merger are responsible for more than 1% of the total mortgage originations in the county. This filter ensures that the merger had a sufficiently large effect on local concentration. Under the second filter ("Filter 2"), we keep only counties where the county itself contributes no more than 2% of each bank's mortgage originations in the given year. This filter ensures that the county was not a material consideration in the decision to undertake the merger.

In this section, we analyze how sensitive the results are to the exact thresholds in Filter 1 and Filter 2. In Table G.12 Panel B, we report the results when running the model six times (the baseline plus five alternative specifications). Columns (1)–(6) present the first stage results and Columns (7)–(12) present the second stage results. We let the filter thresholds for Filter 1 vary between 1%, 2%, and 5%, and we let the filter threshold for Filter 2 vary between 2% and 5%. (Columns (1) and (7) correspond to the baseline specification reported

in the main paper.)

Across the six specification we see consistent positive first stages and positive IV estimates. As the threshold for Filter 1 increases, the number of observations drastically decreases, and when the threshold is 5% the estimate is positive but no longer statistically significant.

Reassuringly, all the IV estimates are in the same order of magnitude. And the baseline estimate reported in the paper is, in fact, the lowest coefficient estimate out of the six different specifications.

D.IV Additional IV Evidence from Bostic et al. (2012)

To supplement the policy-driven variation in refinancing risk used in the main paper, we provide additional evidence using the Anti-Predatory Law (APL) Index from Bostic et al. (2012). The APL index captures cross-state variation in the restrictiveness of anti-predatory lending laws, which directly affect the use and enforceability of prepayment penalties and thereby generate exogenous variation in refinancing frictions.

In Table G.7 Panel B, we report the first-stage results. The estimates confirm that stronger anti-predatory lending laws significantly reduce the likelihood that a loan carries a prepayment penalty, consistent with the intended policy channel. We then use this variation to instrument for the presence of a prepayment penalty and estimate the differential effect of concentration across loans with and without such penalties. Table G.8 reports the corresponding IV results, alongside OLS estimates from the same sample for reference.

We find that the effect of concentration on interest rates is significantly larger for loans with a prepayment penalty than for loans without one. This pattern is consistent with the evidence in the main paper, where higher refinancing frictions strengthen the sensitivity of pricing to market concentration.

E Derivations for the Quantitative Model

This section provides derivations for the quantitative structural model not shown in the text.

E.I Refinance and period 2+ value functions

Using the type-one extreme-value assumption on (ϵ_r, ϵ_n), the expected utility of the refi/do not refi choice is,

$$E\left[\max\left\{u_r(i), u_n(i_0)\right\}\right] = \log\left[\exp(-\alpha i - c + \beta_b Eu(i)) + \exp(-\alpha i_0 + \beta_b Eu(i_0))\right] l. \tag{26}$$

The probability that the borrower refinances given (i_0, i), and that the borrower is considering refinance, $P(i_0, i|consider)$, is,

$$P(i_0, i|consider) = \frac{\exp(-\alpha i - c + \beta_b Eu(i))}{\exp(-\alpha i - c + \beta_b Eu(i)) + \exp(-\alpha i_0 + \beta_b Eu(i_0))}. \tag{27}$$

The ex-ante per-period probability of exit (including exogenous exit and endogenous refinance) is then,

$$P(i_0) = 1 - s(i_0) = \mu + (1-\mu)\phi \int_i P(i_0, i|consider) di(i) \tag{28}$$

Equations (27) and (28) can be computed for any i_0 given the value function $Eu(i_0)$, which is defined implicitly in Equation (26).

Two important quantities for optimal rate setting are the derivatives of $Eu(i_0)$ and $P(i_0) = 1 - s(i_0)$ with respect to i_0. Begin by taking derivatives implicitly of $Eu(i_0)$:

$$\begin{aligned}
\frac{\partial Eu(i_0)}{\partial i_0} =& (1-\mu)(1-\phi)\left(-\alpha + \beta_b \frac{\partial Eu(i_0)}{\partial i_0}\right) \\
&+ (1-\mu)\phi\left(-\alpha + \beta_b \frac{\partial Eu(i_0)}{\partial i_0}\right) \int_i \frac{\exp(-\alpha i - c + \beta_b Eu(i))}{\exp(-\alpha i - c + \beta_b Eu(i)) + \exp(-\alpha i_0 + \beta_b Eu(i_0))} di(i|i_0) \\
=& (1-\mu)\left[(1-\phi)\left(-\alpha + \beta_b \frac{\partial Eu(i_0)}{\partial i_0}\right) + \phi\left(-\alpha + \beta_b \frac{\partial Eu(i_0)}{\partial i_0}\right) \int_i (1 - P(i_0, i|consider))\, di(i|i_0)\right] \\
=& (1-\mu)(1-\phi)\left(-\alpha + \beta_b \frac{\partial Eu(i_0)}{\partial i_0}\right) + \left(-\alpha + \beta_b \frac{\partial Eu(i_0)}{\partial i_0}\right)(\phi - P(i_0) + \mu(1-\phi)) \\
=& (1 - P(i_0))\left(-\alpha + \beta_b \frac{\partial Eu(i_0)}{\partial i_0}\right).
\end{aligned}$$

Solving for the derivative, we obtain,

$$\frac{\partial Eu(i_0)}{\partial i_0} = -\alpha\left(\frac{1 - P(i_0)}{1 - \beta_b(1 - P(i_0))}\right) = -\alpha\left(\frac{s(i_0)}{1 - \beta_b s(i_0)}\right) \tag{29}$$

Observe that this is simply the

Next, take the derivative of $P(i_0)$:

$$\begin{aligned}\frac{\partial P(i_0)}{\partial i_0} &= (1-\mu)\phi \int_i \frac{\partial P(i_0, r|consider)}{\partial i_0} di(i) \\ &= (1-\mu)\phi \left(\alpha - \beta_b \frac{\partial Eu(i_0)}{\partial i_0}\right) \int_i P(i_0, i|consider)\left(1 - P(i_0, i|consider)\right) di(i) \quad (30)\end{aligned}$$

$$\frac{\partial s(i_0)}{\partial i_0} = -\frac{\partial P(i_0)}{\partial i_0} \quad (31)$$

E.II Borrower's choice of lender in period 1

With the type-one extreme value assumption, the probability (equivalently, market share) for lender j given all offers $k \in \{1, \ldots, J\}$ and ex-ante expected utility is,

$$d_j(f, i) = \frac{\exp(-\gamma f_j + \beta_b Eu(i_j))}{\sum_k \exp(-\gamma f_k + \beta_b Eu(i_k))} \quad (32)$$

$$Eu_0(f, i) = \log\left[\sum_k \exp\left(-\gamma f_k + \beta_b Eu(i_k)\right)\right] \quad (33)$$

An important quantity for optimal rate setting is the derivative of $d_j(f, i)$ with respect to both fees and rates,

$$\frac{\partial d_j(f, i)}{\partial f_j} = -\gamma d_j(f, i)(1 - d_j(f, i)) \quad (34)$$

$$\begin{aligned}\frac{\partial d_j(f, i)}{\partial i_j} &= \beta_b \frac{\partial Eu(i_j)}{\partial i_j} d_j(f, i)(1 - d_j(f, i)) \\ &= -\alpha \left(\frac{\beta_b s(i_j)}{1 - \beta s(i_j)}\right) d_j(f, i)(1 - d_j(f, i)) \quad (35)\end{aligned}$$

E.III Lender's profit and optimal pricing

The lender's income per originated dollar of loan is,

$$\mathcal{V}(f, i) = f - mc_f + (i - mc_i) \underbrace{\sum_{t=1}^{\infty} \left[\beta_l s(i)\right]^t}_{\equiv PV_l(i)} \quad (36)$$

Recognizing that $PV_l(i)$ is a geometric series,

$$PV_l(i) \equiv \sum_{t=1}^{\infty} \left[\beta_l s(i)\right]^t = \left(\sum_{t=0}^{\infty} \left[\beta_l s(i)\right]^t - 1\right) = \left(\frac{1}{1-\beta_l s(i)} - 1\right) = \left(\frac{\beta_l s(i)}{1-\beta_l s(i)}\right).$$

The derivative of $PV_l(i)$, and net interest income $(i - mc_i)PV_l(i)$ with respect to i is,

$$\frac{\partial PV_l(i)}{\partial i} = \frac{\beta_l s'(i)}{(1-\beta_l s(i))^2}. \tag{37}$$

The lender's profit (including its endogenous market share) is,

$$P_l(f,i) = d(f,i)\mathcal{V}(f,i) \tag{38}$$

Derivatives of the profit function with respect to fees and rates are,

$$\begin{aligned}
\frac{\partial P_l(f,i)}{\partial f} &= \frac{\partial d(f,i)}{\partial f}\mathcal{V}(f,i) + d(f,i) \\
\frac{\partial P_l(f,i)}{\partial i} &= \frac{\partial d(f,i)}{\partial i}\mathcal{V}(f,i) + d(f,i)\left[PV_l(i) + (i - mc_i)\frac{\partial PV_l(i)}{\partial i}\right].
\end{aligned}$$

For an interior solution for fees, the FOC simplifies to,

$$\mathcal{V}(f,i) = \left(\frac{1}{\gamma}\right)\left(\frac{1}{1-d(f,i)}\right).$$

Likewise, for an interior solution for rates, the FOC simplifes to,

$$\begin{aligned}
\mathcal{V}(f,i) &= \left(\frac{1}{\tilde{\alpha}}\right)\left(\frac{1}{1-d(f,i)}\right)\left[PV_l(i) + (i - mc_i)\frac{\partial PV_l(i)}{\partial i}\right] \\
\tilde{\alpha} &\equiv \alpha\left(\frac{\beta_b s(i)}{1-\beta_b s(i)}\right)
\end{aligned}$$

These values are defined and computed above.

E.IV Fee Salience

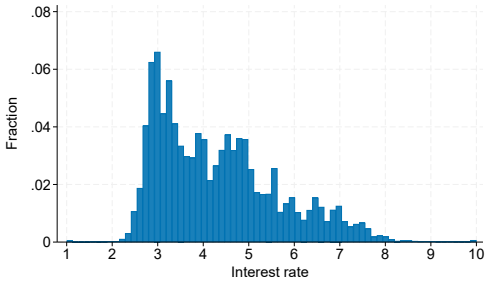
In our model, we assume that interest rates are more salient than fees. How reasonable is this assumption? In addition to the related literature cited in the main paper, we have two "datapoints" that support this assumption. First, according to survey data, borrowers say that they are less likely to consider or pay attention to the fess than the interest rate when choosing their mortgage. Second, the mortgage rate appears to be a very salient feature of American culture. For example, The New York Times recently published an article describing homeowners who are envious over the interest rates that their friends are paying, and the article highlights that comparing your mortgage rate is a typical conversation at dinner parties. (There was no mention of the upfront fees associated with obtaining a mortgage.)[43]

Moreover, we find that unsophisticated borrowers pay less attention to upfront fees and that unsophisticated borrowers have lower elasticities of demand. Specifically, using the NSMO database, we show that borrowers with lower levels of education and lower credit scores are less likely to be familiar with the upfront fees (Table G.14), and that these borrowers are also less likely to consider multiple mortgage lenders when choosing their mortgage (Table G.15).

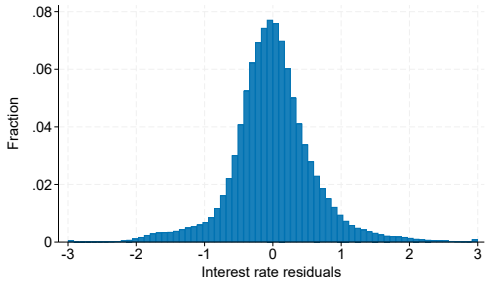
[43] According to survey data from the 2020 National Survey of Mortgage Originations (NSMO), while 98% of borrowers considered the interest rate when choosing their mortgage, only 81% of borrowers considered fees; see https://www.fhfa.gov/sites/default/files/2023-10/NSMO-Select-Weighted-Tabulations-20230303.pdf. The article from The New York Times is: "*Feeling Mortgage-Rate Envy? You're Not Alone.*" https://www.nytimes.com/2023/08/04/realestate/mortgage-rates-increase.html (accesed on September 1, 2024).

F Appendix Figures

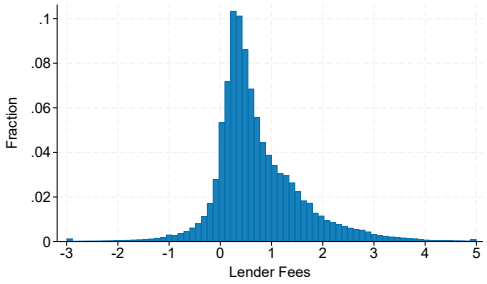
Figure F.1: Distribution of Interest Rates and Lender Fees



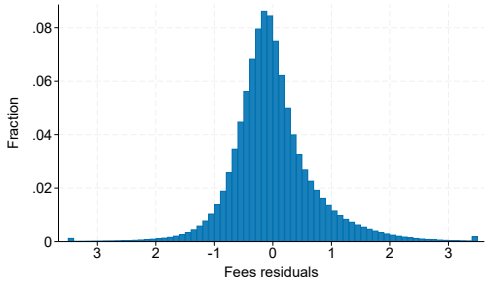
Panel A: Interest rates



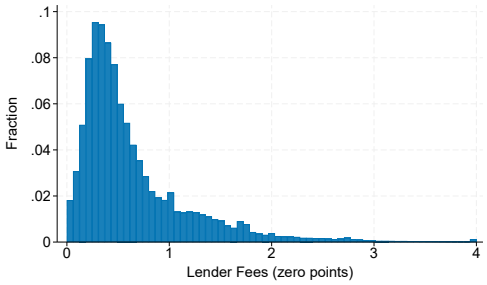
Panel B: Interest rate residuals



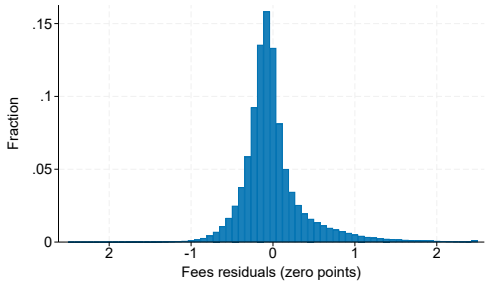
Panel C: Lender fees



Panel D: Lender fee residuals



Panel E: Lender fees (at zero points)



Panel F: Lender fees residuals (at zero points)

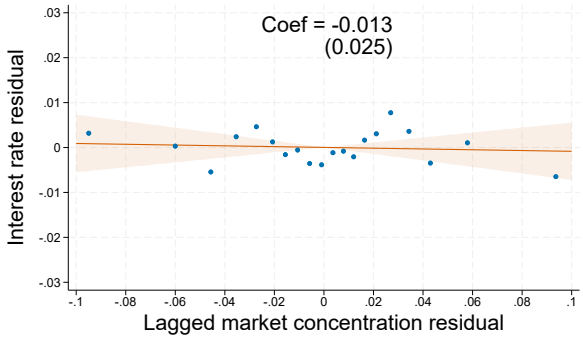
Note: This figure shows the distribution of mortgage interest rates and non-interest lender fees. Panels A, C, and E show the distribution of interest rates, lender fees for all loans, and lender fees for loans with zero discount points and zero lender credits, respectively. Panels B, D, and F show the residuals from Equation (24) where the dependent variable is either interest rates, lender fees for all loans, and lender fees for loans with zero discount points and zero lender credits, respectively.

Figure F.2: The Menu of Discount Points and Interest Rates

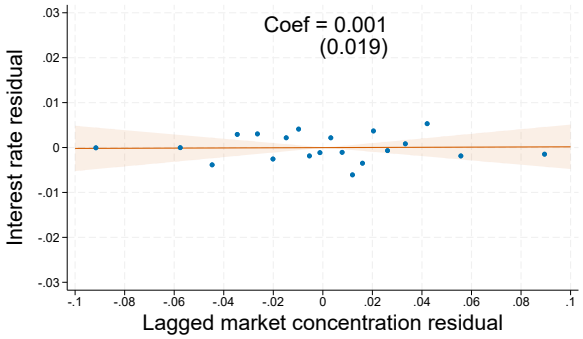


Note: Figure shows an example of how interest rates and discount points are presented from Bank of America. Source: https://bettermoneyhabits.bankofamerica.com/en/home-ownership/buying-mortgage-points-lower-rate

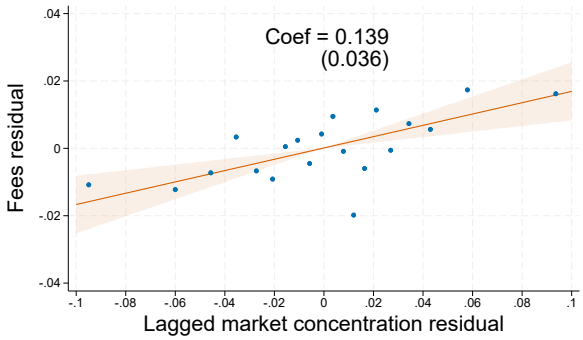
Figure F.3: Robustness: Full Distribution



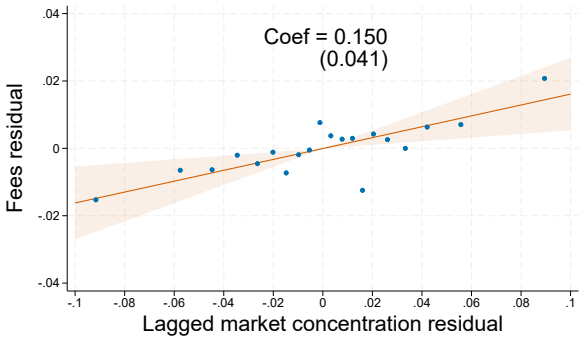
Panel A: Concentration and interest rates
(including loans with points)



Panel B: Concentration and interest rates
(only loans with zero points)



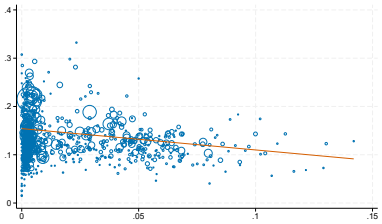
Panel C: Concentration and lender fees
(including loans with points)



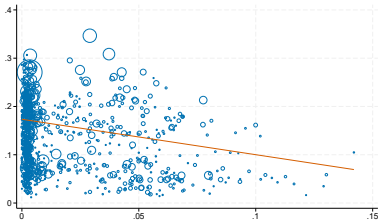
Panel D: Concentration and lender fees
(only loans with zero points)

Note: This figure shows the distribution of residualized interest rates and fees relative to local mortgage market concentration. Both panels show a binned scatterplot of either interest rates (Panels A and B) or fees (Panels C and D) residualized from Equation (24), where both variables are regressed on loan and county characteristics, and year, county, and lender fixed effects. In Panels A and C the sample includes all loans while in Panels B and D, the sample only includes loans with zero discount points and zero lender credits. In each panel, the dots represent 20 equal-sized bins based on the residualized one-year lagged county-level CR4. The solid line is a linear regression on the entire dataset, the transparent bars represent the 95% confidence interval, and the coefficients are displayed. The standard errors (in parentheses) are clustered at the county level.

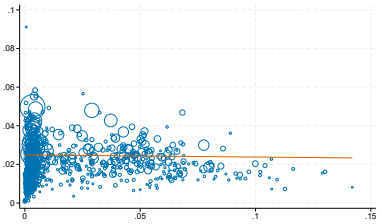
Figure F.4: Failed Lender IV - Correlations: Wachovia



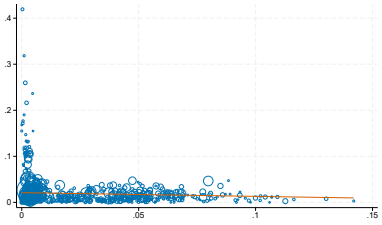
Panel A: NINJA loans (2007)



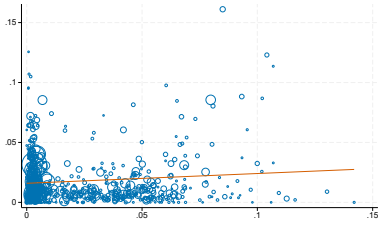
Panel B: Pre-payment penalty (2007)



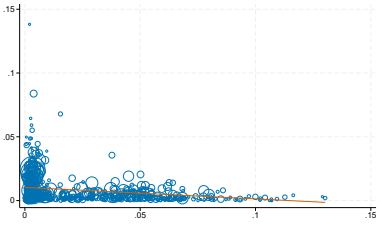
Panel C: Private label (2007)



Panel D: NINJA loans (2017)



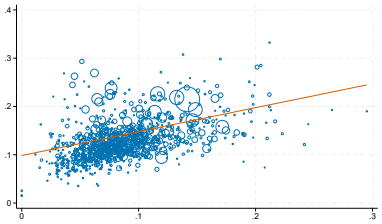
Panel E: Pre-payment penalty (2017)



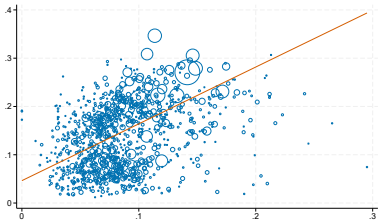
Panel F: Private label (2018)

Note: This figure shows scatter plots of the 1,000 largest counties (by number of mortgages). For each circle, the x-axis is the market share of Wachovia in 2007, and the y-axis is the fraction of mortgages with a specific attribute. Panels A and D show the fraction of NINJA (No Income No Job or Assets) mortgages in 2007 and 2017, respectively. Panels B and E mortgages with a pre-payment penalty in 2007 and 2017. (For these four panels, the data source is Black Knight.) Panels C and F mortgages securitized by private-label firms in 2007 and 2018. (For these two panels, the data source is HMDA.) In each panel, the solid line is the weighted univariate OLS predicted values.

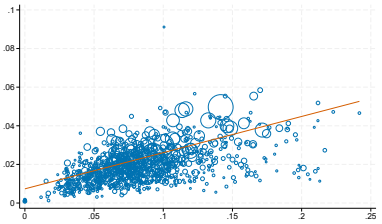
Figure F.5: Failed Lender IV - Correlations: Countrywide



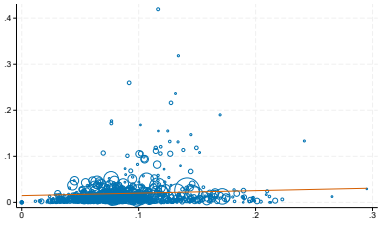
Panel A: NINJA loans (2007)



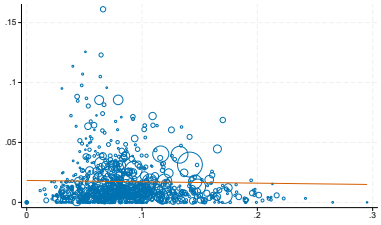
Panel B: Pre-payment penalty (2007)



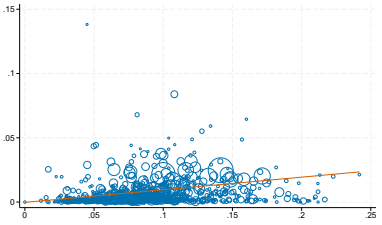
Panel C: Private label (2007)



Panel D: NINJA loans (2017)



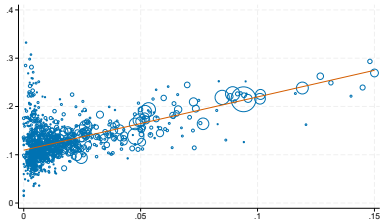
Panel E: Pre-payment penalty (2017)



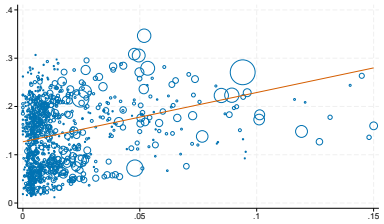
Panel F: Private label (2018)

Note: This figure shows scatter plots of the 1,000 largest counties (by number of mortgages). For each circle, the x-axis is the market share of Countrywide in 2007, and the y-axis is the fraction of mortgages with a specific attribute. Panels A and D show the fraction of NINJA (No Income No Job or Assets) mortgages in 2007 and 2017, respectively. Panels B and E mortgages with a pre-payment penalty in 2007 and 2017. (For these four panels, the data source is Black Knight.) Panels C and F mortgages securitized by private-label firms in 2007 and 2018. (For these two panels, the data source is HMDA.) In each panel, the solid line is the weighted univariate OLS predicted values.

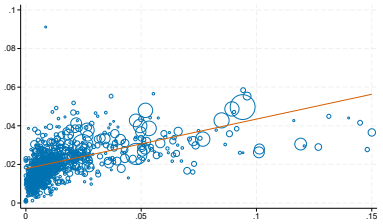
Figure F.6: Failed Lender IV - Correlations: Washington Mutual



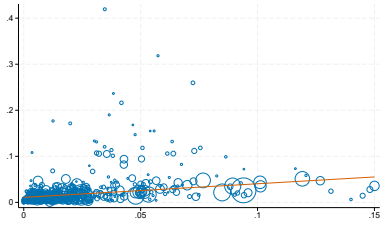
Panel A: NINJA loans (2007)



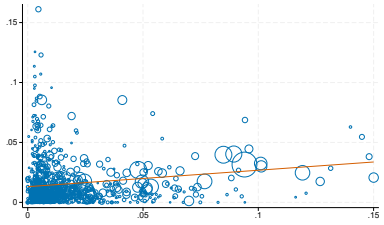
Panel B: Pre-payment penalty (2007)



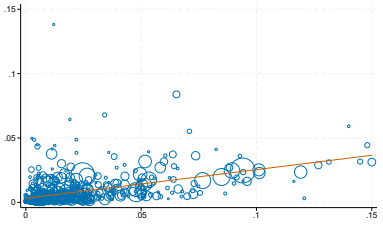
Panel C: Private label (2007)



Panel D: NINJA loans (2017)



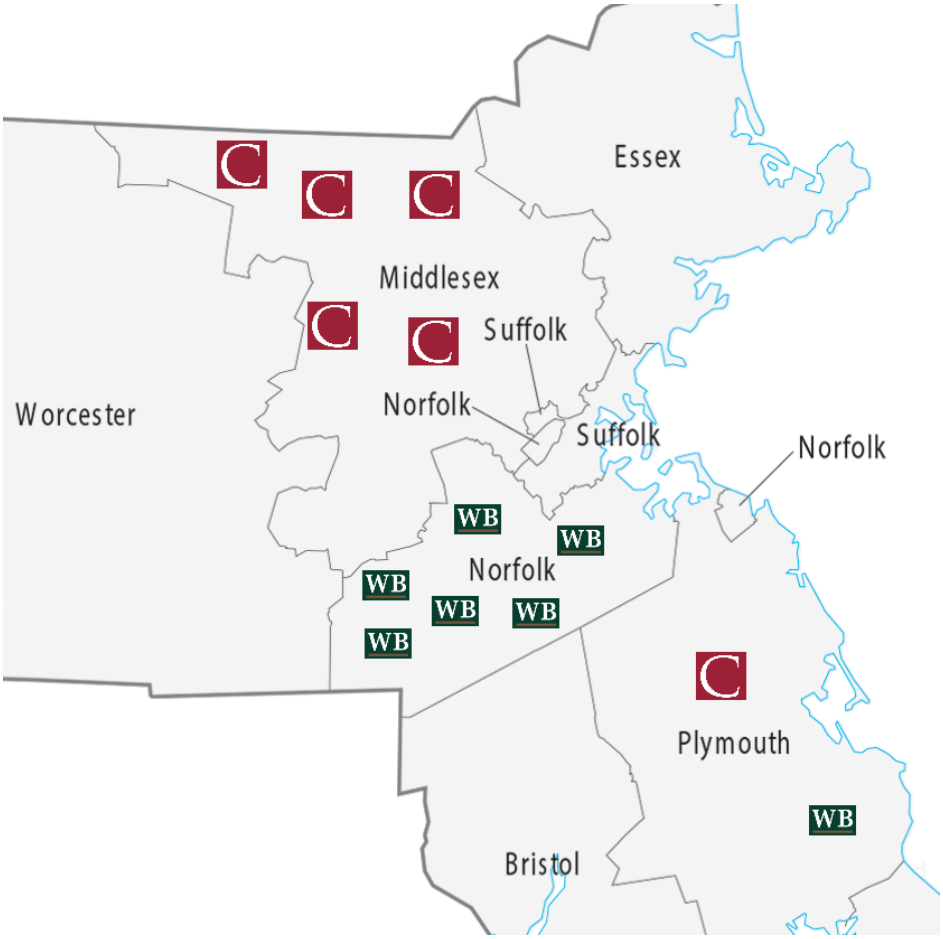
Panel E: Pre-payment penalty (2017)



Panel F: Private label (2018)

Note: This figure shows scatter plots of the 1,000 largest counties (by number of mortgages). For each circle, the x-axis is the market share of Washington Mutual in 2007, and the y-axis is the fraction of mortgages with a specific attribute. Panels A and D show the fraction of NINJA (No Income No Job or Assets) mortgages in 2007 and 2017, respectively. Panels B and E mortgages with a pre-payment penalty in 2007 and 2017. (For these four panels, the data source is Black Knight.) Panels C and F mortgages securitized by private-label firms in 2007 and 2018. (For these two panels, the data source is HMDA.) In each panel, the solid line is the weighted univariate OLS predicted values.

Figure F.7: Bank Merger Instrument Construction



Note: Figure shows the construction and intuition of the merger instrument. In this hypothetical example, Cambridge Trust, primarily active in Middlesex County, purchases Wellesley Bank, primarily active in Norfolk County. The economic motivation for Cambridge Trust's purchase is to acquire branches in Norfolk. However, by virtue of the fact that Cambridge Trust and Wellesly Bank both have branches in Plymouth County, concentration in Plymouth County increases following the merger.

G Appendix Tables

Table G.1: Summary Statistics

Loan-level variables: HMDA

	N	Mean	Std. dev.	10%-tile	90%-tile
Loan amount ($)	12,434,662	336,859.49	236,104.36	135,000.00	575,000.00
Interest rate (percent)	12,419,816	4.31	1.34	2.88	6.38
Total loan costs ($)	12,264,511	5,163.60	13,629.59	2,156.20	9,154.45
Total loan costs (pct.)	12,264,511	1.84	1.53	0.67	3.34
Lender fees ($)	12,352,128	1,906.92	48,547.48	-25.42	4,995.32
Lender fees (pct.)	12,352,128	0.68	0.87	-0.01	1.76
Origination charge ($)	12,352,128	2,378.09	3,187.92	85.94	5,550.00
Origination charge (pct.)	12,352,128	0.83	0.81	0.03	1.91
Discount points ($)	4,902,120	2,744.64	3,809.45	276.67	6,412.50
Discount points (pct.)	4,902,120	0.83	0.83	0.12	1.93
Lender credits ($)	4,745,734	1,231.90	78,168.28	15.30	3,389.00
Lender credits (pct.)	4,745,734	0.39	0.71	0.00	1.04
Third-party fees ($)	12,352,128	2,734.94	13,089.55	1,212.55	4,480.00
Third-party fees (pct.)	12,352,128	1.00	1.02	0.40	1.71
Applicant income ($)	12,315,135	124.17	135.58	45.00	220.00
Combined loan-to-value ratio (pct.)	12,434,662	82.79	16.21	63.37	97.00
Debt-to-income ratio (pct.)	12,369,881	35.32	9.96	25.00	47.00

Note: This table reports the number of observations, the mean and standard deviation, and the 10th and 90th percentiles for the HMDA dataset.

Table G.2: Merger IV - Additional Results

	1st stage	Full sample		Standard Mortgages		Prepayment Penalties	
	(1) CR4	(2) Rates	(3) Fees	(4) Rates	(5) Fees	(6) Rates	(7) Fees
Merger	0.04***						
	(0.01)						
CR4		-0.39	1.07**	-0.40	1.08**	13.02***	-2.80
		(0.31)	(0.49)	(0.32)	(0.50)	(4.20)	(1.92)
Loan controls	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓
Origination date FE	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓
N	215,988	215,820	214,810	215,576	214,576	216	202
R^2	0.93	0.00	0.03	0.00	0.03	-0.09	-0.02
KP rk Wald F-stat	20						

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports IV estimates from the Incidental Merger IV across sample splits. Column (1) reports the first stage results where the sample includes all mortgages. Columns (2)-(7) report the second stage results (equation (11)) where the sample includes either all mortgages (Columns (2) and (3)), standard prepayable mortgages (Columns (4) and (5)), or mortgages with prepayment penalties (Columns (6) and (7)). In columns (2), (4), and (6), the dependent variable is the interest rate, and in columns (3), (5), and (7), the dependent variable is upfront lender fee. Clustered standard errors are in parentheses.

Table G.3: Robustness: Sample definitions

	Interest rates				Lender fees			
	With points		Zero points		With points		Zero points	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HHI	-0.275	0.014	0.047		0.967***	0.203***	0.248***	
	(0.222)	(0.031)	(0.030)		(0.120)	(0.060)	(0.064)	
CR4				0.001				0.150***
				(0.019)				(0.042)
Sample	H	H-G	H-G	H-G	H	H-G	H-G	H-G
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓				✓			
Year-Month FE		✓	✓	✓		✓	✓	✓
FICO bin FE		✓	✓	✓		✓	✓	✓
N	12,340,058	2,984,503	734,445	734,445	12,274,206	2,978,006	731,557	731,557
R^2	0.79	0.93	0.94	0.94	0.25	0.28	0.33	0.33

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the relationship between interest rates, upfront lender fees, and local lender concentration for standard prepayable mortgages. This table shows the results from equation (9) where the dependent variable is either the interest rate (Columns (1)-(4)) or the upfront lender fees (Columns (5)-(8)). In Columns (1), (2), (5), and (6) the sample includes all loans with and without discount points. In Columns (3), (4), (7) and (8), the sample is restricted to loans with zero discount points and zero lender credits. In Columns (1) and (5), the sample is the full HMDA (H) sample, while in the remaining columns the sample is the merged HMDA-GSE (H-G) sample. Clustered standard errors are in parentheses.

Table G.4: Interacting Concentration with Prepayment Risk

	OLS				IV			
	(1) Rates	(2) Rates	(3) Fees	(4) Fees	(5) Rates	(6) Rates	(7) Fees	(8) Fees
CR4	-0.265***		0.315***		-0.393***		1.078***	
	(0.006)		(0.007)		(0.145)		(0.173)	
HHI		-0.269***		0.966***		-1.713***		4.713***
		(0.021)		(0.026)		(0.636)		(0.757)
Penalty	0.008	0.024***	0.103***	0.033***	-2.343*	-0.619	4.094***	1.630***
	(0.015)	(0.009)	(0.019)	(0.011)	(1.288)	(0.427)	(1.295)	(0.460)
CR4 X Penalty	0.189***		-0.437***		5.945**		-9.220***	
	(0.041)		(0.051)		(2.824)		(2.857)	
HHI X Penalty		0.928***		-1.576***		10.336**		-18.029***
		(0.146)		(0.183)		(4.367)		(4.681)
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
N	12,365,342	12,365,342	12,297,482	12,297,482	215,820	215,820	214,810	214,810
R^2	0.79	0.79	0.25	0.25	0.00	0.00	0.03	0.03

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the relationship between local market concentration and mortgage pricing, allowing the effect of concentration to differ between mortgages with and without prepayment penalties through an interaction term. Columns (1)–(4) report OLS estimates and Columns (5)–(8) report IV estimates. The dependent variable is the interest rate in Columns (1), (2), (5), and (6), and upfront lender fees in Columns (3), (4), (7), and (8). Local market concentration is measured using either CR4 or HHI, as indicated, and each specification includes the interaction between concentration and an indicator for the presence of a prepayment penalty. All specifications include loan controls, county controls, lender fixed effects, county fixed effects, and year fixed effects. Standard errors are reported in parentheses.

Table G.5: Robustness: Controlling for interest rates

	Including points				Zero points			
	HMDA		HMDA-GSE		HMDA		HMDA-GSE	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CR4	0.312***		0.134***		0.097**		0.150***	
	(0.038)		(0.038)		(0.039)		(0.041)	
Interest rate	-0.006**	-0.006**	-0.399***	-0.399***	0.053***	0.053***	0.017***	0.017***
	(0.003)	(0.003)	(0.006)	(0.006)	(0.003)	(0.003)	(0.005)	(0.005)
HHI		0.965***		0.209***		0.325***		0.247***
		(0.120)		(0.062)		(0.096)		(0.064)
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓			✓	✓		
Month FE			✓	✓			✓	✓
FICO bin FE			✓	✓			✓	✓
N	12,260,411	12,260,411	2,978,006	2,978,006	3,511,441	3,511,441	731,557	731,557
R^2	0.25	0.25	0.30	0.30	0.48	0.48	0.33	0.33

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the results from a modified version of equation (9), where the outcome variable is the amount of lender fees and the interest rate is included as an independent variable. Clustered standard errors are in parentheses. The sample is the 2018-2023 HMDA dataset.

Table G.6: Prepayment Penalties: Historical Sample

	No penalty		Prepayment penalty	
	(1) Rates	(2) Rates	(3) Rates	(4) Rates
HHI	0.377		2.415***	
	(0.266)		(0.522)	
CR4		0.059		0.730***
		(0.131)		(0.222)
Loan controls	✓	✓	✓	✓
County controls	✓	✓	✓	✓
County FE	✓	✓	✓	✓
Origination date FE	✓	✓	✓	✓
N	2,610,590	2,610,590	514,399	514,399
R^2	0.51	0.51	0.35	0.35

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows the results from equation (9) using the 1990-2017 sample from Black Knight. In Columns (1) and (2), the sample includes loans from the Black Knight dataset that do not have prepayment penalties. In Columns (3) and (4), the sample includes loans from the Black Knight dataset that have prepayment penalties. Note that the Black Knight dataset does not include lender identifiers, so we cannot include lender fixed effects. Clustered standard errors are in parentheses.

Table G.7: First Stage Results

Panel A: Failed Lender IV

	(1) HHI	(2) CR4	(3) HHI	(4) CR4	(5) HHI	(6) CR4
Wachovia share	-0.048***	-0.228***				
	(0.011)	(0.045)				
CoWi & WaMu share			-0.151***	-0.587***		
			(0.007)	(0.028)		
All lenders share					-0.144***	-0.562***
					(0.006)	(0.025)
Loan controls	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓
N	12,061,303	12,061,303	12,339,373	12,339,373	12,339,424	12,339,424
R^2	0.42	0.45	0.42	0.47	0.42	0.47
Kleibergen Paap F-statistic	19	25	463	448	535	522

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel B: Merger IV & Anti-predatory law index IV

	(1) HHI	(2) CR4	(3) Penalty	(4) Penalty X HHI	(5) Penalty	(6) Penalty X CR4
Merger	0.009***	0.040***				
	(5.57)	(4.49)				
Anti-predatory law index			0.025***	0.001***	0.043***	0.010***
			(4.64)	(4.24)	(4.23)	(3.67)
Anti-predatory law index X HHI			-0.166***	-0.000		
			(-3.22)	(-0.09)		
Anti-predatory law index X CR4					-0.077***	-0.014**
					(-3.36)	(-2.08)
Loan controls	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓
Year FE	✓	✓				
Lender FE	✓	✓				
County FE	✓	✓				
Month FE			✓	✓	✓	✓
FICO bin FE			✓	✓	✓	✓
N	215,744	215,744	1,663,167	1,663,167	1,663,167	1,663,167
R^2	0.91	0.93	0.16	0.13	0.16	0.15
Kleibergen Paap F-statistic	31	20	13	13	13	13

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the first stage results from the three instruments. Panel A shows the first stage results for the Failed Lender IV. Columns (1) and (2) show the results when the independent variable is the market share of Wachovia, Columns (3) and (4) when it is the combined market share of Countrywide and Washington Mutual, and Columns (5) and (6) when it is the combined market share of all three lenders. Panel B shows the first stage results for the Incidental Merger IV (Columns (1) and (2)) and the Anti-predatory law index IV (Columns (3)-(6)).

Table G.8: Additional IV results: Anti-Predatory Law Index

	Baseline OLS		Anti-predatory IV	
	(1) Rates	(2) Rates	(3) Rates	(4) Rates
HHI	-0.611***		-2.110**	
	(0.191)		(0.887)	
Penalty	0.279***	0.141*	-0.240	-1.085
	(0.042)	(0.079)	(0.621)	(1.024)
HHI X Penalty	3.052***		21.785**	
	(0.536)		(9.540)	
CR4		-0.217***		-0.719**
		(0.080)		(0.342)
CR4 X Penalty		0.857***		5.834**
		(0.202)		(2.915)
Sample	BK	BK	BK	BK
Loan controls	✓	✓	✓	✓
County controls	✓	✓	✓	✓
Month FE	✓	✓	✓	✓
FICO bin FE	✓	✓	✓	✓
Lender FE	1,740,325	1,740,325	1,660,452	1,660,452
County FE	0.52	0.52	0.06	0.06

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table shows OLS and IV results using the 1990-2017 sample from Black Knight. Columns (1) and (2) report OLS estimates when including an interaction effect between local concentration and the prepayment penalty indicator. Columns (3) and (4) reports second stage results when using the Anti-Predatory Law Index from Bostic et al. (2012) as an instrument for the prevalence of prepayment penalties. Note that the Black Knight dataset does not include lender identifiers, so we cannot include lender fixed effects. Similarly, the index is at the state level, so we cannot include county fixed effects. Clustered standard errors are in parentheses.

Table G.9: Instrument robustness I: Controlling for interest rates

	Failed Lender IV				Incidental Merger IV			
	First stage		IV		First stage		IV	
	(1) CR4	(2) HHI	(3) Fees	(4) Fees	(5) CR4	(6) HHI	(7) Fees	(8) Fees
Share failed	-0.228***	-0.048***						
	(0.045)	(0.011)						
Interest rate	0.001***	0.000***	-0.005	-0.006	-0.001	-0.000	-0.011*	-0.011*
	(0.000)	(0.000)	(0.018)	(0.018)	(0.000)	(0.000)	(0.006)	(0.006)
CR4			2.793***				1.082**	
			(0.731)				(0.498)	
HHI				13.124***				4.746**
				(3.734)				(1.858)
Incidental merger					0.040***	0.009***		
					(0.009)	(0.002)		
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓				
County FE					✓	✓	✓	✓
N	12,047,410	12,047,410	11,969,502	11,969,502	215,576	215,576	214,417	214,417
R^2	0.45	0.42	-0.00	-0.03	0.93	0.91	0.03	0.03
F-stat	25	19			20	31		

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results from a modified version of the IV specification that includes the interest rate as an independent variable. Columns (1) and (2) show the first stage and Columns (3) and (4) the second stage for the Failed Lender IV (equation 12). Columns (5) and (6) show the first stage and Columns (7) and (8) the second stage for the Incidental Merger IV (equation 11). Clustered standard errors are in parentheses.

Table G.10: Instrument robustness II: Alternative lenders

	Countrywide & Washington Mutual				All Failed Lenders			
	First stage		IV		First stage		IV	
	(1) CR4	(2) HHI	(3) Fees	(4) Fees	(5) CR4	(6) HHI	(7) Fees	(8) Fees
Without Wachovia	-0.587***	-0.151***						
	(0.028)	(0.007)						
CR4			1.466***				1.534***	
			(0.192)				(0.189)	
HHI				5.695***				6.006***
				(0.746)				(0.734)
With Wachovia					-0.562***	-0.144***		
					(0.025)	(0.006)		
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓	✓	✓
N	12,339,373	12,339,373	12,259,842	12,259,842	12,339,424	12,339,424	12,259,893	12,259,893
R^2	0.47	0.42	0.03	0.03	0.47	0.42	0.03	0.02
F-stat	448	463			522	535		

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results from the Failed Lender IV specification using different sets of failed lenders. Columns (1)-(4) show the first and second stage results using only Countrywide and Washington Mutual, while Columns (5)-(8) show the results using all three failed lenders. Clustered standard errors are in parentheses.

Table G.11: Instrument robustness III: Alternative samples

	Zero points				HMDA-GSE			
	First stage		IV		First stage		IV	
	(1) CR4	(2) HHI	(3) Fees	(4) Fees	(5) CR4	(6) HHI	(7) Fees	(8) Fees
Share failed	-0.539***	-0.140***			-0.285***	-0.184***		
	(0.028)	(0.007)			(0.044)	(0.024)		
CR4			1.151***				1.311***	
			(0.176)				(0.433)	
HHI				4.421***				2.025***
				(0.678)				(0.667)
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓				
Month FE					✓	✓	✓	✓
FICO bin FE					✓	✓	✓	✓
N	3,561,690	3,561,690	3,514,090	3,514,090	2,984,147	2,984,147	2,977,650	2,977,650
R^2	0.52	0.48	0.11	0.10	0.35	0.24	0.06	0.07
F-stat	366	360			41	58		

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results from the IV specifications using alternative sample. In Columns (1)-(4), the sample includes loans with zero discount points, and in Columns (5)-(8), the sample includes the HMDA-GSE sample. Columns (1), (2), (5), and (6) show the first stage for the Failed Lender IV and Columns (3), (4), (7), and (8) show the second stage results. Clustered standard errors are in parentheses.

Table G.12: Instrument robustness IV: Alternative threshold values

Panel A: Failed Lender IV

	First stage					IV				
	(1) CR4	(2) CR4	(3) CR4	(4) CR4	(5) CR4	(6) Fees	(7) Fees	(8) Fees	(9) Fees	(10) Fees
Share failed	-0.566***	-3.914***	-2.720***	-1.233***	-0.749***					
	(0.025)	(0.180)	(0.049)	(0.038)	(0.029)					
CR4						1.526***	0.431***	0.717***	1.331***	1.311***
						(0.188)	(0.108)	(0.067)	(0.145)	(0.174)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sample filter	None	5%	10%	15%	20%	None	5%	10%	15%	20%
N	12,354,039	525,084	3,088,814	8,253,900	11,357,230	12,274,043	522,602	3,070,464	8,202,940	11,287,074
R^2	0.48	0.47	0.59	0.54	0.49	0.03	0.08	0.06	0.04	0.04
F-stat	521	469	3,089	1,051	642					

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel B: Merger IV

	First stage						IV					
	(1) CR4	(2) CR4	(3) CR4	(4) CR4	(5) CR4	(6) CR4	(7) Fees	(8) Fees	(9) Fees	(10) Fees	(11) Fees	(12) Fees
Incidental merger	0.040***	0.038***	0.173***	0.021***	0.038***	0.173***						
	(0.009)	(0.012)	(0.019)	(0.007)	(0.012)	(0.019)						
CR4							1.080**	1.916**	0.973	1.954**	1.898**	0.973
							(0.497)	(0.775)	(0.989)	(0.752)	(0.767)	(0.989)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Loan controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Filter 1	1%	2%	5%	1%	2%	5%	1%	2%	5%	1%	2%	5%
Filter 2	2%	2%	2%	5%	5%	5%	2%	2%	2%	5%	5%	5%
N	215,744	69,826	1,182	357,945	70,561	1,182	214,576	69,511	1,174	356,123	70,163	1,174
R^2	0.93	0.95	0.91	0.95	0.95	0.91	0.03	0.03	0.06	0.04	0.03	0.06
F-stat	20	10	88	9	10	88						

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports the results from estimating the two instruments under different sample filters. Panel A reports the failed lender IV and Panel B the Merger IV. In Panel A, the "Sample Filter" row represents the threshold value for which counties to include in the sample. For example, in Columns (2) and (7) we include only counties where the failed lender share is between 0 and 5%. In Panel B, the two rows "Filter 1" and "Filter 2" refers to our sample filters. Filter 1 keeps only counties where each lender in the merger is involved in X percent of the total mortgage originations in the county. Filter 2 keep only counties where the county contributes no more than X percent of each lender's mortgage originations in the given year.

Table G.13: Expected Present Value

	OLS		IV: 1st Stage		IV: 2nd Stage	
	(1) E[PV]	(2) E[PV]	(3) HHI	(4) CR4	(5) E[PV]	(6) E[PV]
HHI	3.678***				19.677***	
	(0.373)				(7.101)	
CR4		1.111***				4.188***
		(0.115)				(1.444)
Share failed			-0.048***	-0.228***		
			(0.011)	(0.045)		
Loan controls	✓	✓	✓	✓	✓	✓
County controls	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓
N	12,260,416	12,260,416	11,969,502	11,969,502	11,969,502	11,969,502
R^2	0.79	0.79	0.42	0.45	0.00	0.01
F-stat			19	25		

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results from the robustness analysis where the outcome variable is the combined proxy for the expected value of the mortgage. Columns (1) and (2) show the OLS coefficients, Columns (3) and (4) the first stage results, and Columns (5) and (6) the second stage results. Clustered standard errors in parentheses. The dataset is the 2018-2023 HMDA data.

Table G.14: Familiar with Upfront Fees?

	Familiar with money at closing		
	(1)	(2)	(3)
High school graduate	-0.005		
	(0.035)		
Technical school	0.003		
	(0.038)		
Some college	0.005		
	(0.032)		
College graduate	0.027		
	(0.031)		
Postgraduate studies	0.020		
	(0.030)		
Education Level		0.007***	
		(0.002)	
Credit Score			0.031***
			(0.005)
Year FE	✓	✓	✓
Demographics FE	✓	✓	✓
N	21,621	21,621	21,621
R^2	0.08	0.08	0.09

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results an OLS using the NSMO database. The dependent variable is a dummy variable indicating whether the borrower is either *very familiar* or *somewhat familiar* with the money needed at closing. (This corresponds to question *x05g* taking the values 1 or 2.) In Column (1), the main independent variables are dummy variables indicating the level of education, where the omitted group is the lowest level of education ("Some Schooling"). In Column (2), the independent variable is the education level. In Columns (3), the independent variable is the borrowers VantageScore at origination, where the coefficient is scaled to represent the effect of a one-standard-deviation change in the credit score. Each regression includes a year fixed effect and the following demographic control variables: age, age-squared, a dummy variable indicating whether this is the first mortgage, marital status, sex, ethnicity, and race. Standard errors (in parentheses) are clustered at the survey-wave level.

Table G.15: Mortgage Shopping Behavior

	Number of brokers/lenders			More than one broker/lender		
	(1)	(2)	(3)	(4)	(5)	(6)
High school graduate	0.134**			0.079**		
	(0.051)			(0.036)		
Technical school	0.229***			0.137***		
	(0.045)			(0.029)		
Some college	0.223***			0.147***		
	(0.049)			(0.032)		
College graduate	0.331***			0.209***		
	(0.045)			(0.030)		
Postgraduate studies	0.417***			0.244***		
	(0.047)			(0.030)		
Education Level		0.074***			0.043***	
		(0.007)			(0.004)	
Credit Score			0.077***			0.038***
			(0.012)			(0.006)
Year FE	✓	✓	✓	✓	✓	✓
Demographics FE	✓	✓	✓	✓	✓	✓
N	21,621	21,621	21,621	21,621	21,621	21,621
R^2	0.03	0.03	0.02	0.03	0.02	0.02

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the results an OLS using the NSMO database. In Columns (1)–(3), the dependent variable is the number of brokers or lenders that the borrower seriously considered. (This corresponds to question *x11*.) In Columns (4)–(6), the dependent variable is a dummy variable taking the value one if the borrower considered more than one broker/lender. In Columns (1) and (4), the main independent variables are dummy variables indicating the level of education, where the omitted group is the lowest level of education ("Some Schooling"). In Columns (2) and (5), the independent variable is the education level. In Columns (3) and (6), the independent variable is the borrowers VantageScore at origination, where the coefficient is scaled to represent the effect of a one-standard-deviation change in the credit score. Each regression includes a year fixed effect and the following demographic control variables: age, age-squared, a dummy variable indicating whether this is the first mortgage, marital status, sex, ethnicity, and race. Standard errors (in parentheses) are clustered at the survey-wave level.