Frictions in Mortgage Refinance Choices: Evidence from Federal Housing Administration Mortgages

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November 2025

Abstract

Households with a Federal Housing Administration (FHA) loan who refinance to a new FHA loan may overpay on their mortgage. I study frictions involved in mortgage refinance product choices. Using loan level data, I find that about 40% of FHA-to-FHA refinancers during 2009-2020 could have saved approximately $110 (10%) per month and $2,957 upfront by switching to a conventional Government Sponsored Enterprise (GSE) loan at refinance. Minority and low-income FHA borrowers are less likely to make the switch. These borrowers continue to pay an avoidable mortgage insurance premium (MIP), even though their property value appreciation are qualified for a GSE loan, since they do not reassess their property value when refinance. I then examine both demand-side and supply-side channels to explain these frictions. On the demand side, I find that property value information updates can reduce refinance frictions. Households who received an updated property tax bill are more likely to refinance to a GSE loan. On the supply side, I demonstrate that lenders may prefer FHA-to-FHA refinance loans due to higher upfront fees and securitization revenue. An exogenous increase in lenders' revenue (cost) of originating FHA loans results in less (more) refinance to GSE mortgages.

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I   Introduction

Mortgage refinance has been a key channel for transmitting monetary policy to the household sector. Frictions in mortgage refinance have been widely discussed in the literature (e.g., Keys et al., 2016; Di Maggio et al., 2017; Andersen et al., 2020). However, most of the literature focuses on how households decide *whether* or *when* to refinance, based on changes in interest rate. In this paper, I investigate a new aspect of refinancing decisions, namely, the choice of mortgage refinance products. I emphasize that households should also refinance based on changes in their risk profile. Specifically, households should decide which type of mortgage loan they refinance to, based on changes in their property value. There are significant frictions in this decision as well, causing borrowers to overpay on their mortgages.

Federal Housing Administration (FHA) mortgages are particularly well-suited for studying frictions involved in refinancing product choices. FHA charges borrowers higher risk premium through mortgage insurance, to compensate the default risk associated with low down payment. When FHA mortgage borrowers refinance, they have the option to switch products to reduce their risk premium by removing mortgage insurance. FHA mortgages have comprised 28% of all owner-occupied home mortgages—totalling $1.3 trillion—from 2009 to 2017, and are more prominent for minority, low-to-moderate income and first time home-buying households.[1] Despite their prominence, the FHA market is less studied in the research literature compared to the conventional mortgage market, particularly regarding how FHA borrowers' mortgage choices differ from other borrowers.

My research specifically answers the following questions: What product do FHA borrowers choose to refinance to, when interest rates and property values change, given that they have the option to switch from FHA to Government-sponsored Enterprises (GSE) mortgage? What are the factors that explain FHA refinance product choices, and how can regulators respond to reduce these financial market frictions?

To answer these questions, I examine the population of FHA borrowers who purchased single-family residential property after 2009 and subsequently refinanced their mortgages

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[1]https://www.clevelandfed.org/newsroom-and-events/publications/economic-trends/2015-economic-trends/et-20150414-fha-lending-rebounds-in-wake-of-subprime-crisis.aspx

before 2020. In this sample period, 60% of FHA borrowers refinanced to a new FHA loan, while 40% of FHA borrowers switched to a GSE loan. The decision to stay with an FHA mortgage or switch to a GSE mortgage can significantly impact monthly payments. Refinance to a conventional GSE loan removes the Mortgage Insurance Premium (MIP), which adds about 1% to the mortgage rate, and has to be paid for the entire lifetime of the mortgage. To be qualified for the switch, borrowers need to have at least 20% equity in the property at the time of origination. This loan-to-value (LTV) requirement can be achieved through home value appreciation. On the contrary, FHA-to-FHA refinances are conducted through the FHA Streamline Refinance program, which has a "no reassessment" feature intended to protect underwater households. Since properties were not reassessed, the LTV used in FHA-to-FHA refinances does not reflect changes in the property value. This results in FHA borrowers staying with FHA mortgages at refinance may overpay on their mortgage rate, because they overpay on their risk premium.

These frictions in FHA refinance choices are substantial, resulting in sizeable costs to FHA borrowers. Using a hedonic model to predict counterfactual property equity growth, I find that 40% of the FHA borrowers who refinanced to a new FHA loan were eligible for a GSE loan. Switching to GSE loans at refinance would save them on average $110 (10%) monthly and $2,957 upfront on mortgage payments by eliminating the MIP. This represents 1.7% of the household income of an average FHA borrower. I also find that these frictions in mortgage choices were more prevalent among minority and low-income borrowers. Black FHA borrowers are 12% less likely to refinance to GSE loans when eligible. FHA borrowers with income in the lowest quartile of the population are 23% less likely to refinance to GSE loans when eligible.

To understand these frictions, I specifically examine two main channels from the demand side and the supply side. From the demand side, frictions may arise if households are not aware of their property value change. Property value is the key factor determining the eligibility for FHA-to-GSE refinance. To test how property value information affects refinance choices, I examine the exogenous shock of tax reassessment events in states where property taxes are infrequently updated. I find that after receiving a new property tax bill indicating the increase of their property value, eligible households are 12% more

likely to refinance their FHA mortgage to a GSE mortgage.

From the supply side, I examine the variation in FHA refinance choices across lenders, and how FHA refinance choice outcomes change when lenders' incentives change. Lender fixed effects explain about 10% variation in FHA refinance choices. FHA borrowers are 13% less likely to refinance to a GSE loan when they refinance with a nonbank lender. I further discuss potential incentives for lenders to prefer originating FHA-to-FHA refinance loans than FHA-to-GSE refinance loans. Lenders charge higher upfront origination fees to FHA refinance loans. FHA refinance loans can be sold at a higher price in the secondary market. To show the causal relationship between lender incentives and FHA refinance choices, I tested how two policy shocks affected FHA refinance choices, through their effects on lenders' revenue and cost of originating FHA loans. Specifically, when new regulations granted FHA mortgages preferred status in Liquidity Coverage Ratio calculations, affected eligible FHA borrowers became less likely to refinance to GSE loans. The usage of the False Claim Act against bank lenders, increased the probability for affected eligible FHA borrowers to refinance to a GSE loan.

My research contributes to several strands of the literature. First, it extends the classic literature on mortgage choice by incorporating risk premium (mortgage insurance) as an additional factor. Previous work by Stanton (1995), Stanton and Wallace (1998), and Agarwal et al. (2013) provides frameworks to analyze optimal mortgage choice based on assumptions about interest rate dynamics and expected mortgage rate distributions. I argue that factors determining risk premium (for example, LTV) should also enter the choice function. Especially in the context of the FHA mortgage market, because mortgage insurance premium costs are a significant component of mortgage costs.

Second, my research provides new empirical evidence of households deviating from optimal mortgage refinance choices, complementing work by Keys et al. (2016), Agarwal et al. (2016) and Andersen et al. (2020). Keys et al. (2016) documented the fact that about 20% of households failed to refinance and save $160 per month. Andersen et al. (2020) used Danish data to show there is a psychological cost related to inaction behavior in mortgage refinance, and the degree of inaction is related to multiple demographic characteristics including age, education, and wealth. My research shows that households still leave money

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on the table when they choose to refinance, due to the additional feature in FHA mortgage refinance choice mentioned above. I also find demographic characteristics are correlated with this specific suboptimal choice.

Third, my research examines the role of lenders' strategies in the FHA market, contributing to the literature on the industrial organization of financial intermediaries. Kim et al. (2018), Buchak et al. (2018), Jiang (2019), and Benetton et al. (2021) discuss various aspects of lender competition in the mortgage market, including warehouse lending channels, cannibalization effects, fintech technology, and competition for profit on different dimensions of financial product features. I illustrate that the mortgage refinance choice outcome is correlated with lenders, especially when financial products are more complicated, when borrowers have less information, and when lenders have more market power.

Finally, my research contributes to the discussion on the heterogeneity of macro policy pass-through. Previous work by Wong (2019), Beraja et al. (2019), Auclert (2019), Di Maggio et al. (2020), Berger et al. (2021), and Zhang (2022) examine the refinance channel for the transmission of monetary policy and its heterogeneity with respect to demographic characteristics and regional variation. Wong (2019) studies age-based heterogeneity in consumption effects. Di Maggio et al. (2020) find that central bank MBS purchases increase refinancing activity and aggregate consumption. Berger et al. (2021) show how refinancing decisions depend on both current interest rates and their expected path. Benetton et al. (2021) discuss how lenders react to a reduced interest rate by increasing mortgage fees and how this impacts the welfare allocation between borrowers and lenders. While previous research focuses on the decision of *whether* to refinance, I show that given people have refinanced, there is still substantial heterogeneity of payment savings, because households still need to decide *what* to refinance to. Thus interest rate policies may create mortgage payment gaps in frictional financial markets.

The rest of this paper proceeds as follows. Section II introduces the institutional background of the FHA mortgage market, the choice problem of borrowers and the dataset. Section III presents stylized facts about FHA refinance choices and quantifies suboptimal decision patterns. Section IV examines the robustness of the estimation

and heterogeneity of my results. Section V examines the demand-side factors, focusing on how information frictions influence borrowers' decisions. Section VI investigates the supply-side factors, focusing on how lender incentives influence refinance outcomes. Section VII discusses policy implications and concludes.

II Institutional Background of FHA Mortgages

(i) FHA Mortgages

Established under the U.S. Department of Housing and Urban Development (HUD) by the National Housing Act of 1934, the Federal Housing Administration (FHA) aims to increase homeownership accessibility, particularly for first-time and low-to-moderate income buyers, by insuring mortgages with more lenient credit requirements. As the subprime mortgage market collapsed during the 2008 financial crisis, FHA-insured loans experienced a surge in popularity. FHA mortgages account for 28.1% of total home purchase loan amount (32.6% of loan count) in 2009, according to U.S. Department of Housing and Urban Development calculations. [2] Over the last decade, FHA loans consistently represent over 20% of the mortgage market. 49.7% Low-to-Moderate Income (LMI) borrowers (income less than 80% of area median income), and 41.9% borrowers under 35 use FHA mortgages to buy their first home.[3] The FHA's unique institutional settings make it a particularly intriguing area of study, offering insights into government intervention in housing finance and household mortgage decisions for marginal homebuyers.

The LTV requirement for a conventional GSE loan is 80% (20% down payment).[4] FHA loans offer more lenient requirements compared to conventional mortgages. Applicants can qualify with a LTV of up to 96.5% (3.5% down payment). Additionally, the

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[2]https://www.hud.gov/program_offices/housing/rmra/oe/rpts/fhamktsh/fhamktqtrly

[3]https://www.urban.org/sites/default/files/2023-07/Housing-Finance-At-A-Glance-Monthly-Chart-book-July-2023.pdf

[4]Borrowers can also get a GSE loan with LTV greater than 80% by purchasing private mortgage insurance. Recent industry reports suggest that FHA mortgages are cheaper for borrowers with LTV over 90%, after comparing rates and fees, and almost all of the borrowers in my sample fall in this LTV range, thus the competition between private mortgage insurance market and the FHA mortgage market should not be a concern for the scope of this paper.

minimum credit score for FHA-insured mortgages is 500, significantly lower than the 620 typically required for conventional GSE loans. However, for the majority of households, the down payment requirement tends to be the primary limiting factor rather than the credit score threshold.

To compensate for the increased default risk associated with high LTV, the FHA charges a risk premium in the form of mortgage insurance premium. This mortgage insurance premium is composed of two parts: an upfront mortgage insurance premium (UFMIP) and a monthly mortgage insurance premium (MIP). Both UFMIP and MIP are uniform to all FHA borrowers across the U.S. applying in the same period. This mortgage insurance premium is required for the entire lifetime of the mortgage, unless the FHA loan is prepaid. The level of the insurance premium has changed several times in the past decade, with an increase right after the 2008 financial crisis and a decrease recently (See Table A.1). [5]

(ii)   FHA Refinance Choice

The choice problem for FHA borrowers can be more complicated than for conventional GSE borrowers. As illustrated in Figure 1, there are four components that determine the rate a mortgage borrower actually pays.

$$P_{i,j,t,m} = R_t + Q_{i,m,t} + I_{i,m,t} + \eta_{i,j}$$

Where $P_{i,j,t,m}$ represents the total mortgage rate paid by borrower i for mortgage product m originated by lender j at time t. R_t is the baseline long-term rate, which reflects the funding cost for lenders to originate a mortgage. This usually depends on macroeconomic policy, such as, the change in the Federal Funds Rate and the effect of RMBS purchasing programs. In this context, R_t is approximately the same across lenders. $Q_{i,m,t}$ is the risk premium associated with borrower, usually a function of credit score, LTV ratio and Debt-to-Income (DTI) ratio. A commonly used pricing function is the Loan Level Price Adjustment table (LLPA) from the Federal National Mortgage

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[5]On February 22, 2023, the U.S. Department of Housing and Urban Development (HUD) announced a 30 basis points reduction in the FHA's annual mortgage insurance premium.

Association (FNMA) and the Federal Home Loan Mortgage Corporation (FHLMC). $I_{i,m,t}$ is the mortgage insurance premium that applies when the LTV is greater than 80%. This insurance protects the mortgage security investors in the event of default. For FHA mortgage this will be the UFMIP and MIP discussed in the previous section. For GSE mortgage this will be the price of private mortgage insurance. Finally $\eta_{i,j}$ reflects the mark-up charged by the lender. This term typically depends on the market structure of the local lenders, as well as the shopping behavior and bargaining power of the borrowers.

In the literature studying mortgage refinance choices, the choice problem of a mortgage borrower is a function of the mortgage rate of the previous loan and the mortgage rate at the time of refinance, for example in Agarwal et al. (2013). Previous studies typically estimated this rate difference using only changes in the Federal Funds Rate or Primary Mortgage Market Survey (PMMS) rate, which captures only changes in the baseline R_t. The borrower's choice function would be:

$$V_t(r_0, i) - V_t(r_t, i) - c_{i,t} \geq \delta_{i,t}$$

$V_t(r_0, i)$ represents the discounted value of all remaining future mortgage payments for individual i at time t when the existing mortgage rate is r_0. $V_t(r_t, i)$ represents the discounted value of all future mortgage payments for individual i at time t if they refinance the existing mortgage to a new mortgage at rate r_t. The benefit of refinance minus the cost of refinance $c_{i,t}$ should be greater or equal to a certain threshold $\delta_{i,t}$ for individual i for the mortgage refinance to happen.

While this model effectively approximates refinancing choices for conventional GSE mortgages, FHA borrowers face a more complicated choice:

$$V_t(R_0 + Q_0 + I_0, i) - V_t(R_t + Q_t + I_t, i) - c_{i,t} \geq \delta_{i,t}$$

Where

$$Q_0 + I_0 = f(FICO_0, LTV_0)$$

$$Q_t + I_t = f(FICO_t, LTV_t)$$

$$c_{i,t} = c_{i,t}^r + c_{i,t}^I$$

Compared to the previous case, the new mortgage rate change depends on both change in long term risk free rate and borrower specific risk premium, which is a function of the borrowers' credit score and LTV. The upfront cost of refinance has the component of regular processing cost and UFMIP cost if refinance to a new FHA mortgage. It's safe to assume this part is small enough to ignore in most of the conventional GSE refinance cases, but the magnitude of mortgage payment and upfront cost reductions from the change in risk premium can be substantial for FHA refinances.

The major friction in overpaying FHA mortgages after refinance is from the MIP. An FHA borrower who qualifies for a conventional GSE mortgage should refinance to a GSE mortgage and avoid the continued payment of the FHA MIP. The primary factor typically constraining FHA borrowers is the LTV, which is closely related to the equity amount on their home balance sheet. In the absence of a substantial cash influx, it generally takes approximately 10 years for a FHA mortgage, initially at 96.5% LTV, to accumulate 20% equity through amortization from monthly payments alone. It is crucial to note that amortization is not the sole mechanism by which homeowners can build equity. Property value appreciation, particularly common in a thriving economy, also contributes to lowering the LTV. The FHA program was designed to enable low-to-moderate income households to invest in real estate with lower entry costs. These homeowners should benefit from property value growth, not only through capital gains in real estate value, but also through reduction in their borrowing costs. Specifically, FHA borrowers who experience enough property value growth may become eligible to refinance their FHA mortgages into conventional GSE mortgages. This switch result in considerable long-term savings by eliminating MIP.

(iii)   The FHA Streamline Refinance Program

When borrowers refinance, are they not required to reassess their property value? Not for FHA-to-FHA refinances. One important feature of FHA-to-FHA refinances is the FHA Streamline Refinance Program. This program is designed to facilitate the refinance of an existing FHA-insured mortgage, by waiving some documentation requirements, including reassessment of the property value. There are several rules that apply to FHA streamline refinances. First, the FHA loan must be originated at least 6 months ago. Second, the FHA loan must be current (not delinquent). Third, regular cash out refinance can not be taken through the FHA Streamline Refinance program, since there is a $500 cap on cash out amount.

A prominent feature of the FHA streamline refinance program is that it waives the appraisal requirement. This provision was purposefully designed to protect underwater borrowers during economic downturns, enabling them to refinance their FHA loans even with declining property values. Under this program, borrowers use the original property value from the time of purchase for the new loan, irrespective of current market conditions. This mechanism also serves the countercyclical nature of FHA lending by mitigating further downward pressure on the housing market that could result from FHA borrowers defaulting and selling their properties.

The borrowers have to pay the upfront mortgage insurance premium (UFMIP) again for the new FHA mortgage under FHA streamline refinance program. Even though there exists a "UFMIP refund", the refund benefit diminishes fast over time. Figure A.2 illustrates the UFMIP refund schedule as a function of time since origination of the FHA mortgage. FHA borrowers only get 10% of the UFMIP back if they refinance 32 months (median time to refinance) after the initial loan was originated.[6]

In summary, for FHA borrowers who meet the eligibility criteria for GSE mortgages, the refinance choice has significant financial implications. Opting for an FHA-to-FHA refinance through the FHA streamline refinance program, while seemingly more convenient, generally results in higher overall costs compared to refinance to a GSE loan with a new property appraisal. This cost differential comes in two primary ways: first, in

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[6]See https://www.hud.gov/sites/documents/4155-2_7.pdf for details about UFMIP refund.

the immediate UFMIP, and second, in the long term through the monthly MIP.

(iv) Data

My analysis compares borrowers' credit status and mortgage loan characteristics between home purchase and refinance. This information is from Black Knight McDash mortgage servicing data (hereafter referred to as the McDash data). The McDash data is a comprehensive database of mortgage performance and servicing. It collects information from mortgage servicers and covers about 80% of mortgages in the U.S., providing information on loan amount, interest rates, credit scores, property values, LTV, product types and other information. The McDash data also tracks the performance of each mortgage monthly until the mortgage is prepaid or foreclosed.

One limitation of the McDash data is that it is anonymized at the loan level. When a borrower refinances and prepays a loan, researchers can not identify which new loan prepays the old loan. To connect the refinance loan with the prepaid loan, I merged the McDash data with the ATTOM recorder data following Bartlett et al. (2021), by exploiting overlapping variables with a statistical-learning algorithm. The ATTOM data collects data from local recorder and assessor offices, provides transaction records of each property, as well as lender identities. The ATTOM data also provides information on property characteristics that are essential to estimate pricing models for counterfactual market price, including location, number of bedrooms and bathrooms, square footage, year the property was built and other variables.

To enrich my analysis, I also incorporated additional borrower characteristics data from HMDA, dynamic credit score and income from Equifax, MBS price estimate from TRACE and eMBS. The Home Mortgage Disclosure Act (HMDA), mandated by federal law since 1975, requires financial institutions to maintain, report, and publicly disclose loan-level information about mortgage applications and decisions. HMDA covers approximately 90 percent of US mortgage originations. It contains mortgage information and location that enables researchers to merge it with the above datasets. This additional borrower information—borrower race, gender and income—is used in my analysis. Equifax is one of the three commonly used credit bureaus in the U.S. They provide and maintain

their proprietary Equifax Credit Score for each borrower. Equifax updates credit scores monthly, providing a dynamic view of consumer credit status.

III   Empirical Strategy

(i)   Sample Construction

I use the population of households who purchased a single family residence house using FHA mortgage starting from 2009. This is the year right after the Great Financial Crisis and FHA mortgages become a major choice for low-to-moderate income households, due to the collapse of private label securitization market for subprime loans. I then restrict the population to every borrower who refinanced their FHA mortgage by the end of 2020. These households already overcame the inertia of refinance, worked with their lender and successfully got approved for the refinance mortgage. Focusing on borrowers who already refinanced allows me to make minimal assumptions on both the credit eligibility and refinance decision process. Borrowers' credit status at the time of refinance are observed in the data. These households also clearly care about reducing their mortgage payments. From 2009 to 2020, I end up observing 522,561 FHA borrowers who refinanced their mortgage in the McDash-ATTOM merged data. This is about half of total FHA refinances recorded, due to sample losses during the merging process. The distributions of initial FHA loan features (interest rate, loan-to-value, FICO score and property value at origination) are similar between the final sample and the sample dropped due to incomplete information (see Table B.1).

(ii)   Actual Refinance Choices

As mentioned in the previous section, the main choice these FHA borrowers have to make is whether to do an FHA streamline refinance and stay with an FHA mortgage, or do a reassessment of their property and refinance to a conventional GSE mortgage, and remove their MIP. Among all the 522,561 FHA borrowers who refinanced their mortgage during 2009 and 2020, 216,080 refinanced to a GSE loan and 306,481 refinanced to an FHA loan.

Table 1 compares the summary statistics of the variables used in my analysis between the two groups. Panel A summarizes the FHA borrowers who refinanced to a GSE mortgage and Panel B summarizes the FHA borrowers who refinanced to a new FHA mortgage. Table 1 presents the following stylized facts.

First, both FHA-to-FHA and FHA-to-GSE groups experience a drop in mortgage payment and interest rate after refinance. This indicates that borrowers generally benefited from lower monthly payments after refinancing, consistent with people refinancing optimally. It's also important to point out that we see FHA-to-FHA refinances seem to save more on mortgage payments. This is because that a lot of the FHA-to-GSE refinances increased their loan amount at refinance to take a large amount of cash out. We can think of the additional mortgage payments for some FHA-to-GSE refinances as additional borrowing using their house as a collateral.

Second, the credit scores of FHA-to-GSE and FHA-to-FHA groups are similar at the time of purchase and refinance, with the FHA-to-GSE group having a slightly higher FICO score. Specifically, the median FHA-to-FHA refinancier have a credit score better than the 25 percentile FHA-to-GSE financier. This means these FHA-to-FHA will pass the FICO score requirements for refinancing to a GSE loan. Figure A.6 further illustrates the distribution of credit score at refinance, I will discuss credit score eligibility in later sections.

Third, FHA-to-FHA refinance happens faster than FHA-to-GSE refinance. It takes on average 35 months for an FHA loan to refinance to an FHA loan, but it takes on average 47 months for an FHA loan to refinance to a GSE loan.

Finally, the group of FHA-to-FHA refinance and FHA-to-GSE refinance exhibit similar property value at origination. But their property values on refinance documents at the time of refinance are dramatically different. Both groups start from average property value at about $250,000, but at the time of refinance, the FHA-to-FHA group on average shows 5% property value growth, while the FHA-to-GSE group experiences 20% property value growth. However, this property value growth of FHA-to-FHA refinance group does not reflect the actual property value growth and equity positions of these borrowers. As mentioned in Section II, FHA streamline refinance do not conduct a reappraisal and

cannot take cash out, so the staleness of property value is mechanical and inaccurate.

(iii)   Constructing Counterfactual Property Value Growth

Figure 2 plots the property value growth over total months from original FHA purchase loan to refinance. No matter how long has passed since the property was purchased, FHA borrowers who refinanced their mortgage through the FHA streamline refinance program report almost the same property value on their mortgage refinance application. While the group of FHA borrowers who refinanced their FHA mortgages to GSE mortgages report a substantial property value growth consistent what people would expect during the booming housing cycle of 2009-2020.

This result is mechanical, but what the property values would be for the FHA-to-FHA refinance borrowers, if they actually go through a reappraisal process? I construct a measure of property value growth using a hedonic pricing model with available data:

$$\ln(P_i) = \alpha + \beta X_i + \gamma N_i + \epsilon_i$$

Where P_i is the price of property i; X_i is a vector of characteristics of property i, including square footage, number of bedrooms and bathrooms, and year when the property was built. N_i is a vector of controls at the local level, specifically census tract by year fixed effects to control for neighborhood characteristics. ϵ_i is the error term. I first use the FHA-to-GSE refinance property value as left-hand side variable to estimate the model. I then predict the log property value for the FHA-to-FHA refinance properties. The underlying assumption is that properties with same characteristics and in the same location should on average experience the same amount of property value growth over the same period of time.

Figure 3 shows the comparison between property value growth on refinance application and property value growth I constructed using hedonic model for both the FHA-to-FHA and FHA-to-GSE refinance groups. Under the assumption that property value should be predictable by a hedonic model, the property value growth is almost identical between the two groups. The the two groups show dramatic differences in

property values on refinance application record, if the FHA-to-FHA refinance group borrowers got an reappraisal of their property, on average they should experience the same amount of property value growth as the FHA-to-GSE refinance group. More importantly, these borrowers will find themselves eligible for an FHA-to-GSE refinance and remove the MIP. I consider alternative measures of counterfactual property growth in the Section IV.

(iv) Quantifying the Magnitude of Suboptimal Choices

After constructing the counterfactual property value growth, I calculate the proportion of FHA borrowers who refinanced to another FHA loan but were potentially eligible for a GSE loan. I then quantify how much money they could have saved by switching to a GSE loan. In the baseline results, I assume the property value increase needs to be larger than 16.5%, which would make an FHA loan of 96.5% LTV eligible for a GSE loan with 80% LTV, even without any amortization happening between purchase and refinance. The FICO score at refinance should be greater than 620, the usual cutoff applied by GSE underwriters.

I then estimate the savings on mortgage payments if the identified eligible FHA borrowers actually make the switch. The results are reported in Table 2. 41% of FHA-to-FHA refinances would have been eligible for refinancing to a GSE loan. Figure 6 plots the histogram of estimated monthly and upfront savings if an eligible FHA borrower switched from an FHA streamline refinance to a GSE refinance. The mean and median savings from switching an FHA-to-FHA refinance to a FHA-to-GSE refinance are $110 and $100 dollars per month, which is about 1.7% of their household monthly income. They will also save the mean and median of $2,957 and $2,632 dollars from the upfront mortgage insurance premium cost.

This result is economically significant compared to the literature. In Keys et al. (2016), an average of $160 per month potential savings was estimated for GSE borrowers who failed to respond to decrease in interest rates. In Andersen et al. (2020), Danish households missed DKK 2,700 (USD $400) per year ($33 per month) and 58 basis points of household income in mortgage savings by not refinancing optimally. Even if the credit score and property value appreciation constraints are restricted to a very strict range, the

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data still identify more than 20% of the FHA borrowers who refinanced to an FHA loan during the sample period, leaving a large amount of money on the table. The savings is also comparable to the automatic refinance scheme estimated by Gerardi et al. (2021), where the authors estimated the average equity growth for FHA borrowers is $23,000 and refinance can save about $93 on mortgage payments.

To quantify total overpayment on suboptimal FHA refinance decisions, we need to consider how long borrowers continue to pay their refinanced mortgage before conducting a second refinance or moving out. Refinance at a time when the mortgage rate is low usually means that the interest rate level is unlikely to decrease further within a few years. In my sample during 2009 to 2019, 62% FHA borrowers who refinanced to a new FHA mortgage continued to pay the same refinance mortgage until the end of 2019. Only 16.7% FHA borrowers who refinanced to a new FHA loan conduct a second refinance. Even for those who refinanced again, the average time they keep paying their first refinance loan is longer than the average lifetime of an FHA loan, with a mean value of 44 month and a median value of 40 months. Thus, a lower bound estimate of lifetime overpayment on FHA MIP for an average FHA borrower who suboptimally refinanced to a new FHA mortgage would be $7,797.

Figures 4 and 5 illustrate the count and share of refinance choices made by FHA borrowers. These are categorized into: 1) FHA-to-GSE refinances; 2) FHA-to-FHA refinances eligible for FHA-to-GSE refinance; and 3) FHA-to-FHA refinances not eligible for FHA-to-GSE refinance. Figure 4 shows the decomposition by the year when refinancing occurred, while Figure 5 shows the decomposition by quarters since home purchase to refinance. The figures demonstrate that during the years when refinance happens more often due to low mortgage rates, there are also more FHA borrowers experience suboptimal refinance product choices. The proportion of FHA-to-FHA refinances that were eligible for FHA-to-GSE refinance slightly increased over the sample period. The trend in the first few years is consistent with the fact that property value growth is highly correlated with tenure in the property. So the longer an FHA borrower stays in their house, the more home equity they accumulate over time, and the more likely they are eligible to refinance to a GSE mortgage and reduce their mortgage payments.

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After a few years of residence, most people have already accumulated more than enough home equity to make them eligible to refinance to a GSE loan, in these situations other factors including individual specific credit shocks and influence from lenders dominate.

IV   Robustness and Heterogeneity

In the previous section, I estimated the proportion of FHA borrowers eligible for GSE refinancing and quantified their potential savings upon transitioning to a GSE mortgage. This estimation is based on counterfactual calculations of how much an FHA borrower's property value would increase following a reappraisal, which is a key factor in determining the likelihood of approval for a GSE refinance loan. In this section, I will address potential concerns regarding the robustness of this estimation. Specifically, I will present results using alternative measures of property value, credit score, and income. Furthermore, I will explore the heterogeneity in FHA refinance choices across various demographic groups.

(i)   Robustness of Property Value Estimate

First, there are concerns about the hedonic model method used to construct counterfactual property value growth. If FHA-to-FHA refinances occur without corresponding FHA-to-GSE refinances in the same neighborhood and with similar property characteristics, the estimated property value growth will closely approximate the average FHA-to-GSE refinance property value for a similar property in a different neighborhood. This might result in an upward bias for properties in less developed neighborhoods or those with certain unpopular characteristics. Additionally, while the hedonic pricing method is commonly used in appraisal practices, not all property appraisals follow this method.

To address these concerns, I use the Zillow Home Value Index as an alternative measure of property value growth. The results are shown in Figure A.4. There is a noticeable gap between the Zillow index changes for the FHA-to-FHA refinance group and the FHA-to-GSE refinance group, indicating that the aforementioned concerns exist. A proportion of the FHA-to-FHA refinance group may indeed reside in zip codes experiencing less property value growth.

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Despite the Zillow estimates showing a gap in property value growth between FHA-to-GSE and FHA-to-FHA refinance groups, most households experienced property value growth more than 16.5%, which makes them eligible to refinance to a GSE loan. Using the Zillow Home Value Index as the specification to estimate the proportion of FHA-to-FHA borrowers eligible for GSE loan refinancing does not alter the main conclusion.

Second, concerns have been raised about FHA borrowers potentially not maintaining their properties adequately. There might be characteristics not reflected in the assessor data that are endogenous to a borrower's decision not to get an appraisal, such as outdated systems, appliances, and interiors. To address this concern, I examine the subset of the FHA-to-FHA refinance group that sold their houses before the end of my sample period, comparing their sales prices to their property values at the time of refinancing.

The results are presented in Figure A.5. FHA-to-FHA refinanced households later sold their houses at significantly higher prices than their purchase values. On average, property values increase by more than 20% when they resale on the market. This growth far exceeds what is reflected in the FHA Streamline refinance profile.

This finding provide strong evidence that the selection of FHA borrowers who skip a home value appraisal and refinance to another FHA loan is unlikely to be explained by poor property maintenance. The significant appreciation in property values, even within this group, indicates that these homeowners are indeed maintaining their properties to a standard that supports considerable value growth.

(ii)   Robustness of Credit Score and Income

Additional concerns about the eligibility to refinance to a GSE mortgage could be that the credit score reported on the FHA streamline refinance profile may not be accurate. Even though the credit score I observe in McDash updates at refinance, this may be subject to bias due to inaccurate reporting practices.

To validate the FICO score and income change between purchase and refinance loans, I use an alternative data source: Equifax. Equifax Credit Risk Insight Servicing Data provides monthly panel of credit scores (Vantage Score 3.0) and income estimate. This is a separate source of borrowers' credit status. Figure A.9 and Figure A.10 plots the

binscatter of McDash credit score collected at origination and refinance, as well as McDash credit score collected at refinance and Equifax credit score at refinance. The credit score is updated from origination to refinance. The two credit score measures closely track each other. Figure A.7 shows the distribution of FICO score for FHA-FHA refinanciers and FHA-GSE refinanciers in Equifax. Similar to the result using McDash data, over 80% FHA-to-FHA refinances have their Equifax reported credit score greater than 620 at the time of refinance, the minimum requirement for GSE loan, as well as the 10% percentile of all FHA-GSE refinanciers.

Concerns about the eligibility to refinance also come from income verification. As documented in DeFusco and Mondragon (2020), FHA streamline refinances require employment verification since 2009. Figure A.8 further confirm the eligibility from borrowers' financial status by showing the distribution of income growth during FHA borrowers first purchase and refinanced their mortgages. Most people experienced an increase in income, though the FHA-to-FHA group experienced less income growth than the FHA-to-GSE group. After refinance mortgage payment will decrease, thus their Debt-to-Income ratios are unlikely to prevent them from getting approved for a GSE mortgage.

(iii)   Heterogeneity

How do refinancing patterns vary across demographic groups? Are FHA borrowers' refinance choices correlated with their demographic characteristics? In this section I split my sample according to different criterion and show the heterogeneity of FHA refinance choices across different demographics.

I estimate the heterogeneous effect in the following regression explaining refinance choices:

$$y_{ijct} = \alpha + \beta\lambda_i + \gamma X_j + \xi_{ct} + \varepsilon_{ijct} \tag{1}$$

y_{ijct} is the dummy variable indicating refinance to GSE loan conditional on the hedonic model predicted property value increase larger than 16.5% and FICO score greater than 620 at time of refinance for borrower i, loan j in county c at time t. λ_i

are borrower demographic characteristics, including borrower race (Black, Hispanic and Asian), gender and income quartile. X_j are loan level controls including FICO score, property value growth, loan amount, interest rate and time from purchase to refinance. ξ_{ct} is year-by-county fixed effects.

The estimates of coefficients of interests β are reported in Figure 7, holding other demographic and loan factors constant, eligible Black FHA borrowers are about 12% less likely to refinance to a GSE loan compared to non-Hispanic white FHA borrowers, and eligible Hispanic borrowers are 2% less likely to refinance to a GSE loan compared to non-Hispanic white FHA borrowers. Female borrowers are 1% less likely to refinance to a GSE loan when eligible compared to male borrowers. This heterogeneous pattern is consistent with the research documenting that Black and Hispanic homeowners pay significantly higher mortgage interest rates than white and Asian homeowners (Gerardi et al., 2023).

I then decompose the sample according to the quartile of their reported income. Households with incomes in the second, third and fourth quartile are 22%, 26% and 29% more likely to refinance to a GSE loan when eligible, compared to households with incomes in the lowest quartile. This result indicates these suboptimal mortgage refinancing decisions correlate with borrower income and other factors that affect household financial decisions, including financial literacy, access to financial service and experience in the financial market.

V   Demand Side Channel –Information Frictions

What factors explain this additional frictions in FHA mortgage refinance? In this and next section I provide evidence from both the demand and supply side of mortgage refinance frictions. On the demand side, information about how much property value has changed explains differences in the FHA mortgage refinance choice. I tested this hypothesis by using property tax reassessment as an information shock. I find that in the states where the property tax basis is infrequently updated, the probability of eligible FHA borrowers refinancing to a GSE loan increases after they receive a new property tax

bill. On the supply side, I show FHA refinance choice outcome is correlated with lenders. I discuss evidence on why lenders may prefer FHA refinance over GSE refinance, from the perspective of upfront fee, securitization revenue and other factors. Then I showed a shift in securitization revenue due to policy shock affects the propensity to conduct more efficient refinance.

Property value information plays a crucial role in FHA households' refinancing decisions, particularly when considering refinancing to a GSE loan. The importance of information is multifold: First, knowledge of increased property value helps FHA borrowers recognize their credit worthiness. They will understand their default risk decreases as their property value increase, thus borrowers should be eligible to save on their monthly mortgage payment. Second, increased property value may qualify borrowers for larger cash-out amounts, enjoying the weath effect of investing in the real estate market. Finally, even if borrowers initially pursue an FHA streamline refinance, accurate property value knowledge should prompt them to reconsider. Because they will notice that the property value on the application is much lower than their own knowledge of their home's value. Correcting this mistake naturally increases their propensity to refinance to a GSE loan. To investigate the impact of property value information on refinancing decisions, I conduct a test that exogenously separate households with and without the information about their property value, and compare their refinance choices using property tax reassessment as a natural experiment.

(i)   Set Up

In North Carolina, residential properties are reassessed every 4-8 years to calculate the new property tax basis. The time of tax reassessment is different across counties, and all properties in the same county are reassessed in the same year. This creates a natural staggered adoption of treatment, where some homeowners receive updated property value information earlier than others. The North Carolina Department of Revenue publishes this tax reassessment schedule. [7] Similarly in Ohio, property taxes are reassessed every 6

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[7]North Carolina Department of Revenue. "County Property Tax Rates and Reappraisal Schedules." Available at :https://www.ncdor.gov/taxes-forms/property-tax/property-tax-rates/county-property-tax-rates-and-reappraisal-schedules

years. [8] For FHA borrowers residing in North Carolina and Ohio, upon receiving a new tax bill, they should update their information about their property value. This update in information will affect the refinance choice decision for FHA borrowers.

I implement a difference-in-difference method to compare the probability of an eligible homeowner refinancing to a GSE loan before and after receiving a new property tax bill.

$$y_{ict} = \sum_{\tau=t-3}^{t+3} \beta_\tau D_{it}^\tau + \gamma X_{it} + \xi_c + \eta_t + \varepsilon_{ict} \tag{2}$$

The outcome variable y_{ict} is a dummy variable indicating whether the qualified household refinances their FHA loan to a GSE loan. Qualified is defined as the property value growth from purchase to refinance exceeded 16.5% according to the hedonic model in the previous section and credit score is above 620 at the time of refinance. D_{it}^τ is a dummy variable equal to 1 if year t is τ years before or after tax reassessment year. X_{it} are borrower control variables including credit score, property value and loan amount. ξ_c is the county fixed effect. η_t is the year fixed effect. The standard error is clustered at the the county level. The coefficient of interest is β_τ, which measures the difference, conditional on controls, in the outcome between treated and control borrowers τ years after the tax reassessment.

(ii) Result

I report year-by-year estimation results in Figure 8 and a single DIDs estimate that pool post-periods for the outcome in Table 3. After receiving a new property tax bill, households are on average significantly 12% more likely to refinance to a GSE loan when eligible, which is consistent with my hypothesis. The baseline probability of an eligible FHA borrower to refinance to a GSE loan is 43.3%. The effect increases over time following receipt of a new property tax bill, suggesting persistent information treatment effects.

Under this framework, the identifying assumption is that FHA borrowers who have not received an updated property tax bill in the 0-3 years period prior to the county level property tax reassessment event form a valid counterfactual group for FHA borrowers who

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[8]Ohio Department of Taxation "Property Value Reappraisal and Update Schedule" https://tax.ohio.gov/government/real-state/reappraisal-and-triennial-update

are in the 1-3 years period after receiving the new property tax bill, conditional on control variables. This assumption implies that refinancing outcomes of the two groups would share parallel trends in the absence of property tax reassessments. The plot in Figure 8 supports this assumption, as the estimates before tax reassessment are not significantly different from zero, indicating similar trends between groups.

(iii) Robustness

An alternative explanation for refinancing decisions following property tax reassessment could be that households might experience financial pressure from higher property tax bills. So as a response, they choose to offset this increased tax burden by refinancing their mortgage. However, this alternative explanation does not weaken our main argument for two reasons. First, existing literature provides limited support for the effect of tax bill on refinance propensity. For example, Wong (2020) find no evidence of increased refinancing following increased tax bills. Second, while financial pressure from increased tax bills might explain a higher propensity to refinance, it does not explain why households would choose suboptimal refinancing products.

To further test this alternative channel, I separately analyze borrowers with higher credit scores and higher property values. Credit score and property value are highly correlated with income, and would indicate the borrower is less financially constrained, so that a sudden increase in property tax bill should not change their refinance choice much compared to lower income groups. As reported in column (2) and (3) in Table 3, the results remain consistent for the high FICO score and high property value groups. Even among relatively higher-income FHA borrowers eligible for GSE loan refinancing, receiving a new tax bill significantly predicts higher GSE refinancing probability. So the concern about increased property tax payment change refinance choice is unlikely to replace the informational channel and explain FHA refinance choice.

The observed 12.2% increase result is the average treatment effect based on the population of FHA borrowers in North Carolina and Ohio, and should be a lower bound on the treatment effect on households who are actually compliers to this informational treatment. In this exercise, it is difficult to distinguish between households who are already

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aware of their property value increases and those who rely on property tax information to update their knowledge. From the result in the Table 3, the average treatment effect is smaller among households with high property value, suggesting that the treatment effect may be larger among households less attuned to property value changes.

VI Supply Side Channel –Lender Strategy

In complex financial decisions, such as mortgage refinancing, financial intermediaries play a critical role. Research by Allen et al. (2019) highlights the significant impact of search frictions on price discrimination, while Buchak et al. (2023) finds that fintech lenders leverage market power over recaptured borrowers by charging higher fees. As discussed in the previous sections, FHA refinance choices are particularly intricate and incur high information costs, creating an environment where lenders can substantially influence choice outcomes. In the pre-2008 FHA mortgage market, Woodward and Hall (2012) documented that borrowers overpaid lenders at least $1,000 in Yield Spread Premium. The Yield Spread Premium was banned in 2010 and no longer applies to the FHA mortgage market in my analysis. But can suboptimal FHA refinance choices discussed in this paper be partially attributed to lenders' influence?

Anecdotal evidence supports this argument. The Consumer Financial Protection Bureau (CFPB) maintains a database of consumer complaints regarding household financial products and services. [9] Multiple FHA borrowers have filed complaints indicating that their failure to refinance to a GSE mortgage was influenced by their lenders. For example:

> On XX/XX/2019 I was contacted by Caliber Home Loans to refinance, the only product offered was a FHA streamline refi... I come to find out that this was not the best option for me. The agent failed to explore all the refinancing options available to me. Since this process lacks an appraisal and it wasn't done I was placed back on a FHA loan when I could of saved more money by going conventional. Contacted the company and the manager agreed that Conversation could of been a better option but offered no way to remediate the companies lack of guiding me in the right direction. Not being presented with all the options has cost me about XXXX

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[9]https://www.consumerfinance.gov/data-research/consumer-complaints/#download-the-data

in the back end of the loan and about XXXX dollars more a month.[10]

While anecdotal evidence provides valuable insights into borrower-lender interactions, systematic data analysis provides more robust and informative results. In this section, I explores how lenders may affect the refinancing decisions of FHA borrowers. First, I present empirical evidence showing the heterogeneity in refinance outcomes by lenders. Lender fixed effects account for a significant portion of FHA refinance choices, after controlling for borrower characteristics. Next, I delve into potential incentives for lenders to favor originating FHA streamline refinances over GSE refinances. Finally, I use exogenous changes in FHA refinance loan profits to show that FHA refinance outcomes respond to these changes.

(i)   Empirical Evidence of Lender Fixed Effects

Do the refinancing outcomes of FHA borrowers correlate with the lenders they choose? In this section I will show empirical evidence to answer this question.

Lender Fixed Effects Explain Refinance Outcomes I first examine lender fixed effects in the regression explaining refinance choices:

$$y_{ijct} = \alpha + \beta X_i (+\gamma W_j) + \xi_{ct} + \varepsilon_{ijct} \tag{3}$$

y_{ijct} is the dummy variable indicating refinance to GSE loan conditional on the hedonic model predicted property value increase larger than 16.5% and FICO score greater than 620 at time of refinance. X_i are borrower controls including FICO score, the hedonic model predicted property value growth, loan amount, interest rate and time from purchase to refinance. ξ_{ct} is year and county fixed effects. W_j is lender fixed effects. I first run the regression without lender fixed effects, and then add the lender fixed effect. Adding lender fixed effects increases marginal R-squared from 38% to 48%. This result is robust to a series of alternative set of specifications (See Table B.2).

Heterogeneity across Lenders Then I show that lender type also correlates with the type of mortgage product (FHA or GSE) FHA borrowers refinance to. In Table 4, I

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[10]The exact date and values are redacted from the CFPB database for privacy concerns.

run the similar specification as before:

$$y_{ijct} = \alpha + \beta L_j + \gamma X_i + \xi_{ct} + \varepsilon_{ijct} \qquad (4)$$

y_{ijct} is the dummy variable indicating refinance to GSE loan conditional on the hedonic model predicted property value increase larger than 16.5% and FICO score greater than 620 at time of refinance. L_j are dummy variables indicating whether the lender originating the original loan that got prepaid is a bank, nonbank or credit union, as well as the lender originating the refinance loan is a bank, nonbank or credit union. X_i are borrower controls including FICO score at time of refinance, the hedonic model predicted property value growth, loan amount at refinance, refinance interest rate and time from purchase to refinance. ξ_{ct} is year and county fixed effects.

Table 5 presents the results, showing that after controlling for borrower characteristics, eligible FHA borrowers are less likely to refinance to a GSE loan when working with a nonbank lender than with a bank. Credit unions, despite their smaller market share, demonstrates higher likelihoods in borrowers switching to a GSE loan. This pattern persists regardless of whether the lender originated the purchase or refinance loan, indicating that lender are closely related to borrower refinancing decisions.

Nonbank Growth in FHA Market A notable trend about nonbank market share in FHA mortgages emerges from the analysis. Figure 9 plots the count of FHA mortgage origination from 2010 to 2018 from eMBS data. There is a persistent and fast growth in nonbank share of the FHA mortgage origination market. This trend implies that FHA borrowers increasingly refinance with nonbank lenders. Nonbanks are faced with less competition from other competing lenders who are subject to a different regulatory schedule. While the following sections will discuss how some policies contribute to the change in market structure, the current state of market structure itself appears to directly impact FHA refinance outcomes. Supporting this view, Buchak and Jørring (2021) show lenders in more concentrated markets charge higher fees. Figure 10 plots the probability of eligible FHA borrowers to refinance to a GSE mortgage on Herfindahl-Hirschman Index (HHI) at the county level. As market concentration increases, the probability of refinance

to a GSE loan decreases. This result suggest lenders have market power to affect refinance choices.

(ii)   Underwriting Fees and Processing Time

Why originating FHA streamline refinances may benefit lenders? FHA mortgages typically carry higher default risk and impose greater costs on borrowers. Home buyers who are eligible for a GSE mortgage generally prefer GSE mortgage over FHA mortgages to avoid overpaying on mortgage risk premiums. The same logic extends to refinance decisions. However, the payment on UFMIP and MIP are collected by the government agency, it is not obvious why lenders can benefit from originating more FHA mortgages. This section examines several factors that make FHA streamline refinancing attractive to lenders.

Higher Upfront Origination Fees FHA streamline refinancing generates higher upfront fees for lenders. Figure 11 summarizes the 2018-2020 HMDA data about origination costs, showing that an FHA refinance costs borrowers on average $3,000 (1.5% of average loan amount) more to originate than a GSE refinance. This cost to the borrowers translates into revenue for the lenders.

Why lenders can charge a higher upfront fee for FHA loan origination? While researchers do not have access to the exact decomposition of upfront fee at this time, some reports attributed the higher upfront fee to the corresponding conveyence cost in the event of mortgage default. According to a research by Urban Institute [11] , the combined first legal action penalty and property preservation loss can be as high as $9,539 (5.4% of loan amount) per nonperforming event.

> The FHA's conveyance process differs from that of the GSEs. Servicers of FHA mortgages have 30 days after foreclosure to repair the property and convey it to HUD with a clean title. The GSEs follow a direct conveyance model. They take possession of the property after the auction and hire vendors to perform repair before putting properties back on the market. Data show that the conveyance process significantly slows down property disposition and imposes heavy costs on the FHA, neighborhoods, communities, and servicers.

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[11]Reforming the FHA's Foreclosure and Conveyance Processes by Karan Kaul, Laurie Goodman, Alanna McCargo, and Todd Hill, Feb 2018

Notice that even though the average default risk for FHA mortgages (5%) is higher than the average default risk of GSE mortgages (1.5%), the FHA streamline refinanced mortgage pool exhibits a default rate that is much closer to GSE mortgages. This suggest that lenders' potential risk exposure to default event is much lower when they originate an FHA streamline refinance. This makes originating FHA streamline refinance mortgages profitable, since they can charge a high underwriting fee to borrowers whose risk are relatively low .

Faster Processing Time FHA streamline refinancing offers efficiency and cost advantages for lenders. Evidence suggests originating FHA streamline refinance is faster and thus incur less labor cost. According to Fuster et al. (2019), the average process time for refinance loan is 40-50 days. However, FHA streamline refinance FHA streamline refinance can take as little as 30 days.[12] This is partly because that property appraisal usually takes 1-2 weeks.[13]

Marketing materials provide additional evidence of lender preference for FHA streamline refinance. Grundl and Kim (2019) find that advertising increases the refinance probability who should refinance by approximately 5.6 percentage points. In their sample, nonbank lenders make up more than a half of the total direct mailings received. I found in these advertisements, the option of refinance to a GSE loan is missing and the fast and convenient feature of FHA streamline refinances is emphasised. For example, in the mail advertisement in Figure A.3, the nonbank lender emphasizes the "no appraisal" feature of FHA streamline refinance, and did not mention the potential higher cost of mortgage insurance premium. Another example advertisement from a fintech lender, the largest mortgage lender in the U.S. as of 2023, Rocket Mortgage (formerly Quicken Loans), explained the FHA streamline refinance options for FHA borrowers who are looking for a refinance in their online article, and also did not mention the option to refinance their FHA loan to a GSE loan in the entire article, as of April 2023. [14]

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[12]Mutual Mortgage. "Streamline Refinance FAQs." available at https://www.mutualmortgage.com/articles/refinancing/streamline-refinance-faqs/

[13]Pacres Mortgage. "Your Loan Timeline from Offer through Closing." available at https://pacresmortgage.com/knowledge-center/news-insights/your-loan-timeline-from-offer-through-closing

[14]https://www.rocketmortgage.com/learn/fha-streamline-refinance

(iii) Exogenous Shock in FHA Mortgage Revenue

Secondary Market Revenue Difference

According to Zhang (2022), the profit from upfront closing costs constitute approximately 20% of the total profit from mortgage origination with the remaining derived from secondary market sales. This is also consistent with the originate-to-distribute model discussed in Kim et al. (2018) and Kim et al. (2022). During the sample period of this paper, FHA mortgages are sold at a higher price in the secondary secularization market. Following Gete and Reher (2021), I compared the TBA MBS price for Ginnie Mae and GSE loans. As shown in Figure A.11, during the decade from 2010 to 2020, Ginnie Mae loans in TBA market are traded at a higher price than GSE (FNMA and FHLMC) loans during the sample period. FHA loans are fully guaranteed by the U.S. government. This full guarantee significantly reduces the risk for investors in the MBS market, making FHA-backed securities more attractive. Gete and Reher (2021) argued that lenders originate more FHA purchase mortgage by lowering the credit requirement. The Liquidity Coverage Ratio (LCR) regulation increased the attractiveness of securitized FHA loans by granting them favorable regulatory treatment. This caused a rise in the secondary market prices for these loans, reducing funding costs for nonbank lenders. In response, nonbanks loosened their lending standards and originated more FHA-insured mortgages. The expansion of FHA mortgage lending can reach the other side of the distribution– borrowers with good credit profile who are eligible for a GSE mortgage looking for a refinance.

Research Design

To test the causal relationship between lender incentives and refinance outcomes, I employ the same shock used in Gete and Reher (2021) to test the effect of LCR regulation change on FHA refinance mortgage origination. I perform a difference-in-difference analysis across lenders, quarters and loan types. The baseline regression equation is

$$y_{i,j,t} = \beta(Nonbank_j \times Premium_t) + \gamma X_{i,t} + \xi_c + \eta_t + \varepsilon_{i,j,t} \tag{5}$$

Where i, j, t index borrower, lender and time respectively. $y_{i,j,t}$ is a dummy variable

indicating whether the qualified household refinances their FHA loan to a GSE loan. Qualified is defined as the property value growth from purchase to refinance exceeded 16.5% according to the hedonic model in the previous section and credit score is above 620 at the time of refinance. $Nonbank_j$ indicates if the lender is a nonbank. Similar to the literature, I use nonbanks as "treated lenders" and measure of relative price of GNMA MBS and GSE MBS as treatment. $X_{i,t}$ are borrower control variables including credit score, property value and loan amount. ξ_c is the county fixed effect. η_t is the year fixed effect.

The identifying assumption is that the LCR-induced increase in the GNMA premium does not coincide with unobserved shocks that affect nonbanks' propensity to prefer originating FHA streamline refinance over conventional loans to FHA borrowers looking for refinance, relative to banks' propensity. This asymmetry arises because nonbanks are more exposed to market-based funding and rely less on deposits, making them more sensitive to changes in the secondary market prices for mortgages. Banks, on the other hand, are more concerned about the risk corresponded to originating FHA loans, for example the putback risk documented in Benson et al. (2023) and Mayer et al. (2023).

Results

The result are reported in Figure 12 and Table 6. After the implementation of new LCR rules, there is a decline in the probability of FHA-GSE refinancing with nonbanks, refinance outcome are 13% less likely to be a GSE mortgage. The results are statistically significant at the 1% level in all specifications. These results imply that higher GNMA price in the TBA market due to the introduction of the new LCR rules influenced the lending practice of nonbanks about FHA mortgage refinance.

(iv)   Exogenous Shock in FHA Mortgage Cost

So far I have demonstrated how policy shocks affecting FHA mortgage revenue may influence FHA refinance outcomes. Next I examine the impacts of policy shocks affecting FHA mortgage cost. Specifically, increased putback risk from the False Claims Act (FCA) led banks to perceive higher costs in FHA mortgage origination, subsequently increased the probability of FHA-to-GSE refinance.

FCA and Bank Exit

Bank of America (BOA) exited the FHA mortgage market around 2012. This decision was largely in response to prosecutions by the Department of Justice (DOJ) under the False Claims Act (FCA). The use of the FCA in this context was unprecedented, enabled by the Fraud Enforcement and Recovery Act of 2009. The DOJ sued lenders for damages resulting from the government's losses due to fraudulent lending practices. According to Benson et al. (2023), Banks were disproportionately affected by these actions for two primary reasons: 1. They faced greater reputational risk. 2. Their substantial financial resources made it feasible for the government to put FHA mortgages back on their balance sheets. U.S. Bank paid the United States government $200 million to resolve allegations that it violated the False Claims Act by knowingly originating and underwriting mortgage loans insured by the Federal Housing Administration (FHA) that did not meet applicable requirements. [15] Jamie Dimon, Chase CEO, noted in a 2016 shareholder letter that "FCA settlements wiped out a decade of FHA profitability."[16] This shock increased the perceived risk associated with FHA lending, which out-weighted the benefits from originating FHA streamline refinance loans for banks, but not for nonbanks. Benson et al. (2023) find that in the FHA purchase mortgage market, bank market share significantly decreased. I extend the analysis to the FHA refinance market and test the effects of this policy shock in FHA mortgage cost on borrowers' mortgage refinance choice.

Research Design

I implement this identification strategy using a DID framework. Figure 13 shows the county level market share of BOA in FHA refinance mortgage dropped from 8% to 0% after 2011. When BOA pulled back nationally from FHA origination, counties with larger BOA share are faced with higher change in the lenders' operating strategy, while other counties experienced insignificant changes in lenders' behavior. The regression equation is as follows:

$$y_{ict} = \sum_{\tau} \alpha_\tau S_c 1[\tau = t] + X_{ict}\gamma + \xi_c + \epsilon_{ict} \tag{6}$$

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[15]https://www.justice.gov/opa/pr/us-bank-pay-200-million-resolve-alleged-fha-mortgage-lending-violations

[16]https://reports.jpmorganchase.com/investor-relations/2016/ar-ceo-letters.htm

y_{ict} is the dummy variable indicating FHA borrowers refinance to GSE loan conditional on the hedonic model predicted property value increase larger than 16.5% and FICO score greater than 620 at time of refinance for borrower i in county c at time t. The treatment exposure S_c is measured in two ways. (1) The origination lender being BOA and (2) the county-level BOA market share pre-exit in 2010. X_{ict} are individual level control variables including credit score at time of refinance, the hedonic model predicted property value growth, loan amount at refinance, refinance interest rate and time from purchase to refinance. ξ_c is county fixed effect. In addition to the year-by-year regressions, I also include results pooling together periods before and after exit together, yielding a single DID estimate.

Results

Figure 15 and Figure 14 reports the year-by-year estimates of treatment effect, and Table 7 pools the treatment years together and reports the point estimate. After the exit of BOA, eligible FHA borrowers who obtained their FHA loan are 5% more likely to refinance to a GSE mortgage. Eligible borrowers residing in the counties where BOA used to have a high market share are more likely to refinance to a GSE loan. A 1% decrease in county BOA market share predicts about 2% increase in the probability of refinance to a GSE loan for eligible FHA borrowers. This effect is stronger over time 3 years after the exit event.

FHA borrowers typically first consult their original mortgage lender for refinancing options. After BOA exited the FHA market due to perceived higher cost associated with increased putback risk, BOA would guide borrowers to refinance to a GSE mortgage instead. Similar pattern happens in the region where BOA has a larger market share, because FHA borrowers who search for lenders to refinance their mortgage are more likely to consult with BOA, which would recommend a GSE refinance to them.

To summarize, financial intermediaries significantly influence FHA borrowers' refinancing choices. There is significant heterogeneity in refinance choices across lenders, with lender fixed effects accounting for a substantial portion of the variation in outcomes. Borrowers work with nonbank lenders are less likely to switch GSE loans. I discussed several factors that may incentivize lenders to favor FHA streamline refinances, including

higher upfront fees, faster processing times, and higher secondary market prices for FHA securities. Analysis of exogenous shocks–both LCR regulation changes (affecting revenue) and FCA enforcement (affecting costs)–demonstrates that lenders respond to these policy changes, and significantly impact FHA borrowers' likelihood of refinancing to GSE loans.

VII   Conclusion

Mortgage refinance is crucial for households to reduce their mortgage payment and for interest rate policy to pass through to the household sector. Frictions in mortgage refinance can both reduce the efficiency of interest rate policy and generate distributional mortgage payment inequality among households. This research introduces a novel mechanism understanding how FHA mortgage refinance choices are made, and quantify how actual FHA mortgage refinance choices deviates from model predicted optimal choices. From my estimation, 40% of FHA borrowers who refinanced their mortgage to a new FHA mortgage in the past decade were actually eligible for refinancing to a GSE mortgage. They would save about $110 per month and about $2,957 upfront on their mortgage payment by doing so, because they can remove the mortgage insurance premium that is no longer necessary for their actual equity level in the mortgage.

I find that both demand and supply side factors can explain the refinance frictions. On the demand side, information on property value appreciation helps FHA borrowers make better choice. On the supply side, lenders make more profit by originating FHA loans, and exogenous increase in lenders' revenue (cost) of originating FHA loans results in less (more) refinance to GSE mortgages.

This result has significant implications for policymakers seeking to improve the welfare of FHA borrowers. Based on my findings, policymakers can enhance the efficiency of mortgage refinancing and reduce the amount of mortgage money left on the table from both the credit demand and credit supply perspectives.

On the credit demand side, efforts should focus on reducing information frictions. Facilitating easier access to information about LTV changes and household balance sheet evolution over time can empower households to make better financial decisions.

Additionally, information about how a household's balance sheet situation affects borrowing costs should be provided. Optimal refinancing choices involve not only responding to interest rate changes but also to property value fluctuations, as well as refinancing to the most suitable type of mortgage.

On the credit supply side, encouraging competition among lenders can mitigate the agency problem between borrowers and lenders, leading to more efficient mortgage refinancing choices. The results indicate that lenders have market power over borrowers, as refinancing outcomes change in response to lenders' profit margins. Increased competition, or reducing the search cost for borrowers to work with multiple lenders, can help address this imbalance.

Finally, it is important to note that policies designed to protect borrowers in one economic environment can inadvertently reduce borrower welfare in a different economic context. For example, the no-reassessment feature for FHA streamline refinancing protects borrowers who may be underwater during economic downturns. However, in a booming housing market, this feature may prevent borrowers from capitalizing on their property value growth and realizing potential savings on mortgage payments.

Given that FHA borrowers typically include minorities, individuals with low-to-moderate incomes, and first-time home buyers, policies aimed at reducing frictions in their mortgage choices are likely to have a more significant impact on marginal housing market participants. Such policies could help reduce inequalities in housing costs and wealth accumulation across the United States.

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Figures and Tables

(i) Figures

Figure 1. Illustration of FHA Refinance Choice
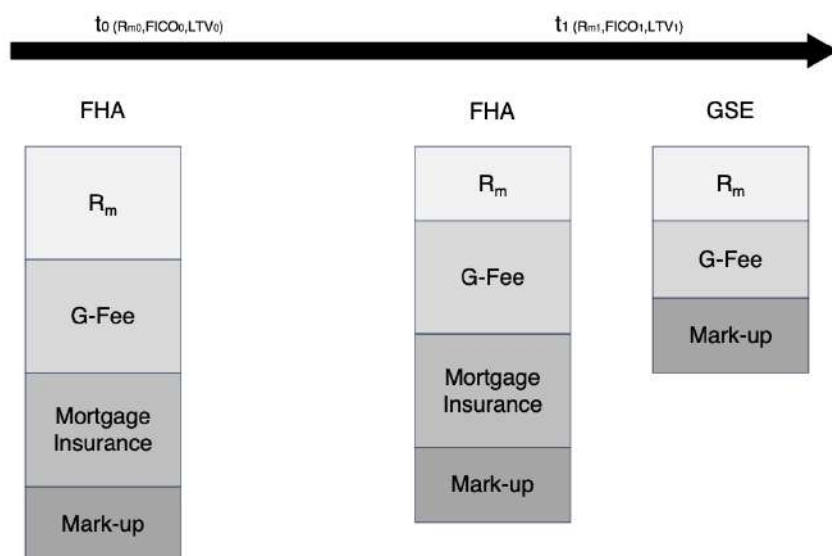
Figure 2. Property Value Growth on Refinance Application
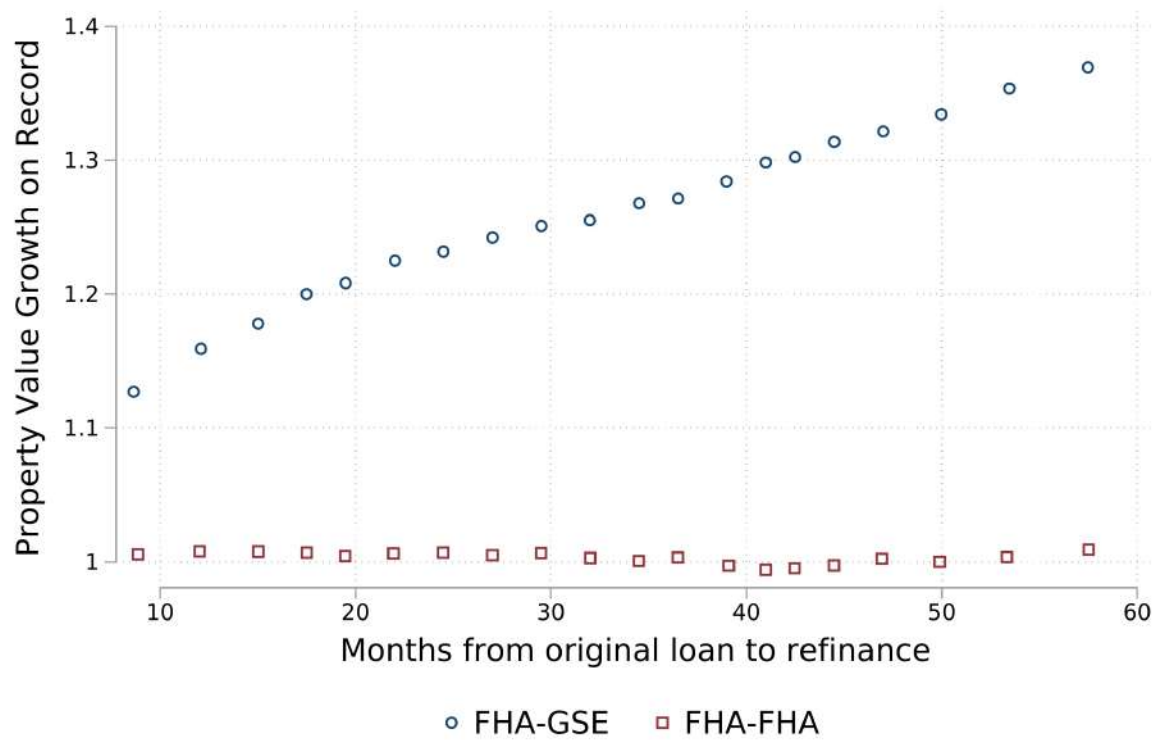
Note: These figures plot the property value growth on mortgage refinance applications. The x-axis shows months from original loan to refinance. The y-axis shows the property value on refinance profile, divided by the property value at purchase. The blue circle represents the group where the FHA purchase loan was refinanced to a GSE loan; the red square represents the group where the FHA purchase loan was refinanced to another FHA loan.
Source: ATTOM, McDash.

Figure 3. Property Value Growth Estimated by Hedonic Pricing Model
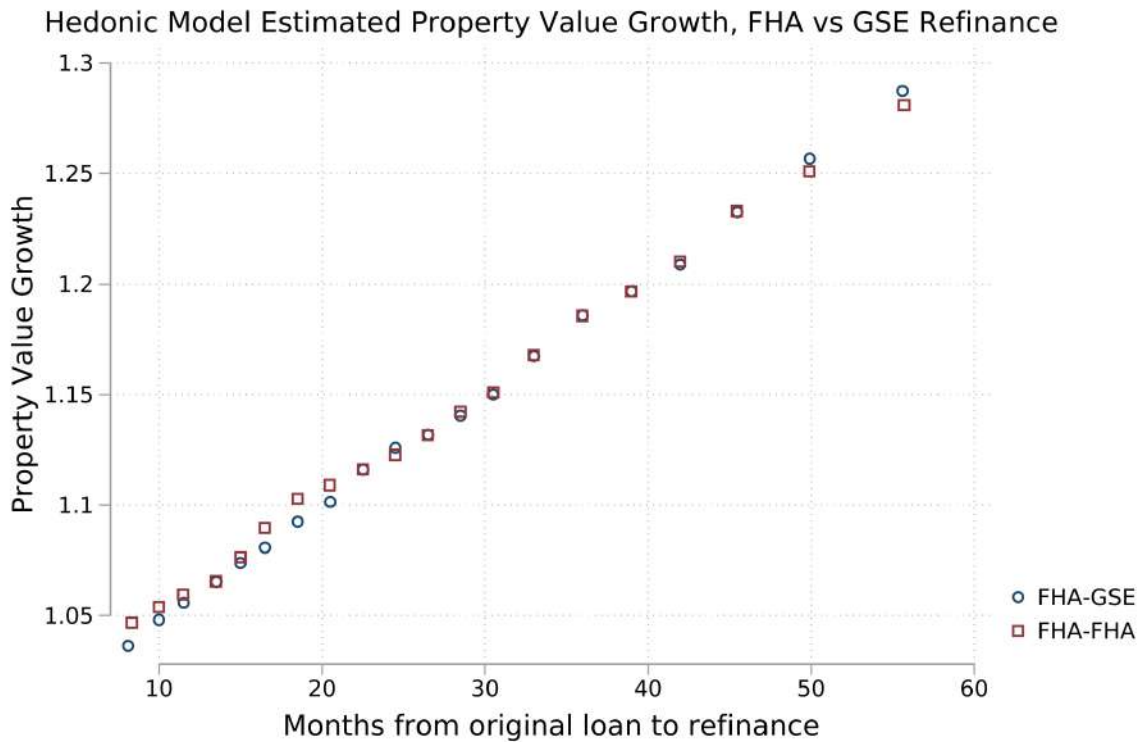
Note: Note: These figures plot the hedonic-model predicted property value growth. The x-axis shows months from original loan to refinance. The y-axis shows the property value estimated by hedonic model at refinance time divided by the property value at purchase. The blue circle represents the group where the FHA purchase loan was refinanced to a GSE loan; the red square represents the group where the FHA purchase loan was refinanced to another FHA loan.

Source: HMDA, ATTOM, McDash, author's own calculations.

Figure 4. Identified Suboptimal Refinance Choices

Panel A: Count of Refinance Choices by Year
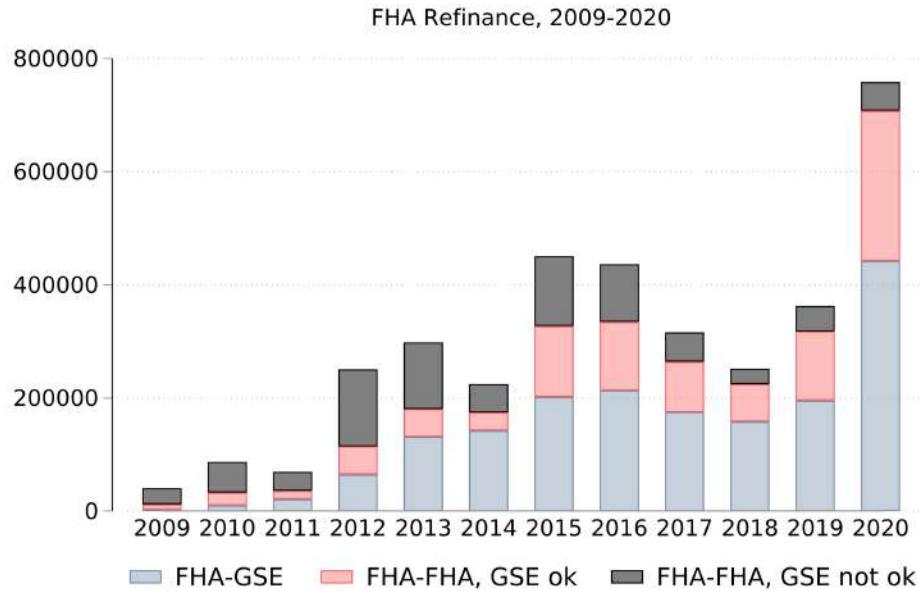
Panel B: Share of Refinance Choices by Year
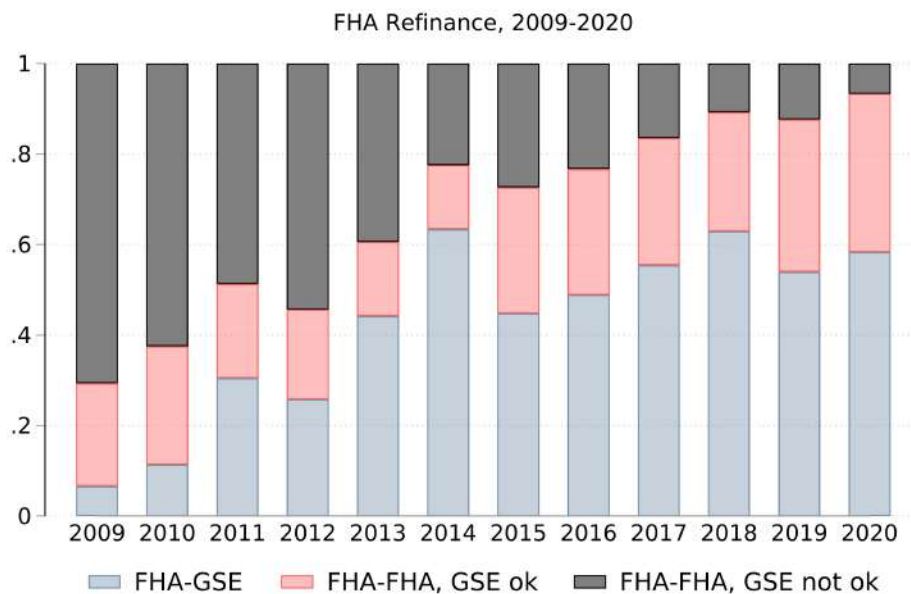
Note: These figures plot the distribution of FHA refinance choices across years. The blue bar at the bottom represents FHA loans refinanced to a GSE loan. The red bar in the middle represents the FHA loans refinanced to an FHA loan, but have a FICO score greater than 620 at the time of refinance and experienced 16.5% property value growth according to the hedonic model described in Section III. The grey bar on the top represents FHA loans refinanced to another FHA loan but do not satisfy the above standards at the time of refinance. Panels A plots the count and Panel B plots the share.

Source: HMDA, ATTOM, McDash, author's own calculations.

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Figure 5. Identified Suboptimal Refinance Choices

Panel A: Count of Refinance Choices by Quarters from Purchase to Refinance
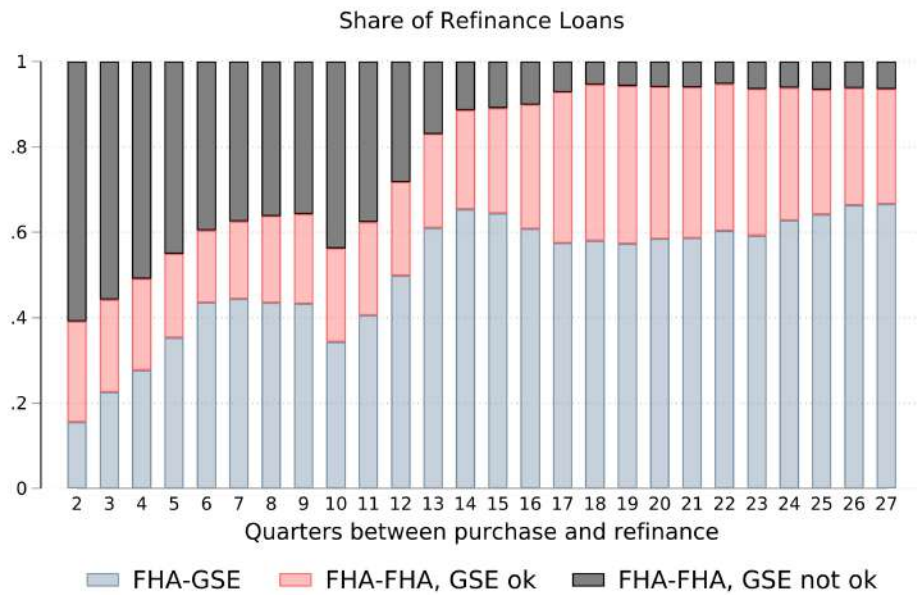
Panel B: Share of Refinance Choices by by Quarters from Purchase to Refinance

Note: These figures plot the distribution of FHA refinance choices across years. The blue bar represents FHA loans refinanced to a GSE loan. The red bar represents the FHA loans refinanced to another FHA loan, but have a FICO score greater than 620 at the time of refinance and experienced 16.5% property value growth according to the hedonic model described in Section III. The grey bar represents FHA loans refinanced to another FHA loan but do not satisfy the above standards at the time of refinance. Panels A plots the count and Panel B plots the share.
Source: HMDA, ATTOM, McDash, author's own calculations.

Figure 6. Distributions of Estimated Mortgage Savings

Panel A: Distribution of Estimated Monthly Mortgage Payment Savings
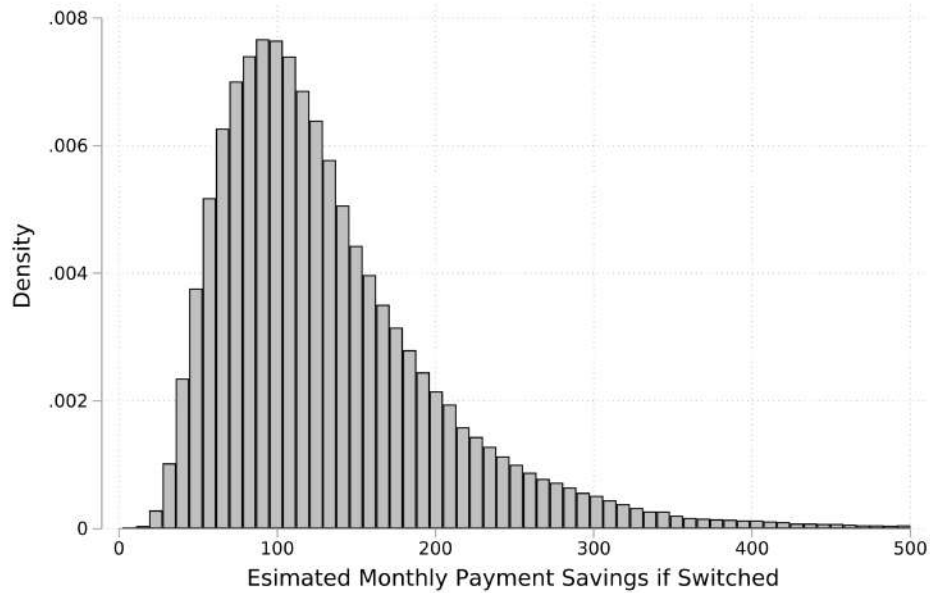
Panel B: Distribution of Estimated Upfront Mortgage Payment Savings
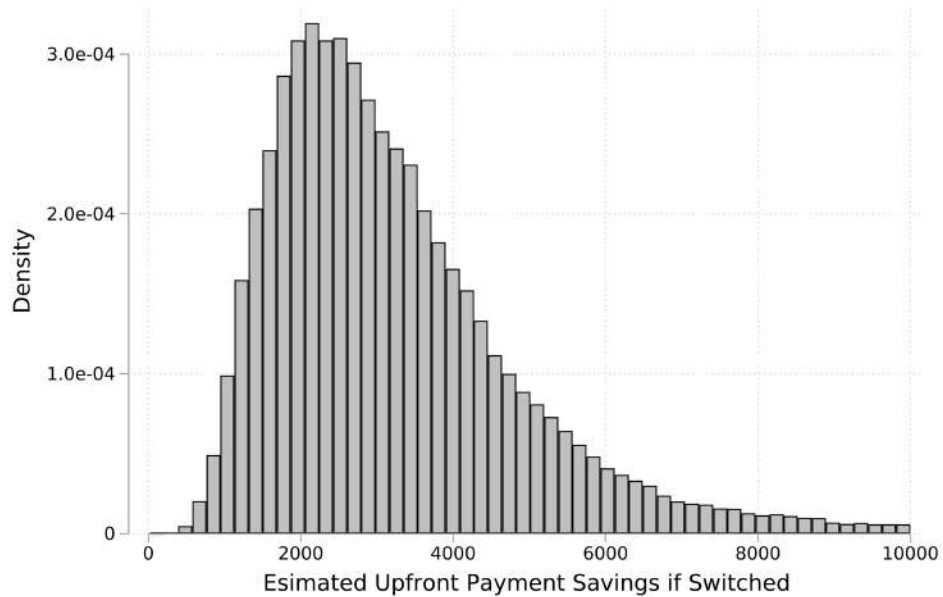
Note: This figure plots the histogram distribution of estimated savings in dollar amount if eligible FHA borrowers who conducted an FHA streamline refinance switched to a GSE refinance. Panel A plots monthly savings and panel B plots upfront savings. The savings on monthly payment is the monthly MIP at the time of refinance adjusted by average rate difference for the corresponding FICO score and LTV bin in the LLPA table. The savings on upfront payment is the UFMIP at the time of refinance adjusted by UPMIP reimbursement.

Source: HMDA, ATTOM, McDash, author's own calculations.

Figure 7. Heterogeneity in Share of FHA-GSE Refinance
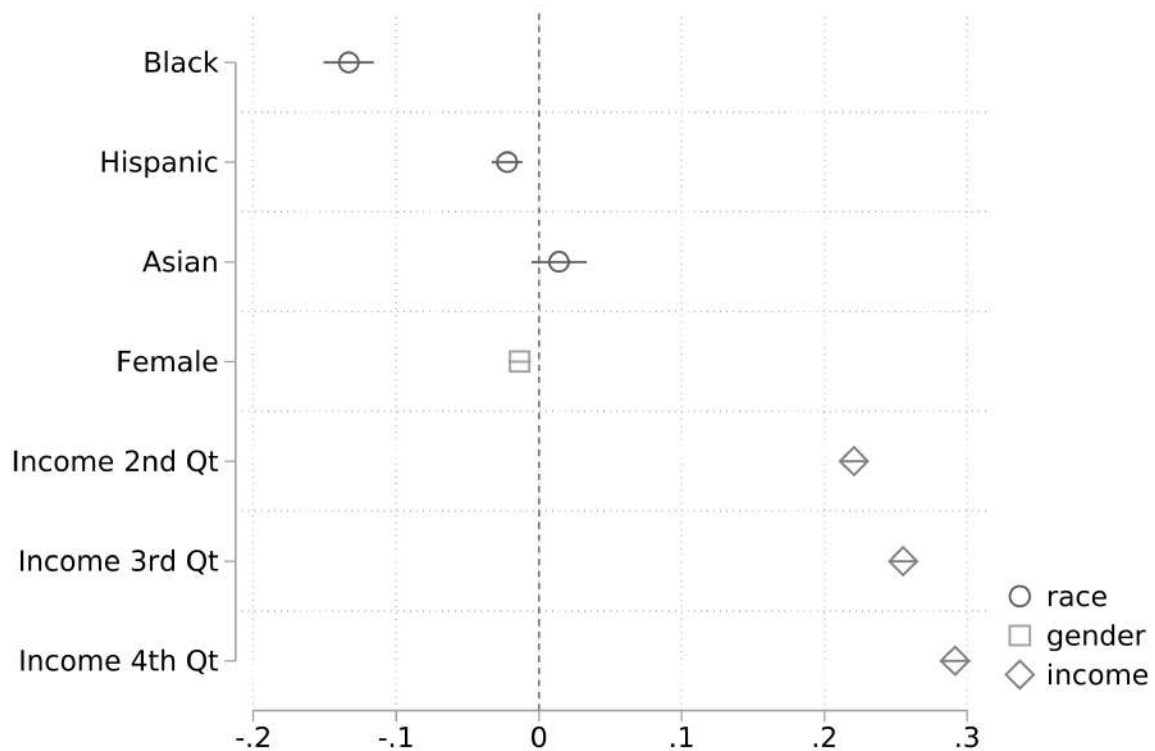
Note: This figure plots the heterogeneity in share of eligible FHA borrowers refinance to a GSE mortgage. The dependent variable is a dummy variable indicating refinance to a GSE mortgage. The regression controls year and county fixed effect, borrower FICO score, refinance loan amount and interest rate, property value and estimated property value growth. The bars plot 95% confidence intervals for each point estimate. Robust standard errors are reported.
Source: HMDA, ATTOM, McDash, author's own calculations.

Figure 8. Effect of New Tax Bill on Refinance Choice
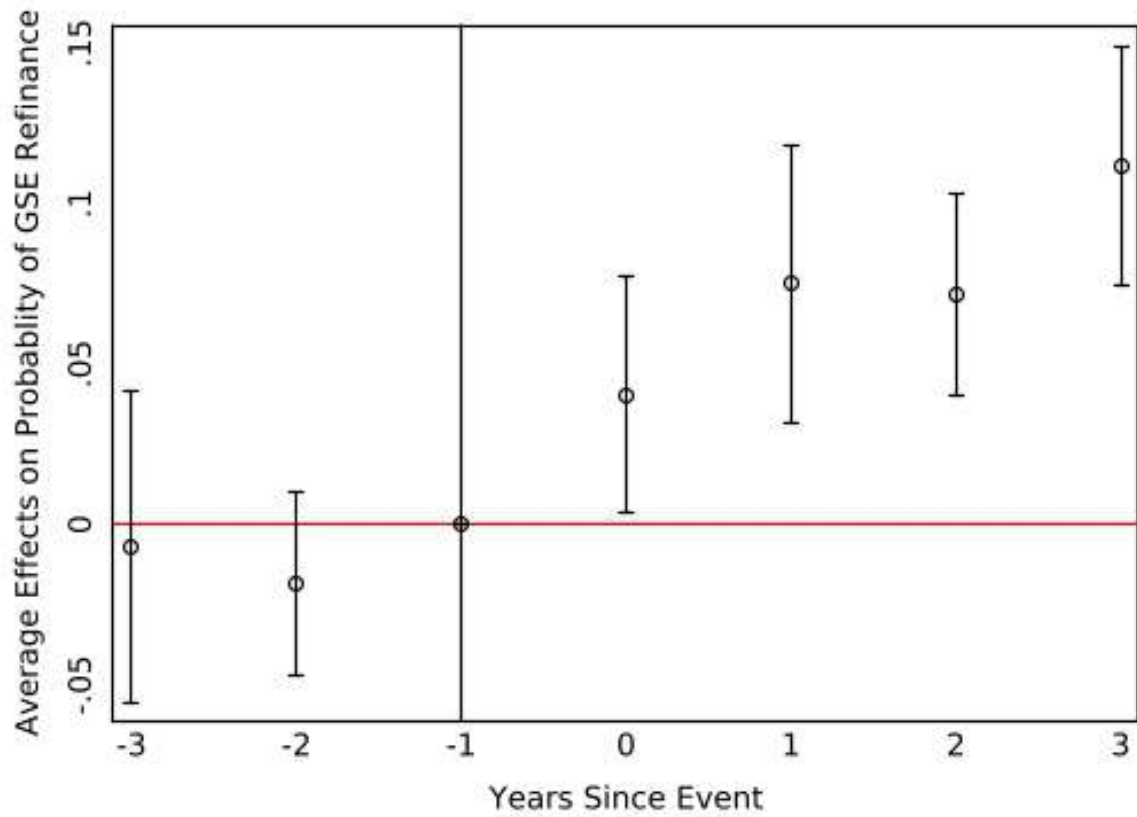
Note: This figure plots the effect of information treatment on refinance choice by equation 2. The y-axis measures the effects on probability to refinance to a GSE loan given eligible. The x-axis is the relative years to the event year, with -1 as the baseline year. The regression includes county fixed effects and lender FICO score, property value as controls. The line plots the 95% confidence intervals for each point estimate. Robust standard errors are clustered at county level.
*Source:* HMDA, ATTOM, McDash, author's own calculations.

Figure 9. FHA Mortgage Origination by Lender, 2010-2018

Panel A: Count of FHA Mortgages Originated by Banks
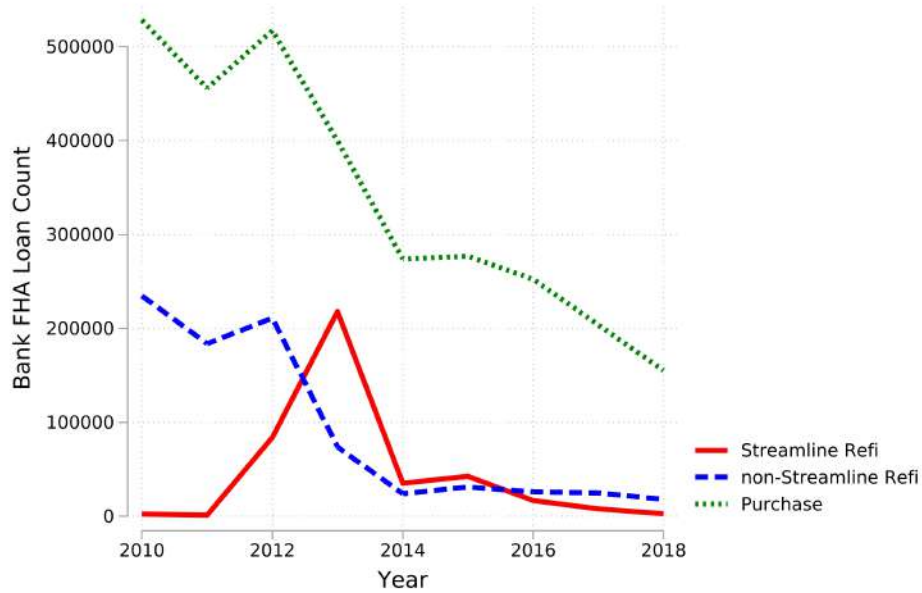
Panel B: Count of FHA Mortgages Originated by Nonbanks
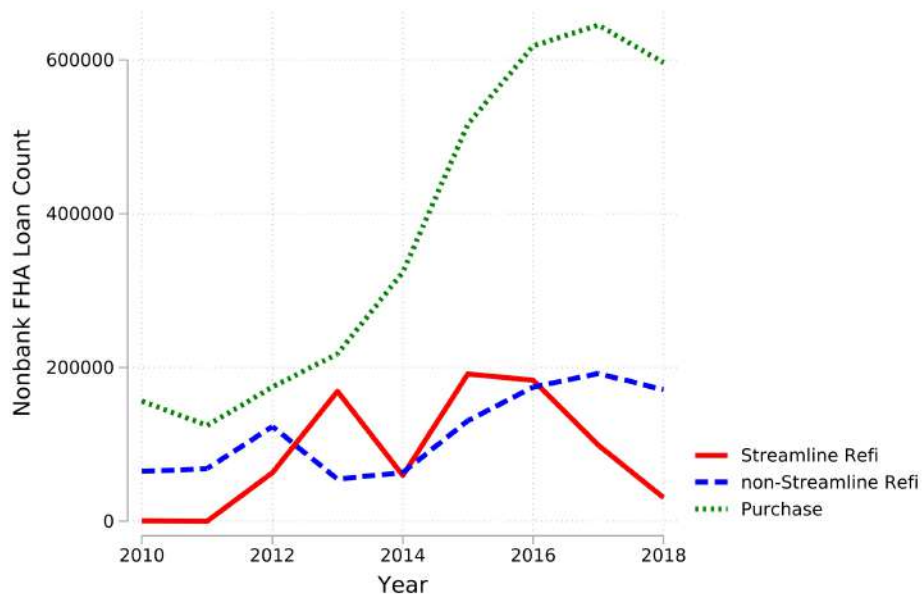
Note: This figure plots the count of FHA mortgage origination by year from 2010 to 2018. The red solid line represents FHA streamline Refinance and the blue dash line represents other FHA refinance. The green line represents FHA purchase mortgages. Panel A plots bank origination and panel B plots nonbank origination.
Source: eMBS

Figure 10. Refinance Choices and Market Competition
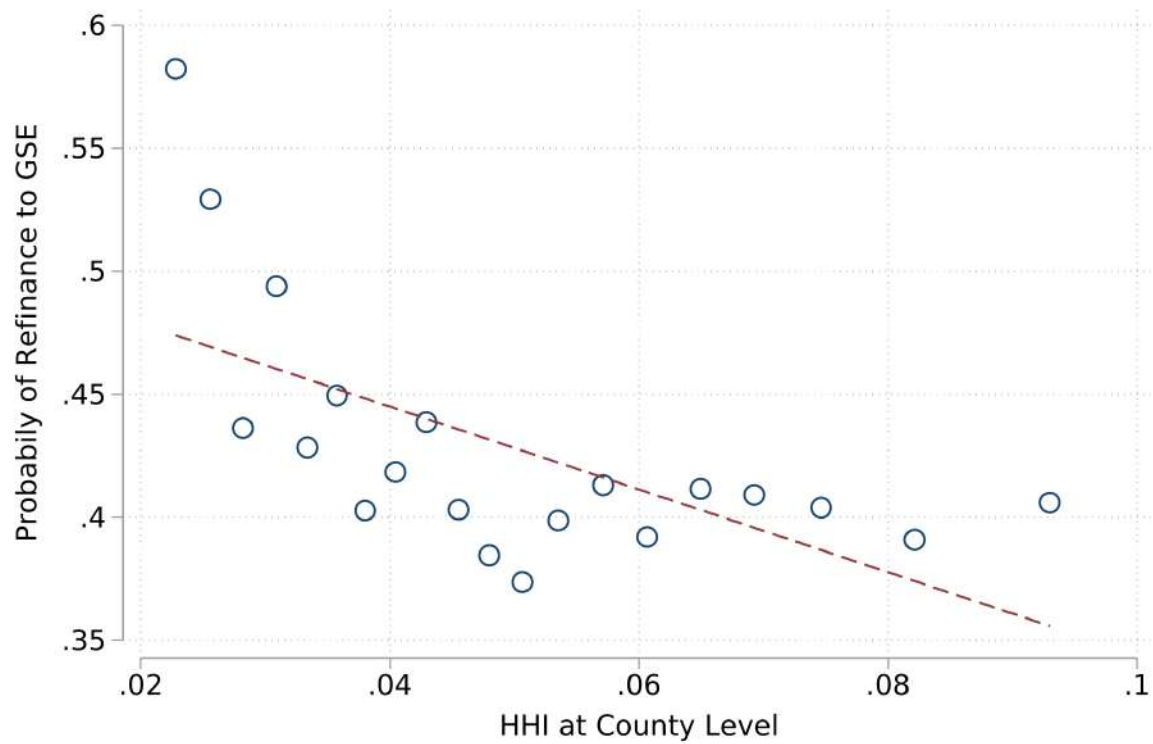
Note: This figure plots the correlation between market concentration and FHA refinance outcome. The x-axis is Herfindahl-Hirschman Index (HHI) at county level, calculated using HMDA data. The y-axis is the probability of eligible FHA borrowers to refinance to a GSE mortgage.
Source: HMDA, ATTOM, McDash, author's own calculations.

Figure 11. Upfront Fees from HMDA 2019
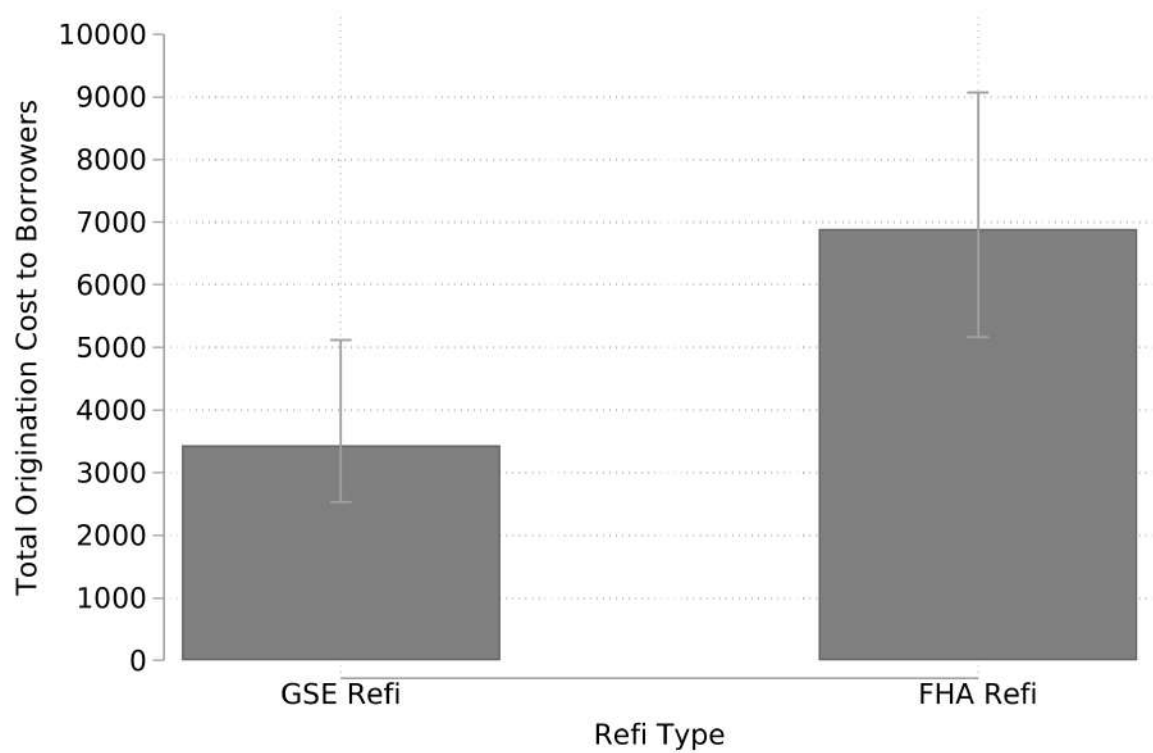
Note: This figure plots the upfront cost charged by lenders reported in HMDA 2019 data. The bar graph plots the median total cost and the capped lines shows the inter-quartile range. Th number of observations are 307,232 for FHA refinance and 1,652,120 for GSE refinance.
Source: HMDA.

Figure 12. Effect of LCR Schock on Refinance Outcome
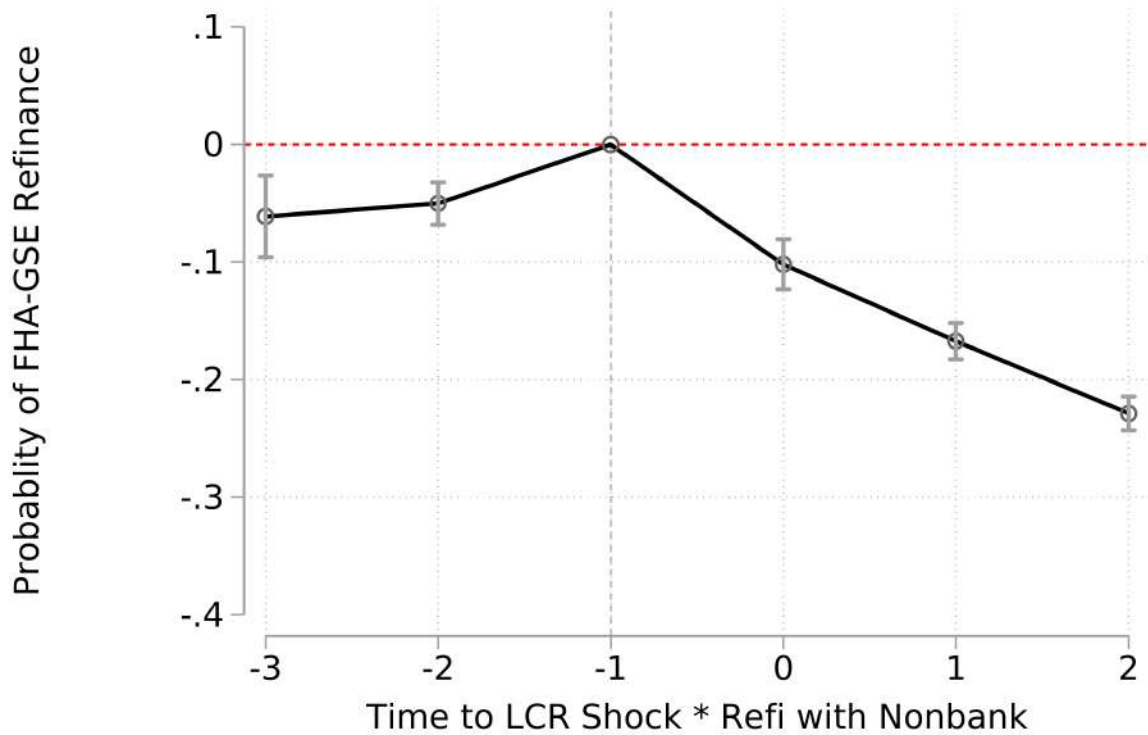
Note: This figure plots the effect of liquidity coverage ratio (LCR) shock on refinance choice. The regression is defined in equation 5. The y-axis measures the effects on probability to refinance to a GSE loan given eligible. The x-axis is the relative years to the event year, with -1 as the baseline year. The regression includes county fixed effects and borrower FICO score, property value as controls. The line plots the 95% confidence intervals for each point estimates. Robust standard errors are clustered at county level.

Source: ATTOM, McDash, TRACE author's own calculations.

Figure 13. Bank of America Exit Event
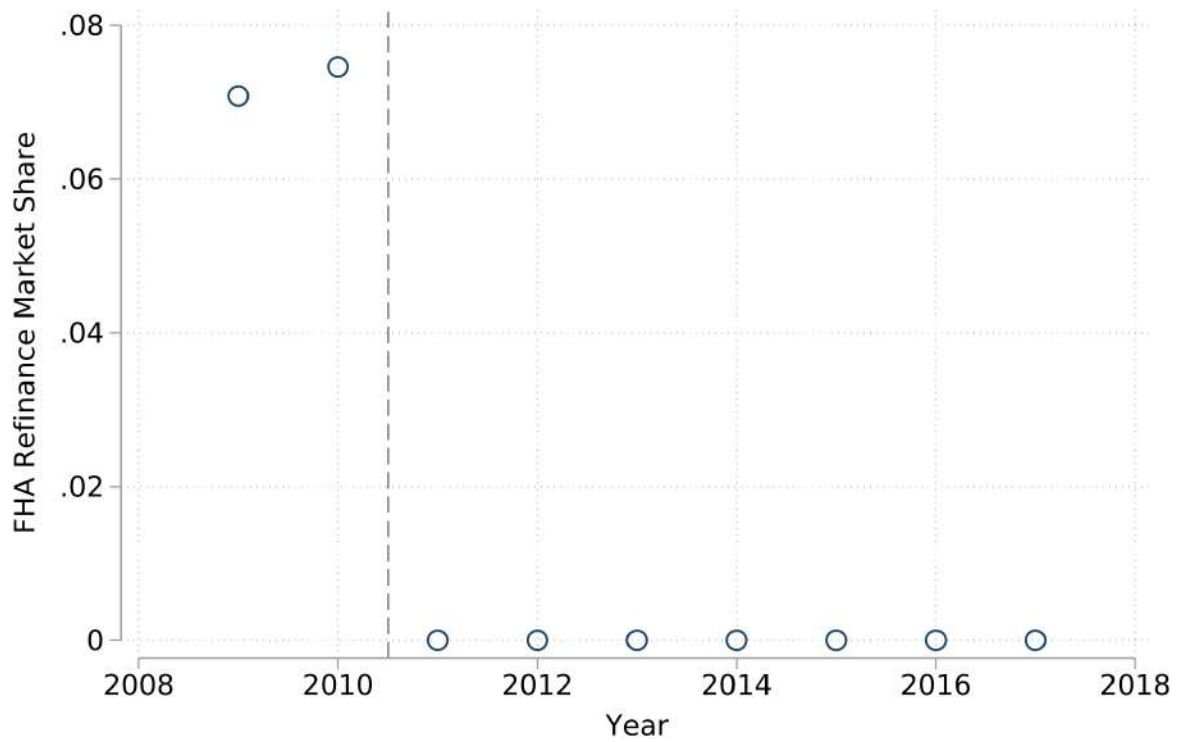
Note: This figure plots the average county level market share of Bank of America for FHA refinance origination. As a response to the law suits with DOJ on False Claim Act, Bank of America decided to stop originating FHA loans, both in the FHA purchase loan market and FHA refinance market.
Source: HMDA, author's own calculations.

Figure 14. DID Estimation on BOA Exit Event
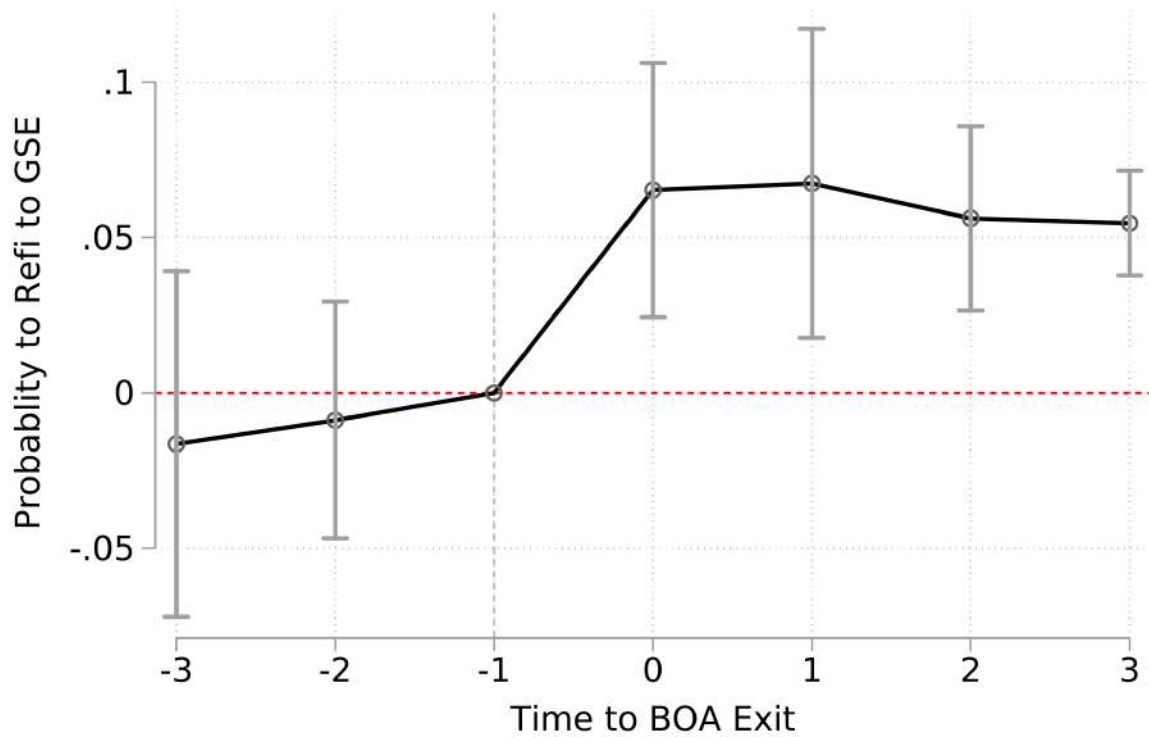
Note: This figure plots the treatment effects of BOA exiting FHA market by event year, estimated by Equation 6. The y-axis measures the effects on probability to refinance to a GSE loan given eligible. The x-axis is the relative years to the year of BOA exiting FHA market, with -1 as the baseline year. The regression includes county fixed effects and lender FICO score, property value as controls. The line plots the 95% confidence intervals for each point estimates. Robust standard errors are clustered at county level.

Source: HMDA, ATTOM, McDash, author's own calculations.

Figure 15. DID Estimation on BOA Exit Event
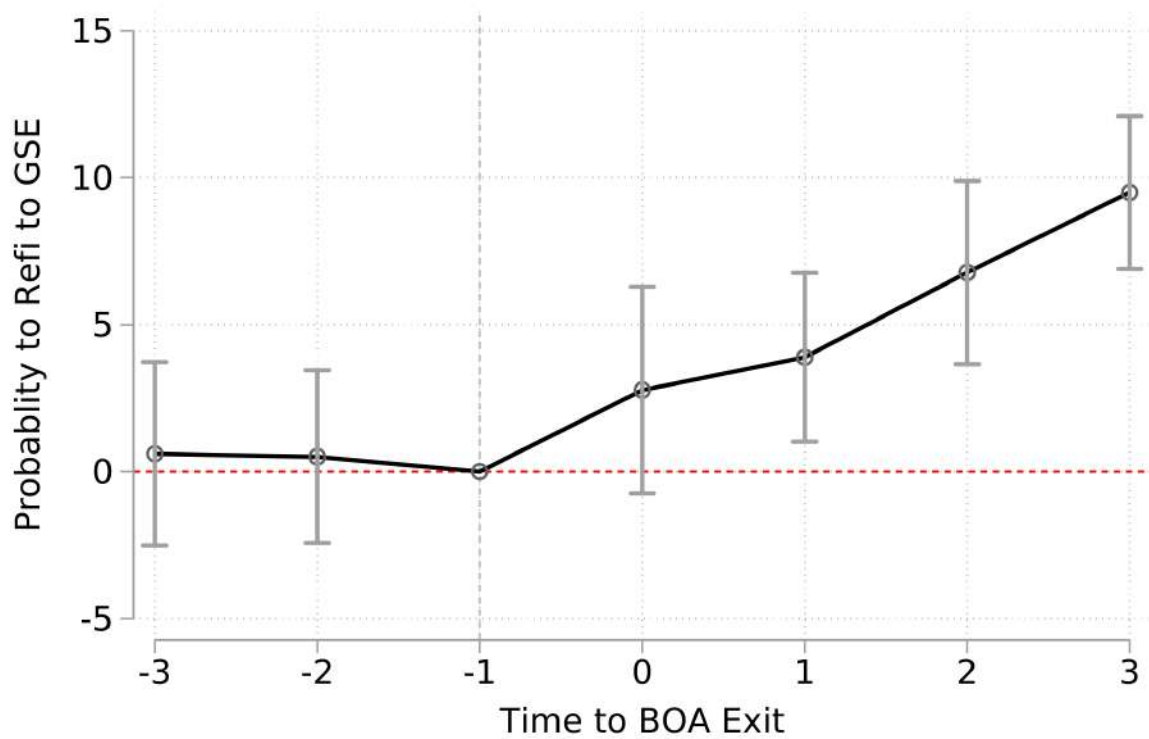
Note: This figure plots the treatment effects of a 100% decline in BOA market share on refinance choice by event year, estimated by Equation 6. The y-axis measures the effects on probability to refinance to a GSE loan given eligible. The x-axis is the relative years to the year of BOA exiting FHA market, with -1 as the baseline year. The regression includes county fixed effects and lender FICO score, property value as controls. The line plots the 95% confidence intervals for each point estimates. Robust standard errors are clustered at county level.

Source: HMDA, ATTOM, McDash, author's own calculations.

(ii) Tables

TABLE 1. Summary Statistics

Panel A: FHA-GSE Observations = 216,080

Variables	Mean	SD	p25	Median	p75
Montly Pmt. (Prepaid Loan)	1210.8	554.9	775.7	1067.6	1476.82
Montly Pmt. (Refi. Loan)	1182.1	680.7	755.4	1044.3	1454.7
Int. Rate (Prepaid Loan)	0.0448	0.00677	0.0388	0.0450	0.0500
Int. Rate (Refi. Loan)	0.0431	0.00534	0.0388	0.0425	0.0463
LTV at Origination (Prepaid Loan)	0.920	0.0978	0.899	0.962	0.981
LTV at Origination (Refi. Loan)	0.759	0.128	0.693	0.776	0.821
FICO (Prepaid Loan)	709.6	50.89	670	706	751
FICO (Refi. Loan)	729.7	50.08	695	733	770
Prop. Value (Prepaid Loan)	250,912	135,126	155,000	218,000	310,000
Prop. Value (Refi. Loan)	317,524	166,172	200,000	276,000	391,000
Time to Refinance	47.16	29.25	28	44	65

Panel B: FHA-FHA Observations = 306,481

Variables	Mean	SD	p25	Median	p75
Montly Pmt. (Prepaid Loan)	1245.2	622.7	817.2	1117.3	1518.8
Montly Pmt. (Refi. Loan)	1061.5	617.4	787.9	1066.9	1442.9
Int. Rate (Prepaid Loan)	0.0496	0.00634	0.0450	0.0500	0.0550
Int. Rate (Refi. Loan)	0.0404	0.00533	0.0375	0.0388	0.0437
LTV at Origination (Prepaid Loan)	0.932	0.0887	0.916	0.967	0.982
LTV at Origination (Refi. Loan)	0.903	0.101	0.865	0.935	0.970
FICO (Prepaid Loan)	697.9	52.99	657	692	739
FICO (Refi. Loan)	706.6	54.32	666	702	750
Prop. Value (Prepaid Loan)	238,882	118,074	157,000	214,000	290,000
Prop. Value (Refi. Loan)	248,403	125,214	162,000	220,000	300,000
Time to Refinance	35.03	26.99	16	32	47

Note: This table summarizes the characteristics of the merged population of borrowers who purchased their property with an FHA mortgage after 2009 and refinanced their FHA mortgage before the end of 2020. Panel A summarized the FHA borrowers who refinanced to a GSE mortgage and Panel B summarized the FHA borrowers who refinanced to a new FHA mortgage.
Source: HMDA, ATTOM, McDash, author's own calculations.

TABLE 2. Summary of Estimated Overpayment on Mortgage Insurance Premium

Panel A: Sensitivity of Identified Suboptimal Choices

FICO	620	620	680	680
ΔLTV	16.5%	20%	16.5%	20%
Share of Suboptimal Choices	40.99%	25.96%	28.3%	24.15%

Panel B: Quantify the Savings on Mortgage Payment

	Mean	SD	P25	Median	P75
Interest Rate	4.06%	0.53%	3.75%	3.99%	4.38%
Loan Amount	195,106	103,023	133,000	176,000	235,000
FHA MIP (bp)	95.95	21.50	85	85	115
Actual Payment ($)	1048.00	569.32	714.43	948.39	1258.74
Counterfactual Payment ($)	938.02	515.81	634.96	845.07	1127.18
Payment Savings ($)	109.98	59.98	72.19	99.55	134.49
Income (in $1,000)	78.74	74.45	48	67	93
Savings as Income Percentage	1.68%	0.97%	1.80%	1.78%	1.74%
Savings on UFMIP	2957.21	1713.28	1914.5	2632	3628

Note: This table summarizes the Estimated Overpayment on the Mortgage Insurance Premium. Panel A summarizes identified suboptimal choices under different credit score at the time of refinance and LTV change cutoff. Panel B shows the summary statistics of suboptimal FHA-FHA refinance loans and how much they could have saved by refinance to a GSE loan instead.
Source: HMDA, ATTOM, McDash, author's own calculations.

TABLE 3. Information Treatment Effects on Refinance Choice

VARIABLES	(1) Full Sample	(2) High FICO	(3) High Property Value
After	0.122***	0.159***	0.0901***
	(0.0194)	(0.0206)	(0.0194)
Constant	0.382***	0.459***	0.408***
	(0.0133)	(0.0138)	(0.0133)
Observations	11,455	6,694	7,487
R-squared	0.127	0.091	0.131
FICO Score Bin	Y	Y	Y
County FE	Y	Y	Y

County clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: This table shows the estimates of the information treatment effects on refinance choice by equation 2. The dependent variable is a dummy variable indicating refinance to a GSE loan given model predicted property value growth greater than 16.5% and FICO score at the time of refinance greater than 620. Column (1) regress the full sample with county and lender FICO score fixed effects. Column (2) restrict the sample to borrowers with FICO score greater than 700 and Column (3) restrict the sample to borrowers with above median property value to rule out the potential income effect due to raised property tax.

TABLE 4. Regression Results on Refinance Choice and Refinance Lender

VARIABLES	(1) Baseline	(2) Zillow Index	(3) High FICO	(4) High FICO Zillow
Nonbank	-0.136***	-0.142***	-0.144***	-0.133***
	(0.00236)	(0.00211)	(0.00275)	(0.00239)
Credit Union	0.211***	0.219***	0.143***	0.188***
	(0.00471)	(0.00537)	(0.00544)	(0.00562)
Loan Amount	2.38e-07***	7.87e-08***	1.84e-07***	1.40e-07***
	(1.43e-08)	(1.27e-08)	(1.59e-08)	(1.39e-08)
Time to Refi	0.000944***	0.00415***	0.00115***	0.00466***
	(8.72e-05)	(5.69e-05)	(0.000112)	(6.79e-05)
Prop Val Growth (Model)	0.166***		0.174***	
	(0.0158)		(0.0193)	
Prop Val Growth (Zillow)		0.192***		0.185***
		(0.00604)		(0.00697)
Constant	0.427***	0.162***	0.484***	0.186***
	(0.0184)	(0.00754)	(0.0219)	(0.00856)
Observations	142,975	176,119	89,265	131,632
R-squared	0.156	0.335	0.184	0.332
Year FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: This table shows OLS estimates of a linear probability model on factors correlated with FHA borrowers refinance choice. The dependent variable is a dummy variable indicating refinance to a GSE loan given model predicted property value growth greater than 16.5% and FICO score at the time of refinance greater than 620. Column (1) and (2) use the full sample of FHA borrowers, and column (3) and (4) only look at borrowers with FICO score greater than 680. Column (1) and (3) use the hedonic model and column (2) and (4) use Zillow Home Value Index to measure property value growth.

TABLE 5. Regression Results on Refinance Choice and Lender

VARIABLES	(1) Original Lender	(2) Refi Lender	(3) Both Lenders
Purchase w/ Nonbank	-0.0334***		-0.0125***
	(0.00248)		(0.00247)
Purchase w/ Credit Union	0.0579***		0.0105
	(0.0202)		(0.0197)
Refi w/ Nonbank		-0.136***	-0.134***
		(0.00236)	(0.00240)
Refi w/ Credit Union		0.211***	0.212***
		(0.00471)	(0.00472)
Loan Amount	2.47e-07***	2.38e-07***	2.39e-07***
	(1.45e-08)	(1.43e-08)	(1.43e-08)
Prop Val Growth	0.219***	0.166***	0.167***
	(0.0162)	(0.0158)	(0.0158)
Time to Refi	0.000991***	0.000944***	0.000943***
	(9.00e-05)	(8.72e-05)	(8.72e-05)
Constant	0.308***	0.427***	0.433***
	(0.0186)	(0.0184)	(0.0184)
Observations	142,975	142,975	142,975
R-squared	0.128	0.156	0.156
Year FE	Y	Y	Y
County FE	Y	Y	Y

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: This table shows OLS estimates of a linear probability model on factors correlated with FHA borrowers refinance choice. The dependent variable is a dummy variable indicating refinance to a GSE loan given model predicted property value growth greater than 16.5% and FICO score at the time of refinance greater than 620. Column (1) only look at the lender of purchase loan, column (2) only look at the lender of refinance loan, column (3) include both purchase loan and refinance loan.

TABLE 6. LCR Shock Effect on Refinance Choice

VARIABLES	(1) FHA-GSE	(2) Spread
$Nonbank \times t \geq 2013$	-0.130***	
	(0.0109)	
$Nonbank \times Premium$		-0.0357***
		(0.0127)
Nonbank	-0.0685***	-0.168***
	(0.0103)	(0.00668)
Constant	0.208***	0.146***
	(0.0375)	(0.0378)
Observations	63,543	62,731
R-squared	0.263	0.262
MSA-Year FE	Y	Y
Borrower Controls	Y	Y

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

Note: This table shows the estimates of the treatment effects of annoucement of Liquidity Coverage Ratio Rules on FHA refinance choice by equation 5. The dependent variable is a dummy variable indicating refinance to a GSE loan given model predicted property value growth greater than 16.5% and FICO score at the time of refinance greater than 620. Column (1) measures LCR by an indicator of $t > 2013$, the year before LCR regulation was announced.. Column (2) measures LCR shock by the difference in price between GNMA MBS and GSE (FNMA and FHLMC) MBS in the TBA market.

TABLE 7. BOA Exit Effect on Refinance Choice

VARIABLES	(1) BOA Exit	(2) BOA Exit
After * Pre-exit BOA Share	2.148***	1.878**
	(0.773)	(0.751)
Nonbank Lender		-0.169***
		(0.00209)
FICO Score	0.00189***	0.00183***
	(2.07e-05)	(1.84e-05)
Interest Rate	-11.13***	-10.45***
	(0.211)	(0.201)
Loan Amount	-5.73e-08***	-4.99e-08***
	(1.24e-08)	(1.21e-08)
Time to Refinance	0.00128***	0.000934***
	(5.43e-05)	(5.09e-05)
Observations	168,578	175,095
R-squared	0.307	0.330
Year FE	Y	Y
County FE	Y	Y

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

Note: This table shows the estimates of the treatment effects of a 100% decline in BOA market share on refinance choice by equation 6. The dependent variable is a dummy variable indicating refinance to a GSE loan given model predicted property value growth greater than 16.5% and FICO score at the time of refinance greater than 620. Column (1) is the baseline regression with controls of borrower characteristics. Column (2) add the control variable of refinance with a nonbank lender.

For Online Publication

Appendix to "Frictions in Mortgage Refinance Choices:
Evidence from Federal Housing Administration Mortgages" by Yunbo Liu

A   Additional Figures

Figure A.1. FHA Mortage Insurance Premium

FHA premiums rose significantly in the years following the housing crash, with annual premiums rising from 50 to 135 basis points between 2008 to 2013 as FHA worked to shore up its finances. In January 2015, President Obama announced a 50 basis points cut in annual insurance premiums. In February 2023, Vice president Harris announced another 30 basis points cut to FHA insurance premiums, making FHA mortgages more attractive than GSE mortgages for the overwhelming majority of borrowers putting down less than 5%. As shown in the bottom table, a borrower putting 3.5 percent down with a FICO score less than 740 will currently find FHA financing to be more financially attractive, borrowers with FICOs of 740 and above will find GSE execution with PMI to be more attractive. This calculation reflects both the FHA MIP cut and the more favorable GSE LLPAs for LMI borrowers.

FHA MI Premiums for Typical Purchase Loan

Case number date	Upfront mortgage insurance premium (UFMIP) paid	Annual mortgage insurance premium (MIP)
1/1/2001 - 7/13/2008	150	50
7/14/2008 - 4/5/2010*	175	55
4/5/2010 - 10/3/2010	225	55
10/4/2010 - 4/17/2011	100	90
4/18/2011 - 4/8/2012	100	115
4/9/2012 - 6/10/2012	175	125
6/11/2012 - 3/31/2013[a]	175	125
4/1/2013 – 1/25/2015[b]	175	135
1/26/2015 – 3/19/2023[c]	175	85
Beginning 3/20/2023	175	55

Sources: Ginnie Mae and Urban Institute.

Figure A.2. FHA Streamline Refinance Upfront MIP Refund Schedule
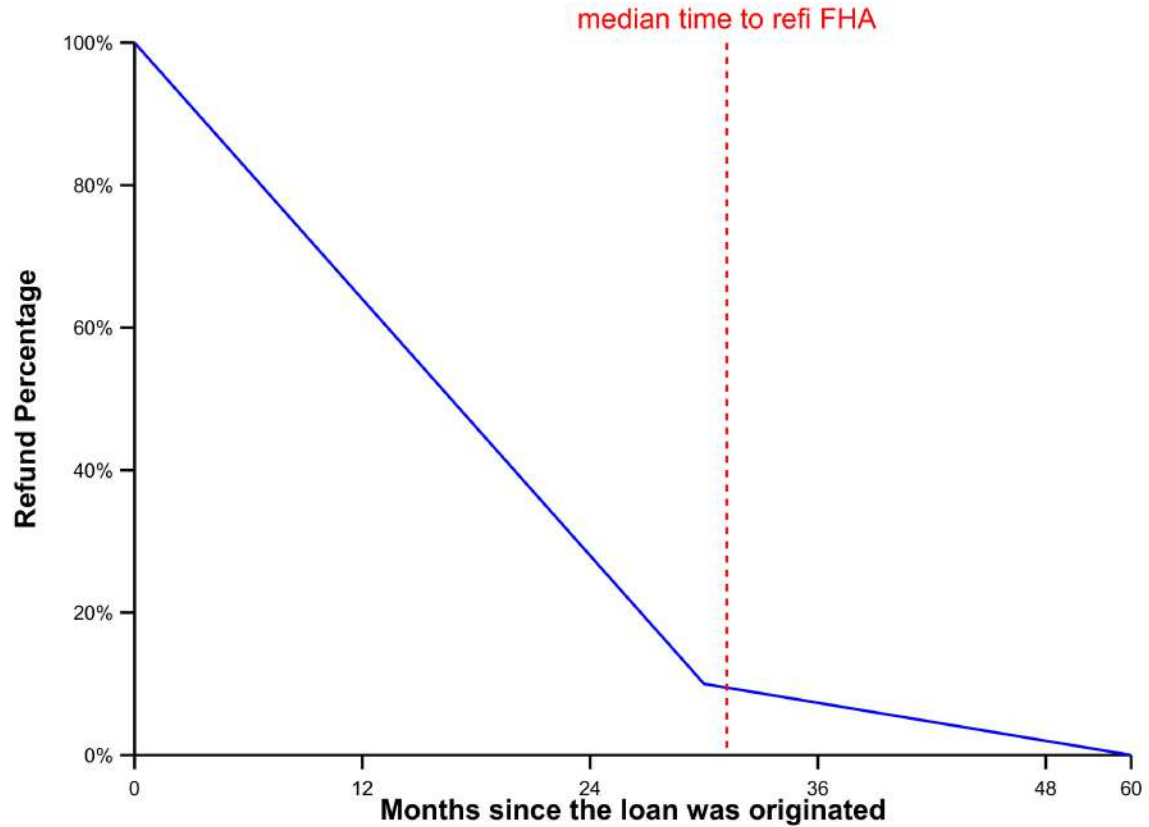
Note: This figure plots the UPMIP refund schedule for FHA streamline refinance program. The x-axis is the months from FHA loan origination to streamline refinance, the y-axis is percentage of UFMIP refund received by the borrower. The red vertical line is the median time (32 months) from origination to refinance in my 2010-2019 sample. More than 50% of borrowers, especially borrowers who refinance after more than 30 months, will receive less than 10% refund in UFMIP, and pay the full amount of UFMIP at the time of streamline refinance.
Source: https://www.hud.gov/program_offices/housing/comp/premiums/ufrfnd

Figure A.3. FHA Streamline Refinance Letter Advertisement

Source: https://www.theaddressers.com/mortgagemailer/fha-mortgage-direct-mail
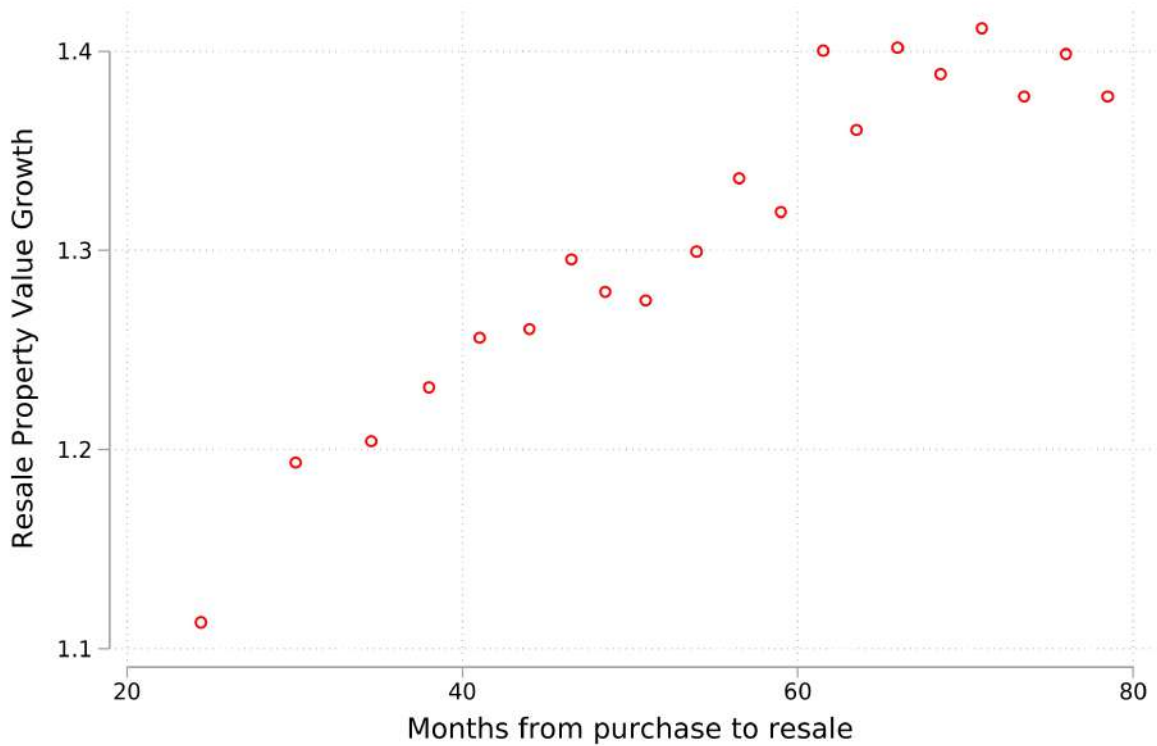
Figure A.4. Zillow Property Value Growth
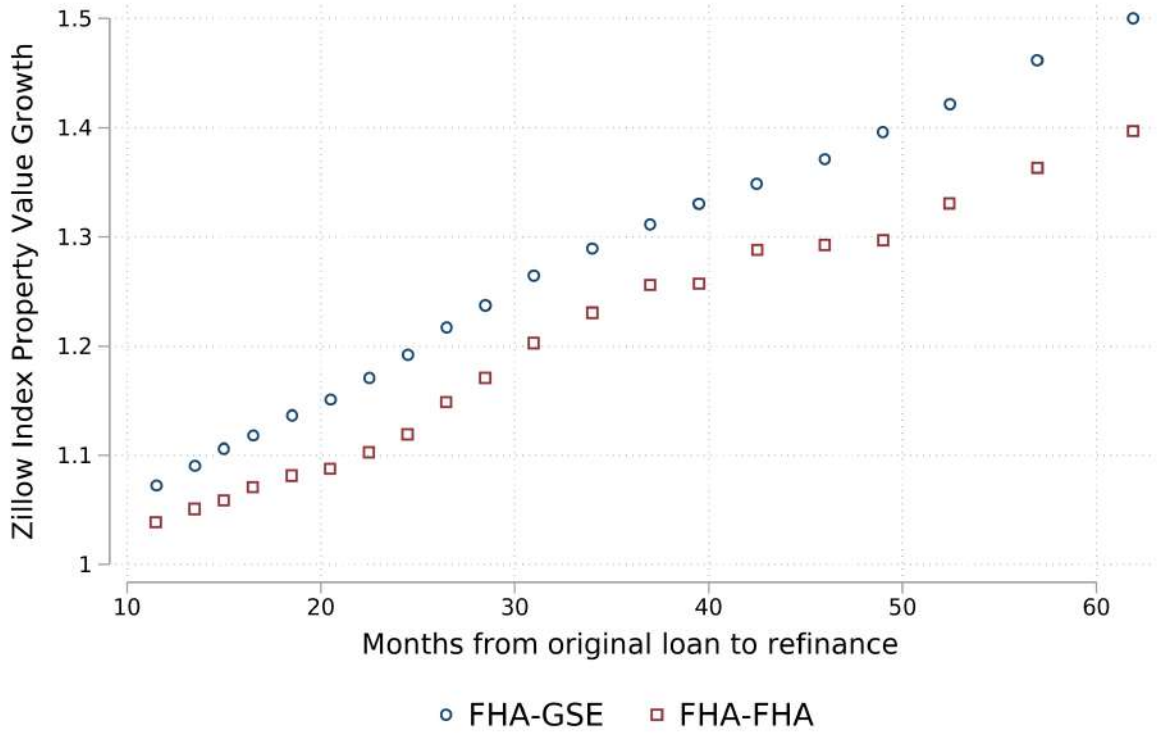
Note: This figure plots the property value growth estimate using Zillow Home Value Index (ZHVI) for the sample of FHA borrowers from 2009 to 2020. The y-axis is the ZHVI of the zipcode where the property is located at the time of refinance divided by the ZHVI at the time of purchase. The x-axis is months from home purchase to refinance. The blue circle is the group where the first FHA purchase loan was refinanced to a GSE loan, the red square is the group where the first FHA purchase loan was refinance to another FHA loan.

*Source:* Zillow, ATTOM, McDash, author's own calculations.

Figure A.5. Resale Property Value Growth

Note: This figure plots the property value growth of properties that was first purchased after 2009 with an FHA mortgage and refinanced to another FHA loan, later experienced an arm's length transfer before the end of 2020. The y-axis is the resale price divided by the purchase price, the x-axis is months from home purchase to resale.
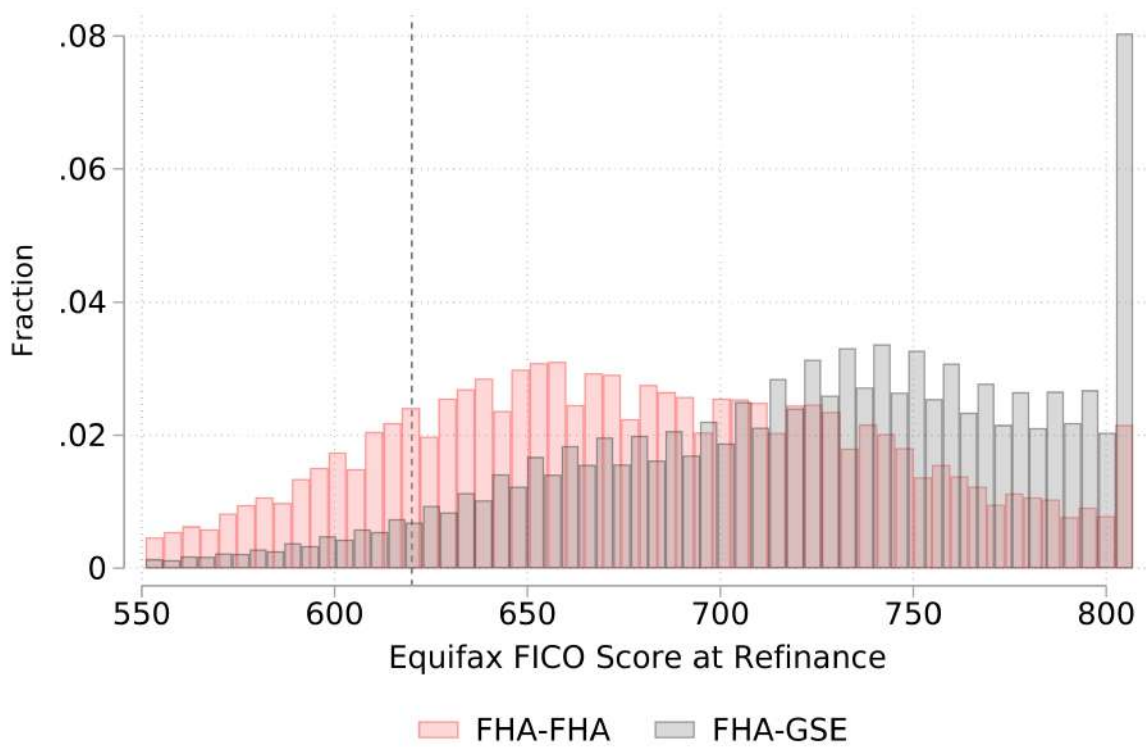*Source:* ATTOM, McDash, author's own calculations.

Figure A.6. Credit Score Distribution at Refinance
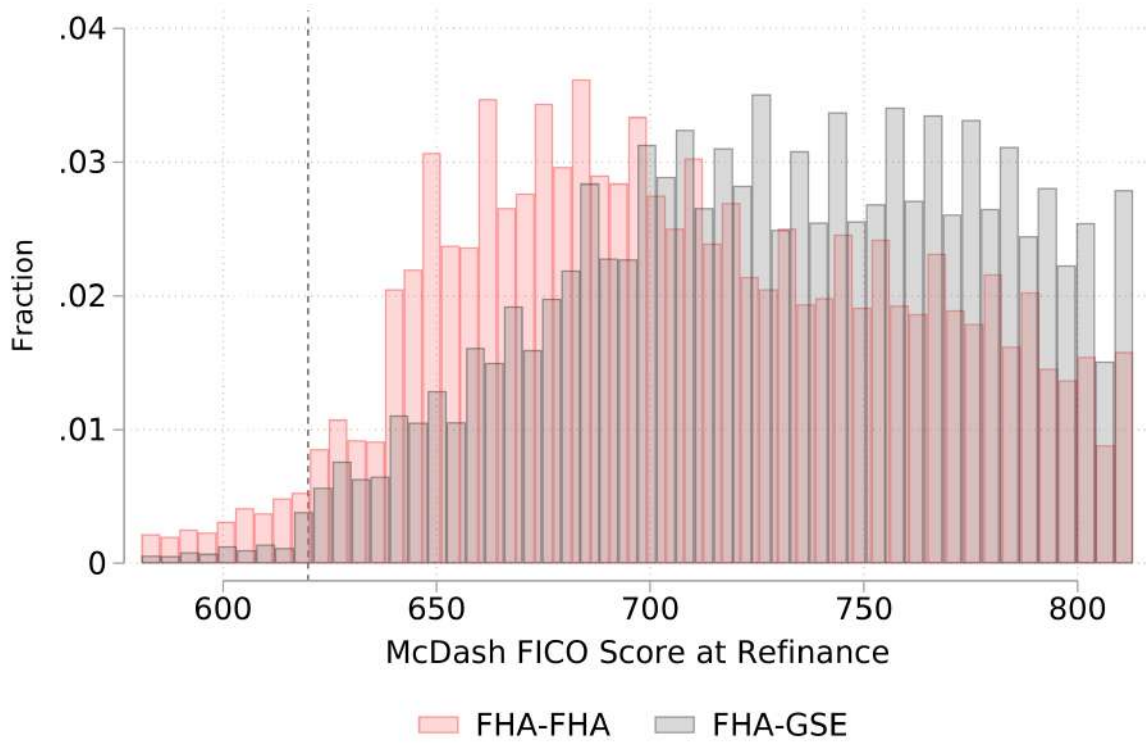
Note: This figure plots the credit score for FHA borrowers who refinanced their mortgage during the sample period in McDash. The dashed vertical line represents credit score=620 which is the typical threshold eligible for GSE mortgage. The red bar represents FHA borrowers who refinanced to another FHA loan through FHA streamline program, and the grey bar represents FHA borrowers who refinanced to a GSE loan.
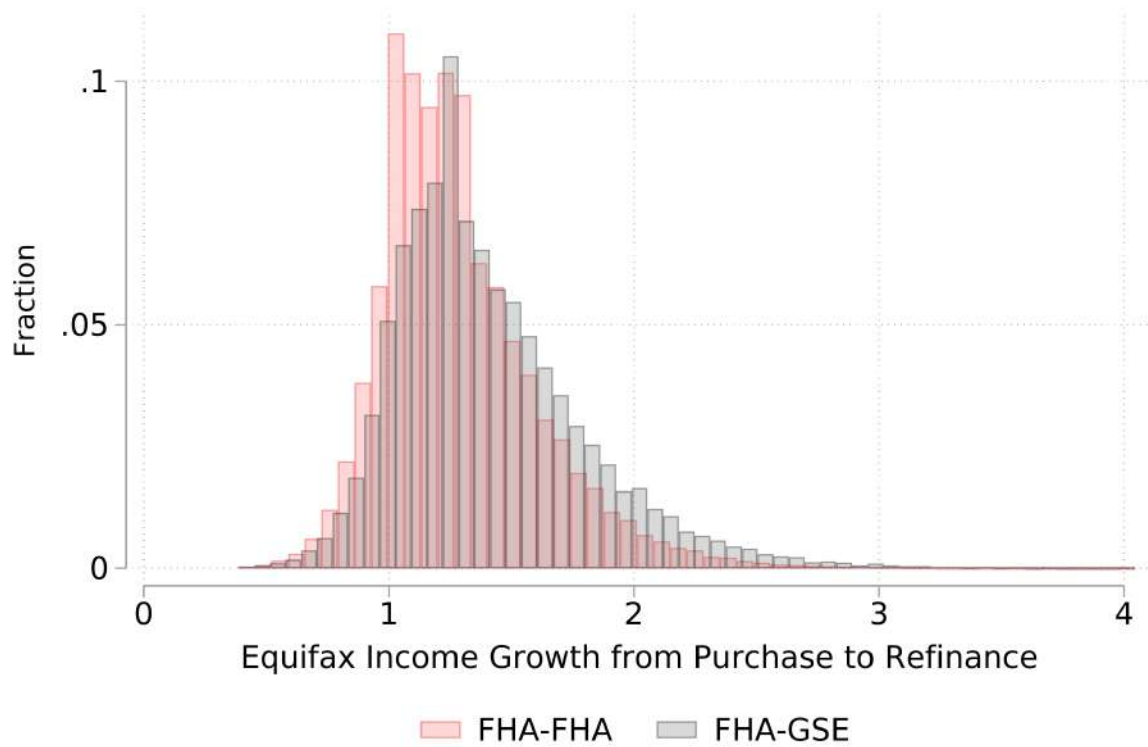*Source:* McDash, author's own calculations.

Figure A.7. Equifax Credit Score Distribution

Note: This figure plots the Equifax collected credit score (vantage score 3.0) for FHA borrowers who refinanced their mortgage during the sample period. The dashed vertical line represents credit score=620 which is the typical threshold eligible for GSE mortgage. The red bar represents FHA borrowers who refinanced to another FHA loan through FHA streamline program, and the grey bar represents FHA borrowers who refinanced to a GSE loan.
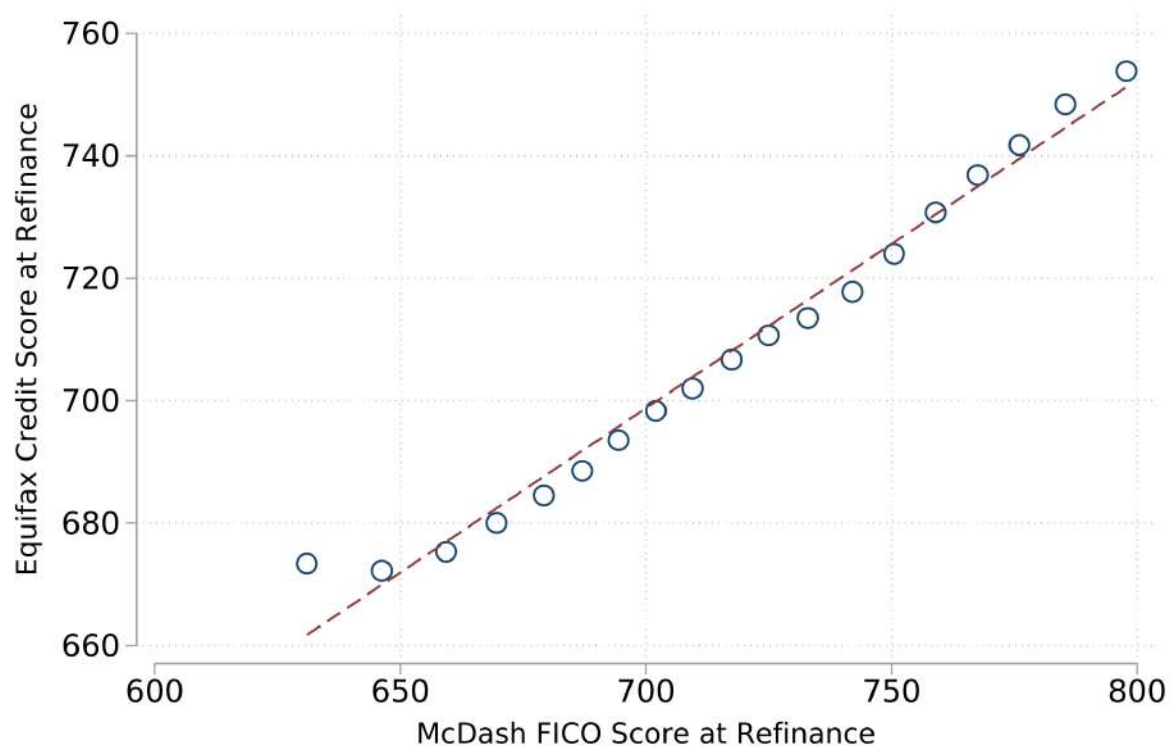*Source:* Equifax, McDash author's own calculations.

Figure A.8. Equifax Income Distribution

Note: This figure plots the Equifax collected borrower income change between the time of FHA loan origination and refinance. The red bar represents FHA borrowers who refinanced to another FHA loan through FHA streamline program, and the grey bar represents FHA borrowers who refinanced to a GSE loan.

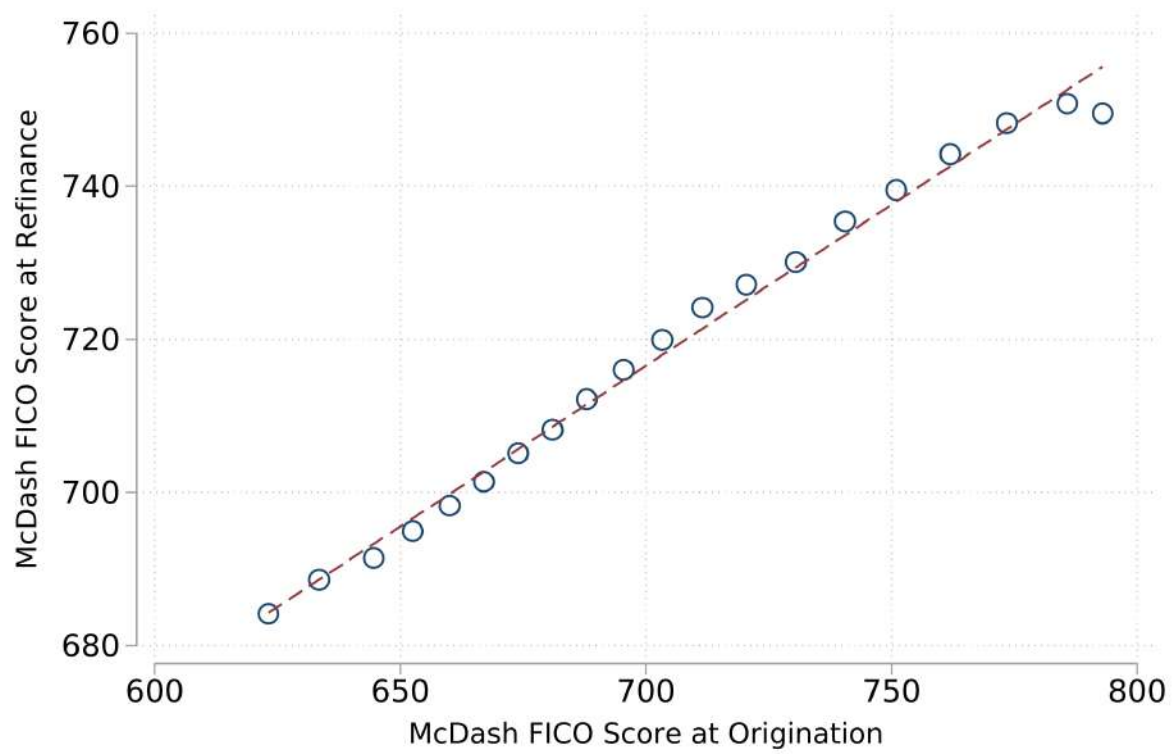*Source:* Equifax, McDash, author's own calculations.

Figure A.9. Equifax and McDash Credit Score Comparison

Note: This figure plots the binscatter of Equifax collected borrower credit score and McDash credit score at the time of refinance.
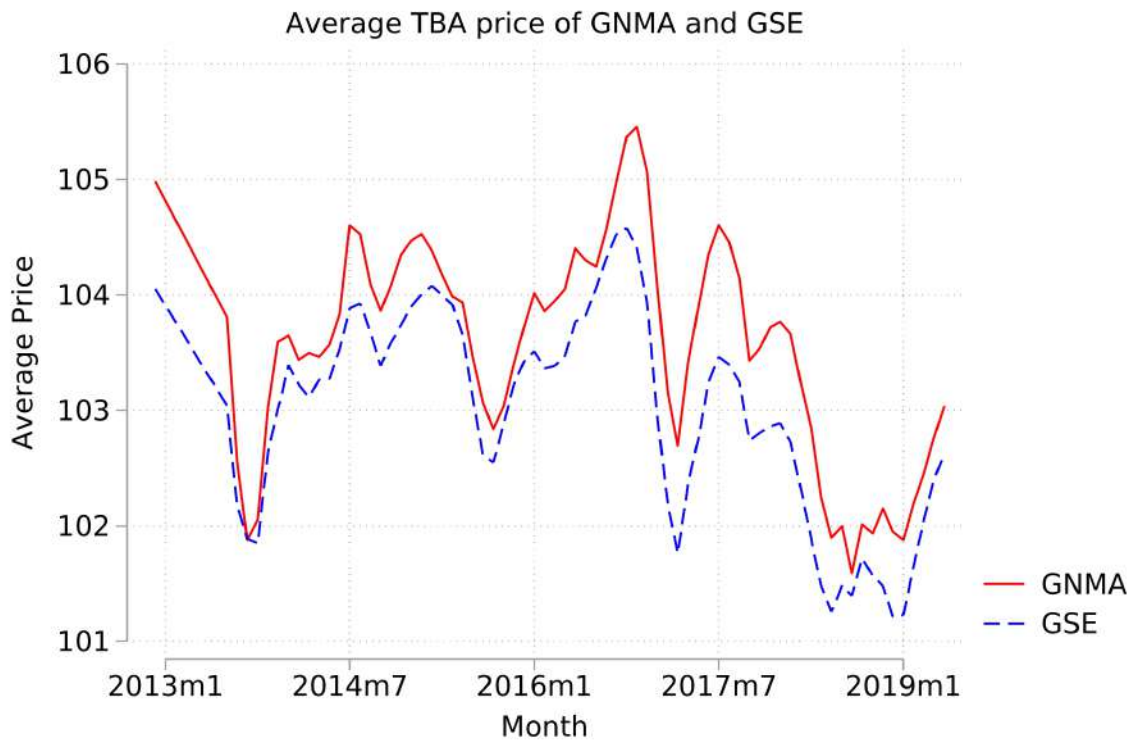*Source:* Equifax, McDash, author's own calculations.

Figure A.10. Equifax and McDash Credit Score Comparison

Note: This figure plots the binscatter of McDash credit score at the time of origination and refinance.
Source: McDash, author's own calculations.

Figure A.11. TBA GNMA Price relative to GSE

Note: This figure plots the price of most commonly traded MBS for GNMA and GSE(FNMA and FHLMC), measured using TRACE Daily Trade Summary data from WRDS. The red line is GNMA MBS and the blue line is GSE MBS. The price are smoothed over 3 month period.
Source: TRACE.

B Additional Tables

TABLE B.1. Summary Statistics of Merged and Dropped Sample

Merged Sample Observations = 522,561

	Mean	SD	P25	Median	P75
Int. Rate (Prepaid Loan)	0.0476	0.00694	0.0425	0.0487	0.0525
LTV at Origination (Prepaid Loan)	0.927	0.0927	0.909	0.966	0.982
FICO (Prepaid Loan)	702.8	52.44	662	698	744
Prop. Value (Prepaid Loan)	243,865	125,559	156,000	215,000	297,000

Dropped Sample Observations = 611,734

	Mean	SD	P25	Median	P75
Int. Rate (Prepaid Loan)	0.0454	0.00694	0.0400	0.0450	0.0500
LTV at Origination (Prepaid Loan)	0.938	0.0807	0.933	0.970	0.982
FICO (Prepaid Loan)	702.8	51.87	662	697	743
Prop. Value (Prepaid Loan)	225,630	118,023	143,000	199,000	276,000

Note: This table summarizes the loan characteristics of the merged and dropped population of borrowers who purchased their property with an FHA mortgage between 2009 and 2020. Panel A summarized the sample that successfully merged across multiple datasets for both purchase and refinance loan and end up using in the main analysis. Panel B summarized the dropped FHA loans that either the purchase loan or the refinance loan could not be merged across datasets.
Source: ATTOM, McDash.

TABLE B.2. R^2 of different specifications

Borrower Control	Fixed Effect Control	R^2 w/o Lender FE	R^2 w/ Lender FE	R2 Diff
Linear credit score	Year, County	0.337	0.445	0.108
Linear credit score	Year # County	0.351	0.456	0.105
LLPA Bins	Year, County	0.335	0.448	0.113
LLPA Bins	Year # County	0.355	0.160	0.105

Note: This table shows the R^2 of observables for different specifications of the linear probability model regression specified by equation 4. The left hand side is refinancing to GSE loan given eligible. First two rows use controls as a linear function of credit score and loan amount measures. The last two rows use credit score bins according to GSE LLPA table.