The Impact of Collateral Value on Mortgage Originations

Brittany Almquist Lewis*

August 10, 2022

Abstract

In a model of optimal contracting between a mortgage borrower and lender, we show that when the lender's outside option decreases, she lends to a new, previously dominated, market. The optimal mortgage contract in this market has an alternate structure relative to the standard market. We map the decrease in the outside option to a strengthening creditor rights on mortgage-backed collateral in 2005. Following this change, we show lenders increase lending to high-income-variability borrowers using alternate mortgage products. The model offers insight into the sudden expansion of negative amortizing mortgage products leading up to the Great Financial Crisis, the products' ensuing defaults, and has implications for minority borrowers.

Keywords: collateral, mortgage backed securities, repo, race
JEL Classification: G20

*Olin Business School, Washington University - St. Louis. E-mail: **b.almquist.lewis@gmail.com**, website: **www.brittanylewis.org**. I am deeply grateful to Chris Clayton and Candace Miller for influential discussions. I have greatly benefited from conversations with Kosali Simon and Amir Kermani. I gratefully acknowledge the Guthrie Center for Real Estate Research and Indiana University's Racial Justice Research Fund for their support. Any errors in this manuscript are my own.

1 Introduction

There are several theories of why different contracts are good for different kinds of markets (Galperti (2015), Piskorski and Tchistyi (2010)). Piskorski and Tchistyi (2010) describes the optimal mortgage contract in an environment with both individuals who have high versus low variability in their income and net worth. An established result in contracting theory, under certain assumptions, is that when the value of the lender's outside option decreases, the terms of the optimal contract do not change but the division of surplus changes. If the value of the outside option falls low enough, certain contracts that were not previously profitable become worth originating. In this paper, we utilize the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA) as a policy change that granted preferred bankruptcy status to private-label mortgage collateral used in the sale and repurchase ("repo") markets. We use this policy change to study whether strengthening repo, or repurchase agreement, creditor rights decreases the value of lenders' outside option in contracting for private-label mortgage collateral. We ask whether the relative decrease in the outside option is sufficient to to incentivize lenders to originate mortgage products that prior to BAPCPA were dominated by the outside option.

Understanding whether strengthening creditor rights leads lenders to expand into new products by lowering the value of their outside option is important because if so, changes in lenders' upstream secured funding structure can change the contracts they offer to their downstream customers. These products have implications for the stability of the financial system. In order to study this phenomenon, we first propose a model to generate testable implications. The model features two types of borrowers, those with high and those with low income variability, and a lender. For ease of exposition, we assume that the borrower proposes the contract to the lender. We show that when the lender's outside option decreases, it incentivizes the lender to move into a new mortgage market, originating mortgage products to the borrowers with high income variability. The optimal mortgage product in this market has an alternate amortization structure. Prior to the policy change, these products were dominated by the outside option.

To study whether the implications of our model hold, we set up a difference-in-differences (DiD) research design that utilizes BAPCPA as a natural experiment to plausibly exogenously shock creditor rights on repos. We first show that the yields on private-label mortgage collateral decrease relative to the yields on agency mortgage collateral following BAPCPA's introduction in Congress, consistent with the value of dealers' outside option (agency mortgage collateral) decreasing relative to the value of private-label collateral. We then set up a treatment intensity research design following Lewis (2021) and define treated mortgage

companies to be the independent mortgage companies (IMCs) that received funding from dealers via warehouse repurchase agreements. We therefore define treated counties as counties with a higher market share of IMCs as they were more exposed to repo funding in 2004, the year prior to BAPCPA. We find that a 10% increase in treatment leads to a significant 2.7% increase in mortgage originations following BAPCPA. Consistent with the implications of the model, post-BAPCPA dealers expanded into mortgage products with characteristics resembling the optimal contract for high income variability borrowers in Piskorski and Tchistyi (2010). Higher treatment intensity leads to a significant increase in the fraction of option-adjustable rate mortgages (ARMs), negative amortizing, balloon, two-step, interest only, and hybrid mortgages. These products contributed significantly to the defaults during the GFC. Consistent with the expansion occurring mainly at the extensive margin, as the model implies, we find that a 10% increase in treatment intensity significantly increases credit score at origination in the post-period by 0.5%.

The model implies that when the lender's outside option decreases, she moves into a new market. The new market has higher income variability, making an alternate mortgage product optimal. Kermani and Wong (2021) find that minority groups have higher volatility in both net worth and labor income. Therefore we hypothesize that minorities should be differentially affected by the policy change. We utilize a triple difference research design to study the differential effects on mortgage products by racial makeup of a zip code pre- versus post-BAPCPA. We interact the IMC market share in 2004 in a zip code with the percent of the population that identifies as Black, Non-White Hispanic or Latino, and White in that zip code. We find that following the policy change, the fraction of originations comprising alternate mortgage products increased for Black and Latino zip codes relative to White zip codes. This paper implies that granting preferred bankruptcy treatment on private-label repo collateral can incentivize lenders to move into new markets where alternate financial products are optimal. These new products pose risks to financial stability associated with repo safe harbors over and above the four risks proposed in Duffie and Skeel (2012): lowering incentives to monitor collateral, increasing financial interlinkages, inefficient substitution toward short-term repo funding and facilitating collateral fire sales in the capital markets.

In Section 2, we discuss the BAPCPA policy change. In Section 3, we present a stylized model that studies what happens when the outside option of the lender decreases. In Section 4, we discuss the data, provide evidence consistent with BAPCPA decreasing lenders' outside option in their contracting for private-label mortgage collateral, and present evidence consistent with lenders increasing mortgage originations at the extensive margin. In the fifth section we discuss the implications that this has for minority borrowers. In Section 6, we conclude.

2 Introduction to BAPCPA

Repurchase agreements using collateral defined in the bankruptcy code receive *exemption from automatic stay*. This grants the holder of the underlying collateral super-senior bankruptcy status since it is exempt from the hold on a firm's assets when the firm enters bankruptcy proceedings. However other types of collateral, not explicitly defined in the bankruptcy code, are also traded in the repo markets. All repurchase agreements are written with the standard contract in the hopes that the court will interpret them as receiving preferred bankruptcy status. However, the preferred bankruptcy status relies on the court's interpretation (Lumpkin (1993)). The market contraction in response to two important bankruptcy court cases where the court failed to grant repo collateral preferred bankruptcy status, Lombard Wall (1982) and Criimi Mae (2000)– both heavily funded with repos – underscores this point. These court cases are discussed further in the Online Appendix of Lewis (2021).

BAPCPA was introduced in Congress in February 2005 and signed into law in April 2005.[1] The law expanded the definition of repurchase agreements in the Bankruptcy Code to include: (1) mortgage loans; (2) mortgage-related securities; (3) interests in mortgage-related securities or mortgage loans. This granted private-label mortgage securities and whole loans exemption from automatic stay, giving the final creditor super senior bankruptcy status. This expansion only affected private-label mortgage collateral, since agency mortgage collateral had been exempted in 1984.

3 Model

Here we develop a model of mortgage lending. We use the model to study the impact that increasing collateral value to the lender has on mortgage originations.

4 Model Set-up

We consider a one-period model of a mortgage lender and borrower. The borrower receives utility from housing (h), which requires a mortgage (M) to purchase, and dislikes paying the mortgage payment at interest rate (r):

[1]The law was introduced in Congress on February 1, 2005 by Republican Senator Chuck Grassley, passed by Congress on April 14, 2005, and signed into law by the president of the U.S. on April 20, 2005 (https://www.congress.gov/bill/109th-congress/senate-bill/256/text/enr). It applied to consumer bankruptcy cases after October 17, 2005. See: Bankruptcy Abuse Prevention and Consumer Protection Act of 2005, Pub. L. No. 109-8, §907, 119 Stat. 23, 171-172 (codified as amended at 11 U.S.C. §101(47) (2012))

$$u(r, h, M) = v(h) - (1 + r) \times M$$

With a decision problem of $v(1) - (1 + r) \times M > v(0)$ so that the borrower takes out a mortgage if the utility he derives from purchasing a home minus the mortgage payment is greater than his utility from not purchasing a home.

The lender is competitive and has utility function over the value she receives from creating the mortgage which is equal to the mortgage payment inflated by the shadow value she receives from using it as collateral.

$$u(r, c) = (1 + r) \times (1 + c) \times M - p \times M \tag{1}$$

So that ceteris paribus, as collateral value increases, either the value of the interest rate will decrease, or the value of the mortgage will increase.

[Comparative statics for the model to follow.]

5 Data and Empirics

5.1 Data

Securitization and Price of Mortgage Backed Securities (MBS) In order to study the effect of BAPCPA on the price of PLS in the secondary market, we study the daily average yields on the LD10OAS Bloomberg Barclays agency MBS index and the BNA10AS Bloomberg Barclays private-label MBS index from October 2003 through December 2006.

Home Mortgage Disclosure Act (HMDA) Data To establish the effect of BAPCPA on IMCs' lending to households, we utilize the HMDA data. In order to supervise and enforce fair lending practices nationwide, the U.S. Congress mandates that all loan applications related to home purchase, refinancing, and home improvement be reported to the federal government. The main variables that we use are mortgage status (denied, approved, originated), who the originator was, whether the originator was an IMC, the year, and county in which it was originated and the race of the borrower.

We use these data to construct the IMC county level market share in 2004, the year prior to BAPCPA. To identify the IMCs, we use the crosswalk maintained by Robert Avery to match subsidiaries belonging to the same parent company and aggregate mortgages originated by each parent company. We define a mortgage company as an IMC if it underwrites

and funds a loan in its own name, following the HMDA definition of IMCs. We also utilize the county, month data provided by Neil Bhutta in order to study granular time variation around BAPCPA, as the public HMDA data only publishes data at the annual level.[2] At the county month level, the HMDA data no longer tracks individual IMCs.

CoreLogic Data We use the CoreLogic Loan Level Market Analytics (LLMA) data to study mortgage characteristics pre- and post-BAPCPA. Due to data restrictions, we do not observe the originator of a mortgage, prohibiting comparison of the individual mortgages originated directly by treated versus control IMCs, or non-IMCs, pre- and post-BAPCPA. To overcome this, we aggregate all variables to the county level and merge with the pre-period IMC market share in that county to analyze the effect of exposure to IMC lending on changes in loan characteristics.

The LLMA contain detailed information on mortgage characteristics at origination as well as monthly performance data for a large sample of anonymized borrowers. CoreLogic collects these data from 25 of the largest mortgage servicers in the U.S.. The data track approximately 5.7 million mortgages each year and in a typical year during 2003-2008 include 45% of mortgages originated in the U.S.. The main variables that we utilize are the mortgage's initial interest rate, occupancy status, mortgage product (balloon, negative amortizing, adjustable rate mortgage (ARM)), and prime versus subprime status.

Race Data This paper merges race variables from the American Community Survey (ACS) 5-year estimates for race from IPUMS National Historical Geographic Information System NHGIS data to the mortgage origination data by 5 digit zip code.

5.2 Decrease in Value of Outside Option

We hypothesize that BAPCPA decreased the value of dealer banks' outside option in contracting for private-label mortgage products. To study this we compare the yields on the LD10OAS Bloomberg Barclays agency MBS index and the BNA10AS Bloomberg Barclays private-label MBS index. We run the following regression:

$$\log(yield_{i,t}) = \omega Post_t + \nu PLS_i + \sum_T \beta_T \ PLS_i \times \mathbb{1}_{t=T} + \epsilon_{i,t} \tag{2}$$

For MBS index i, in month t, we regress yield on the indicator variable PLS_i, which equals one for the private-label MBS index and zero for the agency MBS index, and interaction terms that interact PLS_i with monthly indicators. $\log(yield_{i,t})$ is the log of the yield on

[2]For all specifications, I limit the data to the top 500 counties captured in the dataset published by Neil Bhutta: https://sites.google.com/site/neilbhutta/data.

an index of MBS securities. β_T is the coefficient on the interaction between PLS_i and an indicator for each month pre and post BAPCPA. The indicator variable is set to zero in January 2005, as it was the month before BAPCPA was introduced in Congress in February 2005.

Figure 1 shows that the yields on agency MBS decreased relative to those on private-label MBS when BAPCPA was brought to Congress in February 2005. This is consistent with the value of private-label MBS post BAPCPA. Prior to the introduction of BAPCPA, PLS relative to agency yields were fairly stable. There is a slight downward trend beginning in November 2004. This may have been due to the Republicans gaining seats in the 2004 Senate elections. There had been drafts of the bill in Congress as early as 2002, however it was not thought that BAPCPA would pass until November 2004 when the Republicans gained seats in Congress.

[FIGURE 1 about here.]

5.3 Implications of the Model

The model implies that when the outside option of the lender falls low enough, the distribution of the surplus slit by the borrower and the lender changes. If the value of the outside option falls low enough, it becomes worthwhile for the lender to enter a new market, which prior to BAPCPA had been dominated by the outside option. When the new market has variable income and low net worth, the Piskorski and Tchistyi (2010) model finds that the optimal contract structure takes the form of Option ARM mortgages. It also finds that an approximately optimal mortgage contract, which simplifies the terms of the Option ARM contract, has little loss in efficiency.

To investigate whether empirical evidence is consistent with dealer lending to a new market as the model suggests will happen post BAPCPA, we use a treatment intensity research design where market share of is the treatment variable. IMCs were directly exposed to credit lines from the dealers affected by BAPCPA, and for the sake of exposition, can be thought of as originating mortgages on behalf of the treated dealers. The variable $IMCMarketShare_{c,2004}$ captures the exposure of a county to the IMCs in 2004, the year prior to BAPCPA. This variable is calculated using the number of mortgage originations in the HMDA data:[3]

$$IMCMarketShare_{c,2004} = \frac{Number\ of\ originations\ by\ IMCs_{c,2004}}{Total\ number\ of\ all\ originations_{c,2004}}. \tag{3}$$

[3]We construct the 2004 IMC county market share using value of mortgage originations and find that the distribution of market share is very similar to the measure using number of originations.

Figure 2 depicts all IMC market share per county in 2004. The variation in IMC market share is likely due to the Fannie Mae and Freddie Mac scandals in 2003 and 2004 which decreased barriers to entry for IMCs to enter the mortgage market. The market share of IMCs was relatively stable throughout 2004, the year that we define treatment. To alleviate concerns that the results are driven by a pre-existing trend in IMC expansion, we examine pre-period home prices and income and include *state* × *month* and *county* fixed effects. We find no statistically significant difference in the 1999 census per capita income or in home prices in counties with high versus low IMC market share after controlling for state fixed effects. The pre-period balance in home prices and income helps to mitigate concerns that the treatment and control counties were significantly different in ways that varied with BAPCPA after controlling for fixed effects.

[FIGURE 2 about here.]

We first investigate whether the overall number of mortgages increased following BAPCPA. We study how $IMCMarketShare_{c,2004}$ affects county level mortgage characteristics and home prices. We run the following dynamic regression:

$$Y_{c,t} = \gamma_c + \eta_{s,t} + \sum_T \beta_T IMCMarketShare_{c,2004} \times \mathbb{1}_{t=T} + \epsilon_{c,t}. \quad (4)$$

Where $Y_{c,t}$ is the variable of interest in county c, at month t, γ_c denotes county level fixed effects, and $\eta_{s,t}$ denotes *state* × *month* fixed effects. $IMCMarketShare_{c,2004} \times \mathbb{1}_{t=T}$ is the interaction term between the market share variable, and an indicator variable for month of origination. The reference month is March 2005, the month prior to the passage of BAPCPA. Standard errors are clustered at the county level. We report the regression results with *county* fixed effects alone and with both *county* and *state* × *month* fixed effects. The regression with both *county* and *state* × *month* fixed effects is our preferred specification as it compares mortgage characteristics in counties with high versus low IMC market shares within the same state and month, absorbing state-month housing market effects. For all of the mortgage characteristic regressions, we study a narrow window around BAPCPA. The narrow window, fixed effects, and stable pre-period IMC market share help to ensure that the pre-period is a valid counterfactual for the post-period. Callaway, Goodman-Bacon and Sant'Anna (2021) note that continuous treatment in a DiD setting can introduce bias if the estimator's weighting of treatment doses differs from the population-weighted treatment doses. In Appendix A in the Appendix, we show that the population-weighted doses are close to normally distributed and therefore the estimator closely approximates the population weights, thus the potential bias would be small.

As shown in Figure 5 (a), the total number of mortgage originations increased statistically significantly following BAPCPA for counties with high IMC exposure. A 10% increase in treatment leads to a 2.7% increase in mortgage originations following BAPCPA. The increase in the number of mortgage originations is consistent with an increase in mortgage originations to the extensive margin, or borrowers who would not otherwise have received a mortgage product. Not only did the number of originations increase, the fraction of balloon and negative amortizing mortgages increased significantly by 0.3 percentage points and 0.6 percentage points respectively as shown in Figure 5 (b) and (c). Product types recorded in the CoreLogic data do not include Option ARMs, however negative amortizing products include Option ARM products. This is because each month the typical Option ARM allowed the borrower to pay the full principal and interest payment, only the interest payment, or a payment that was less than the interest due. This meant that the unpaid interest was added to the principal balance owed on the mortgages, increasing the balance owed, rather than decreasing it as a traditional mortgage does.

Additionally, a 10% increase in IMC market share in 2004 in a given county leads to a statistically significant decrease of 2.39% on ARMs' introductory interest rate directly following BAPCPA. This introductory interest rate or "teaser rate" on adjustable rate mortgages was pegged to the twelve month Treasury rate. The Treasury rate was monotonically increasing during this time period, as the Federal Reserve was in monetary tightening regime. We also observe an increase in hybrid and two-step mortgages in results available upon request. The decrease in the "teaser rate" offered on mortgages with the balloon, balloon ARM, hybrid and two-step structures is consistent with the approximately optimal mortgage contract derived in Piskorski and Tchistyi (2010). This is because these mortgages allow the borrower to pay the "teaser rate," which is less than the interest actually accruing on the mortgage product, and they offer an adjustable rate feature.

Consistent with the increase in mortgage originations coming from the extensive margin, as the model suggests, rather than the intensive margin, is the increase in credit scores at origination in counties with higher levels of treatment pre-BAPCPA shown in Figure 5 (e). If IMCs were increasing the number of mortgages that they originated but lending to their existing stock of borrowers, the credit score associated with these mortgages would begin to fall, both because the high credit score borrowers would be exhausted and because originating multiple mortgages to the same borrower would increase their leverage ratio and lower their credit score. Figure 5 (e) shows that the credit score associated with new mortgage originations continued to increase over time, consistent with new borrowers entering the mortgage market. The increasing credit score is also consistent with the increase in alternate mortgage products with a riskier amortization structure – lenders likely compensated for

increased income volatility and low down-payments by increasing borrower credit scores on these products.

[FIGURE 3 about here.]

6 Effect on Minority and Low Income Borrowers

6.1 Origination of Alternative Products

The model predicts that low income, high income variability people are more likely to receive alternate mortgage products following the passaged of BAPCPA. Due to the racial wealth and income gap, minorities are likely to be disproportionately represented in the group of borrowers who receive the new alternate products that lenders began originating following BAPCPA. We conduct a zip code level analysis where we create a variable, $IMCMarketShare_{z,2004}$, the zip code level analog of the variable calculated in Equation 4, that captures the exposure of a zip code to the IMCs in 2004, the year prior to the shock. $\%RACE_z$ is defined as the total number of inhabitants of a certain race in a zip code divided by the total population of the zip code. We define the percent race of a zip code to be:

$$\%RACE_z = \frac{Number\ of\ RACE\ inhabitants_z}{Total\ number\ of\ inhabitants_z}. \tag{5}$$

Figure 4 contains a U.S. heatmap that documents for each zip code of the proportion of Black inhabitants in panel (a), the proportion of Non-White Hispanic (referred to as Latino for the remainder of the paper) inhabitants in panel (b), and the proportion of White inhabitants in panel (c).

[FIGURE 4 about here.]

This paper utilizes a triple difference empirical specification to study the impact of race on the credit supply expansion caused by BAPCPA. The econometric design studies zip codes pre- versus post-BAPCPA as the first difference, across high- versus low-IMC market share counties as the second difference, and across high- versus low-minority zip codes as the third difference. The insight of the research design is that absent a differential effect of race on lending, relative differences in origination trends between majority Black versus non-Black (White and Latino) zip codes, for example, should not change post-BAPCPA relative to their trends pre-BAPCPA. Controlling for changes in bank lending (less treated areas), in Black relative to non-Black areas, controls for relative differences in trends between Black versus non-Black mortgage originations absent a credit supply shock. In the research design,

we compare zip code-level mortgage originations across counties within the same state and month and controlling for county level time invariant factors.

To understand whether zip codes with difference racial makeups were differentially affected by BAPCPA, we estimate the specification in Equation 6 which compares zip codes with high- versus low-market share of IMCs in 2004 interacted with the percent of inhabitants of a given race in the zip code. We exploit a narrow 15-month window pre- and post-BAPCPA from January 1, 2004 to December 31, 2006 to help ensure that the post-period is a valid counterfactual for the pre-period.

$$\begin{aligned} Y_{z,t} = \alpha \log(AvgCLTV_{z,t}) + \delta \log(AvgIntRate_{z,t}) + \lambda \log(AvgDTI_{z,t}) \\ + \rho \log(AvgFICO_{z,t}) + \zeta IMCMarketShare_{z,2004} + \xi \%RACE_{z,2016} \\ + \mu IMCMarketShare_{2004} \times Post_t + \nu \%RACE_{c,2016} \times Post_t \\ + \tau IMCMarketShare_{2004} \times \%RACE_z \\ + \beta IMCMarketShare_{2004} \times \%RACE_z \times Post_t \\ + \gamma_c + \eta_{s,t} + \epsilon_{z,t} \end{aligned} \tag{6}$$

Where $Y_{z,t}$ is $\log(Originations_{z,t})$, $FracBalloon_{z,t}$, $FracNegAm_{z,t}$, $FracTwoStep_{z,t}$, $FracHybrid_{z,t}$, $FracInterestOnly_{z,t}$. log is the natural logarithm of a number. For each zip code z in month t, $Originations_{z,t}$ is the total number of originations. $AvgCLTV_{z,t}$, $AvgIntRate_{z,t}$, $AvgDTI_{z,t}$, $AvgFICO_{z,t}$ are the average combined-loan-to-value ratio, debt-to-income ratio, and credit score in a zip code in month t. The continuous treatment variable, $IMCMarketShare_{z,2004}$ is the market share of IMCs in a zip code z in 2004. $Post_t$ is an indicator variable that equals one for April 2005 and later – since BAPCPA was passed by Congress on April 20, 2005 – and zero otherwise. β is the coefficient on the interaction term, $Post_t \times IMCMarketShare_{z,2004} \times \%RACE_z$. β measures how higher values of $\%RACE_z$ affect mortgage originations in the post-period relative to the pre-period, holding constant the IMC market share in 2004 in each zip code. γ_c represents county level fixed effects and $\eta_{s,t}$ represents $state \times month$ fixed effects. Standard errors are clustered at the county level.

The previous section establishes that areas more exposed to IMCs receive an increase the number of mortgages originations and a shift toward mortgages with riskier amortization structures such as balloon, negative amortizing, adjustable rate, and interest only products following BAPCPA. By interacting the exposure of the credit supply increase with the racial makeup of an area, this paper studies how a strengthening creditor rights on mortgage collateral affected racial groups differently. The causal identification of the impact of race comes from comparing the origination differential between two zip codes, one with a higher

$\%RACE_z$, that both have the same IMC market share with two more zip codes that have the same $\%RACE_z$ differential but a lower IMC market share.

The paper estimates the same regression specification first setting the $\%RACE_z$ equal to Black, then Latino, and finally White inhabitants in a zip code. The continuous treatment variable is the specified race and the control group contains the races not specified. If zip codes with different racial makeups were both affected by BAPCPA in the same way, we would expect to see no differential increase (decrease) in mortgage lending by the IMCs in areas with different racial makeup.

6.1.1 Results

Figure 5 plots the results of Equation 6. The figure depicts the change in total mortgage originations, both purchase and refinance, for zip codes with higher $\%BLK_z$ in panel (a), higher $\%LTN_z$ in panel (b), and higher $\%WHT_z$ in panel (c). Zip codes with higher $\%BLK_z$ do not benefit from as much of the BAPCPA-driven credit supply increase as do those with higher $\%LTN_z$ and $\%WHT_z$, controlling for average combined-loan-to-value (CLTV) ratio, average interest rate, debt-to-income (DTI) ratio, and credit score in the zip code. In a zip code with 100% IMC market share, relative to one with 0% IMC market share: a 10% increase in $\%BLK_z$ leads to an 11.2% decrease in mortgage originations; a 10% increase in $\%LTN_z$ leads to 3.1% increase in mortgage originations; and a 10% increase in $\%WHT_z$, leads to a 2.8% increase in mortgage originations.

[Figure 5 about here.]

One possible source of endogeneity that we address is that the reason that higher percent Black zip codes receive less credit is because, as found in Haughwout, Lee, Scally, Van der Klaauw et al. (2020), they have lower credit scores on average. Agarwal, Chomsisengphet, Mahoney and Stroebel (2018) find that banks' marginal propensity to lend is much higher for high credit score borrowers. A one percentage point decrease in bank cost of funds increases borrower credit limits by $127 for borrowers with a credit score below 660, and by $2,203 for borrowers with credit scores above 740. We address this by controlling for credit score in our regression analysis. Our results suggest that following BAPCPA, IMCs expanded their lending by less to areas with higher $\%BLK_z$ even after accounting for lower credit scores in these areas.

To test whether zip codes more exposed to BAPCPA disproportionately increased originations with riskier amortization structures in zip codes with higher $\%BLK_z$ and $\%LTN_z$ relative to those with higher $\%WHT$, we estimate Equation 6. We set $Y_{z,t}$ equal to the fraction of balloon mortgages, $FracBalloon_{z,t}$; negative amortizing mortgages, $FracNegAm_{z,t}$;

two step mortgages, $FracTwoStep_{z,t}$; hybrid mortgages, $FracHybrid_{z,t}$; and interest only mortgages, $FracInterestOnly_{z,t}$ in a zip code.

We find that increasing from 0% IMC market share in a zip code to 100% IMC market share, a 10% increase in $\%LTN$ significantly increases the fraction of balloon mortgages by 0.44 percentage points; a 10% increase in $\%BLK$ decreases the fraction of balloon mortgages by 0.03 percentage points. While the change in the fraction of balloon mortgages in zip codes with higher $\%BLK_z$ is negative on average over the post period, the plot shows that it is on an increasing trajectory from the passage of BAPCPA in April 2005 through the end of 2006. This is consistent with increased supply of balloon mortgages and increased use of products with alternate amortization structures in zip codes with lower down payments and more variable income, consistent with the model. A 10% increase in $\%WHT$ statistically significantly decreases the fraction of balloon mortgages, by 0.42 percentage points, and balloon originations remain on a decreasing trend in these areas.

[FIGURE 6 about here.]

Additionally, we study hybrid, two step, interest only (IO) and negative amortizing mortgages and we find evidence consistent with IMCs specializing the types of lending to minority zip codes as shown in Figure 7. Consistent with the model, the evidence is consistent with IMCs increasing originations of alternate mortgage products to borrowers with higher income variability and lower wealth (lower capability to pay down payments) and it having a disproportionately large effect on minority zip codes.

Figure 7 panels (a) and (b) show that higher $\%BLK_z$ received more hybrid and IO and mortgages and panels (c) and (d) show that high $\%LTN_z$ zip codes received more negative amortizing and two step mortgages. The main benefit of these products were their initial fixed "teaser rate" which was typically lower than the interest rate on a fixed rate mortgage and would reset, usually to a much higher rate. Interest only mortgages were mortgage products that borrowers only needed to pay the interest payment, not the fully amortizing payment. These kind of mortgages were left with large balloon payments at the end of the mortgage. Hybrid mortgages were mortgages that combined fixed rate and adjustable rate features.[4] Negative amortizing mortgages are mortgages that allow only a portion of the interest payment to be paid and any unpaid interest is added to the balance of the mortgage and begins accruing additional interest. Two step mortgages offer a fixed initial interest rate for an agreed-upon introductory period, typically 5 - 7 years before the interest rate resets to a rate that reflects the prevailing one.

[4]They have a fixed interest rate for a specified period of time, after which the rate adjusts periodically for the remaining loan term. For example a 30-year, 3/1 hybrid ARM loan has an initial interest rate fixed for the first 3 years. After this period the rate will then adjust each year for the next 27 years.

[FIGURE 7 about here.]

BAPCPA also lowered credit constraints so that borrowers who were not wealth constrained could receive mortgages at lower credit scores – traditional subprime mortgages. The evidence is consistent with IMCs originating more alternate-A paper products in minority zip codes and more subprime products in White zip codes. This ties in with the racial wealth gap and income gap. The Survey of Consumer Finances indicates that by 2016, the median net worth of White families was $171,000, while the median for black families was $17,600, almost ten times lower (Bricker et al. (2017)). Morduch et al. (2018) document that minority income volatility is significantly higher than that of White earners, primarily driven by gaps in the low and middle of the income distribution.

Rugh (2015) argues that White borrowers were backing out of the housing market during the late 2000s while Latinos kept borrowing. The evidence is consistent with minority borrowers increasing their borrowing using alternate amortization structure products. This is consistent with higher income volatility borrowers requiring products that delayed amortization and interest payments to the end of the loan. These products would lower introductory monthly payments relative to those on standard (fully amortizing) products at the peak of the housing boom when the Federal Reserve was raising interest rates. Following BAPCPA the recovery value of collateral increased for investors and repo borrowers. Therefore, investors could equate expected returns to those in the pre-period by increasing the overall risk of the collateral. In its 2005 annual report, an IMC, HomeBanc, stated that:

> "Mortgage loans that are referred to generally as ARMs may include any of the following types of loans: ... hybrid, interest-only, negative amortization, option ARMs."
>
> "The primary attraction to borrowers of these adjustable-rate mortgage loan products is that **initial monthly mortgage loan payments** can be significantly **lower** than fixed-rate or level-pay mortgage loans under which the borrower pays both principal and interest at an interest rate fixed for the life of the mortgage loan. As a result, many borrowers are able to incur substantially **greater mortgage debt** using one of these adjustable-rate mortgage loan products than if they used a fixed-rate mortgage loan."
>
> "When evaluating a mortgage loan application from a prospective borrower for an adjustable-rate or interest-only mortgage loan, many mortgage originators determine the amount of loan that **borrower can afford** based on the borrower?s

initial scheduled monthly payments ...rather than based on the adjusted monthly payments as of future mortgage interest reset dates"[5]

6.2 Mortgage Acceptance Rates

To test whether the trends in origination of mortgage products are reflected in mortgage acceptance rates, we use loan-level HMDA data to identify the differential effect of BAPCPA on mortgage approval rates by race. We utilize a triple difference empirical specification. The first difference is the pre versus post BAPCPA period. The second difference is IMC lender versus non-IMC – banks, affiliated mortgage companies, and other traditional lenders – and the third difference is the race of a borrower.

Since the IMCs were funded heavily by warehouse repurchase agreements from dealers, the empirical design utilizes IMC lenders to causally identify the effect of BAPCPA's strengthening of repo creditor rights. The applicant race reported in the data allow the research design to identify whether a borrower of a given race received a differential increase (decrease) in mortgage approval rate post policy change borrowing from IMC lenders versus non-IMCs lenders. We estimate the following regression:

$$\begin{aligned} Accepted_b = \alpha post_t + \delta IMC_b + \lambda RACE_b \\ +\rho IMC_b \times post_t + \zeta IMC_b \times RACE_b + \xi post_b \times RACE_b \\ +\beta IMC_b \times \%Race_b \times Post_t \\ +\gamma_c + \eta_{s,t} + \epsilon_b. \end{aligned} \tag{7}$$

Where $Accepted_b$ is an indicator variable equal to one if the mortgage application is approved. The public HMDA data is only available at the annual frequency. $Post_b$ is an indicator variable set equal to one for 2005 and later. IMC_b is an indicator variable set equal to one if an application is received by an IMC lender. $RACE_b$ is an indicator for whether an applicant identifies as Black, Latino, or White. We iterate through specifying one race and including the other two in the control group. γ_c represents county level fixed effects and $\eta_{s,t}$ represents the $state \times year$ fixed effects. β represents the change in the application acceptance rate post-BAPCPA relative to pre-BAPCPA when the application is received by an IMC lender and the borrower identifies as a given race.

[5]HomeBanc 2005 Annual Report p. 55-56 of 173.

6.2.1 Results

Table 1 presents the results of Equation 7. Relative to other racial groups, Black borrowers experienced a significant decline in mortgage acceptance rate by 5.5%. Latino borrowers experienced a significant decline in acceptance rate of 6.6% and White borrowers received a significant relative increase in mortgage acceptance rate of 3%. This is consistent with White borrowers receiving more subprime mortgages that had lower credit score requirements but were fully amortizing and therefore slacked the credit constraint. While minorities borrowers received more Alt-A products that required higher credit scores in order to originate and had riskier amortization structures in order to loosen the wealth constraint.

[Table 1 about here.]

7 Conclusion

We utilize a model of the optimal mortgage contract and show that when the lender's outside option falls low enough, it leads her to expand lending to a new market that was previously dominated by the outside option. The optimal contract in this new market features an alternative amortization structure that allows borrowers to delay repayment of the mortgage product. Borrowers with higher income variability and lower income levels relative to the price of the home receive larger utility gains from these products. We map this model to the BAPCPA's strengthening of creditor rights on private-label mortgage collateral and hypothesize that this event increased the value of private-label mortgages relative to the outside option. We show that following BAPCPA, lenders increased their originations of alternative mortgage products, consistent with an expansion into a new market. We find that this has a disproportionately large effect on minority borrowers.

References

Agarwal, S., Chomsisengphet, S., Mahoney, N. and Stroebel, J. (2018), 'Do banks pass through credit expansions to consumers who want to borrow?', *The Quarterly Journal of Economics* **133**(1), 129–190.

Bricker, J., Dettling, L. J., Henriques, A., Hsu, J. W., Jacobs, L., Moore, K. B., Pack, S., Sabelhaus, J., Thompson, J. and Windle, R. A. (2017), 'Changes in us family finances from 2013 to 2016: Evidence from the survey of consumer finances', *Fed. Res. Bull.* **103**, 1.

Callaway, B., Goodman-Bacon, A. and Sant'Anna, P. H. (2021), 'Difference-in-differences with a continuous treatment', *arXiv preprint arXiv:2107.02637* .

Duffie, D. and Skeel, D. A. (2012), 'A dialogue on the costs and benefits of automatic stays for derivatives and repurchase agreements', *U of Penn, Inst for Law & Econ Research Paper* (12-02).

Galperti, S. (2015), 'Commitment, flexibility, and optimal screening of time inconsistency', *Econometrica* **83**(4), 1425–1465.

Haughwout, A. F., Lee, D., Scally, J., Van der Klaauw, W. et al. (2020), Inequality in us homeownership rates by race and ethnicity, Technical report, Federal Reserve Bank of New York.

Kermani, A. and Wong, F. (2021), Racial disparities in housing returns, Technical report, National Bureau of Economic Research.

Lewis, B. (2021), 'Creditor rights, collateral reuse, and credit supply', *Lewis, Brittany Almquist. Essays on Financial Intermediation. Diss. Northwestern University* .

Lumpkin, S. A. (1993), 'Repurchase and reverse repurchase agreements', *Instruments of the money market* pp. 59–74.

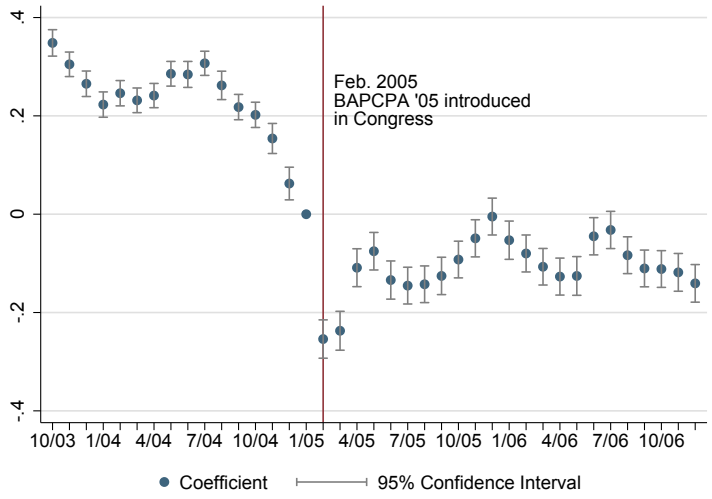
Morduch, J., Hardy, B., Darity, W. and Hamilton, D. (2018), 'Wealth inequality, income volatility, and race', *Working Paper* .

Piskorski, T. and Tchistyi, A. (2010), 'Optimal mortgage design', *The Review of Financial Studies* **23**(8), 3098–3140.

Rugh, J. S. (2015), 'Double jeopardy: Why latinos were hit hardest by the us foreclosure crisis', *Social Forces* **93**(3), 1139–1184.

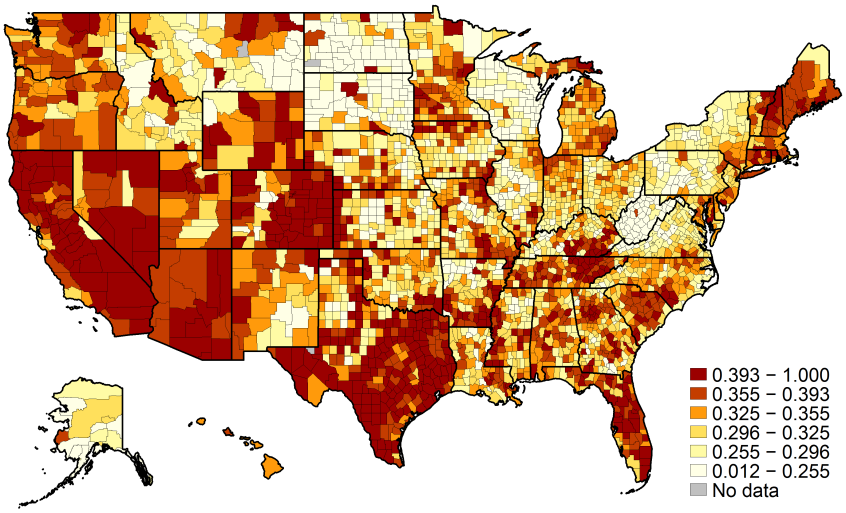
Stanton, R., Walden, J. and Wallace, N. (2014), 'The industrial organization of the us residential mortgage market', *Annu. Rev. Financ. Econ.* **6**(1), 259–288.

Figure 1: Private-Label vs. Agency MBS Yields



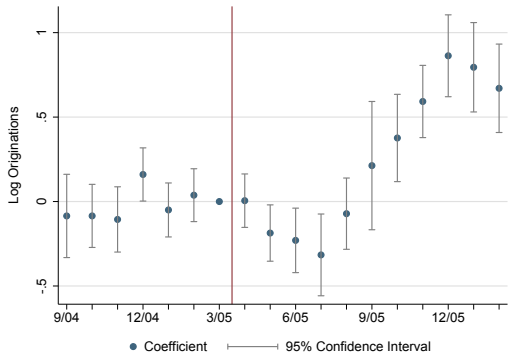
Notes: Figure plots the dynamic response of private-label MBS relative to agency MBS yields pre vs. post the introduction of BAPCPA 2005 in Congress on February 1, 2005. We estimate Equation 2. β_T is the coefficient of interest. It is the coefficient on the indicator variable that interacts the indicator for PLS with an indicator for each month pre and post shock. The results indicate the yield on the PLS index dropped relative to that on the agency MBS index following BAPCPA announcement. This is consistent with a relative increase in the price of these PLS index in February 2005 when BAPCPA was introduced in Congress.

Figure 2: Independent Mortgage Company (IMC) Market Share

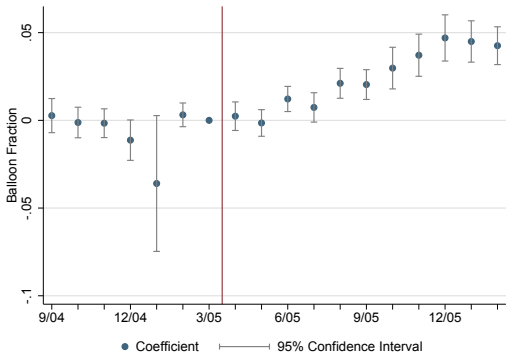


Notes: The figure depicts the county level market share of all IMCs reported in 2004. The market shares are calculated using the 2004 HMDA data.

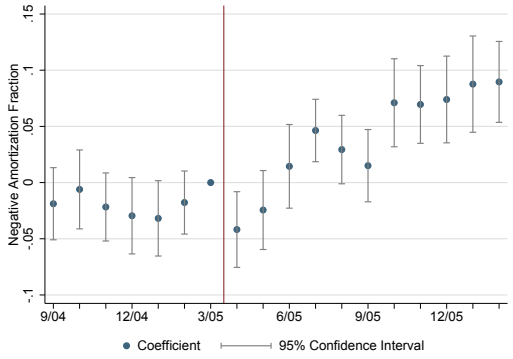
FIGURE 3: IMC COUNTY MARKET SHARE EFFECT ON MORTGAGE ORIGINATIONS



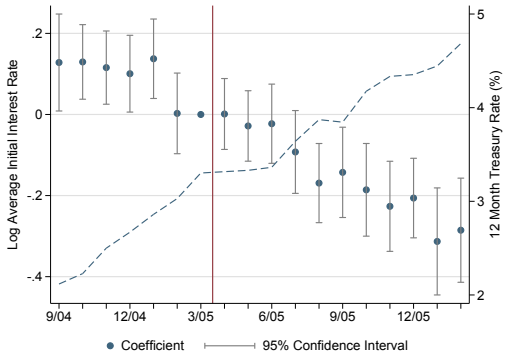
(a) Total Mortgage Originations



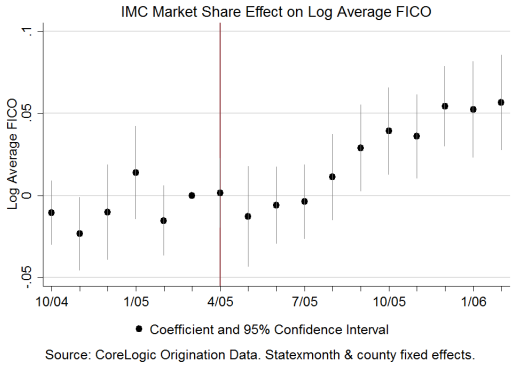
(b) Fraction Balloon Originations



(c) Fraction Negative Amortizing Originations



(d) Initial Interest Rate

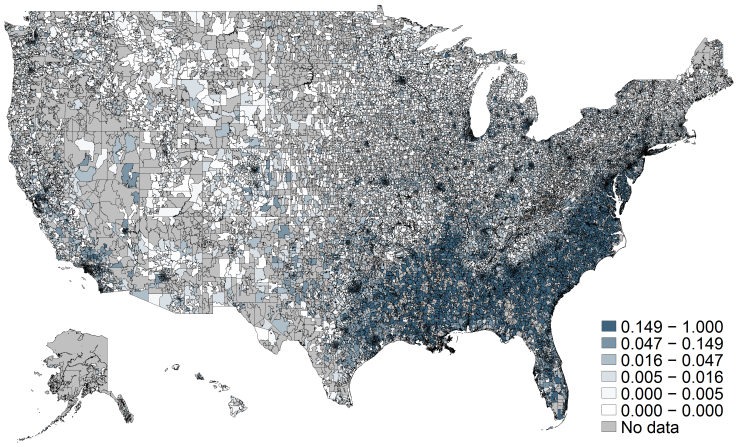


(e) Total Mortgage Originations

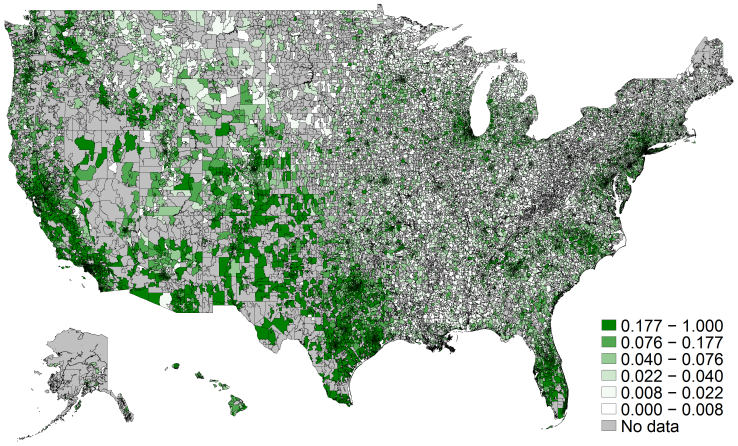
Notes: Figure plots the dynamic response of total mortgage originations in a given county to the 2004 market share of independent mortgage companies (IMCs) in that county. We estimate Equation 4. β_T is the coefficient of interest. It is the coefficient on the indicator variable that interacts $IMCMarketShare_{c,2004}$ with an indicator for each month pre and post the shock. We use the public HMDA data to compute the 2004 county level IMC market share and the county month HMDA data to study originations.[a] The figure indicates that following BAPCPA counties more exposed to policy change significantly increased the number of mortgages that they originated and shifted toward alternative mortgage products relative to less exposed counties.

[a]Neil Bhutta publishes the HMDA data reported at the county month level on his personal website: https://sites.google.com/site/neilbhutta/data.

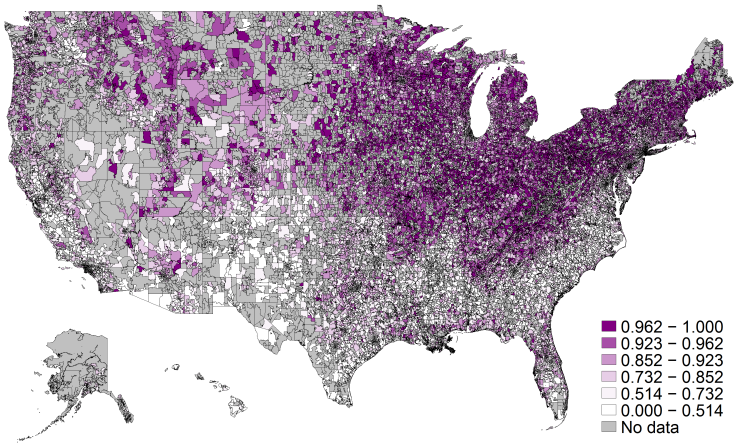
Figure 4: Population by Race



(a) Population of Black Inhabitants



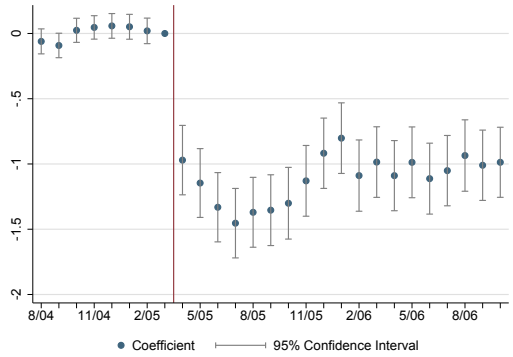
(b) Population of Latino Inhabitants



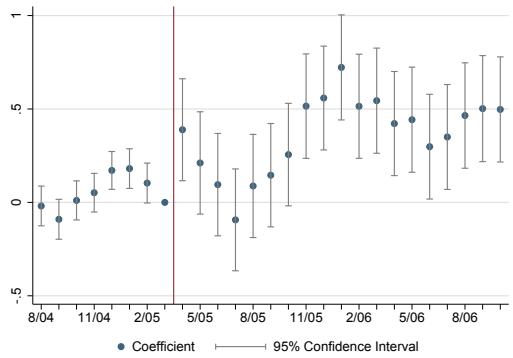
(c) Population of White Inhabitants

Notes: The figure depicts the zip code level population of inhabitants by race. The calculation utilizes the American Community Survey (ACS) 5-year estimates for race from IPUMS National Historical Geographic Information System NHGIS.

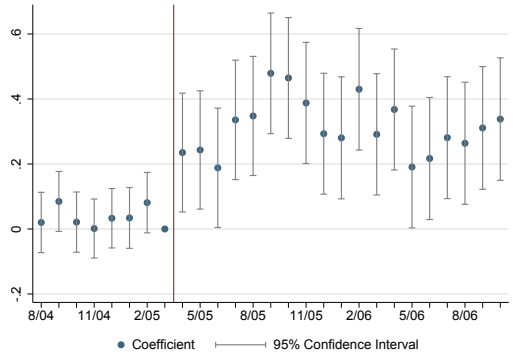
FIGURE 5: TRIPLE DIFFERENCE COEFFICIENT ON MORTGAGE ORIGINATIONS BY RACE



(a) Mortgage Originations in High % Black Counties



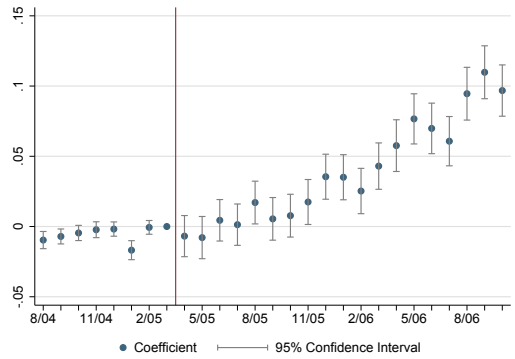
(b) Mortgage Originations in High % Hispanic Counties



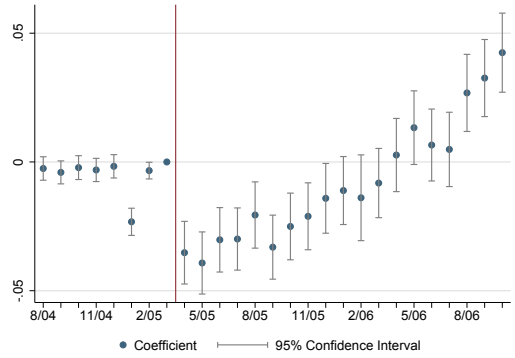
(c) Mortgage Originations in High % White Counties

Notes: Figure plots the dynamic response of the coefficient of interest β from Equation 6 on the triple difference interaction term $IMCMarketShare_{z,2004} \times \%Race_z \times Post_t$.

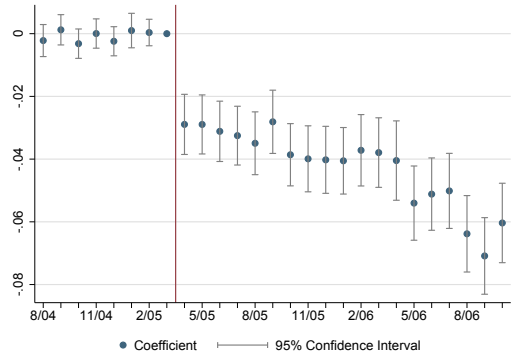
FIGURE 6: TRIPLE DIFFERENCE COEFFICIENT ON FRACTION BALLOON ORIGINATIONS BY RACE



(a) Fraction Balloon Originations in High % Hispanic Counties



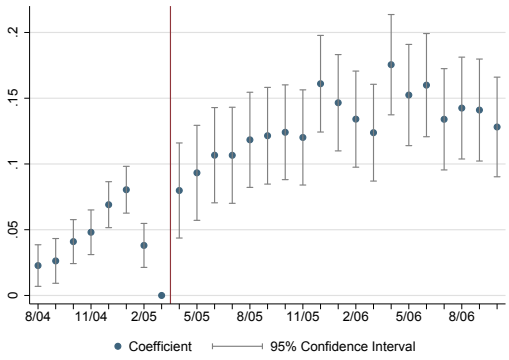
(b) Fraction Balloon Originations in High % Black Counties



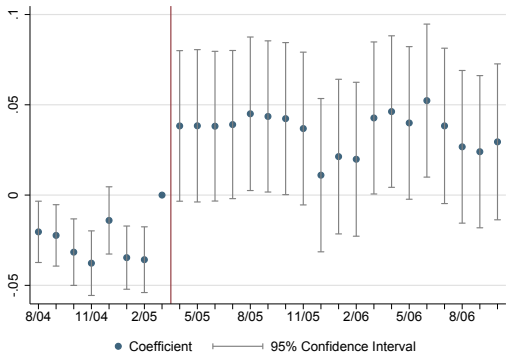
(c) Fraction Balloon Originations in High % White Counties

Notes: Figure plots the dynamic response of the coefficient of interest β from Equation 6 on the triple difference interaction term $IMCMarketShare_{z,2004} \times \%Race_z \times Post_t$.

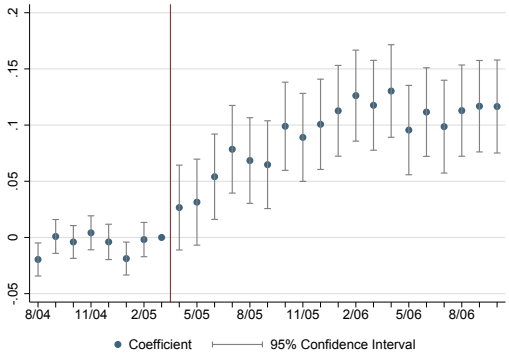
FIGURE 7: TRIPLE DIFFERENCE COEFFICIENT ON HIGH %LTN ZIPCODE MTG. PRODUCTS



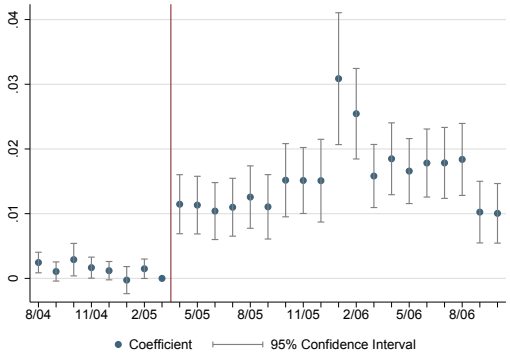
(a) Frac. Hybrid in High $\%BLK_z$



(b) Frac. IntOnly in High $\%BLK_z$



(c) Frac. NegAm in High $\%LTN_z$



(d) Frac. Two-Step in High $\%LTN_z$

Notes: Figure plots the dynamic response of the coefficient of interest β from Equation 6 on the triple difference interaction term $IMCMarketShare_{z,2004} \times \%Race_z \times Post_t$.

TABLE 1: HMDA Mortgage Acceptance Rates by Race

	(1)	(2)	(3)
		Acceptance Rate	
	BLK	LTN	WHT
Race	-0.075***	-0.017***	0.248***
	(0.005)	(0.006)	(0.004)
IMC	-0.132***	-0.138***	-0.073***
	(0.006)	(0.005)	(0.004)
$Race \times IMC$	0.081***	0.130***	-0.048***
	(0.006)	(0.005)	(0.004)
$Race \times Post$	0.022***	0.023***	-0.019***
	(0.002)	(0.002)	(0.002)
$IMC \times Post$	0.112***	0.112***	0.074***
	(0.003)	(0.003)	(0.003)
$Race \times IMC \times Post$	-0.055***	-0.066***	0.030***
	(0.004)	(0.004)	(0.003)
CountyFE	Yes	Yes	Yes
StatexMonthFE	Yes	Yes	Yes
r2	0.017	0.018	0.063
N	185,793,007	185,793,007	185,793,007

Appendix

A Continuous Difference-in-Differences

Callaway, Goodman-Bacon and Sant'Anna (2021) note that bias in the continuous difference-in-differences setting can arise when the weights of treatment doses used in the estimator are not similar to the actual treatment dose distribution in the population. Theorem 3 part 2 of the paper states that under the strong parallel trends assumption, when the distribution of the treatment dose in the population is symmetric and closer to normal, the two-way fixed effect (TWFE) estimand can be close to or even identical to weighting average causal response (ACR(d)) parameters by the distribution of the treatment dose, the natural target parameter. In the continuous (Cont) or multivalued (MV) treatment case, the TWFE estimator can be decomposed as follows:

$$\beta^{twfe} = \int_{d_L}^{d_U} w_1(l) ACR(l) dl + w_0 \frac{ATE(d_L)}{d_L}, \qquad (Cont)$$

$$\beta^{twfe} = \sum_{d_j \in D_+} w_l(d_j) \frac{ACR(d_j)}{d_j - d_{j-1}}, \qquad (MV)$$

Where the weights are equal to

$$w_1(l) := \frac{(\mathbb{E}[D|D \geq l] - \mathbb{E}[D])P(D \geq l)}{var(D)} \; and \; w_0 := \frac{(\mathbb{E}[D|D > 0] - \mathbb{E}[D])P(D > 0)d_L}{var(D)}$$

We calculate a histogram of the treatment doses of $IMCMarketShare_{c,2004}$ for the counties used in the regression analysis. We find that $IMCMarketShare_{c,2004}$ is symmetric and close to normally distributed. We then calculate the weights used in the TWFE estimator and find that the weights closely track the population distribution of treatment. Under the strong parallel trends assumption, this indicates that the TWFE estimand found in the regression analysis will be a close approximation of the desired weighted average causal response of treatment.

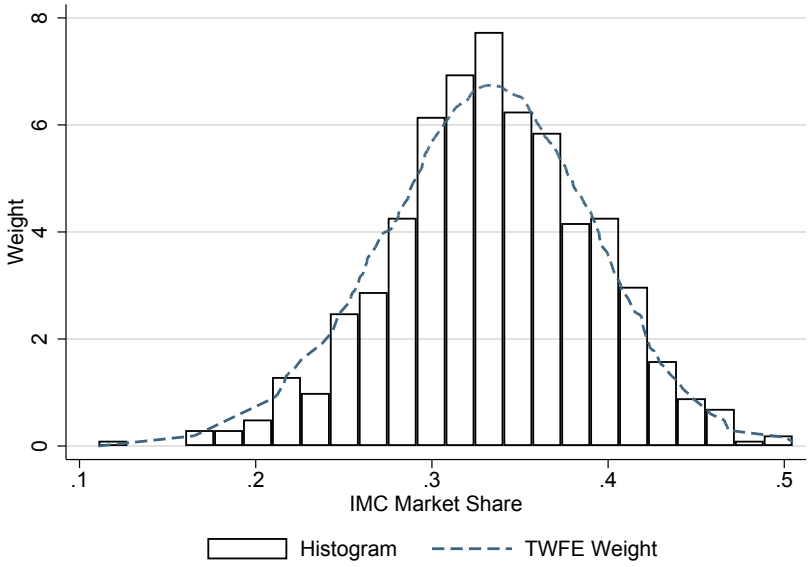
[Figure 8 about here.]

If strong parallel trends does not hold, the population weights being similar to the TWFE will not eliminate bias. This is because there still may be bias in the treatment response at each dose. In our setting the bias is likely to be small. The Fannie Mae and Freddie Mac fraud cases, which placed limits on Fannie/Freddie debt levels and limited their ability to fund mortgages, plausibly exogenously lowered barriers for entry for IMCs to enter counties, driving variation in the IMC market share. This growth in IMCs was concentrated in 2003 and stabilized by 2004. We calculate the treatment measure in 2004. Treatment is also well

distributed across the United States. IMC populated areas are similar in the pre-period income levels and home prices after taking out $state \times month$ and *county* fixed effects. This alleviates worries that the areas were significantly different along dimensions that would bias the results. We conduct the analysis over a relatively short window, ten months post treatment, to help ensure that the post-period is a valid counterfactual for the pre-period.

Additionally, although the TWFE weights and the population weights are very similar, the TWFE estimator slightly overweights lower treatment doses relative to higher treatment doses. This would bias the estimand downward. If we thought that strong parallel trends may not hold and "selection bias" was likely to be higher at higher treatment levels, this underweighting of higher treatment levels would help to mitigate selection bias in the TWFE estimand.

Figure 8: Continuous DID Weights



Notes: The figure plots the distribution of treatment, $IMCMarketShare_{c,2004}$ against the weights applied in the continuous difference-in-differences or two-way fixed effects specification.