The Impact of Collateral Value on Mortgage Originations

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Abstract

We generate a model of mortgage lending where a lender lends in two markets: one for conforming mortgages and one for alternative mortgages. The model assumes that alternative mortgage products are optimal for borrowers with higher income variability. When the collateral value of alternative mortgages increases, it decreases lenders' cost of capital, leading lenders to decrease the price that they charge. If the price falls below the borrowers' reservation price, lending expands in this market. We interpret BAPCPA 2005 as an increase in collateral value of alternative mortgages. Consistent with the model, regions more exposed to BAPCPA increased lending to high-income-variability borrowers via alternative products. The paper documents that BAPCPA caused the sudden expansion of negative amortizing and alternative mortgage products, especially among minority-dominant zip codes, leading up to the Global Financial Crisis, and disproportionately increased mortgage default in these areas during the crisis.

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1 Introduction

There are several theories of why different contracts benefit different kinds of markets (Galperti (2015), Piskorski and Tchistyi (2010)). Piskorski and Tchistyi (2010) describes different mortgage contracts that are optimal in an environment with individuals who have high versus low variability in their income and net worth. They find that the contract that is optimal for borrowers with low income variability is a fixed rate mortgage and the contract that is optimal for borrowers with high income variability is an Option Adjustable Rate Mortgage, or option-ARM, or similar products which offer the option to pay less than the interest payment required. In this paper, we interpret fixed rate mortgages as the agency mortgage market and option-ARM, or alternative mortgages, as the private-label mortgage market. We assume that high income variability borrowers utilize the private-label market and low income variability borrowers utilize the agency mortgage market.

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. This policy change only affected private-label mortgage collateral since agency mortgage collateral was granted preferred bankruptcy status in the Bankruptcy Amendments Act of 1984. We use this policy change to study whether strengthening repo creditor rights on private-label collateral decreases the marginal cost of originating private-label mortgages relative to agency mortgages. This decreased marginal cost of originating private-label mortgages relative to agency mortgages can be thought of as decreasing the value of lenders' outside option, agency mortgages. 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. In our framework, this implies that the contracts offered in either market would not change, but the price offered on the private-label contract would. Thus, we ask whether the decrease in the marginal cost of originating private-label mortgages relative to agency mortgages enabled lenders to lower mortgage prices below borrowers' reservation value; allowing lenders to expand into a new market following the policy change.

This question sheds light on whether changes in lenders' upstream secured funding structure affects the contracts they offer to their downstream customers, which has implications for the stability of the financial system. In order to study the role of secondary market collateral value on primary market originations, 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. We show that when the lender's marginal cost of originating

private-label mortgages decreases, it incentivizes her to expand originations by lowering the price charged on these mortgages. If the price falls below borrowers' reservation price, the lender expands into a new market, that for high income variability borrowers.

To provide a brief overview of the model: lenders have a break even condition since they are competitive. Their value of collateral is, in part, determined by the collateral value. When the collateral value increases, the interest rate lenders require to break even decreases. If the interest rate prior to BAPCPA was above borrowers' reservation price, no borrowers would enter the market. Following BAPCPA, if the interest rate in the private-label market falls below borrowers' reservation price, it would open up lending in a new market.

We study independent mortgage company (IMC) mortgage originations to understand whether indeed BAPCPA caused an increase in private-label mortgages among high income variability borrowers. As background, Lewis (2021) documents that there is an intricate funding structure behind IMC originations. Large dealer-banks provide IMCs with warehouse lines of credit, which the IMCs use to fund mortgage origination. Prior to the Global Financial Crisis (GFC), these warehouse lines of credit were implemented as mortgage repo contracts in the sale and repurchase market and were funded by the largest dealer-banks. The intuition is that BAPCPA increased funding for riskier mortgage products by granting private-label mortgage collateral preferred bankruptcy status if an IMC declared bankruptcy. This improved the recovery process for creditors, which incentivized dealers-banks to lend to IMCs using lines collateralized by riskier collateral. Since the recovery process improved, should an IMC declare bankruptcy, the mortgage quality could decrease to maintain the same average recovery rate as in the pre-period. The funding structure that dealers-banks used post BAPCPA made private-label mortgage collateral a valuable tool to increase their leverage. This valuable tool, however, was limited by the number of home buyers who could enter the market. We conjecture therefore, that the dealer-banks would choose to create more mortgages by increasing funding for option-ARMs in order to attract a new market of borrowers, those who had previously been excluded from the housing market.

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. This is consistent with the value of agency mortgage collateral, the outside option, decreasing relative to the value of private-label collateral. We set up a treatment intensity difference-in-differences (DiD) research design that utilizes BAPCPA to plausibly exogenously shock creditor rights on repos. We follow Lewis (2021) and define mortgage companies who are exposed to the change to be the IMCs, who received funding from dealers via repurchase agreements. We therefore define treated counties as counties with a higher market share of IMCs 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 option-ARM. Higher treatment intensity leads to a significant increase in the fraction of option-ARMs, negative amortizing, balloon, and two-step mortgages. These products all had artificially low introductory interest rates that deferred interest payments to later periods of the mortgage, similar to an option-ARM. Consistent with the expansion occurring mainly at the extensive margin, or lenders lending to a new market, we find that a 10% increase in treatment intensity significantly increases credit score at origination in the post-period by 0.5%.

To test whether IMCs increase lending to borrowers with higher income volatility, who may not have qualified for a mortgage prior to BAPCPA, we run a triple difference treatment intensity regression specification. Since income growth is highly correlated with income volatility, we interact IMC market share with a measure of income growth from 2001 to 2004. We find that it is the counties with lower income growth that see a statistically significant increase in fraction of mortgages that are negative amortizing (including option-ARMs), balloon, interest only, and hybrid relative to counties with high income growth.

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 difference-in-difference research design by racial subgroup 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, majority Latino and white zip codes received an overall increase in mortgage originations while majority Black zip codes received a statistically significant decrease in overall originations relative to majority Latino and white zip codes. The fraction of originations comprising alternate mortgage products increased for Black and Latino zip codes relative to white zip codes. A 10% increase in IMC market share led to a 31% increase in balloon mortgages for Latino zip codes, and a 42% increase in balloon mortgages for Black zip codes while it led to only a 20% increase in balloon mortgages for white zip codes. A 10% increase in IMC market share led to a 21% increase in negative amortizing mortgage products in Latino zip codes relative to a 10% increase in negative amortizing mortgages in Latino and white zip codes. A 10% increase in IMC market share led to a 29% increase in two-step mortgages in Latino zip codes relative to a 8% increase in Black zip codes and a 2% increase in white zip codes. These differences are statistically significant.

We also find that while a 10% increase in IMC market share leads to a statistically significant 1% increase in full document mortgages for white zip codes and no change in documentation for Latino zip codes, the same increase in IMC market share leads to a 4% decrease in full documentation mortgages in Black zip codes. Full documentation refers to whether all assets and income are fully verified. This decrease in full documentation loans following BAPCPA for Black zip codes indicates less stringent income verification which is consistent with an increase in mortgages for higher income variability borrowers. These changes are all accompanied by statistically significant increases in credit scores for Black, Latino, and white zip codes. The results are consistent with minority zip codes receiving disproportionately more alternative mortgages. These higher minority zip codes would likely have more difficulty sustaining over the life of the loan or during an economic downturn relative to white zip codes, due to higher income variability and other systemic factors.

In order to study the consequences to borrowers of these mortgage products, we study both early payment default and total default using the same regression specification. We find that a 10% increase in IMC market share in the pre-period leads to a .2 percentage point increase in early payment default for Black zip codes. This increase is statistically significantly higher than that for white and Latino zip codes, which both saw a .1 percentage point increase in early payment default for an equivalent increase in pre-period IMC market share. Studying overall loan default, we find that a 10% increase in IMC market share in the pre-period leads to a 2.8 percentage point increase in total default for Latino zip codes. This number is statistically significantly different from the 1.6 percentage point increase in total default that Black zip codes and white zip codes for the same increase in pre-period treatment.

The DiD framework isolates the effect of BAPCPA increasing the value of alternative mortgages on borrowers. The results indicate that treated zip codes increase lending to borrowers with higher credit scores, in minority-dominated zip codes, and with lower income growth (higher income volatility). Combined with the early payment and total defaults in minority zip codes, these results suggest that the mortgages originated following BAPCPA lowered near term mortgage payments, making them more affordable for borrowers with higher income variability but did not accurately assess the borrowers' ability to repay the mortgages over the longer term. This paper provides evidence that innovations in the secondary market that change lenders' incentives to move into new markets can have differential effects by race and income level.

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, 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

3.1 Model Set-up

Here we develop a model of mortgage lending. The value that the dealer-bank receives from repledging collateral (c) is exogenous. There are two separate markets. One for Private-Label (PL) mortgage borrowers, and one for Agency (A) mortgage borrowers. The borrowers in each type of market do not consider mortgages of the other type; they are not mobile across

[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))

markets. In both markets, the lender and borrower solve the same objective functions, so we use notation for the Private-Label to set up the model.

We assume here that the market for Private-Label mortgages mainly reflects Alternate-A product mortgages, as we seek to explain the increase in Alt-A mortgage products following BAPCPA. We also assume that the market for Private-Label mortgages is for borrowers who have more volatile income and for whom it is more costly to repay their mortgage payment. We take as given that the optimal mortgage product for borrowers with more volatile income and pricier mortgage to income ratios is the option-arm, or similar, mortgage product as defined in Piskorski and Tchistyi (2010).

We use the model to study the impact that increasing the value received from repledging Private-Label mortgage collateral (c^{PL}) has on the interest rate charged to the Private-Label borrowers, r^{PL}. We consider a one-period model of a mortgage lender and a borrower. The borrower receives utility from housing ($h \in \{0,1\}$), where the choice $h = 1$ means the purchase of a home whereas $h = 0$ means no purchase. The borrower has quasi-linear utility. He derives utility from owning a home $v(1)$. The purchase of the home requires a mortgage at dollar value M and requires no downpayment. The borrower dislikes paying the mortgage payment required on the mortgage at interest rate (r where $r \geq 0$)

$$u = v(h) - \frac{1}{\theta}(1 + r^{PL})M \times h, \quad h \in \{0,1\}. \tag{1}$$

Since $v(0)$ and $v(1)$ are constant, the household maximizes by choosing between $v(0)$ and $v(1) - (1 + r)M$, therefore he chooses between housing $h = \{0,1\}$. Given h, the value of $v(1)$ and $v(0)$ and M are fixed. Choosing $h = 1$ requires that the borrower take out a fixed mortgage amount, M, at interest rate, r. In other words 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. We assume that $v(0)$ is the utility that the borrower receives from renting a home. $v(1) - v(0)$ is the incremental value that the borrower receives from owning a home relative to renting a home. We assume there is a distribution over how costly mortgage repayment is θ. The cost of borrowing is captured by $\frac{1}{\theta}$. A higher θ reflects credit worthiness, in the sense that it indicates borrowers for whom it is less costly to repay the mortgage payment. While lower θ reflects borrowers for whom it is more costly to replay the mortgage payment.

$$\theta \sim F \quad \text{on} \quad [\underline{\theta}, \overline{\theta}] \tag{2}$$

Borrowers choose $h = 1$ if

$$v(1) - \frac{1}{\theta}(1 + r^{PL})M > v(0) \tag{3}$$

For every mortgage originated, the lender gains utility from the mortgage payment received, inflated by the shadow value generated by using it as collateral, c^{PL}. p is the dealer-bank's funding cost to provide the money necessary for the mortgage. It is assumed to be exogenous. We assume for ease of exposition that it varies linearly with the value of M and is the same whether the dealer is funding a Private-Label mortgage or an Agency mortgage. The lender dislikes the cost p that she pays to originate a mortgage. The risk profile of borrowers and any differences in screening costs for the Private-Label relative to the Agency borrowers are subsumed in the interest rates r^{PL} and r^{A}. The lender is competitive and therefore chooses to originate the value of mortgages that sets marginal cost equal to marginal revenue. She sets the price of the mortgage r accordingly and meets demand based on that interest rate:

$$u = (1 + r^{PL})(1 + c^{PL})M - pM = 0 \tag{4}$$

3.2 Model Results

The lender's break even condition gives us:

$$r^{PL} = \frac{p}{1 + c^{PL}} - 1 \tag{5}$$

Our main result follows from this break even condition:

Proposition 1 *The interest rate decreases when the shadow value of collateral increases:*

$$\frac{\partial r^{PL}}{\partial c^{PL}} < 0 \tag{6}$$

Ceteris paribus, taking a comparative static of r^{PL} with respect to c^{PL}, we can see that as c^{PL} increases, r^{PL} falls.

From the borrower's problem, we have a threshold borrower type – everyone w/ $\theta > \theta^*(r^{PL*})$ will borrow:

$$\theta^*(r^{PL*}) = \frac{(1 + r^{PL*})M}{v(1) - v(0)}. \tag{7}$$

θ^* gives a breakeven point such that $v(1) - \frac{1}{\theta^*}(1 + r^{PL})M = v(0)$. Types with higher θ will always choose to buy a home. This yields an interest rate threshold value, which we denote by r^{PL*}.

$$r^{PL*} := \frac{\theta^*(v(1) - v(0))}{M} - 1 \tag{8}$$

We have the following comparative statistics:

Lemma 2 *The threshold interest rate at which a borrower is willing to take out a mortgage, r^{PL*}, is*

1. *increasing in $v(1) - v(0)$*
2. *increasing in θ*
3. *decreasing in M*

The interest rate threshold at which the borrower is willing to borrow is equal to their relative utility from buying a home, over and above renting, per unit of mortgage value M, and scaled up by a measure reflecting the borrower's credit worthiness θ. Ceteris paribus, Lemma 1.2 indicates the following. The threshold interest rate is increasing when the relative benefit of owning a home is higher, when the cost of borrowing $\frac{1}{\theta}$ is lower, and when the value of the mortgage M is lower.

When the interest rate set by the lender requires a θ that is higher than $\overline{\theta}$, the highest borrower type in the support of the θ distribution in the Private-Label market, the interest rate charged is higher than any interest rate that borrowers are willing to pay. We can see this from Equation 8. Holding fixed $v(1)$, $v(0)$, and M, if the r^{PL} that lenders charge on Private-Label mortgage products is set so high that it requires a θ that is higher than $\overline{\theta}$, then no borrowers will enter into the market to purchase a mortgage. This can occur when the collateral c^{PL} is low. We can see this by combining Equation 5 and Equation 8:

$$\theta^*(r^{PL*}) = \frac{(1 + r^{PL})M}{v(1) - v(0)} = \frac{p}{1 + c^{PL}} \times \frac{M}{v(1) - v(0)}. \tag{9}$$

When the value of c^{PL} increases, the value of the interest rate set by the lender will fall. If the new interest rate, $r^{PL'}$ falls, then the threshold type θ^* will fall. If θ^* falls lower than $\overline{\theta}$ it will open up a new market of borrowers. This is because now, the interest rate that lenders are willing to charge on Alt-A mortgage products, such as option ARMs and balloon

mortgages, will be low enough that borrowers in this market, i.e. higher income volatility borrowers, are willing to borrow.

4 Data and Empirics

4.1 Data

Securitization and Price of Mortgage Backed Securities (MBS) In order to study the effect of BAPCPA on the price of private-label mortgage collateral (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 are 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 data contain detailed information on mortgage characteristics at origination

[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.

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.

Income Data This paper merges data on average income by zip code estimated from the IRS's Statistics of Income (SOI) data. We estimate average income in a zip code using the number of tax returns filed in a given income bracket relative to the total number of tax returns filed in that zip code. We calculate the average income growth in a zip code between 2001 and 2004.

Race Data This paper merges race variables from the 2000 Census data to the mortgage origination data by 5 digit zip code.

4.2 Empirical Evidence of the Mechanism

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:

$$\log(yield_{i,t}) = \omega Post_t + \nu PLS_i + \sum_T \beta_T \; PLS_i \times \mathbb{1}_{t=T} + \epsilon_{i,t} \tag{10}$$

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 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 increasing 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.]

4.3 Implications of the Model

The model implies that when the outside option of the lender falls low enough, the distribution of the surplus split 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 an Option ARM and that a 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 IMCs 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 those 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]

$$IMCMarketShare_{c,2004} = \frac{Number\ of\ originations\ by\ IMCs_{c,2004}}{Total\ number\ of\ all\ originations_{c,2004}}. \tag{11}$$

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.

[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 about here.]

We study how $IMCMarketShare_{c,2004}$ affects county level mortgage characteristics. We run the following dynamic regression:

$$Y_{c,t} = \gamma_c + \eta_{s,t} + \sum_T \beta_T IMCMarketShare_{c,2004} \times \mathbb{1}_{t=T} + \epsilon_{c,t}. \quad (12)$$

Where $Y_{c,t}$ is $\log(Originations_{c,t})$, $FracBalloon_{c,t}$, $FracNegAm_{c,t}$, $\log(Initial\ Interest\ Rate_{c,t})$, and $\log(AvgFICO_{c,t})$ in county c, at month t. γ_c denotes county level fixed effects, and $\eta_{s,t}$ denotes $state \times month$ 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 $state \times month$ fixed effects. The regression with both *county* and $state \times month$ 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.

We first investigate whether the overall number of mortgages increased following BAPCPA. As shown in Figure 7 (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 at the extensive margin, or to 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 7 (b) and (c). Option ARM products are included in negative amortizing products since CoreLogic does not report Option ARMs separately. Each month an Option ARM allowed the borrower to pay the fully amortizing principal and interest payment, only the interest payment, or a payment that was less than

the interest due. This meant that any unpaid interest was added to the principal balance owed on the mortgages, which increased the balance owed instead of decreasing it, as a traditional mortgage does.

When we limit the sample to only adjustable rate mortgages (ARMs), a 10% increase in IMC market share in 2004 in a given county leads to a statistically significant decrease of 2.39% in the 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. 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 offer a rate reset in the future.

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 7 (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 7 (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.]

5 Effect on Borrowers by Demographic Groups

5.1 Low Income Growth (High Income Volatility)

In this section we study whether the mortgage originations following BAPCPA were focused among borrowers with relatively higher income volatility. In order to study this, we utilize income growth as a measure of income volatility. We use income growth to proxy for income volatility because income volatility and growth are highly correlated with each other. We

measure income growth as the average estimated income in 2004 minus the average estimated income in 2001 divided by the average estimated income in 2001.

The Piskorski and Tchistyi (2010) model shows that the optimal product for borrowers with higher income volatility is an Option ARM product or a mortgage similar to an Option ARM. Therefore, we set up a triple difference regression specification to study whether areas with higher exposure to BAPCPA began originating differentially more mortgages to high income variability borrowers post BAPCPA. We run the following specification:

$$\begin{aligned} Y_{z,t} &= \mu\ IMCMarketShare_{z,2004} \times Post_t \\ &+ \nu\ IMCMarketShare_{z,2004} \times IncomeGrowth_z + \tau\ IncomeGrowth_z \times Post_t \\ &+ \beta\ IMCMarketShare_{z,2004} \times IncomeGrowth_z \times Post_t \\ &+ \gamma_z + \eta_{s,t} + \epsilon_{z,t}. \end{aligned}$$

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. 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 and zero otherwise. β is the coefficient on the interaction term, $Post_t \times IMCMarketShare_{z,2004} \times IncomeGrowth_z$, which is the income growth in a zip code from 2001 to 2004. β measures how lower values of $IncomeGrowth_z$ 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_z represents zip code level fixed effects and $\eta_{s,t}$ represents $state \times month$ fixed effects. Standard errors are clustered at the zip code level.

The insight behind this regression specification is that, relative to banks, IMCs are more exposed to the BAPCPA policy change via their funding from dealers. Therefore, we expect zip codes that have a higher market share of IMC lenders to increase their originations among higher income volatility borrowers at a faster rate relative to those funded by banks. This result would be consistent with borrowers with higher income volatility being locked out of the market for conforming mortgages due to their income volatility not qualifying for traditional income documentation or ability to repay requirements.

The results in Figure 4 and Figure 5 show that more alternative products are originated in areas that have lower income growth, which is associated with higher income volatility, in the pre-period. Although total mortgage originations increased as income growth increased, the fraction of balloon, negative amortizing, hybrid and interest only originations increased sta-

tistically significantly in zip codes as pre-period income growth decreased. This is consistent with increasing the fraction of mortgages that used alternate amortization characteristics similar to an Option-ARM, which gave borrowers artificially low initial mortgage payments, among areas with low income growth or high income volatility. Although the coefficients are not significant, we also see a higher fraction of no documentation and low documentation originations in areas with lower income growth or higher income volatility, and an increase in the fraction of full documentation loans in zip codes with high income growth or low income volatility. Following the increase in credit post-BAPCPA, these results are consistent with an increase in originations that would qualify for full documentation in high income growth/low income volatility zip codes, and an increase in originations that would not qualify for full documentation in areas with low income growth/high income volatility in the pre-period.

[Figure 4 about here.]

[Figure 5 about here.]

The IMC market share variable is a continuous measure. However, to understand the insight of the regression, imagine that zip codes were made up of either 100% banks or 100% IMCs. What this regression does is it compares the originations in an IMC zip code with those in a bank zip code. It calculates the difference between bank lending in high versus low income growth zip codes in the pre-period as well as in the post period. It then calculates the difference between the difference in the pre-period versus the post-period and compares it to the analogous difference for IMC mortgage originations.

The insight behind this is that I study the difference in bank lending in high income growth and low income growth areas pre-policy change relative to post-policy change. I then compare it to the difference in IMC lending in high income growth areas and low income growth areas pre-policy change relative to post policy change. The trend of lending may be different in high income growth areas relative to low growth areas. BAPCPA may have changed the way that banks lend to high growth relative to low growth areas. The insight however is that the way banks lend to high income growth versus low income growth areas pre- versus post-BAPCPA is an economic barometer for how lending was moving. Therefore, the effect associated with IMCs over and above that associated with banks, captures the effect of increasing collateral value on lending in the private-label market. The gap between high and low income growth in zip codes in the pre-period relative to the same gap for bank zip codes captures how we would expect IMCs to change their funding to low growth (high volatility) borrowers, absent the policy change. If, in the post period, the gap for IMCs between high/low growth areas changes significantly relative to the analogous gap for banks,

then there is evidence consistent with the mechanism. In other words, BAPCPA changed the collateral value to dealers, in response dealers increased their lending in a new market, the optimal structure in the new market was Option-ARMs, leading to more originations of the Option ARM structure in areas with low income growth (high income volatility).

The model predicts that low income, high income variability people are more likely to receive alternate mortgage products following the passage of BAPCPA. This is consistent with higher income volatility borrowers requiring products that delay amortization and interest payments to the end of the loan. These products would lower introductory monthly payments relative to the high payments on standard (fully amortizing) mortgages at the peak of the housing boom when the Federal Reserve was raising interest rates. 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. 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, ... 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"[4]

5.2 Minority Borrowers

Due to the racial wealth and income gap, minorities are likely to be disproportionately represented in the group of borrowers who have low income and high income variability. Morduch

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

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.

To study whether minorities were thus more likely to receive the alternate products that IMCs began originating following BAPCPA, we estimate a treatment intensity difference-in-differences regression design by separately for majority Black, Latino, and white zip codes. Our treatment intensity is measured as a zip code's exposure to IMC market share in 2004, the year prior to the shock, $IMCMarketShare_{z,2004}$. The underlying assumption is that $IMCMarketShare_{z,2004}$ captures exposure to the credit supply shock because IMCs pass increased funding for alternative products on to borrowers at a faster rate than do banks (Lewis (2021)). This variable is the zip code level analog of the variable calculated in Equation 12.

We define a zip code to be majority Black if 30% or more of its population identify as Black in the census data, Latino if 30% or more identify as Latino, and white if 30% or above identify as white. As a reference point, the fraction of the population identifies as Black is 13.6%, the fraction that identify as Latino is 18.9%, and the fraction that identify as non-hispanic white is 59.5%. For the remainder of the paper we will call these Black, Latino, and white zip codes respectively. Once we identify the zip codes' race, we estimate the same difference-in-differences specification on each of these subgroups, following Curtis, Garrett, Ohrn, Roberts and Serrato (2021).

The econometric design studies zip codes pre- versus post-BAPCPA as the first difference, across high- versus low-IMC market share zip codes as the second difference. In the research design, we compare mortgage originations across zip codes controlling for both state $\times$ month and zip code level time invariant factors. The insight of the research design is that absent a differential effect of race on lending, relative differences in origination trends between Latino versus white zip codes, for example, should persist post-BAPCPA. If the relative difference in lending between these zip codes changes post-BAPCPA, it is consistent with BAPCPA having a different impact on zip codes by race. Holding fixed $IMCMktShare_{z,2004}$, in zip codes that differ in racial makeup, controls for different lending trends across zip codes absent a credit supply shock. We estimate the specification on the zip codes that identify as Black, then separately on the zip codes that identify as Latino, and then separately on the zip codes that identity as white. This analysis allows us to study whether origination trends for certain mortgage products follow different trends post policy change for white versus Black and Latino zip codes.

$\%RACE_z$ 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:

$$\%RACE_z = \frac{Number\ of\ RACE\ inhabitants_z}{Total\ number\ of\ inhabitants_z}. \tag{13}$$

Figure 6 contains a U.S. heat map that documents, for each zip code, 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 6 about here.]

By estimating a difference-in-differences regression on Latino zip codes and then separately on white zip codes, for example, we are studying how IMC originations responded to BAPCPA relative to bank originations in each subgroup. Since BAPCPA created a credit supply increase that affected IMCs more than banks, we expect counties with a higher proportion of IMCs to increase their funding for mortgage originations by more than counties with a higher proportion of banks. Holding fixed the market share of IMCs in a zip code, if for example, Latino zip codes have a higher proportion of borrowers with high income variability, we expect to see more alternative products originated in these zip codes, since BAPCPA increased collateral value for these alternative products. Thus, we should see larger DiD coefficients in Latino zip codes relative to white zip codes post BAPCPA. This regression specification allows us to test precisely this – whether IMCs have a larger origination response in Latino zip codes relative to white zip codes.

Measuring the difference between bank originations and IMC originations in the pre-period allows us to construct a counterfactual world – one where BAPCPA has no effect on IMC originations, neither by funding nor collateral value. We do this by measuring the average bank originations in the post-period and layering on the pre-period difference between bank and IMC originations. Any additional effect associated with IMC market share, over and above this counterfactual, in the post-period, can be attributed to IMCs' increased credit supply and their resulting shift toward alternate mortgage products post shock.

Our difference-in-differences specification controls for pre-existing differences in IMC lending relative to bank lending in each racial subgroup. The assumption is that absent the policy change, the IMCs would have continued to lend in the same way that they had prior to the policy change. The empirical design removes any pre-period mean effect associated with time as well as the pre-period trend associated with treatment. If the pre-period coefficients lie on a relatively flat line close to zero, the dependent variable for both the

treated and control group followed a similar trend for each of the racial subgroups studied. Post policy change, if we observe a differential increase in originations for minority zip codes relative to white zip codes, it indicates that one subgroup was disproportionately affected by treatment relative to another subgroup.

By estimating this regression separately by subgroup, we control for differences in IMC versus bank lending trends that may differ by the majority race in a zip code. For example, the design allows us to test whether there was a larger effect of IMCs' increased credit supply in Latino zip codes relative to white zip codes. The regression controls for the trends in the pre-period for each racial subgroup and estimates the differential effect of treatment in the post-period relative to the pre-period. Under the null hypothesis that 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. Seeing a larger effect for Latino zip codes for example, would be consistent with Latino borrowers receiving more alternate products following the policy change. This would be consistent with the mechanism that BAPCPA decreased funding costs for private-label or alternative products and these products were optimal for minority borrowers.

We estimate the difference-in-differences specification in Equation 14 which compares zip codes with high- versus low-market share of IMCs in 2004 pre- versus post-policy change. 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. We estimate the following regression:

$$Y_{z,t} = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMarketShare_{z,2004} \times \mathbb{1}_{t=T} + \epsilon_{z,t}. \tag{14}$$

Where, for each zip code z, in month t, $Y_{z,t}$ is $\log(Originations_{z,t})$, $\log(CreditScore_{z,t})$, $\log(FullDoc_{z,t})$, $\log(Balloon_{z,t})$, $\log(NegAm_{z,t})$, and $\log(TwoStep_{z,t})$. log is the natural logarithm of a number. The continuous treatment variable, $IMCMarketShare_{z,2004}$ is the market share of IMCs in a zip code z in 2004. $IMCMarketShare_{z,2004} \times \mathbb{1}_{t=T}$ is the interaction term between the market share variable and an indicator variable for month of origination. β_T is the effect of the interaction term from September 2004 to February 2006 that measures the effect of a one unit increase in IMC market share on the dependent variable in each month relative to March 2005. γ_z represents zip code level fixed effects and $\eta_{s,t}$ represents $state \times month$ fixed effects. Standard errors are clustered at the zip code level.

[FIGURE 7 about here.]

Figure 7 panel (a) plots the coefficient β_T that measures the effect of the pre-period IMC market share on $\log(Originations_{z,t})$ each month relative to March 2005. $Originations_{z,t}$ is the total number of originations including both purchase and refinance mortgages. In the pre-period there was no differential change in lending between treated and control zip codes for any racial subgroup. Following the policy change, a 10% increase in pre-period IMC market share leads to a 0.6% increase in originations for white and Latino zip codes post BAPCPA, with the increase in originations for white zip codes being statistically significant. However, a 10% increase in IMC market share leads to a 2.7% decrease in mortgage originations in majority Black zip codes. This evidence is consistent with BAPCPA leading to a credit supply increase in white and Latino zip codes, while it led to a decrease in credit to black zip codes.

[FIGURE 8 about here.]

As shown above, BAPCPA led to an increase in mortgage originations and Latino and white zip codes received the majority of the this increase in originations. To understand whether the increase in originations was driven by alternative mortgage products and whether these products plaid a role in the disproportionate effect of BAPCPA by racial subgroup, we estimate Figure 7 with balloon, negative amortizing and two step mortgages as outcome variables.

Piskorski and Tchistyi (2010) find that the optimal mortgage for high income volatility borrowers is an option ARM, which is a type of negative amortizing mortgage, or similar. They define this similar mortgage as one that has a flexible enough introductory payment scheme. The insight of our paper is that the two step, negative amortizing, and balloon mortgages constitute products that are similar to the option ARM in key ways that allow borrowers to shift payments when their income is low into future periods when their income may be higher. The main benefit of these products was their initial fixed "teaser rate" which was typically lower than the interest rate on a fixed rate mortgage. This teaser rate 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. 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.

The model finds that if the value of collateral increases enough, the price at which banks

are willing to lend decreases, which can lead to lending in a new market. Consistent with the model, following BAPCPA, we see a disproportionate increase in originations of these products in minority zip codes. Figure 7 panel (b) shows that a 10% increase in IMC market share leads to a 20% increase in balloon mortgages in white zip codes, a 31.9% increase in balloon mortgages in Black zip codes, and a 42.9% increase in balloon mortgages in Latino zip codes. We report a t-test of whether the average effect of treatment in the post period is statistically significantly different for white zip codes relative to Black zip codes and for white zip codes relative to Latino zip codes. The increases in balloon mortgages for Black and Latino zip codes were both statistically significantly higher that those for white zip codes.

Similarly, a 10% increase in IMC market share leads to a statistically significant 10.4% increase in negative amortizing mortgages for white zip codes, a statistically significant 9.9% increase in negative amortizing mortgages for Black zip codes, and a statistically significant 21.5% increase in negative amortizing mortgages for Latino zip codes. The increase in negative amortizing mortgages in Latino zip codes was significantly higher than that for white zip codes. The increase in Black zip codes was not statistically different than that for white zip codes. We also study two step mortgages. Although we do not find a statistically significant increase in white or Black zip codes post BAPCPA, we do find a statistically significant increase in two step mortgages for Latino zip codes. Two step mortgages increased statistically significantly by 28.8% for Latino zip codes and this number was statistically different from the1.6% increase that white zip codes experienced

The evidence is consistent with IMCs disproportionately increasing originations of alternate mortgage products to minority zip codes. This is consistent with the model's insight that that lowering IMCs' cost of funding for alternative mortgage products would allow IMCs to lower the interest rate on these products. If prior to the policy change, interest rates were above borrowers' reservation value in this market, and following the policy change, interest rates fell below borrowers' reservation value, it could lead to the expansion of these products in a new market. If a higher fraction of minorities have higher income variability, consistent with Morduch et al. (2018), we should see a disproportionate expansion of these products in minority zip codes. Consistent with the story that BAPCPA lowered the cost of funding for alternative mortgage products that were optimal for higher income volatility borrowers, and minorities have a higher incidence of having higher income variability than white borrowers, 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 following the BAPCPA policy change in April of 2005.

In order to study the consequences of these alternative mortgage products to borrowers, we study early payment default and total loan default following the policy change. To define early payment default, EPD_i, we utilize the Federal Housing Administrations's definition of early payment default which calculates if a borrower becomes 60 or more days delinquent within the first six months of the loan origination. Early payment default is typically an indicator of potential risk management issues such as lax underwriting standards. In other words, it signals that the borrower's ability to repay a mortgage may not have been accurately calculated at the time of the mortgage origination. To define total default, $Defaulted\ Loan_i$, we create an indicator variable that is equal to one if the loan ever enters 90 day delinquency, foreclosure, or REO property in its lifetime and zero if the loan remains active. We run the following regression which is the loan level version of Equation 14.

$$Y_i = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMarketShare_{z,2004} \times \mathbb{1}_{t=T} + \epsilon_i. \tag{15}$$

Where Y_i represents $Defaulted\ Loan_i$ and EPD_i. Again, we estimate this regression separately by racial subgroup. We find that a 10% increase in IMC market share in the pre-period leads to a .2 percentage point increase in early payment default for Black zip codes. This increase is statistically significantly higher than that for white and Latino zip codes, which both saw a .1 percentage point increase in early payment default for an equivalent increase in pre-period IMC market share. Studying overall loan default, we find that a 10% increase in IMC market share in the pre-period leads to a 2.8 percentage point increase in total default for Latino zip codes. This number is statistically significantly different from the 1.6 percentage point increase in total default that Black zip codes and white zip codes for the same increase in pre-period treatment.

The DiD framework isolates who the IMCs are more likely to lend to – borrowers with higher credit scores, in minority-dominated zip codes, with lower income growth (higher income volatility). Combined with the early payment and total defaults in minority zip codes, these results suggest that the mortgages originated following BAPCPA lowered near-term mortgage payments, making them more affordable for borrowers with higher income variability but did not accurately assess the borrowers' ability to repay the mortgages over the longer term.

[Figure 9 about here.]

6 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 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.

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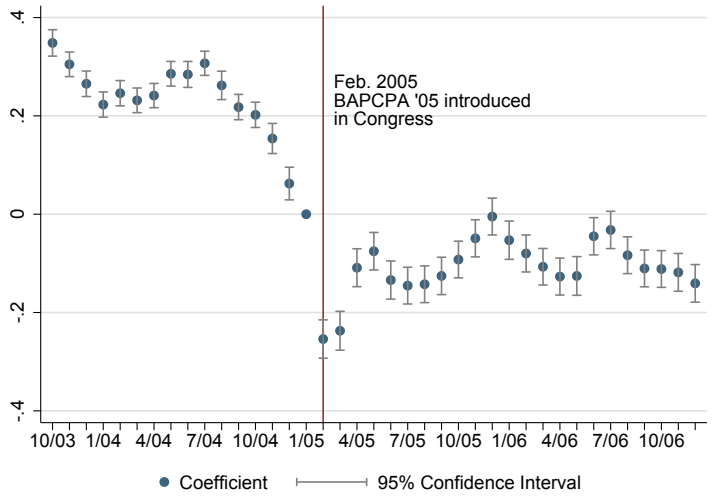
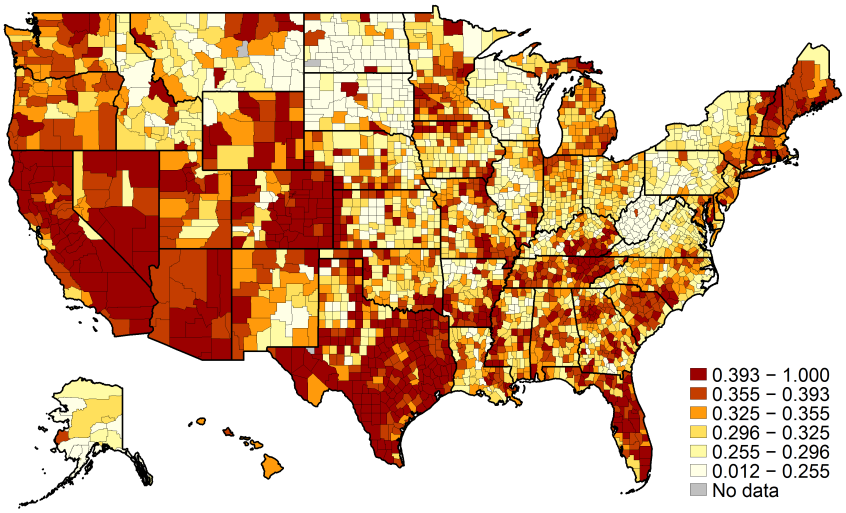
Figure 1: Private-Label vs. Agency MBS Yields



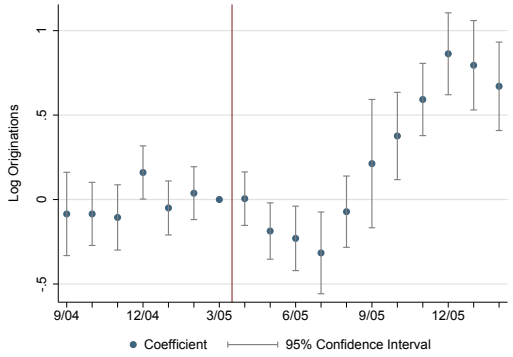
Notes: Figure plots the dynamic response of private-label MBS relative to agency MBS yields pre vs. post the introduction of BAPCPA 2005 in Congress on February 1, 2005. We estimate Equation 10. β_T is the coefficient of interest. It is the coefficient on the indicator variable that interacts the indicator 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

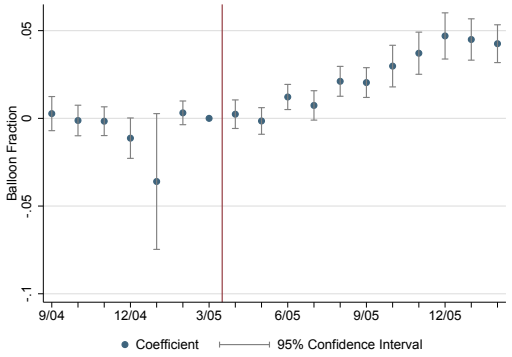


Notes: The figure depicts the county level market share of all IMCs reported in 2004. The market shares are calculated using the 2004 HMDA data.

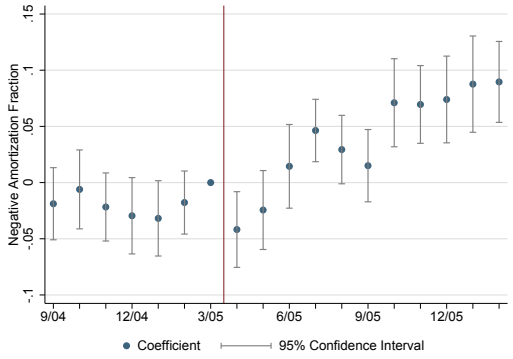
FIGURE 3: IMC COUNTY MARKET SHARE EFFECT ON MORTGAGE ORIGINATIONS



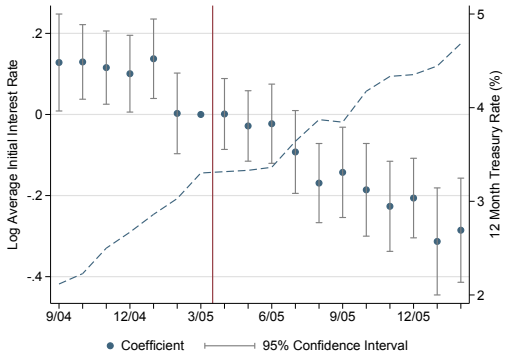
(a) Total Mortgage Originations



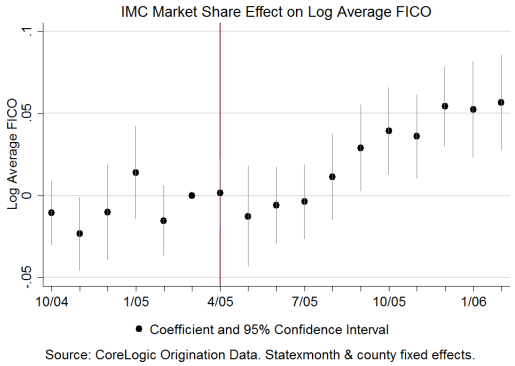
(b) Fraction Balloon Originations



(c) Fraction Negative Amortizing Originations



(d) Initial Interest Rate



(e) Average Credit Score

Notes: Figure plots the dynamic response of the dependent variable to the 2004 market share of independent mortgage companies (IMCs) in a county. We estimate Equation 12. β_T 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: Differential Effect of Treatment on Low Income Growth Zip Codes

	(1) logorig	(2) fracballoon	(3) fracnodoc	(4) fraclowdoc	(5) fracfulldoc
$\text{Post}_t \times \text{IMCMarketShare}_{z,2004}$	-0.1581***	0.0450***	0.0111**	-0.0370**	-0.0555***
	(0.0377)	(0.0023)	(0.0048)	(0.0157)	(0.0194)
$\text{Post}_t \times \text{IncomeGrowth}_{z,2001-2004}$	-0.5420***	0.0092	0.0073	0.0454	-0.0731
	(0.1113)	(0.0062)	(0.0152)	(0.0485)	(0.0607)
$\text{Post}_t \times \text{IMCMarketShare}_{z,2004} \times \text{IncomeGrowth}_{z,2001-2004}$	1.8648***	-0.0476**	-0.0388	-0.0978	0.1426
	(0.3292)	(0.0192)	(0.0465)	(0.1415)	(0.1804)
cons	2.4848***	-0.0027***	0.0176***	0.2536***	0.4474***
	(0.0091)	(0.0006)	(0.0012)	(0.0038)	(0.0047)
ZipFE	Yes	Yes	Yes	Yes	Yes
StatexMonthFE	Yes	Yes	Yes	Yes	Yes
r2	0.9274	0.0968	0.0923	0.1406	0.1402
N	491817	491817	491817	491817	491817

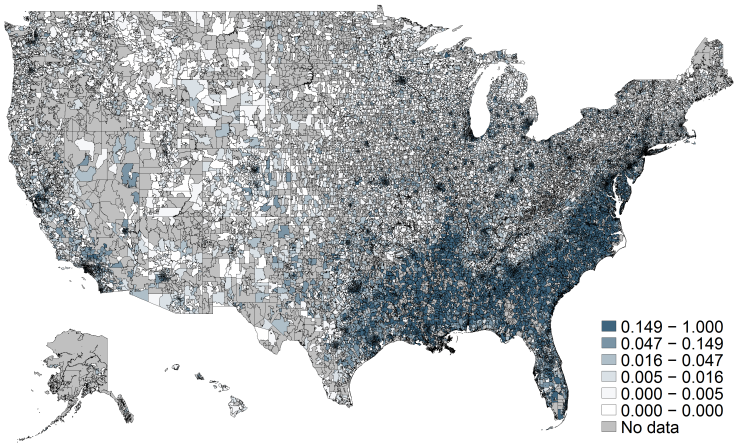
Notes: Table reports the response of housing market characteristics in a given county as a function of the 2004 market share of independent mortgage companies (IMCs) interacted with income growth between 2001 and 2004 in that county. I run the regression in 13.

FIGURE 5: DIFFERENTIAL EFFECT OF TREATMENT ON LOW INCOME GROWTH ZIP CODES (CONT'D)

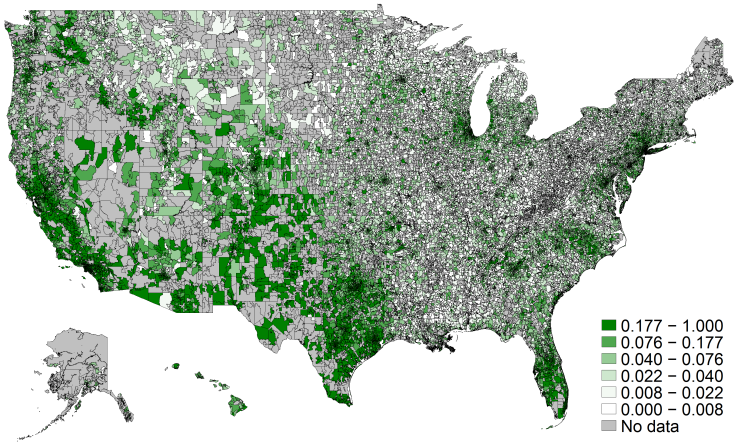
	(6) fracnegam	(7) frachybrid	(8) fractwostep	(9) fracarm	(10) fracio
$\text{Post}_t \times \text{IMCMarketShare}_{z,2004}$	0.0465***	-0.0168**	0.0031***	-0.0498***	0.0269***
	(0.0061)	(0.0076)	(0.0011)	(0.0153)	(0.0064)
$\text{Post}_t \times \text{IncomeGrowth}_{z,2001-2004}$	0.0366*	0.0395	0.0045	-0.0965**	0.0595***
	(0.0216)	(0.0240)	(0.0036)	(0.0485)	(0.0211)
$\text{Post}_t \times \text{IMCMarketShare}_{z,2004} \times \text{IncomeGrowth}_{z,2001-2004}$	-0.1075*	-0.1303*	-0.0129	0.2712*	-0.1718***
	(0.0649)	(0.0724)	(0.0114)	(0.1428)	(0.0641)
cons	0.0168***	0.0472***	0.0002	0.2460***	0.0407***
	(0.0015)	(0.0018)	(0.0002)	(0.0037)	(0.0015)
ZipFE	Yes	Yes	Yes	Yes	Yes
StatexMonthFE	Yes	Yes	Yes	Yes	Yes
r2	0.3893	0.0969	0.0742	0.2849	0.3227
N	491817	491817	491817	491817	491817

Notes: Table reports the response of housing market characteristics in a given county as a function of the 2004 market share of independent mortgage companies (IMCs) interacted with income growth between 2001 and 2004 in that county. I run the regression in 13.

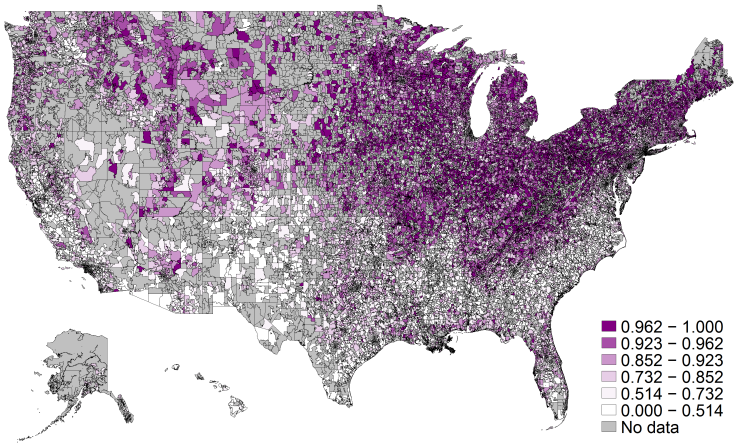
Figure 6: Population by Race



(a) Population of Black Inhabitants



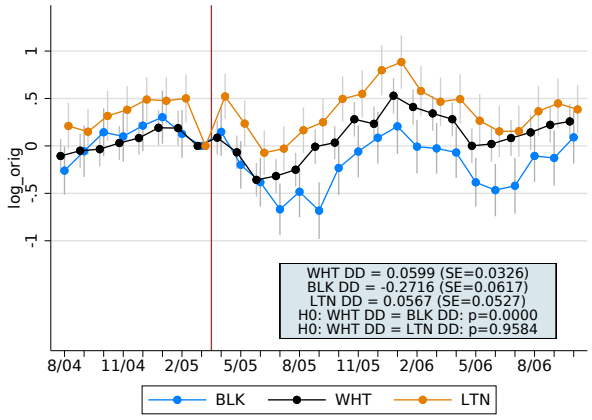
(b) Population of Latino Inhabitants



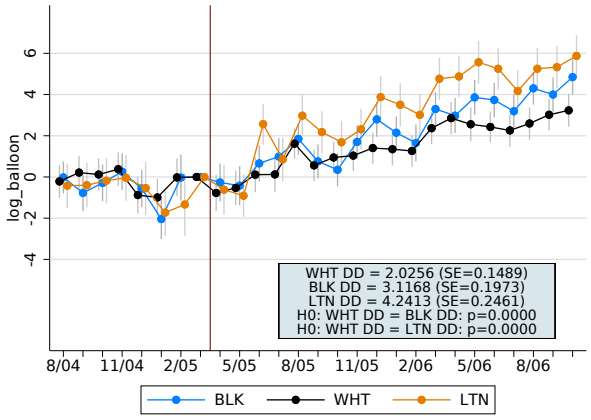
(c) Population of white Inhabitants

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.

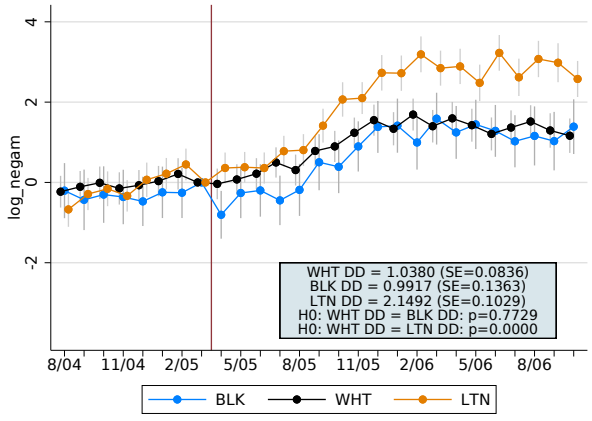
FIGURE 7: DIFFERENCE-IN-DIFFERENCES (DID) BY RACE SUBCATEGORIES - ORIGINATIONS & MORTGAGE PRODUCTS



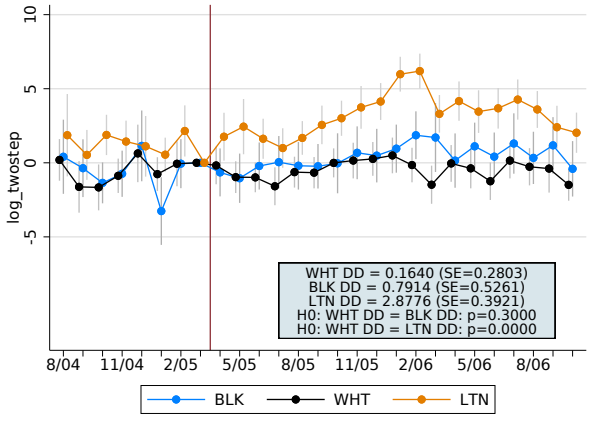
(a) Originations



(b) Balloons



(c) Negative Amortizing

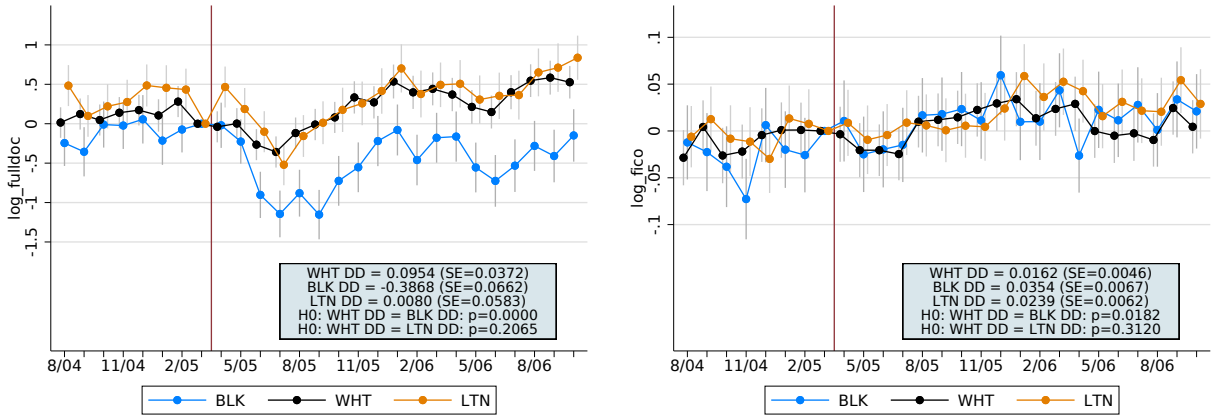


(d) Two Step

Notes: Figure plots the dynamic response of the coefficient of interest β_T from Equation 14 by race subcategory.

$$Y_{z,t} = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMarketShare_{z,2004} \times \mathbb{1}_{t=T} + \epsilon_{z,t}. \tag{16}$$

FIGURE 8: DIFFERENCE-IN-DIFFERENCES (DID) BY RACE SUBCATEGORIES - BORROWER CHARACTERISTICS

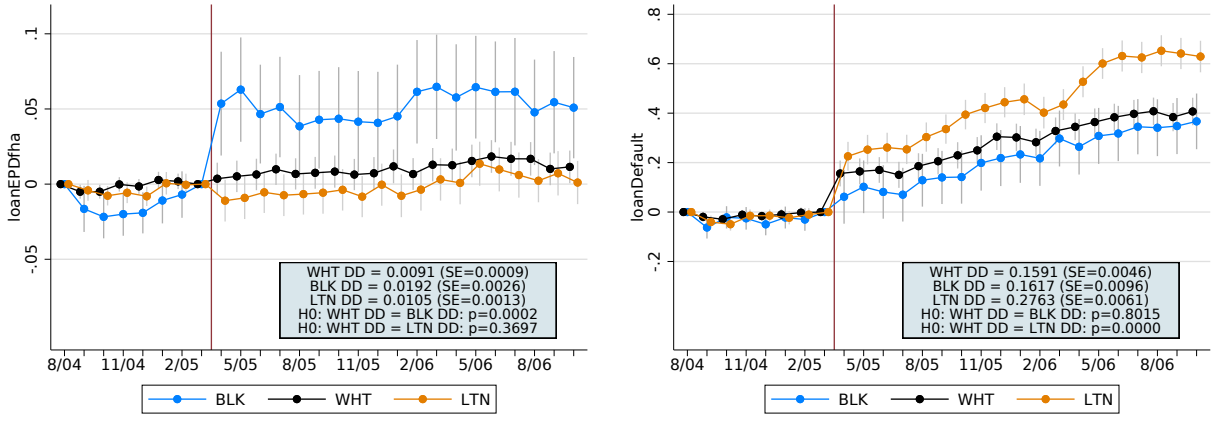


(a) Full Documentation (b) Credit Score

Notes: Figure plots the dynamic response of the coefficient of interest β_T from Equation 14 by race subcategory.

$$Y_{z,t} = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMarketShare_{z,2004} \times \mathbb{1}_{t=T} + \epsilon_{z,t}. \tag{17}$$

FIGURE 9: DIFFERENCE-IN-DIFFERENCES (DID) BY RACE SUBCATEGORIES - DEFAULT



(a) Early Payment Default (b) Total Default

Notes: Figure plots the dynamic response of the coefficient of interest β_T from Equation 15 by race subcategory.

$$Y_i = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMarketShare_{z,2004} \times \mathbb{1}_{t=T} + \epsilon_i. \tag{18}$$

Appendix

.0.1 Mortgage Acceptance Rates

BAPCPA also lowered credit constraints, which would allow borrowers who were not wealth constrained to receive mortgages at lower credit scores. Traditional mortgage products with standard amortization schedules and credit scores below 620 would be considered subprime mortgages for instance. If IMCs simply lowered the credit score required to receive a traditional subprime mortgage, it would loosen the credit constraint however not the downpayment, or wealth constraint, required to receive the mortgage. The acceptance rates are consistent with IMCs originating more alternate-A paper products in minority zip codes and more subprime products in white zip codes. This makes sense in light of the racial wealth gap and racial 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)). Given the stark wealth gap and income volatility gaps, the downpayment and documentation requirements were likely much less binding for white families than for minority families.

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 received a differential increase (decrease) in mortgage approval rate from IMC lenders versus non-IMCs lenders post policy change by race. We estimate the following regression:

$$\begin{aligned} Accepted_b = \alpha post_t + \delta IMC_b + \lambda RACE_b \\ +\rho IMC_b \times post_t + \zeta IMC_b \times RACE_b + \xi post_b \times RACE_b \\ +\beta IMC_b \times \%Race_b \times Post_t \\ +\gamma_c + \eta_{s,t} + \epsilon_b. \end{aligned} \tag{19}$$

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.

Table 1 presents the results of Equation 19. Relative to other racial groups, Black and Latino borrowers experienced significant declines in mortgage acceptance rates by 5.5% and 6.6% respectively. White borrowers experienced a significant relative increase in mortgage acceptance rate by 3%. This is consistent with white borrowers receiving more subprime mortgages, which were fully amortizing but required lower credit scores, and therefore slackened the credit score constraint. While minority borrowers received more Alt-A products, which required higher credit scores but had riskier amortization structures, and therefore slackened the wealth constraint.

[Table 1 about here.]

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

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

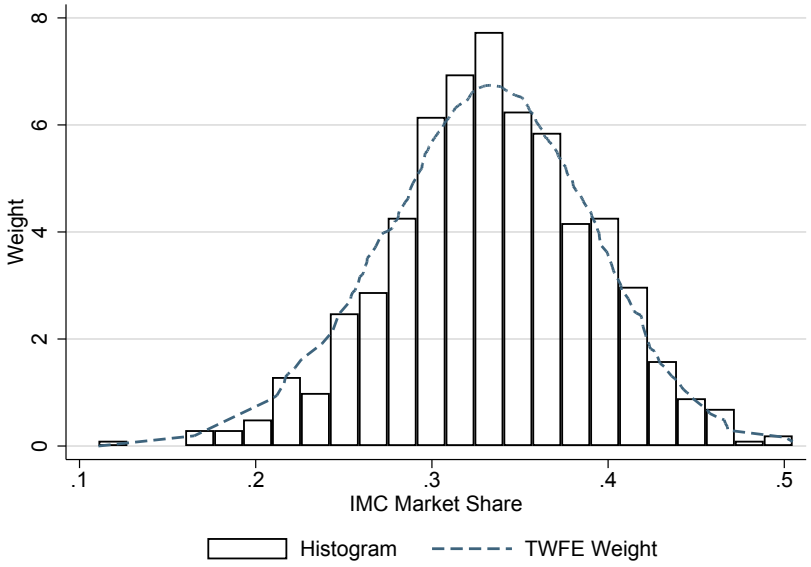
We calculate a histogram of the treatment doses of $IMCMarketShare_{c,2004}$ for the counties used in the regression analysis. We find that $IMCMarketShare_{c,2004}$ is symmetric and close to normally distributed. We then calculate the weights used in the TWFE estimator and find that the weights closely 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 10 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 10: 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.

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