The Impact of Collateral Value on Mortgage Originations

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October 15, 2024

Abstract

This paper establishes that high income-volatility, minority borrowers were disproportionately exposed to the expansion of credit following the BAPCPA 2005 policy that granted preferred bankruptcy status to mortgage backed collateral in the sale and repurchase market. This shock only affected the collateral value of risky alternative mortgages. I generate a model of mortgage lending where a lender lends in two markets: one for conforming mortgages and one for alternative mortgages. When the collateral value of alternative mortgages increases, it decreases lenders' cost of capital, leading them to decrease the price they charge. If the price falls below the borrowers' reservation price, lending expands in this market. I interpret BAPCPA 2005 as an increase in collateral value of alternative mortgages. Consistent with the model, the paper documents that BAPCPA caused the sudden and disproportionate expansion of alternative mortgage products among high-income-variability minority-dominant zip codes leading up to the Global Financial Crisis, and disproportionately increased defaults in these areas during the crisis.

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

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Expanding homeownership rates among low income and high income volatility borrowers has long been a policy goal of federal agencies. It is an important policy goal to increase access to mortgage lending for these borrowers, however we should not do so by developing institutions that set the borrowers up to fail. A growing body of literature has documented that the majority of foreclosures during the Global Financial Crisis (GFC) were clustered in minority zip codes (Haughwout et al. (2020), Kermani and Wong (2021), Rugh (2015)). Consistently, early versions of the proposed Congressional Bill, the Down Payment Toward Equity Grant, aimed to narrow the racial homeownership gap by awarding subsidies to first time home buyers whose parents suffered a foreclosure during the GFC. However, it remains an open question of why minority borrowers were the hardest hit during the GFC. In this paper, I document how a change in the wholesale lending markets pre-GFC allowed the private market to extend credit to high income volatility borrowers via an increasingly fragile internal capital market structure.

To document this, I first establish that a policy change allowed dealers to lend more, I then show that the majority of their increased lending went to high income-volatility borrowers. Next, I discuss how the policy change facilitated a repo warehouse lending structure that made the banks increasingly risky and thus made the funding structure in the primary market especially precarious. I study whether an increase in repo funding resulting from the policy change led to a change in the types of mortgage products offered in the primary market, how these new products may have stimulated demand for more mortgages, and the types of borrowers who were impacted. In the typical narrative of the housing boom, subprime mortgages play a prominent role. However in this paper, I present evidence that suggests there was a second wave of the housing boom. While the first wave involved originations of subprime mortgages with below 620 credit score but fully amortizing mortgage structures, the second wave began following the policy change and involved originations of alternative mortgages. These alternative mortgages featured artificially low introductory payments and negative amortizing structures – which decreased borrower home equity over time, rather than increasing it – and were originated to high-income-volatility, minority dominant zip codes.

I utilize the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA). The policy change 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. I use BAPCPA to plausibly exogenously increase the collateral value of private-label mortgage backed securities to study the effect that this shock had on the expansion of mortgage products originated following 2005.

Since this shock stimulated increased collateral value in the repo market, I show that it caused a shift toward option-ARMs, interest only, negative amortizing, two-step, and hybrid mortgages. These new products increased the risk of the underlying mortgage collateral while at the same time, the policy change amplified the following risks in the repo market: lowering incentives to monitor collateral, increasing critical financial interlinkages, inefficient substitution toward short-term repo funding, and facilitating collateral fire sales in the capital markets.

To empirically document whether BAPCPA drove an expansion of private-label mortgages in a new market of higher-income-volatility borrowers, I set up a treatment intensity difference-in-differences (DiD) research design. I use BAPCPA as a plausibly exogenous increase in collateral value. I assert that it lowered dealer-banks' cost of funding private-label mortgages. It did so by allowing dealer-banks to repledge or reuse collateral to fund new mortgages rather than providing their own capital to do so. Since independent mortgage companies (IMCs) received funding via repo warehouse lines of credit from the large dealer-banks, they have larger exposure to BAPCPA than do deposit taking financial institutions. Thus, I define treated areas to be zip codes with a higher market share of independent mortgage companies in 2004, the year prior to the change, and control areas to be zip codes with a higher market share of deposit taking financial institutions, such as traditional banks and credit unions.

Using this treatment intensity research design, I find that higher IMC market share in 2004 leads to a significant increase in mortgage originations following BAPCPA. Post-BAPCPA, higher treatment intensity leads to a significant increase in the fraction of option-ARMs, an adjustable rate mortgage with three possible payment choices: paying the full principal and interest, paying only the interest, and paying a minimum amount that does not cover the interest. It also leads to an increase in the fraction of negative amortizing, balloon, and two-step mortgages. Similar to option-ARMs, these products all had artificially low introductory monthly payments that deferred interest payments to later periods of the mortgage. Consistent with the expansion in originations occurring mainly at the extensive margin, or lenders lending to a new market, I find that a 10% increase in treatment intensity significantly increases credit score at origination in the post-period by 0.24%, or about 1 point (for example increasing credit score from 690 to 691). These were mainly purchase originations, as second homes and refinances were decreasing over this time period.

To test whether IMCs increase lending to borrowers with higher income volatility, who may not have qualified for a mortgage prior to BAPCPA, I estimate a triple difference treatment intensity regression specification. Since income growth is highly correlated with income volatility, I interact IMC market share with a measure of income growth from 2001 to

2004. I find that the zip codes with lower income growth experience a statistically significant increase in fraction of mortgages that are negative amortizing (including option-ARMs), balloon, interest only, and hybrid, relative to zip codes with high income growth.

Kermani and Wong (2021) find that minority groups have higher volatility in both net worth and labor income. Therefore I hypothesize that minorities should be differentially affected by the policy change. I utilize a difference-in-differences research design by racial subgroup to study the differential usage of mortgage products pre- versus post-BAPCPA by racial makeup of a zip code. I define a zip code to be majority Black if 30% or more of its population identifies as Black in the census data, Latino if 30% or more identifies as Latino, and white if 84% or above identifies as white. If a zip code is defined as Black, the fraction of the population identifying as Black is greater than the fraction identifying as Latino, and vice versa. I 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.

Additionally I find that, 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 Black 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.

I also find that while a 10% increase in IMC market share leads to a statistically significant 1% increase in full documentation mortgages for white zip codes and no change in documentation type 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 originated to 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 potentially vulnerable borrowers would likely have more difficulty sustaining mortgage payments after their reset periods or

during an economic downturn relative to low-income-volatility majority dominant zip codes.

In order to study the consequences to borrowers of these mortgage products, I study both early payment default and total default using the same regression specification. I find that a 10% increase in IMC market share in the pre-period leads to a 0.2 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 0.1 percentage point increase in early payment default for an equivalent increase in pre-period IMC market share. Studying total loan default, I 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 that both Black and white zip codes experience for the same increase in pre-period treatment.

The DiD framework isolates the role that BAPCPA played in increasing the use of alternative mortgages among borrowers. The results indicate that zip codes more exposed to BAPCPA increase lending to borrowers with higher credit scores, in minority-dominated zip codes, with lower income growth (higher income volatility). Combined with the increased 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. Indeed, the Annual Reports of mortgage companies state that many mortgage originators determine the amount of loan that a borrower can afford based on the borrowers' initial scheduled monthly payments rather than on future monthly payments after the interest rate reset date. This paper provides evidence that innovations in the secondary market, which change lenders' incentives to move into new primary markets, can have differential effects by race and income volatility.

In order to highlight the mechanism through which an increase in secondary market collateral value stimulates lending of a new mortgage product in a new primary market, I propose a stylized model. The model features a lender and two types of borrowers: those with high- and low-income-variability. 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 optimal contract is a fixed rate mortgage for low-income-volatility borrowers and an Option Adjustable Rate Mortgage (option-ARM), or alternative mortgage, for high-income-volatility borrowers. In this paper, I interpret fixed rate mortgages as the agency mortgage market and option-ARM, or alternative mortgages, as the private-label mortgage market. I assume that high-income-variability borrowers utilize the private-label market and low-income-variability borrowers utilize the agency mortgage market. In this way I simplify the analysis by assuming that there are two

segmented markets.

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 ability to repledge collateral. Thus when BAPCPA increases the ability to repledge collateral, as shown in Lewis (2023), the collateral value increases.[1] When the private-label collateral value increases, the marginal cost of originating private-label mortgages decreases relative to agency mortgages. This decreased marginal cost of originating private-label mortgages can be thought of as decreasing the value of the 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 my framework, this implies that the contracts offered in either market would not change, but the price offered on the private-label contract would change. Thus, I show that when the lender's marginal cost of originating private-label mortgages decreases, she expands originations by lowering the price charged on these mortgages. If the price falls below borrowers' reservation price, the lender expands into a new market; the one for high-income-variability borrowers. In the data, I study whether the decrease in lenders' marginal cost of originating private-label mortgages enabled them to lower mortgage prices below borrowers' reservation values and expand into a new market following BAPCPA. Consistently, I find that following BAPCPA, IMCs differentially lower the initial interest rate that they charge borrowers, consistent with a decrease in their cost of borrowing.

Literature Review Lewis (2023) establishes that BAPCPA created a credit expansion in 2005 in the secondary market and shows that this credit supply increase was passed on to mortgage companies and ultimately to the housing market. In this paper, I innovate by studying which types of borrowers were the most affected by the credit supply increase and whether the policy changed the types of mortgage products originated. I create a stylized model to illustrate the mechanisms behind the expansion of lending in zip codes with low-income growth. I establish that a credit expansion in the secondary market facilitated mortgage funding in a new housing market; one for high-income volatility borrowers.

Piskorski and Tchistyi (2010) show that income volatility determines the optimal mortgage product for a borrower. Derenoncourt et al. (Forthcoming); Morduch et al. (2018); Gupta et al. (2023); Kermani and Wong (2021) show that minorities have higher income volatility. My paper combines these two background facts and further innovates by showing that income volatility has an important impact on mortgages that minorities receive. I show

[1] As the money multiplier that collateral generates increases, this maps to larger increases in collateral value, since dealers require less equity investment to reach the same ultimate portfolio size.

that a preference for alternative products among high-income volatility borrowers, combined with a change in the funding structure that allowed banks to issue alternative products had differential distributional impacts on home buyers in terms of products that Hispanic and Black borrowers versus white borrowers received. I show that this has important implications for systemic fragility in the housing market.

There is a literature that shows that Black households have higher leverage (Gupta et al. (2023); Kermani and Wong (2021)). Gupta et al. (2023) use a different income process in their general equilibrium model for evolution of housing wealth for Black households relative to white households where the mean on the income process is not only lower for Black households, but the variance is also higher. This is meant to reflect higher income volatility and higher leverage for Black borrowers. Derenoncourt et al. (Forthcoming) documents that Black households have one sixth the wealth of white households. Although the mortgage products that I focus on mainly decrease the initial flow mortgage payments and I do not focus on decreases in down payment values - both wealth and income are important. This is because the income constraint becomes relevant when the wealth constraint binds. To see this, think of a borrower who had enough cash to purchase a home outright, in this case the household would have no mortgage payment due and income volatility would not affect their ability to repay the mortgage. Similarly if a borrower can put larger amounts of money down, the value of the mortgage payment they will owe mechanically decreases. This paper establishes that the financial innovation enabled by BAPCPA enabled banks to offer products with low down payments, artificially low introductory interest rates, and alternative amortization schedules that decreased both the wealth and income constraint initially but that were more vulnerable to income volatility.

The sociology literature has documented that minorities were moving into the markets with high home prices and borrowing via risky mortgage products while white borrowers were moving away from them (Rugh (2015)). My paper sheds light on this puzzle by establishing the role that reducing financing constraints played in minority borrowing leading up to the GFC.

1 Institutional Background and Data

1.1 The Sale and Repurchase "Repo" Market

The sale and repurchase market, or "repo" market is a large wholesale funding market where dealer-banks make and receive repo loans. The typical transaction involves the borrowing institution providing securities as collateral to back a short-term loan from the lending institution. That is, these repo loans serve the same economic function as collateralized

loans, except that the exchange of collateral is considered an outright sale followed by a repurchase.

Large securities dealers often lend cash in the repo markets and then use the securities, obtained in those repo transactions, as collateral to borrow for their own interest, i.e., dealers repledge, rehypothecate, or reuse the collateral they receive. The dealer will typically charge a lower interest rate on the repo loan if the client allows the dealer to rehypothecate the assets that serve as collateral (Copeland et al. (2014)). This indicates that the ability to repledge or rehypothecate collateral is valuable for the dealer.

In order to understand the research design and the credit supply increase that BAPCPA generated, this section describes (1) the structure of IMC credit lines from dealers; (2) how dealers operate in the repo market; (3) how BAPCPA affected the interactions between dealers and IMCs.

Independent Mortgage Company (IMC) Warehouse Repurchase Facilities Independent mortgage companies are not deposit taking institutions. They depend heavily on the sale of their mortgages in order to fund themselves. This sale typically takes between 30-60 days. In the meantime, mortgage companies originate mortgages, package them into a warehouse facility and use this warehouse facility to borrow against. The repayment of these warehouse credit lines varied by contract but they were often repayable either when the financed loans were sold or on the maturity date of the contract.[2]

Repo Market Functioning The repo markets are large short-term funding markets where securities are sold and repurchased, creating short-term loans collateralized by financial assets.[3] Copeland, Martin and Walker (2014) estimate that during July-August 2008, the sum of all repos outstanding on a typical day was approximately $6.1 trillion. The sum of all reverse repos outstanding was about $4 trillion.[4] The main users of repos are large dealer banks and other financial institutions such as money market funds (MMFs), hedge funds, and IMCs.

The repo market consists of two segmented markets: the **bilateral** and the **tri-party** market. Lower overcollateralization rates or "haircuts" are charged in the tri-party market on the same collateral, due to lower counterparty risk. This is because traditionally more credit worthy market participants – such as large dealers and cash investors – trade in the tri-party market, the collateral is held by a clearing house (the third party), and the contracts are

[2]See: HomeBanc 2005 10-Q3 p 101 of 173.

[3]For a succinct description of repos see *Bevill, Bresler & Schulman Asset Management Corp. v. Spencer Sav. & Loan Ass'n* (1989) 878 F.2d 742, 743 (3d Cir. 1989).

[4]About 40% of repo activity was in tri-party repos and the remaining 60% was in bilateral repos. About 92% of reverse repos took place in the bilateral market. Due to double counting, summing the total repo and reserve repo values may overstate the total size of the market. Copeland, Martin and Walker (2014) p. 2348.

short-term in nature. The clearing house provides several important roles, such as settling and netting transactions, and the bankruptcy treatment of collateral affects the clearing house's ability to perform these functions. In the event of bankruptcy, the automatic stay would interfere with the timely settlement of collateral held in the clearing house's custodial accounts. The bilateral market is where opaque, less credit-worthy agents seek short-term funding. The cash borrowers in this market are riskier and face larger haircuts to protect the dealers lending to them.

The tri-party market is the market that connects dealers with nonbank cash investors such as MMFs and securities lenders. Krishnamurthy, Nagel and Orlov (2014) state that the tri-party market is the way in which cash funding enters the shadow banking system through repo. The bilateral repo market is a market through which funds are reallocated between dealers and across dealers and hedge funds, or mortgage companies. Dealers play an important role as repo intermediaries between cash lenders and cash borrowers across these markets. Dealers are likely to be cash borrowers (send securities out), in the tri-party market (Infante (2019)), and to be cash lenders (receive securities in) in the bilateral market (Copeland, Martin and Walker (2014)). Tuckman (2010) states that dealers prefer to use borrowed capital to finance their borrowing rather than to use their own scarce capital. Thus dealers repledge or rehypothecate collateral received in the bilateral market, in the tri-party market (Copeland, Martin and Walker (2014)). This reuse of collateral allows dealers to take advantage of the differential between haircuts in the bilateral and tri-party markets to generate a cash "windfall" (Infante (2019)).

Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (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 the collateral is exempt from the hold on a firm's assets when the firm enters bankruptcy proceedings. However additional 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. The market response to these court cases suggests that collateral must be legally exempt from automatic stay in order for cash lenders in the tri-party market to lend against it. I discuss these court cases further in the Lewis (2023) Appendix A in the Online Appendix.

BAPCPA was introduced in Congress in February 2005 and signed into law in April 2005.[5] 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. I hypothesize that this enabled the clearing house in the tri-party market to hold the collateral without worry that a counterparty's failure would trigger automatic stay.

These institutional details suggest that BAPCPA enabled dealers to reuse, or repledge, warehoused private-label mortgage loans or newly minted private-label MBS in the tri-party market in larger quantities than they had been able to prior to the law change. In the sections that follow, I present evidence consistent with this hypothesis from analyses on dealers' collateralized repo borrowing and MBS yields. In Lewis (2023) Appendix A in the Online Appendix, I provide evidence that participants in the tri-party market increased their lending against mortgage collateral, however, the mechanism will go through even if BAPCPA only increased dealers' reuse of private-label mortgage collateral in the bilateral repo market.

Conceptual Framework This section sets up the conceptual framework that depicts how the money multiplier works and generates predictions, which I empirically test in the following sections. I propose that prior to BAPCPA, reuse of the mortgage collateral was limited. The collateral was simply held – with limited reinvestment capability – to protect dealers from the default risk of the mortgage companies. Following BAPCPA, I propose that dealers' reuse of mortgage collateral expanded, allowing them to generate a money multiplier by taking advantage of the differential between the haircut that they charged in the bilateral market relative to the haircut that they received in the tri-party market.

In Figure 1, I depict a stylized example of the proposed change in dealers' ability to reuse the warehoused mortgage loans posted by an IMC prior to BAPCPA, in panel (a), versus after BAPCPA, in panel (b).[6] To simplify the exposition of the money multiplier, in (a) I depict the tri-party market refusing to lend against warehoused mortgage loans,

[5]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))

[6]Although Figure 1 (b) and the argument below focus on reuse of warehoused mortgage collateral in the tri-party market, the argument would go through if dealers increased reuse of collateral in the bilateral market at lower haircuts than they received prior to the policy change.

corresponding to a 100% haircut. In (b) I propose that BAPCPA increased dealers' ability to reuse the collateral. This argument would go through if dealers were able to repledge whole mortgage loans from the mortgage warehouse, or if they were able to securitize the warehoused loans quickly and pledge the newly minted securities.[7]

[FIGURE 1 about here.]

The literature documents, both theoretically (Gottardi, Maurin and Monnet (2019)) and empirically (Copeland, Martin and Walker (2014), Infante (2019)), that differences in haircuts between the bilateral and tri-party market are larger for riskier collateral classes. The larger haircut differentials imply larger money multiplier potential. To establish the size of the haircut that dealers charged the IMCs in my data, I utilize data from a subset of the IMCs that report both their utilization on credit lines and the value of mortgages they post. This information allows me to estimate the haircut that IMCs paid. In 2005Q4 an *IMC* posted a 36% haircut to insulate dealers from the IMC's risk of default. I propose that the improved creditor rights on private-label collateral (securities or whole mortgage loans), following BAPCPA, decreased haircuts on collateral posted by the *dealer* in the tri-party market, from close to 100% to 5%.[8]

Imagine that pre-BAPCPA, the dealer funded the IMC initially with $100 of capital (the "*first round*" of lending), the IMC posted $136 worth of collateral to secure the repo loan, and the dealer held the collateral. In Figure 1, I depict this as a dealer paying $100 to buy mortgage collateral valued at $136, from the mortgage company in the bilateral market, with an agreement to sell it back in 60 days at $100. The above haircuts imply that post-BAPCPA, dealers could re-sell the $136 collateral, posted by the IMCs in the bilateral market, for $130 in the tri-party market. The process would work as follows. If the dealer funded the IMC with the initial $100 of capital, the dealer could borrow an additional $130 by repledging the IMC's $136 collateral in the tri-party repo market at a haircut of 5%. If the dealer reinvested in warehouse mortgage loans by lending the $130 back to the IMC (the "*second round*" of lending), and haircuts remained the same, the IMC would post $176.8 of new mortgages to secure the repo loan. By repledging this $176.8 of mortgage collateral, the dealer could borrow $169 in the tri-party market. This cycle of lending to an IMC, receiving collateral from the IMC, repledging the collateral to a cash lender, and reinvesting the cash in the IMC could continue for many rounds.

[7] From speaking with market participants, dealers were able to securitize collateral very fast, usually several days or weeks.

[8] Copeland, Martin and Walker (2014) documents that the haircut charged in the tri-party market on private-label mortgage collateral was 5% in July 2008. It is likely the haircut was 5% or lower directly following BAPCPA, since the use of private-label mortgage repo collateral was at an all time high.

This haircut differential would lead to a money multiplier, similar to the multiplier in the fractional reserve system. Moreover, the dealer has incentive to reinvest each round of cash back into private-label mortgages, because the haircut differential on this collateral means that each dollar reinvested would generate more than a dollar in the dealers' own borrowing potential, lowering the cost of capital. Additionally, although this example abstracts from an interest rate charged on the repo borrowing to simplify the exposition of overcollateralization, continuing this cycle of lending would allow the dealer to lever up the return that it received from the IMC in the form of interest rates on the warehouse repurchase facilities.[9]

Consistent with the collateral becoming a valuable tool to lower their cost of capital, I see the dealers offering increasingly favorable overcollateralization terms to the IMCs in my data post-BAPCPA. The haircut required is 36% in 2005Q4, 26% in 2006Q1, 11% in 2006Q2, 15% in 2006Q3, and 16% in 2006Q4. The slight increase in 2006Q3 and 2006Q4 could be driven by an increase in risk of underlying mortgages. As long as the IMC generated enough money from fees or interest on the mortgages originated, it would have enough equity to fund the haircut charged by the dealer. The haircuts that I measure in 2006 are consistent with the haircut differential measured in Copeland, Martin and Walker (2014), which measures the difference between median repo haircuts on private-label collateralized mortgage obligations across the bilateral and tri-party repo market in July 2008 to be 17%. As a reference, the haircut differential on agency MBS at the time was 2%.

The haircuts I calculate for the IMCs from 2005Q4-2006Q4 allow me to calculate an upper bound on the multiplier that dealers could generate following BAPCPA. The majority of private-label mortgage securitizations sold in 30 days (**?**). Therefore I use one month as the interval of the rounds of lending that generate the bilateral/tri-party haircut differential.[10] Given the quarterly haircut differentials between 2005Q4-2006Q4,[11] 15 rounds of lending across 15 months would create a multiplier equal to:

[9]Each additional round of lending to the IMC would increase the interest earned by the dealer. The interest earned (r) on the dealer's lending depicted in **??** (a) would be $r = \$100 \times i^{IMC}$. While in **??** (b) the dealer's interest earned would be: $r = \$100 \times i^{IMC} + \$130 \times (i^{IMC} - i^{Dealer})$. Where i^{IMC} is the interest rate paid by the IMC on repo funding and i^{Dealer} is the interest rate paid by the dealer on repo funding.

[10]The IMC was paid when the dealer purchased the warehoused loans. If the dealer financed its purchase of the warehoused loans in the tri-party market, then once the security was sold to the final investor, the dealer would pay off the cash lender and begin another round of funding to the IMC.

[11]The earliest that IMCs report overcollateralization is 2005Q4 and the latest is 2006Q4. Dividing one plus each of these numbers by 1.05 as in Equation 16 (in the Online Appendix of Lewis (2023)), yields the haircut differential utilized.

$$1+\sum_{i=1}^{3}1.3^i+1.3^3\sum_{i=1}^{3}1.2^i+1.3^3(1.2^3)\sum_{i=1}^{3}1.06^i+1.3^3(1.2^3)(1.06^3)\sum_{i=1}^{3}1.095^i \quad (1)$$
$$+1.3^3(1.2^3)(1.06^3)(1.095^3)\sum_{i=1}^{3}1.10^i = 66.5.$$

For comparison, in subsection A.8 of the Online Appendix of Lewis (2023), I illustrate that dealers could generate infinite supply of credit and leverage if haircuts remained constant.

Using the multiplier in Equation 1, the dealer can supply $6,650 of credit to the economy with its initial $100 of funding. This implies that the dealer can expand its leverage secured by private-label mortgage collateral to 66.5 times its initial equity. This is 4.5 times the multiplier generated by rehypothecating Treasuries in the same way, described in subsection A.7 of the Online Appendix of Lewis (2023). This framework indicates that the credit supply increase caused by BAPCPA was larger than any credit supply increase resulting from the expansion of repo safe harbors to agency collateral in 1984 because the private-label collateral was riskier collateral and thus carried larger haircut differentials.

1.2 Independent Mortgage Companies

Independent Mortgage Companies (IMCs) are not deposit taking institutions, therefore, they they depend heavily on the sale of their mortgages in order to fund themselves. This sale typically takes between 30-60 days. In the meantime, mortgage companies originate mortgages, package them into a warehouse facility and use this warehouse facility to borrow against. Prior to the Global Financial Crisis, this borrowing typically took the form of warehouse repurchase agreements.

Lewis (2023) carefully studies the warehouse credit lines for the 12 largest IMCs and shows that the 29 largest dealers were their main funders and that the dealers passed their credit supply increase on to the IMCs that they were funding. Stanton, Walden and Wallace (2014) finds that five of these 12 IMCs originate a minimum of 49% of all IMC mortgage lending in 2006. As a lower bound, I estimate that the 12 IMCs are responsible for 59% of all IMC originations in 2006. I estimate this by adding mortgage purchases to the origination figures for the top five IMCs in Stanton, Walden and Wallace (2014) and estimating the remaining seven IMCs' originations using HMDA market share. This number is a lower bound since I do not observe the correspondent purchases by the additional seven IMCs that are not in Stanton, Walden and Wallace (2014). Given that the 12 largest IMCs studied in Lewis (2023) make up a minimum of 59% of all IMC originations in 2006, and that they all

utilize the same warehouse funding structure, in the empirical section of the paper, I assume that all IMCs are treated by BAPCPA.

1.3 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, I use 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, I 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 I use are mortgage status (denied, approved, originated), who the originator was, whether the originator was an IMC, the year, and region in which it was originated and the race of the borrower.

I use these data to construct the IMC zip code level market share in 2004, the year prior to BAPCPA. To identify the IMCs, I use the crosswalk maintained by Robert Avery to match subsidiaries belonging to the same parent company and aggregate mortgages originated by each parent company. I define a mortgage company as an IMC if it underwrites and funds a loan in its own name, following the HMDA definition of IMCs.

CoreLogic Data. I use the CoreLogic Loan Level Market Analytics (LLMA) data to study mortgage characteristics pre- and post-BAPCPA. Due to data restrictions, I 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, I aggregate all variables to the zip code level and merge with the pre-period IMC market share in that region 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 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 I utilize are the mortgage's initial interest rate, occupancy status, mortgage product (balloon, negative amortizing, ad-

justable 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. I 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. I 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. A detailed description of the variables used can be found in Appendix A.

2 Stylized Facts

2.1 The Rise of Alternative Mortgage Products

I first begin by establishing stylized facts about mortgage originations leading up to the GFC.

Fact 1: *The expansion of alternative mortgages accelerated rapidly beginning in 2005 and crashed in 2008.*

Fact 2: *The expansion of these alternative mortgages was more prominent among borrowers with low rates of income growth and those in minority-dominant zip codes.*

In Figure 2, I plot the total number of originations of negative amortizing (panel (a)) and interest only (IO) (panel (b)) mortgages from 2001 to 2008. Negative amortizing mortgages are mortgages that do not pay the full amount of interest and principal to amortize or pay down the loan over time. Therefore, the interest owed and not paid is added to the balance of the mortgage and recapitalized, so that interest is owed on the deferred interest. Negative-amortizing products increase borrowers' balance and thus their indebtedness over time, rather than decreasing it. Mayer, Pence and Sherlund (2009) state that negative amortizing mortgages made up about 20% of all Alt-A mortgage products. Interest-only mortgage products include Option - Adjustable Rate Mortgages (ARMs) which offer the option to pay the fully amortizing principal and interest, only the interest payment, or a minimum amount that is less than the interest accrued. 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. These were one of the main types of negative amortizing mortgage products originated in the lead up to the Global Financial Crisis. These alternative mortgage products offered an artificially low interest payment for an initial time period before the payment reset to the fully amortizing price at the market rate. The rates typically reset to the market rate one or two years after origination. This means that borrowers in these mortgages may experience payment shock if the monthly payment that they reset to is higher than their artificially low initial payments.

Independent mortgage company HomeBanc's 2005 annual report states 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"[12]

Figure 2 panels (a) and (b) illuminate two interesting trends. First, they show that alternative mortgages increased suddenly in 2005 and remained at elevated levels in 2006 and 2007, before falling dramatically in 2008, with the onset of the Global Financial Crisis. Second, they show that zip codes in which borrowers experienced low rates of income growth (those in the first quartile of 2001 to 2004 income growth), received disproportionately more of these alternative mortgages than borrowers in areas with high income growth (those in the fourth quartile of 2001 to 2004 income growth). Low rate of income growth is highly correlated with a high level of income volatility, i.e. households with low rates of income

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

growth also have more volatile incomes. For this reason, I use low income growth as a proxy for high income volatility, since individual level income data are difficult to access.

These alternative mortgage products may appeal to borrowers with high income volatility because they offer the ability to postpone the full interest and principal payment at times when borrowers' incomes are low, and to repay the interest and principal owed on the mortgages at a time when their incomes are high. Additionally, borrowers were qualified for the mortgage based on the low introductory monthly payments, allowing borrowers to qualify for larger mortgages than they may otherwise qualify.

[FIGURE 2 about here.]

In Figure 2 panels (c) and (d), I plot the fraction of alternative mortgage products originated, relative to all originations, in majority Black, Latino, and white zip codes.[13] Zip codes are defined as majority Black or Latino if they have above 30% of inhabitants identifying as the respective race and less than 70% of the zip code identifying as white. If a zip code is defined as Black, the fraction of the population identifying as Black is greater than the fraction of the population identifying as Latino, and vice versa. Zip codes with 30% of inhabitants identifying as either Black or Latino are close to the 90^{th} percentile of the minority distribution of zip codes. Zip codes with above 84% of inhabitants identifying as white are defined as majority white zip codes. 84% of inhabitants identifying as white is close to the median of the distribution of white inhabitants by zip code.

I find that the zip codes with more than 30% Black or Latino inhabitants received a disproportionately high fraction of alternative mortgages. This indicates that the likelihood of finding these alternative mortgages in areas with low income growth and high minority populations was higher than in areas with high income growth and a dominant white population. After 2005, the fraction of alternative mortgages[14] increased the most in Latino zip codes, the second most in white zip codes, and the third most in Black zip codes. I also find that the fraction of other alternative mortgage products, which feature initial low monthly payments that reset to higher payments, also increased the most for minority zip codes compared to white zip codes. This pattern is consistent with Rugh (2015)'s observation that Latino borrowers continued to receive alternative mortgages until just before the Global Financial Crisis, whereas white borrowers seemed to know that it was time to retreat from the mortgage market.

[13] I plot negative amortizing and interest only mortgages as a fraction of all originations in a zip code rather than the total number of these originations. Black and Latino households have lower homeownership rates than white households, thus plotting the fraction alternative mortgages better captures the disproportionate exposure that minority zip codes had to alternative mortgage products.

[14] Alternative mortgages include negative amortizing and interest only mortgages plotted in Figure 2 as well as other mortgage types shown later in regressions.

2.2 The Rise of Default Rates

Fact 3: *Early payment defaults and total defaults increased following 2005, and more than doubled their pre-2005 levels leading up to the Global Financial Crisis.*

Fact 4: *The increase in default rates was more prominent among borrowers with low rates of income growth and those in minority-dominant zip codes.*

In Figure 3 panel (a), I plot early payment defaults (EPD) from 2000 to 2008. Early payment defaults are reported using the Government Sponsored Entity (GSE) methodology, which flags whether a loan enters 90 day delinquency within the first 12 months since origination. [15] Historically, mortgages that are underwritten well are unlikely to default in the first year of origination (Mayer, Pence and Sherlund (2009)). Figure 3 shows that approximately 0.7% of loans in both the lowest and highest quartile of income growth experienced early payment default during 2000 to 2004. By 2007, this number more than tripled such that nearly 3.0% of loans originated entered early payment default. Following 2005, the early payment defaults increased at a faster rate for borrowers in the lowest quartile of income growth.

In panel (b), I plot the fraction of total defaults by income quartile. Total defaults also increased dramatically following 2005. The fraction of originated mortgages that defaulted by year of origination hovered around 6% of mortgages from 2000 to 2004. By 2007, this number almost quadrupled, such that nearly 30% of mortgages that were originated in 2007 defaulted. Both the highest and lowest income growth quartiles experienced growth in total defaults by origination year, however the lowest income growth quartile experienced the highest fraction of defaults even when the fraction of defaults peaked in 2006 and 2007.

In panel (c), I explore the fraction of early payment defaults experienced by majority Black, Latino, and white zip codes. Majority Black zip codes endured the largest growth in the fraction of loans that experienced early payment default post 2005. EPDs in Black zip codes hovered around 1.5% during 2000 to 2004, this number outpaced Latino and white zip codes in all years post-2005 and peaked in 2007 at almost 5% of originated loans experiencing early payment default in majority Black zip codes. In majority Latino zip codes, the percent of EPDs remained close to 1% of originations during 2000 to 2004 and peaked in 2007 at about 4.2% of originations. White zip codes experienced an average EPD rate of about 0.4% during 2000 to 2004 and their EPD rate peaked in 2007 with about 1.7% of mortgages

[15] Early payment defaults are reported using the Federal Housing Administration (FHA) methodology flags whether a loan enters 60 day delinquency within the first six months since origination. The FHA measure is consistent with the GSE measure.

originated in 2007 experiencing early payment default.

In panel (d), I explore the fraction of total defaults experienced by majority Black, Latino, and white zip codes. Similar to panel (b) this measure looks at the number of originations that ever experience a default by origination year.[16] This plot reveals that prior to 2005, majority Black zip codes experienced the highest levels of default, however following 2005, majority Latino zip codes outpaced majority Black zip codes and reached the highest levels of default. Prior to 2005, majority Black zip codes experienced default rates near 1.2%. Following 2005, the default rate for these zip codes averaged around 30% and peaked at about 36% in 2007. Prior to 2005, majority Latino zip codes experienced default rates near 0.6%, while following 2005, the default rate in these zip codes averaged around 32% and peaked in 2007 at close to 44%. Prior to 2005, majority white zip codes experienced a default rate close to 0.4%, while following 2005 the default rate in these zip codes averaged around 16% and peaked in 2006 at 2015.

[FIGURE 3 about here.]

3 Effect of BAPCPA on Collateral Reuse and Mortgage Lending

3.1 BAPCPA's Effect on Collateral Reuse

I hypothesize that by granting private-label mortgage collateral super senior creditor rights, BAPCPA increased the value of private-label mortgage collateral relative to agency collateral. To rigorously test this, I estimate a regression,[17] which compares the yields on the Bloomberg Barclays agency MBS index (LD10OAS) and the Bloomberg Barclays private-label MBS index (BNA10AS). I estimate the following regression specification:

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

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

[16] The final year in the performance data sample that I have is 2016. Therefore my measure indicates the fraction of loans that experience default in or before 2016.

[17] Replicated from the analysis in Figure 3 from Lewis (2023).

is set to zero in January 2005, as this was the month before BAPCPA was introduced in Congress in February 2005.

Figure 4 documents evidence consistent with the value of PLS increasing, relative to agency MBS. It shows that the yields on agency MBS decreased steeply 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 was likely due to the Republicans gaining seats in the November 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 4 about here.]

3.2 The Rise of Alternative Mortgages in a New Market

To investigate whether the empirical evidence is consistent with dealer-banks lending to a new market following BAPCPA, I use a treatment intensity difference-in-differences (DiD) research design. Market share of IMCs in 2004 is the treatment variable. The underlying assumption is that $IMCMktShr_{z,04}$ captures exposure to the credit supply shock because IMCs pass on increased funding for alternative products to borrowers at a faster rate than do banks (Lewis (2023)). IMCs were directly linked to dealers who were affected by BAPCPA via warehouse lines of credit. The variable $IMCMktShr_{z,04}$ captures the exposure of a zip code to the IMCs in 2004, the year prior to BAPCPA. This variable is calculated using the number of mortgage originations in the HMDA data:[18]

$$IMCMktShr_{z,04} = \frac{Number\ of\ originations\ by\ IMCs_{z,2004}}{Total\ number\ of\ all\ originations_{z,2004}}. \tag{3}$$

Figure 5 depicts IMC market share per zip code in 2004. The spacial 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 in 2003. The market share of IMCs was relatively stable throughout 2004, the year that I define treatment. To alleviate concerns that the results are driven by a pre-existing trend in IMC expansion, I examine pre-period home prices and include $state \times month$ and region fixed effects. I find no statistically significant difference in home prices in regions with high versus low IMC market

[18] I construct the 2004 IMC zip code 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.

share after controlling for *state* × *month* fixed effects. The pre-period balance in home prices helps to mitigate concerns that the treatment and control zip codes were significantly different in ways that varied with BAPCPA after controlling for fixed effects.

[FIGURE 5 about here.]

I study how $IMCMktShr_{z,04}$ affects zip code level mortgage characteristics. I estimate the following dynamic DiD regression. This regression estimates the differential effect that a high IMC market share has on mortgage originations and characteristics post-BAPCPA. The intuition behind this regression is that zip codes that are more exposed to IMC market share are more likely to be affected by the BAPCPA shock. If the mechanism behind this shock is indeed that dealer banks lower their interest rates in the primary market in response to a decrease in their cost of capital, then borrowers should enter from the extensive margin, or in other words new borrowers are entering the IMC mortgage market. The following analysis seeks to establish facts consistent with this mechanism.

This analysis acts as foundation for the later analyses that study distributional differences in the impact of these mortgages on different borrowers. It is the zip code level equivalent of the county level regression in Lewis (2023).[19] Relative to Lewis (2023), in this paper, I explore more deeply the composition of mortgage originations for additional alternative product types and study the type of borrowers who received them:

$$Y_{z,t} \quad = \quad \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMktShr_{z,04} \times \mathbb{1}_{t=T} + \epsilon_{z,t}. \tag{4}$$

Where $Y_{z,t}$ is $\log(PurchaseOriginations_{z,t})$, $\log(Balloon_{z,t})$, $\log(NegAm_{z,t})$, $\log(TwoStep_{z,t})$, $\log(Initial\ Interest\ Rate_{z,t})$, and $\log(AvgFICO_{z,t})$ in zip code z, at month t, log is the natural logarithm. [20] γ_z denotes zip level fixed effects, and $\eta_{s,t}$ denotes *state* × *month* fixed effects. $IMCMktShr_{z,04} \times \mathbb{1}_{t=T}$ 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 that measures the effect of a one unit increase in IMC market share on the dependent variable in each month relative to March 2005, the month prior to the passage of BAPCPA. Standard errors are clustered at the zip code level.

[19] In that paper, I use the regression to establish not only that the overall number of mortgage originations increased, but also that the composition of mortgages shifted toward alternative mortgages post-BAPCPA.

[20] While county level $\log(PurchaseOriginations)$, $FracBalloon$, $FracNegAm$, and $\log(Initial\ Interest\ Rate)$ were touched on in Lewis (2023), they are explored at the more granular zip code level here and $TwoStep_{z,t}$ and $AvgFICO_{z,t}$ are new to this analysis. I study these variables to establish that there is an overall increase in these variables at the zip code level. Later I will study these variables by different demographic groups to establish distributional differences in the effect of the credit supply increase.

I exploit a narrow window pre- and post-BAPCPA from November 1, 2004 to March 30, 2006 to help ensure that the post-period is a valid counterfactual for the pre-period. I report the regression results with *zip* fixed effects alone and with both *zip* and *state* × *month* fixed effects. The regression with both *zip* and *state* × *month* fixed effects is the preferred specification as it compares mortgage characteristics in zip codes with high versus low IMC market shares within the same state and month, absorbing state-month housing market effects. I 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 B, I 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.

Figure 6 reports the regression results. As shown in Figure 6 panel (a), the total number of purchase mortgage originations increased statistically significantly following BAPCPA for zip codes with high IMC exposure. These purchase originations first decrease and then begin to increase following the shock. This initial decrease is likely due to lenders transitioning into alternative products, which had not been originated as prolifically prior to BAPCPA. Figure 6 panel (b) shows that a 10% increase in IMC market share leads balloon originations to increase by 22%, panel (c) shows that the same increase in IMC market share leads negative amortizing originations to increase by 10.6%, and panel (d) shows that it leads two-step originations to increase by 16.6%. Two-step mortgages offered a fixed initial interest rate for an agreed-upon introductory period, typically for 5-7 years, and then reset once to a fixed rate at the prevailing market rate. Option ARM products are included in negative amortizing products since CoreLogic does not report Option ARMs separately.

Figure 6 panel (e) shows that a 10% increase in IMC market share in 2004 in a given zip code leads to a statistically significant 0.8% decrease, on average, in the introductory interest rate directly following BAPCPA. The actual interest rate that adjustable rate mortgages were pegged to was the twelve month Treasury rate. The Treasury rate was monotonically increasing during this time period, as the Federal Reserve was in a monetary tightening regime. The decrease in the initial interest rate is consistent with an increase in alternative products, which allow the borrower to pay an initial introductory payment that is less than the fully amortizing interest and principal payment accruing on the mortgage.

In Figure 6 panel (f), I plot the credit score at the zip code level pre- versus post-BAPCPA. I find that the credit score increased following the policy change in areas that

were more exposed to the IMCs. Prior to the policy change, there was no statistically significant increase in the credit score between more- versus less-treated zip codes. Following the policy change, a 10% increase in IMC market share led to a persistent 0.17% increase in credit score of new mortgage originations in the zip code. This increase in credit scores is consistent with an increase in mortgage originations from the extensive margin, as the model suggests, rather than the intensive margin. For IMCs, this could have been canabalizing FHA originations, and not be completely new borrowers who otherwise would not have received mortgages. This is because, 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. This is because originating multiple new purchase mortgages to the same borrower would increase the borrowers' leverage ratio and lower their credit score. Additionally, I find that refinance mortgages were falling over this time period, as were second home purchases. The increasing credit score is also consistent with the increase in alternative mortgage products with riskier amortization structures; lenders likely compensated for increased income volatility and low down-payments by increasing borrower credit scores on these products.

[FIGURE 6 about here.]

4 Effect on Borrowers by Demographic Groups

4.1 Low Income Growth (High Income Volatility) Borrowers

I test whether the mortgage originations following BAPCPA were concentrated among borrowers with relatively lower income growth, or higher income volatility. I measure income growth as the 2004 minus 2001 average estimated income, divided by the average estimated income in 2001. I use income growth to proxy for income volatility because income volatility and growth are highly negatively correlated with each other and individual level income data are difficult to access. By setting up a triple difference regression specification, I test for evidence consistent with BAPCPA driving an expansion of originations among borrowers with higher income volatility. I study whether areas with higher exposure to BAPCPA began originating differentially more alternative mortgages to high income variability borrowers post BAPCPA. I estimate the following specification:

$$
\begin{aligned}
Y_{z,t} &= \mu\ IMCMktShr_{z,04} \times Post_t \\
&+ \nu\ IMCMktShr_{z,04} \times IncGrowth_z + \tau\ IncGrowth_z \times Post_t \\
&+ \beta\ IMCMktShr_{z,04} \times IncGrowth_z \times Post_t \\
&+ \gamma_z + \eta_{s,t} + \epsilon_{z,t}. \qquad (5)
\end{aligned}
$$

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 and $Frac$ represents the fraction that a given mortgage product makes up of all mortgage originations in a region. For each zip code z in month t, $Originations_{z,t}$ is the total number of originations. The continuous treatment variable, $IMCMktShr_{z,04}$ 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. $IncGrowth_z$ is the income growth in a zip code from 2001 to 2004. β is the coefficient on the interaction term, $Post_t \times IMCMktShr_{z,04} \times IncGrowth_z$. 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. To put this in perspective, the double difference in Equation 4 measures, for a zip code that has 0% IMC market share, what effect on mortgage originations does moving to 100% IMC market share have post policy change relative to the effect that it has pre-BAPCPA. The triple difference measures what differential effect on mortgage originations does moving from 0% to 100% IMC market share, post- versus pre-shock, for high versus low levels of income growth. 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, zip codes that have a higher market share of IMCs should increase their alternative mortgage originations at a faster rate following BAPCPA relative to zip codes that have a higher market share of banks. Moreover, if the mechanism in the model holds, these mortgages will be disproportionately originated among higher- relative to lower-income-volatility zip codes. Thus the β coefficient on the triple interaction term should be negative since high income volatility is proxied for by low income growth. BAPCPA should drive a larger increase in mortgage originations in zip codes that have both a high IMC market share and low income growth.

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. The regression 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 level of lending may be different in high- relative to low-income growth areas such that BAPCPA may have changed the way that mortgage originators lend to these areas differentially. The insight of the reseearch design however is that the way banks lend to high- versus low-income growth areas pre- versus post-BAPCPA is an economic barometer for trends in lending. Therefore, the effect associated with IMCs over and above that associated with banks, captures the effect of increasing secondary market collateral value on primary market lending. The gap between IMC originations in high and low income growth zip codes relative to the same gap for bank originations in the pre-period informs the counterfactual level of IMC originations in the post period if BAPCPA never occurred. In other words, post-BAPCPA, IMC originations should equal the bank level of originations in the post-period plus the pre-period differential between banks and IMCs (in each type of income growth zip code). Any additional increase in IMC originations at each level of income growth, estimates the causal effect of BAPCPA for a zip code.

The results in Table 1 show that indeed more alternative products are originated in areas that have lower pre-period income growth, or higher income volatility. The fraction of negative amortizing, balloon, hybrid, and interest only originations increased statistically significantly in zip codes as pre-period income growth decreased. The results show that for a zip code with 100% market share of IMCs, post policy change, a 10% decrease in income growth would increase the fraction of negative amortizing originations by 1.08%, the fraction of balloon originations by 0.48%, the fraction of hybrid originations by 1.3%, and the fraction of interest only (IO) originations by 1.72%. The fraction of two-step originations also increased 0.13% more in zip codes with lower income growth, however not statistically significantly at the 95% level. The results also show that total mortgage originations increased as income growth increased, indicating that IMCs were also increasing mortgage originations in high income growth areas. However, in low income growth, or high income volatility, areas IMCs were disproportionately originating alternative mortgages, which gave borrowers artificially low initial mortgage payments.

Although the coefficients are not significant, following the increase in credit post-BAPCPA Table 2, in the appendix, also documents 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. The fraction of total ARM mortgages increases with an increase in income growth, consistent with a total increase in ARM mortgages in all zip codes post-policy

change.

[Table 1 about here.]

The results in Table 1 are consistent with the following mechanism: BAPCPA lowered dealer-banks' cost of capital in the secondary market for private-label mortgages and in response, dealer-banks decreased the primary market interest rate on these mortgages. The decreased mortgage payments in this market created a demand stimulation mechanism and led to more originations of Option ARM, or similar mortgages, in areas with low income growth (high income volatility).

The results suggest that low income growth, high income variability, borrowers are more likely to receive alternative mortgage products following the passage of BAPCPA. This is consistent with higher income volatility borrowers valuing products that offer the ability to delay principal and interest payments at a time when their income is low and repay the amount owed at a time when their income may be higher. Alternative mortgage products achieved this payment flexibility by lowering introductory monthly payments by delaying the fully amortizing principal and interest payments to a later point in the life of the loan. This made these products appear affordable at the peak of the housing boom when the Federal Reserve was raising interest rates and home prices were near peak, making fully amortizing mortgages very expensive.

4.2 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 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, I estimate a treatment intensity difference-in-differences regression design separately for majority Black, Latino, and white zip codes. The treatment intensity is measured as a zip code's exposure to IMC market share in 2004, the year prior to the shock, $IMCMktShr_{z,04}$. I estimate the same specification that I do in Equation 4, except that I run it separately by subgroups of zip codes categorized by race.

As discussed in Section 2, I define a zip code to be majority Black if 30% or more of its population identifies as Black in the census data, Latino if 30% or more identifies as Latino, and white if 84% or above identifies as white. If a zip code is defined as Black, the fraction of the population identifying as Black is greater than the fraction identifying as Latino, and vice versa. For the remainder of the paper, I refer to these zip codes as Black, Latino,

and white respectively. This measure is motivated by the theory of place-based clustering which establishes that people choose to live near other people like them (Logan and Molotch (2007); Charles (2003)). Once I identify the zip codes' race, I estimate the same difference-in-differences specification on each of these separate subgroups, following Curtis, Garrett, Ohrn, Roberts and Serrato (2021).

The econometric design studies mortgage originations pre- versus post-BAPCPA as the first difference and across zip codes with high- versus low-IMC market share as the second difference. This analysis studies whether originations for certain mortgage products follow different trends post policy change for white versus Black and Latino zip codes. I control for both zip code and state × month fixed effects. This allows me to compare zip codes within the same state and month pre- versus post-policy change, to control for differential trends in the housing market. Using Latino zip codes as an example, 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 pre-BAPCPA, 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 potential differences in lending trends across zip codes absent a credit supply 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. I define the percent race of a zip code to be:

$$\%RACE_z = \frac{Number\ of\ RACE\ inhabitants_z}{Total\ number\ of\ inhabitants_z}. \tag{6}$$

Figure 7 contains a U.S. heat map that documents, for each zip code, the proportion of Black inhabitants in panel (a), the proportion of Latino inhabitants in panel (b), and the proportion of white inhabitants in panel (c).

[Figure 7 about here.]

By estimating a difference-in-differences regression separately in Black, Latino, and white zip codes, I study how originations in high-IMC areas responded to BAPCPA relative to originations in low-IMC areas. I then compare the effect of BAPCPA in Black areas to the effect in white zip codes and repeat the comparison for Latino relative to white zip codes. Since BAPCPA created a credit supply increase that affected IMCs more than banks, I expect zip codes with a higher proportion of IMCs to increase their mortgage originations by more than zip codes 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, I expect to see more alternative products originated in these zip codes, since BAPCPA increased collateral value for these alternative products. Thus, I should see larger DiD coefficients in Latino zip codes relative to white zip codes post BAPCPA. This regression specification tests precisely this – whether IMCs have a larger origination response in Latino zip codes relative to white zip codes overall and for certain mortgage product types.

Measuring the difference between non-IMC originations and IMC originations in the pre-period constructs a counterfactual world – one where BAPCPA has no effect on IMC originations. The difference-in-differences specification measures the average non-IMC originations in the post-period and layers on the pre-period difference between bank and IMC originations. The coefficients in the post period measure the additional effect on mortgage originations that is associated with IMC market share, over and above this counterfactual. Positive and significant coefficients are consistent with IMCs increasing their credit supply post-BAPCPA.

The difference-in-differences specification controls for pre-existing differences in IMC lending relative to non-IMC lending separately in Black, Latino, and white zip codes. The assumption is that absent BAPCPA, the IMCs would have continued to lend in the same way that they had prior to the policy change. Thus the regression estimates the pre-period difference in trends between IMC and non-IMC zip codes. It then uses the control group, non-IMC lending, which was not affected by the policy change, to approximate the post-period effect on mortgage origination trends. The null result expects that in the post-period, the IMC zip codes will maintain their pre-period difference in trend, relative to the pre-period non-IMC zip codes. Thus, taking the difference in trends post-BAPCPA relative to the difference pre-BAPCPA, the design highlights the additional effect on IMC zip codes, caused by BAPCPA. This design removes the pre-period mean of lending, as well as the post-period counterfactual lending. Post policy change, if I 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.

The regression coefficients for Black and Latino zip codes are each plotted relative to the regression for white zip codes. Comparing Black and Latino coefficients to the line for white borrowers yields the same coefficient as a triple difference regression specification that interacts race with IMC market share and Post. For example, the design tests whether IMCs' increased credit supply caused a larger mortgage origination response in Latino zip codes relative to white zip codes. For each racial subgroup, the regression controls for the trends in the pre-period and estimates the differential effect of treatment in the post-period relative

to the pre-period. The null hypothesis is that zip codes with different racial makeups were affected by BAPCPA in the same way. If the null holds, I would expect to see no differential increase (decrease) in mortgage lending by the IMCs in areas with different racial makeup. However, a larger effect for Latino zip codes, for example, would be consistent with Latino borrowers receiving more alternative 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 high income volatility borrowers who were disproportionately represented among minority borrowers.

I estimate the difference-in-differences specification in Equation 4 which compares zip codes with high- versus low-market share of IMCs in 2004 pre- versus post-policy change, by racial subgroup. Where, for each zip code z, in month t, $Y_{z,t}$ is $\log(Originations_{z,t})$, $\log(Balloon_{z,t})$, $\log(NegAm_{z,t})$, $\log(TwoStep_{z,t})$, $\log(CreditScore_{z,t})$, and $\log(FullDoc_{z,t})$. log is the natural logarithm of a number. The continuous treatment variable, $IMCMktShr_{z,04}$ is the market share of IMCs in a zip code z in 2004. $IMCMktShr_{z,04} \times \mathbb{1}_{t=T}$ is the interaction term between the market share variable and an indicator variable for month of origination. 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 8 about here.]

Figure 8 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. In other words, Black areas with high IMC market share receive fewer mortgages relative to Black low-IMC zip codes post-BAPCPA than they received prior to BAPCPA, and this pattern is opposite for white and Latino households.

To understand whether the increase in originations in white and Latino zip codes was driven by alternative mortgage products and whether these products played a role in the disproportionate effect of BAPCPA by racial subgroup, I plot Figure 8 with balloon (panel (b)), negative amortizing (panel (c)) and two step mortgages (panel (d)) as outcome variables.

The insight of the 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 that their initial mortgage payments were typically lower than those on a fully amortizing mortgage. This introductory mortgage payment would reset, usually to a much higher payment.

Following BAPCPA, I see a disproportionate increase in originations of alternative products in minority zip codes. Figure 8 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. I 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 than those for white zip codes. This t-test tests whether the difference between either Black or Latino relative to white zip codes is statistically significantly higher post policy change relative to pre-policy change. It is equivalent to a triple difference research design and it tests whether there was a disproportionate increase of alternative products in minority zip codes. The panels in Figure 8 establish that all subgroups' mortgage originations had pre-period parallel trends and they all responded at the same time to BAPCPA. Thus, this research design establishes that pre-period distributional shifts in a subgroup's mortgage originations are not driving the results following BAPCPA.

Similarly, relative to the pre-period, a 10% increase in IMC market share leads to statistically significant increases in negative amortizing mortgages of 10.4% for white zip codes, 9.9% for Black zip codes, and 21.5% for Latino zip codes. Relative to white zip codes, the increase in negative amortizing mortgages in Latino zip codes is significantly higher while the increase in Black zip codes is not statistically different. I also study two step mortgages which increased statistically significantly by 28.8% for Latino zip codes and this number is statistically different from the 1.6% increase that white zip codes experienced. I find a statistically significant increase in two step mortgages for Latino zip codes. However, I do not find a statistically significant increase in white or Black zip codes post BAPCPA.

The results document that IMCs disproportionately increase originations of alternate mortgage products in minority zip codes following BAPCPA.

[Figure 9 about here.]

To study borrower characteristics pre- and post-BAPCPA, I estimate the specification

in Equation 4 with $\log(FullDoc_{z,t})$ as an outcome variable, separately by racial group. Full documentation mortgages are mortgages originated with fully documented income and assets. Borrowers with high income volatility may find it difficult to meet full documentation requirements. I plot the results in Figure 9 panel (a). Prior to the policy change, there was no statistically significant change in full documentation mortgages between more- versus less-treated zip codes for any subgroup. I find that post policy change, a 10% increase in IMC market share led to a 0.95% increase in full documentation mortgages for white zip codes and 3.9% decrease in full documentation mortgages for Black zip codes. These results are statistically significantly different from each other, while there is no statistically significant difference between white and Latino zip codes in the post-period. These results are consistent with borrowers receiving disproportionately fewer full documentation mortgages in Black zip codes relative to white zip codes and with alternative mortgages targeting borrowers with high income volatility following BAPCPA.

I also estimate Equation 4 with $\log(CreditScore_{z,t})$ as an outcome variable, separately by racial group. I plot the results in Figure 9 panel (b). Prior to the policy change, there was no statistically significant increase in credit scores between more- versus less-treated zip codes for any subgroup. I find that post policy change, credit scores for each racial subgroup increase statistically significantly. A 10% increase in IMC market share in the pre-period leads to a significant increase of 0.16% for white zip codes, 0.35% for Black zip codes, and 0.24% for Latino zip codes. Following the BAPCPA, credit scores for Latino zip codes increase statistically significantly more than those for white zip codes. As discussed regarding Figure 6 panel (f), this result is consistent with borrowers entering from the extensive margin. Since second home purchases and refinancing are decreasing during this time period and taking on additional debt would decrease credit scores rather than increase them. This result indicates that borrowers who receive a purchase mortgage on their first home have disproportionately higher credit scores in areas with higher IMC market share post policy change. This effect is disproportionately pronounced for Latino zip codes and is also consistent with lenders attempting to compensate for the increased risk of alternative amortization structures and lack of full documentation by requiring higher credit scores.

In order to study the consequences of these alternative mortgage products to borrowers, I study early payment default and total loan default following the policy change. To define early payment default, EPD_i, I utilize the Federal Housing Administration'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, I create an indicator variable, $Defaulted\ Loan_i$, 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. I run the following regression which is the loan level version of Equation 4.

$$Y_i = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMktShr_{z,04} \times \mathbb{1}_{t=T} + \epsilon_i. \tag{7}$$

Where Y_i is EPD_i and $Defaulted\ Loan_i$. I estimate this regression separately by racial subgroup and standard errors are clustered at zip code level. Studying early payment default (EPD_i), I find that a 10% increase in IMC market share in the pre-period leads to a 0.2 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 experienced a 0.1 percentage point increase in early payment default for an equivalent increase in pre-period IMC market share. Studying total loan default, I 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 larger than the 1.6 percentage point increase in total default that Black zip codes and white zip codes exhibit for the same increase in pre-period treatment.

[FIGURE 10 about here.]

Combined with the results for full documentation originations, the default 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. The defaults were concentrated in zip codes with higher income-volatility because these mortgages had very risky amortization structures. The ability to repay them was based on their artificially low initial monthly payments, and sufficiently high future income, but without lender verification of the reasonableness of the assumption of high future income.

5 Payment Shocks

To establish the effect of IMC origination policy on borrowers, I study mortgage payment shocks. I define a payment shock to be a mortgage payment reset that is 10% or higher above the initial mortgage payment. I estimate the following regression specification:

$$PayShock_l = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCoriginator_l \times \mathbb{1}_{t=T} + \Gamma_l + \epsilon_l \tag{8}$$

Where $PayShock_l$ is an indicator variable set equal to one if a loan experiences an increase in its mortgage payment of 10% or more at the time of the first mortgage payment reset. The dataset is limited to all loans that experience a mortgage reset and I calculate the payment shock measure at the date of the first reset. The regression is estimated at the loan level using CoreLogic Non-Agency Residential Mortgage Backed Securities data. $IMCoriginator_l$ is an indicator variable equal to one if a loan is originated by an independent mortgage company.[21] Γ_l represents control variables that are comprised of credit score, debt-to-income ratio (DTI), loan-to-value ratio (LTV), Original Balance, Origination Year, Product Type and Loan Age at Reset. This regression setting studies mortgages with similar borrower characteristics, product types, origination date, and origination balance and studies the differential effect that being originated by an IMC has on whether a mortgage experiences payment shock.

The regression results in Figure 11 panel (a) indicate that mortgages originated by an IMC are nearly 10% more likely to experience pay shocks relative to mortgages not originated by an IMC on average in the post period. The timing of the pay shock-likelihood-increase is important. It begins in November 2005 and becomes increasingly common through October 2006. November 2005 is seven months after BAPCPA's passage. This is noteworthy since BAPCPA occurred in April 2005 and relaxed mortgage company credit constraints almost immediately, the IMCs could originate alternative products immediately and en masse. Since alternative mortgage products have reset dates that cluster around 6 months, 12 months, and 24 months[22] the results are consistent with pay shocks occurring when mortgage rate resets began, approximately six months following BAPCPA. These results are consistent with a sudden onset of IMC originations of alternative products, with artificially lower mortgage payments beginning in May of 2005, directly following BAPCPA. Thus the reset dates on these mortgage products would be clustered in time and in correlated demographic and geographic regions.[23] The pay shock results are also economically significant in magnitude. For example, Fuster and Willen (2017) find that changes in payment size have a large effect

[21] Independent mortgage companies are identified in the CoreLogic NARMBS data by merging the NARMBS data with the HMDA data using a name match. The name match is designed to do two things. First, it keeps the top five ranked matches, second it matches origination year to the year an originator is seen active in the Avery crosswalk.

[22] Close to 4% of loans with a payment reset have the first reset within 6 months, 16% within one year, and 20% withing two years.

[23] Geographic regions because as the demographic analysis supports, different racial groups were more populated in certain zip codes.

on default rates - reducing the payment size by 50% decreases the default rate by 55%.

I then limit the sample to zip codes that are categorized as majority Black, Latino, and white. I estimate the regression separately by racial subgroup. In panel (b) and (c), I compare the majority Black, Hispanic, and white zip codes. I plot the dynamic DiD coefficients for both BLK and LTN subgroups relative to the WHT subgroup to depict the response of payment shocks in each zip code relative to majority white zip codes. I find that, on average in the post-period, majority white zip codes experience a significant 7% increase in likelihood of experiencing a payment shock of 10% or larger when their mortgage payment resets. The average increase in payment shock likelihood for majority Black zip codes in the post period is not statistically significant, however, it is also on an increasing trend. In panel (c), I plot the effect for majority Latino zip codes relative to majority white zip codes and find that Majority Latino zip codes are a significant 8.4% more likely to experience a payment shock in the post period.

[FIGURE 11 about here.]

6 Model

6.1 Model Set-up

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

I assume here that the market for Private-Label mortgages mainly reflects Alternate-A product mortgages, as I seek to explain the increase in Alt-A mortgage products following BAPCPA. I 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. I 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).

I shut down frictions between the dealer and the IMC. The model investigates how the shock to dealer cost of capital caused by BAPCPA is passed on to households and assumes that the shock is frictionlessly passed from the dealers to the IMCs that they fund. In the context of the model, IMCs can be thought of as originating mortgages on behalf of those

dealers. Thus I call the dealers in the model "dealer-banks" to denote that they function both as dealers operating in the repo market as well as mortgage originators.

I 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}. I 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 $r \geq 0$)

$$u = v(h) - \frac{1}{\theta}(1 + r^{PL})M \times h, \quad h \in \{0,1\}. \tag{9}$$

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. I 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. I 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 repay the mortgage payment.

$$\theta \sim F \ \text{ on } \ [\underline{\theta}, \overline{\theta}] \tag{10}$$

Borrowers choose $h = 1$ if

$$v(1) - \frac{1}{\theta}(1 + r^{PL})M > v(0) \tag{11}$$

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. I 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 mort-

gage. 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:

$$u = (1 + r^{PL})(1 + c^{PL})M - pM = 0 \tag{12}$$

6.2 Model Results

The lender's break even condition gives:

$$r^{PL} = \frac{p}{1 + c^{PL}} - 1 \tag{13}$$

The main result follows from this break even condition:

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

$$\frac{\partial r^{PL}}{\partial c^{PL}} < 0 \tag{14}$$

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

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

$$\theta^*(r^{PL*}) = \frac{(1 + r^{PL*})M}{v(1) - v(0)}. \tag{15}$$

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 I denote by r^{PL*}.

$$r^{PL*} := \frac{\theta^*(v(1) - v(0))}{M} - 1 \tag{16}$$

I 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. I can see this from Equation 16. 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. I can see this by combining Equation 13 and Equation 16:

$$\theta^*(r^{PL*}) = \frac{(1 + r^{PL})M}{v(1) - v(0)} = \frac{p}{1 + c^{PL}} \times \frac{M}{v(1) - v(0)}. \tag{17}$$

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.

7 Discussion

The model implies that when the value of private-label MBS rises in the secondary market relative to the value agency MBS, the value of dealer-bank's outside option (agency MBS) falls. When this happens, the distribution of surplus, which is split between borrower and

lender, changes in the primary market. In other words, the dealer-bank receives less of the surplus when bargaining with the borrower. This manifests itself through the dealer-bank lowering the interest rate that it sets for borrowers in the primary market. The interest rate that dealers set could fall below borrowers' reservation price if the value of PLS collateral increased high enough. An interest rate below the borrowers' reservation price could create a demand stimulating mechanism that leads new borrowers to enter the market. This may appear as if the dealer is entering a new market, a market for private-label mortgages. However, the market may have always existed and the optimal product in the market may have always been an option-ARM, it may have simply been the case that the interest rate that would have been charged in this market was higher than borrowers' reservation price.

When the new market, created by lowering the interest rate below the borrower reservation price, has variable income and low net worth, Piskorski and Tchistyi (2010) finds that the optimal contract structure takes the form of an option ARM, which offers the option to pay the fully amortizing principal and interest, only the interest payment, or a minimum amount that does not even cover the interest. They also find that mortgage contracts which simplify the terms of the option ARM contract have little loss in efficiency. Thus, in this paper, I study balloon, negative amortizing (which includes option ARMs), interest only, hybrid, and two step mortgages to capture these option ARM and similar contracts. These products all feature artificially low mortgage payments early in the life of the loan and then reset to much higher payments. In the theory, these mortgages are optimal for high income volatility borrowers because they allow borrowers to delay mortgage payments when their income may be low and repay them at a later date when their income may be higher. However, in practice, these mortgages added any unpaid interest to the principal balance owed on the mortgages, which increased the balance owed instead of decreasing it, as a traditional mortgage does.

Given that the Piskorski and Tchistyi (2010) paper finds that the optimal product in a market for high income volatility borrowers is an option-ARM (or similar product), then if BAPCPA indeed lowers the cost of capital for these products in the secondary market, we should see an expansion of them in the primary market. The empiricial results support this prediction. The decrease in the introductory interest rate offered on mortgages with adjustable rate structures (balloon ARM, negative amortizing (Option ARM), two step, etc.) is also consistent with the model's prediction.

The model in this paper follows Piskorski and Tchistyi (2010) and assumes that the optimal product for borrowers with higher income volatility is an Option ARM or similar mortgage. The mechanism present in the model is that the Option-ARM mortgage is always optimal in the market for high income volatility borrowers. Once BAPCPA lowers dealer-

banks' cost of capital for these products, they lower the interest rate they charge on the products in the primary market. Under the assumption that the pre-period interest rate charged on these products was above borrowers' reservation price, and the post-period rate falls below borrowers' reservation price, we should see an increase of mortgage originations among borrowers with higher income volatility.

Additionally, if a higher fraction of minorities have higher income variability, consistent with Morduch et al. (2018), there should be a disproportionate expansion of alternative mortgages in minority zip codes. Thus, the results are consistent with BAPCPA lowering dealer-banks' cost of funding for alternative mortgage products, which were optimal for higher income volatility borrowers, resulting in minority borrowers disproportionately increasing their borrowing using alternative amortization structure products. These results also provide a potential explanation for the question posed in Rugh (2015) of why white borrowers were backing out of the housing market during the late 2000s while Latinos kept borrowing.

8 Conclusion

I create a stylized model and show that when the lender's cost of capital decreases in the secondary market, it leads the lender to lower the interest rates that it charges in the primary market, creating a demand stimulating mechanism that enables expansion in a new market. The optimal contract in this new market features an alternative amortization structure that allows borrowers to delay repayment of the mortgage. Borrowers with higher income variability and lower income levels, relative to the price of the home, receive larger utility gains from these products. I map this model to BAPCPA's strengthening of creditor rights on private-label mortgage collateral in April 2005. The model yields several testable implications, which allows me to establish that in response to BAPCPA, lenders increased their originations of alternative mortgage products, consistent with an expansion into a new market. Post-BAPCPA, I find that minority borrowers receive disproportionately more alternative mortgages and suffer the brunt of mortgage defaults during the GFC.

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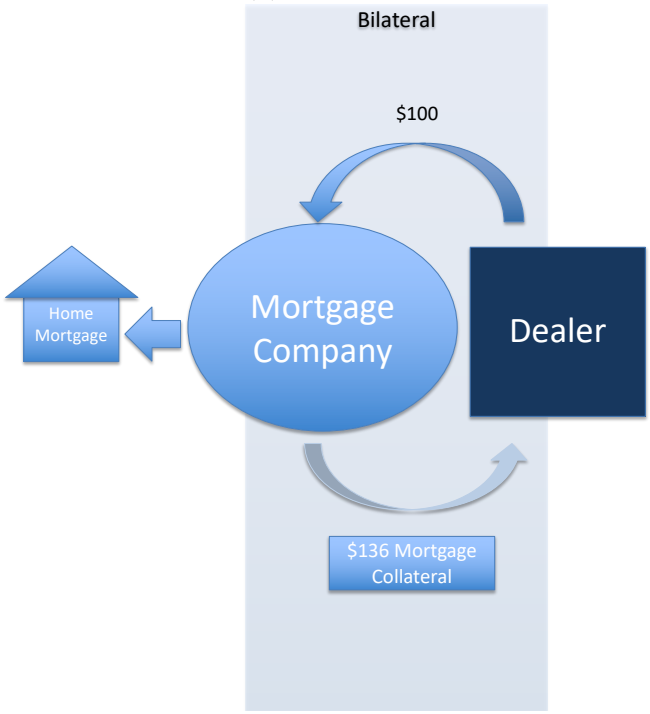
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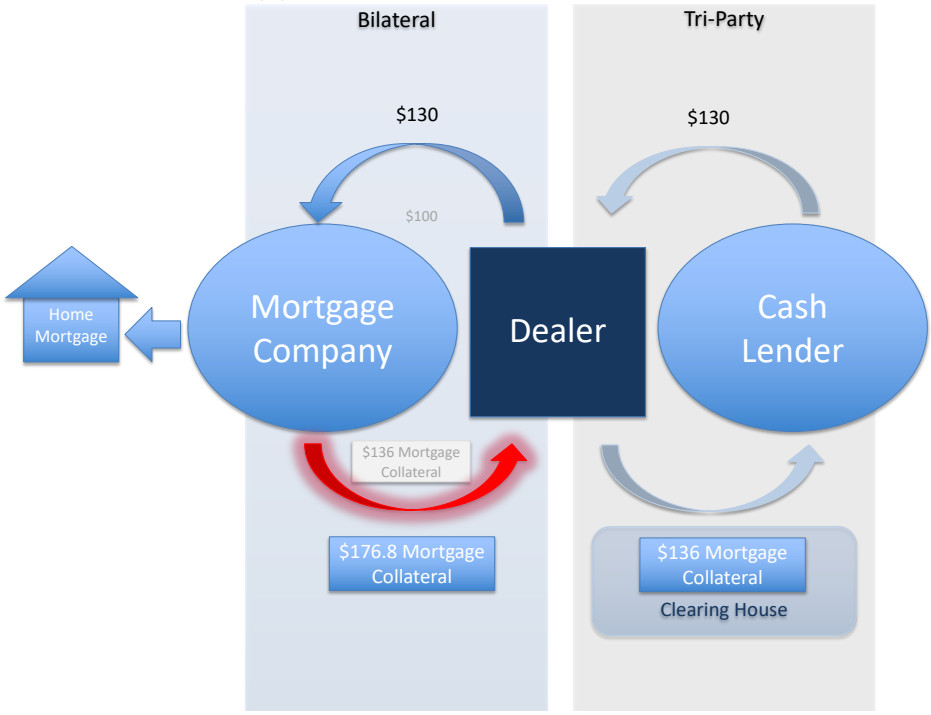
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FIGURE 1: REPO MARKETS BEFORE AND AFTER BAPCPA 2005

(a) Repo markets before BAPCPA

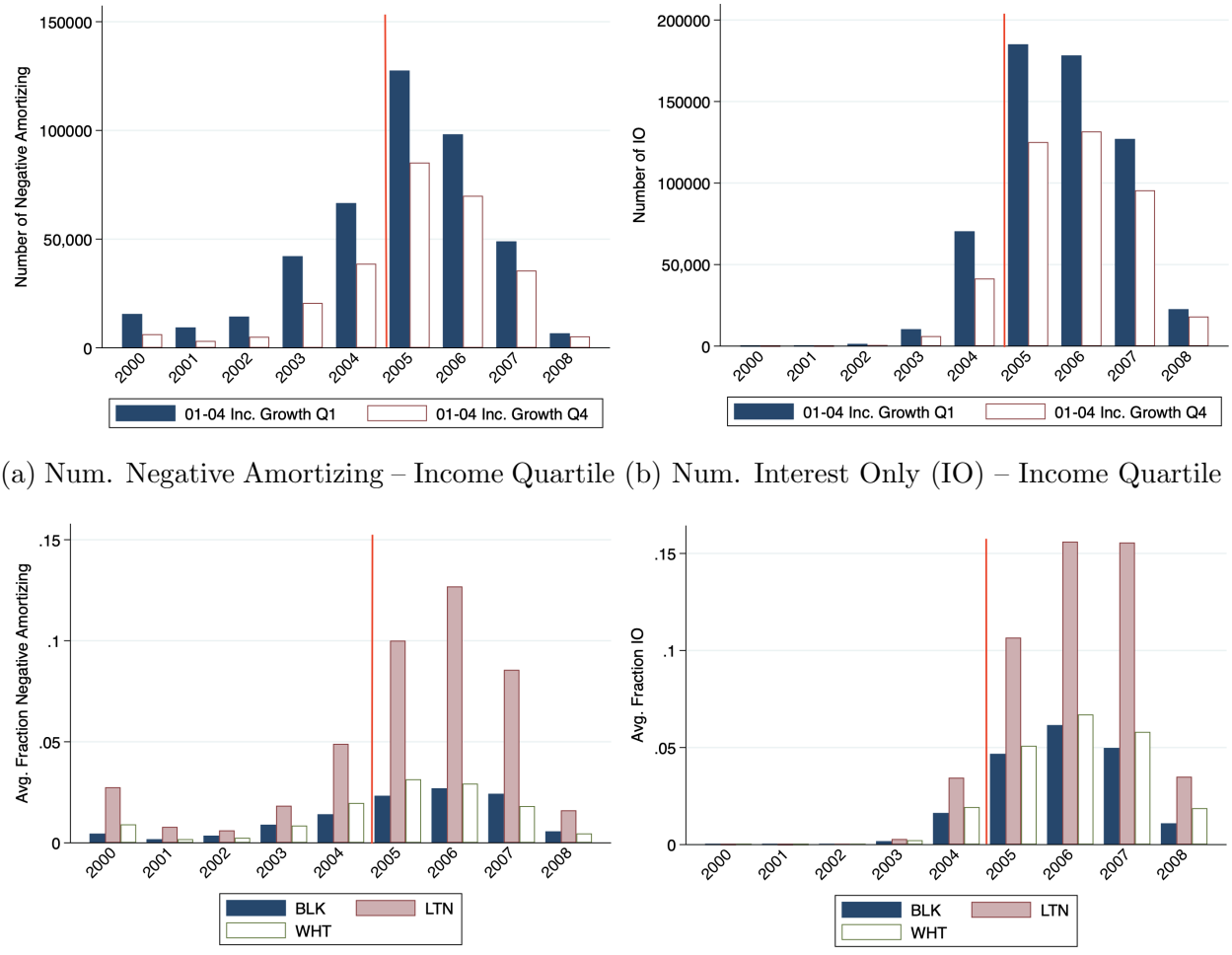


(b) Repo markets after BAPCPA



Notes: Figures depict the process by which a dealer can borrow and lend funds via the tri-party and bilateral repurchase market respectively, using the same underlying private-label mortgage collateral provided by the cash borrower for both contracts. Figure (a) depicts the "first round" of lending from the dealer to the IMC before BAPCPA and Figure (b) depicts the proposed "second round" of lending enabled by BAPCPA.

FIGURE 2: MORTGAGE PRODUCTS BY ZIP CODE INCOME QUARTILE AND RACE

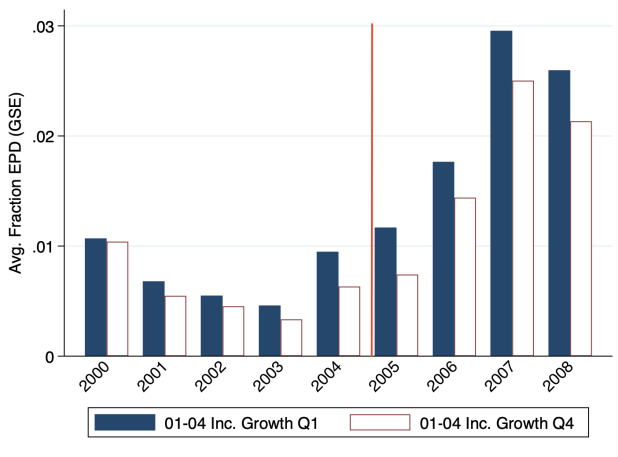


(a) Num. Negative Amortizing – Income Quartile (b) Num. Interest Only (IO) – Income Quartile

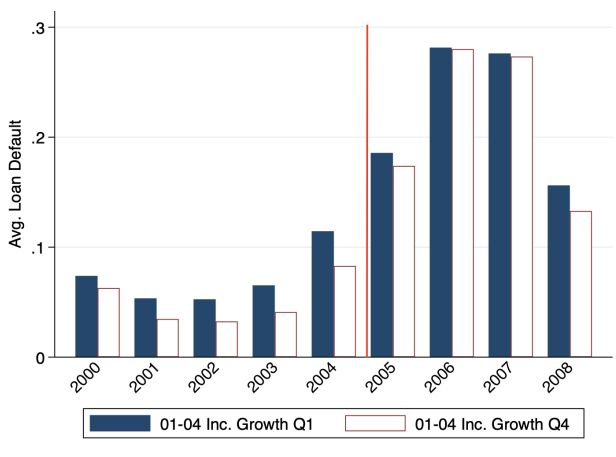
(c) Frac. Negative Amortizing – Race (d) Frac. Interest Only (IO) – Race

Notes: The figure depicts mortgage originations by product type. Panels (a) and (b) depict the total number of mortgages originated each year for a given product type in zip codes that are in the bottom quartile of 2001 to 2004 income growth (Q1) and the top quartile of 2001 to 2004 income growth (Q4). Panels (c) and (d) depict the fraction of mortgages originated each year for a given product type in zip codes that are above 30% Black, above 30% Latino, and above 84% white.

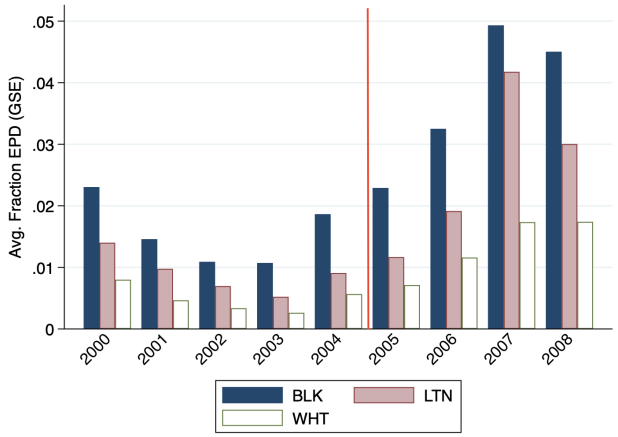
FIGURE 3: MORTGAGE DEFAULTS BY ZIP CODE INCOME QUARTILE AND RACE



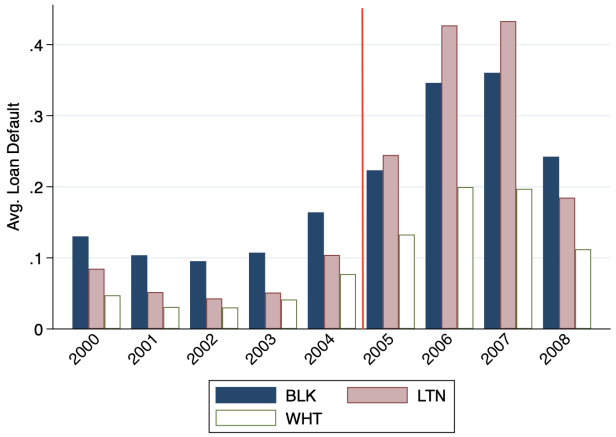
(a) EPD (GSE Measure) – By Income Quartile



(b) Total Defaults – By Income Quartile



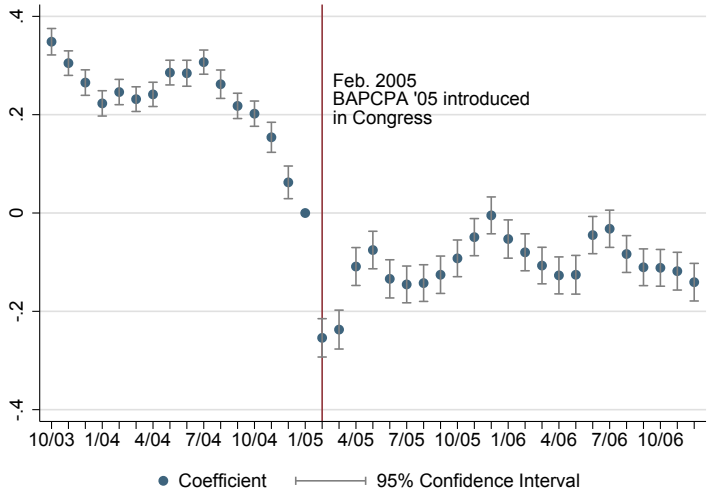
(c) EPD (GSE Measure) – By Race



(d) Total Defaults – By Race

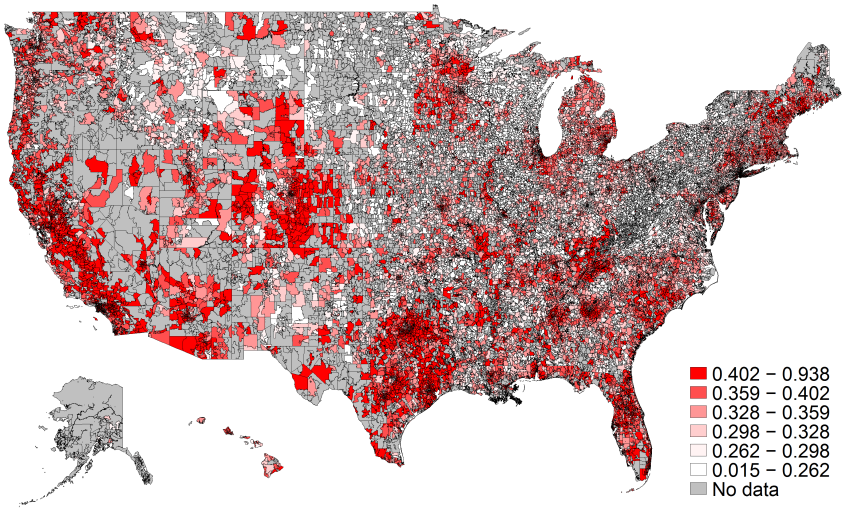
Notes: The figure depicts the fraction of Early Payment Defaults (EPD) and total defaults by year of mortgage origination. The figure depicts the fraction of defaults for the lowest quartile of income growth between 2001 to 2004 (Q1) and the highest quartile of income growth between 2001 to 2004 (Q4) in panels (a) and (b). In panels (c) and (d) the figure depicts the fraction of defaults in zip codes that are above 30% Black, above 30% Latino, and above 84% white.

Figure 4: Private-Label vs. Agency MBS Yields



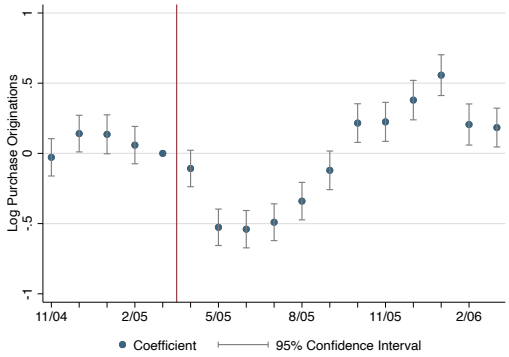
Notes: Figure plots the dynamic response of private-label MBS relative to agency MBS yields pre vs. post the introduction of BAPCPA 2005 in Congress on February 1, 2005. I estimate Equation 2. β_T is the coefficient of interest. It is the coefficient on the indicator variable that interacts the indicator 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 5: Independent Mortgage Company (IMC) Market Share

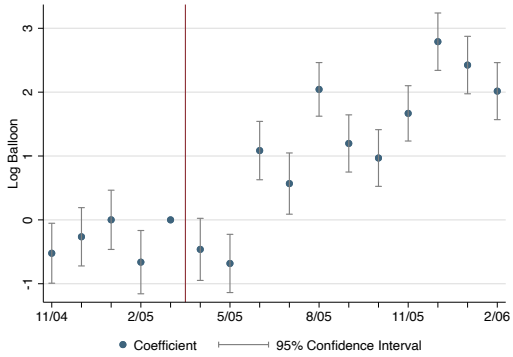


Notes: The figure depicts the zip code level market share of all IMCs reported in 2004. The market shares are calculated using the 2004 HMDA data.

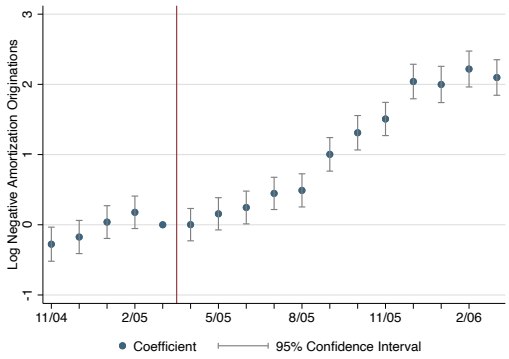
FIGURE 6: ZIP IMC MARKET SHARE EFFECT ON MORTGAGE ORIGINATIONS



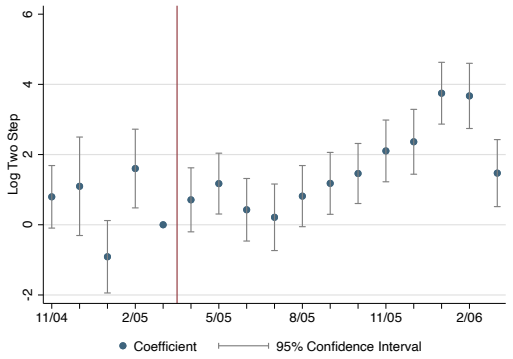
(a) Total Purchase Originations



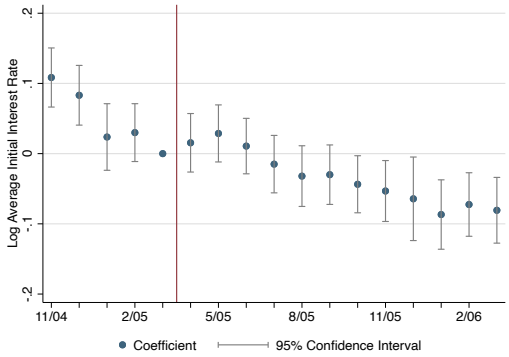
(b) Balloon Originations



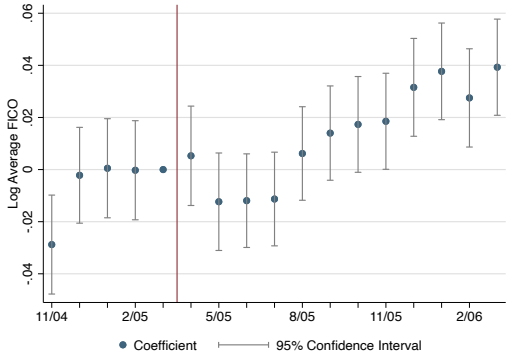
(c) Negative Amortizing Originations



(d) Two Step Originations



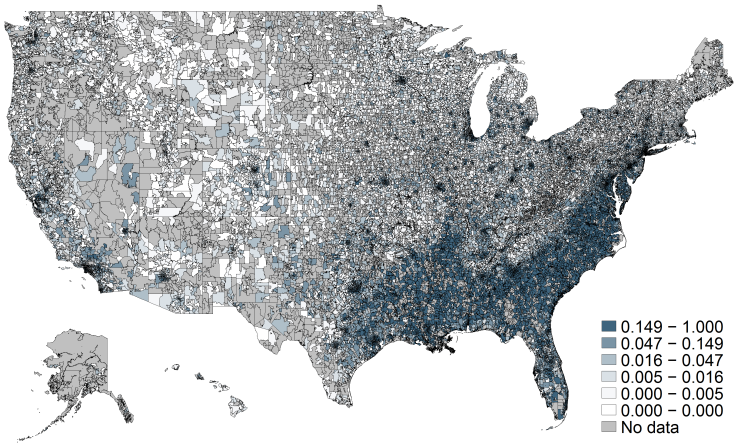
(e) Initial Interest Rate



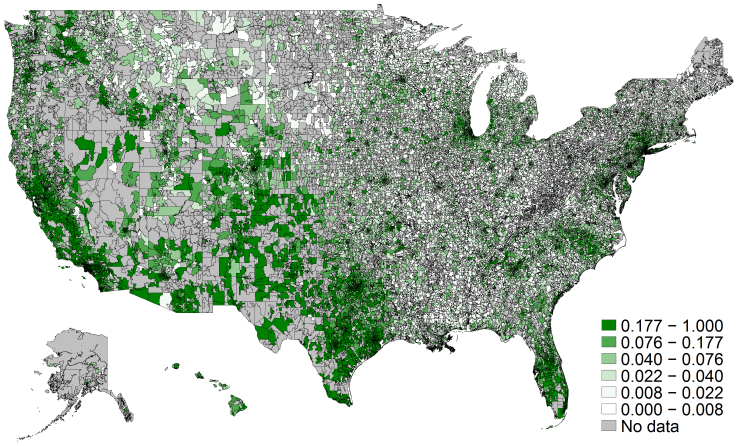
(f) Average Credit Score

Notes: Figure plots the dynamic response of the dependent variable to the 2004 market share of independent mortgage companies (IMCs) in a zip code. I estimate Equation 4. β_T is the coefficient on the indicator variable that interacts $IMCMktShr_{z,04}$ with an indicator for each month pre and post the shock. I use the public HMDA data to compute the 2004 zip code level IMC market share and CoreLogic data to study originations. The figure indicates that following BAPCPA, regions more exposed to the policy change significantly increased the number of mortgages that they originated and shifted toward alternative mortgage products relative to less exposed regions.

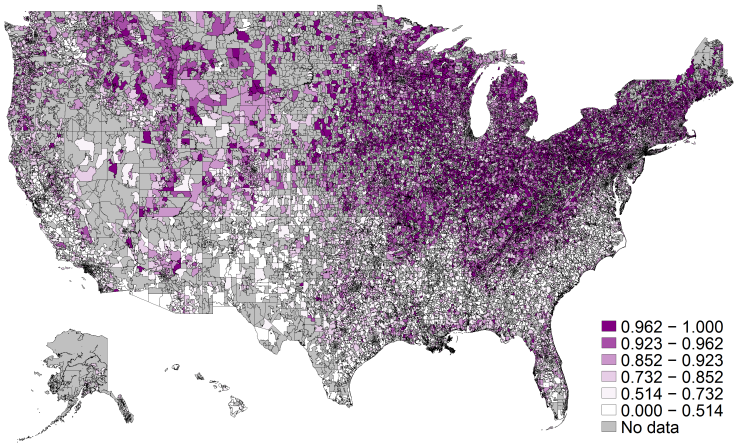
Figure 7: Population by Race



(a) Population of Black Inhabitants



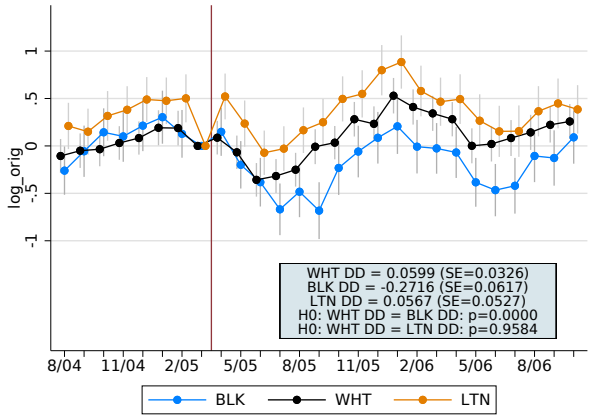
(b) Population of Latino Inhabitants



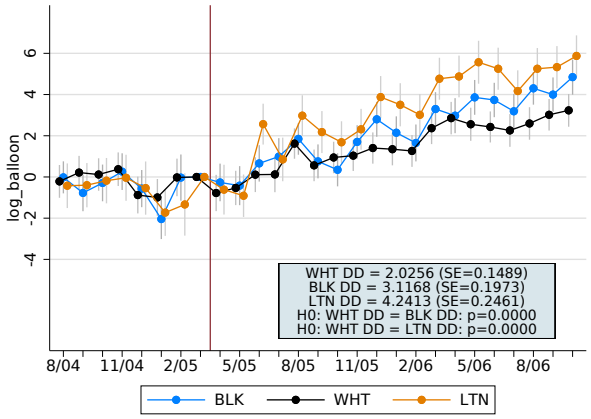
(c) Population of white Inhabitants

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.

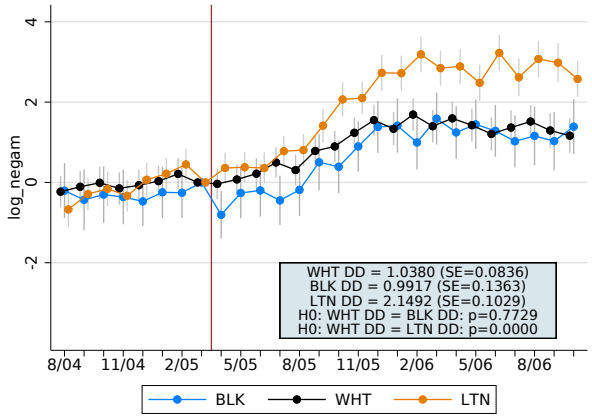
FIGURE 8: DIFFERENCE-IN-DIFFERENCES (DID) BY RACE SUBCATEGORIES - ORIGINATIONS & MORTGAGE PRODUCTS



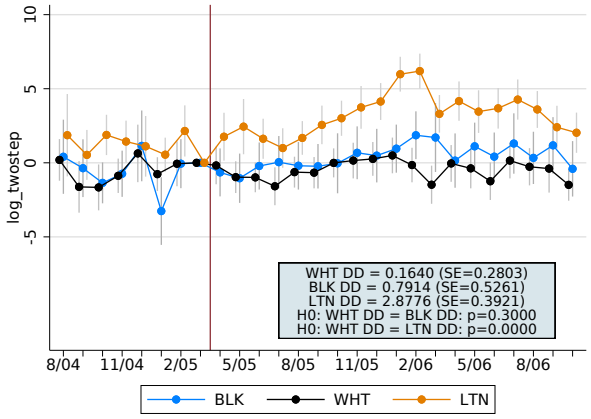
(a) Originations



(b) Balloon



(c) Negative Amortizing

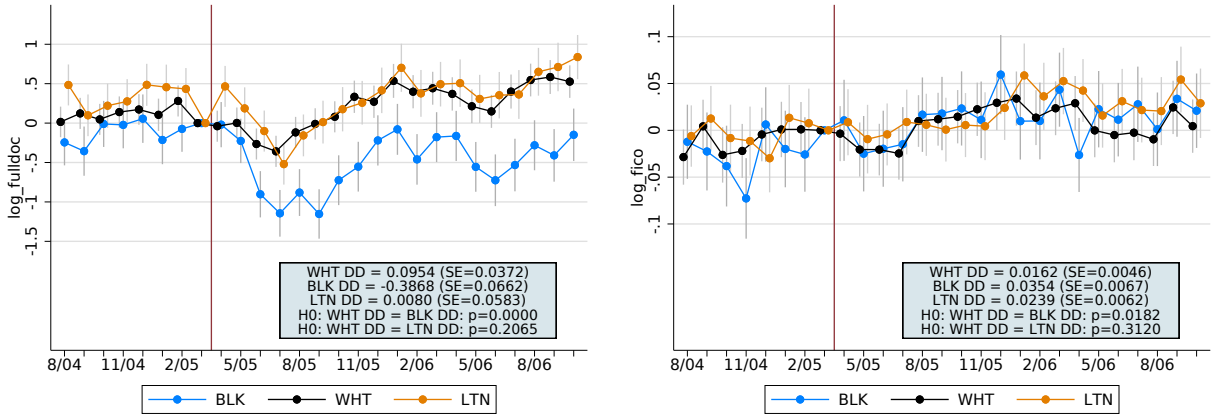


(d) Two Step

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

$$Y_{z,t} = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMktShr_{z,04} \times \mathbb{1}_{t=T} + \epsilon_{z,t}. \tag{18}$$

Figure 9: Difference-in-Differences (DiD) by Race Subcategories - Borrower Characteristics

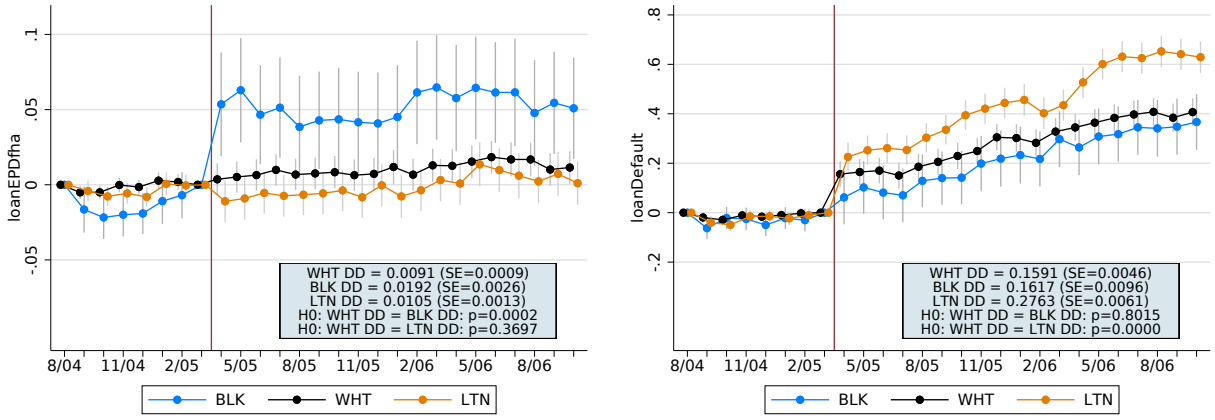


(a) Full Documentation (b) Credit Score

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

$$Y_{z,t} = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMktShr_{z,04} \times \mathbb{1}_{t=T} + \epsilon_{z,t}. \tag{19}$$

Figure 10: Difference-in-Differences (DiD) by Race Subcategories - Default

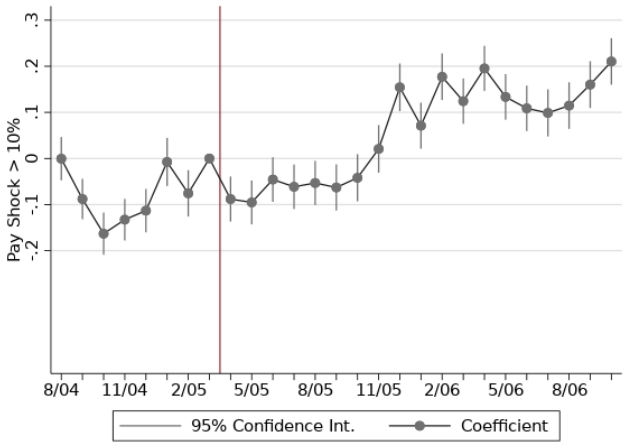


(a) Early Payment Default (b) Total Default

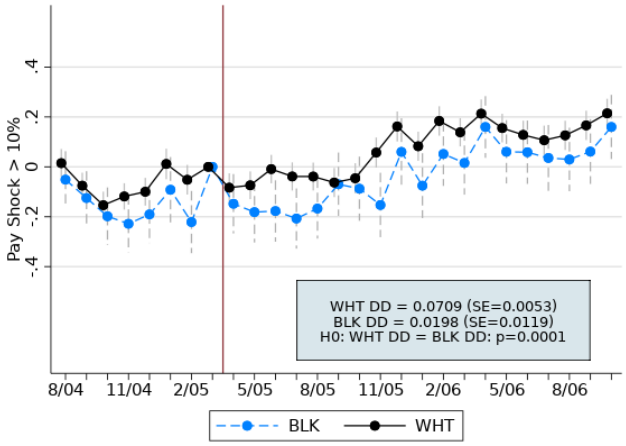
Notes: Figure plots the dynamic response of the coefficient of interest β_T from Equation 8 by race subcategory.

$$Y_i = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMktShr_{z,04} \times \mathbb{1}_{t=T} + \epsilon_i. \tag{20}$$

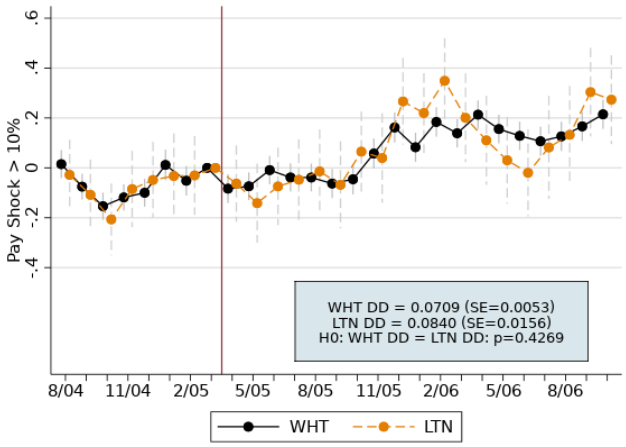
FIGURE 11: 10% PAY SHOCK



(a) Num. Negative Amortizing – Income Quartile



(b) Num. Interest Only (IO) – Income Quartile



(c) Frac. Negative Amortizing – Race

Notes: The figure depicts the likelihood of pay shocks for mortgages originated by an IMC versus a non-IMC pre- versus post-BAPCPA. Panel (a) depicts all loans. Panels (c) and (d) depict mortgages originated in majority Black and majority Latino zip codes, each relative to majority white zip codes.

TABLE 1: Differential Effect of Treatment on Low Income Growth Zip Codes

	Product Types					
	(1) log(Orig)	(2) FracBalloon	(3) FracNegam	(4) FracHybrid	(5) FracTwoStep	(6) FracIO
$Post_t \times IMCMktShr_{z,04}$	-0.1581***	0.0450***	0.0465***	-0.0168**	0.0031***	0.0269***
	(0.0377)	(0.0023)	(0.0061)	(0.0076)	(0.0011)	(0.0064)
$Post_t \times IncGrowth_z$	-0.5420***	0.0092	0.0366*	0.0395	0.0045	0.0595***
	(0.1113)	(0.0062)	(0.0216)	(0.0240)	(0.0036)	(0.0211)
$Post_t \times IMCMktShr_{z,04} \times IncGrowth_z$	1.8648***	-0.0476**	-0.1075*	-0.1303*	-0.0129	-0.1718***
	(0.3292)	(0.0192)	(0.0649)	(0.0724)	(0.0114)	(0.0641)
Cons	2.4848***	-0.0027***	0.0168***	0.0472***	0.0002	0.0407***
	(0.0091)	(0.0006)	(0.0015)	(0.0018)	(0.0002)	(0.0015)
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes
StatexMonthFE	Yes	Yes	Yes	Yes	Yes	Yes
r2	0.9274	0.0968	0.3893	0.0969	0.0742	0.3227
N	491817	491817	491817	491817	491817	491817

Notes: Table reports the response of housing market characteristics in a given zip as a function of the interaction term between 2004 market share of independent mortgage companies (IMCs) × income growth between 2001 and 2004 in that zip × the post period. I estimate the triple difference regression in Equation 5. The coefficients measure the change in the dependent variable if $IMCMktShr_{c,04}$ increased from 0% to 100%. I use the Public HMDA data to compute the 2004 zip level IMC market share. I use CoreLogic LLMA data to study mortgage product types and characteristics.

Appendix

A Census Data Collection and Variables

Data Collection Method: The population data was downloaded from the 2000 Census of Population using the Census Data API (website: https://www.census.gov/data/developers/data-sets/decennial-census.2000.html) with the R programming language. The Census dataset was selected because it contains data specifically from the year 2000, while the NHGIS database only provides data from the 2012-2016 period.

Variables Used: The data used in this analysis is from the year 2000, corresponding to ZIP Code Tabulation Areas (ZCTAs). The following variables were used:

From '/data/2000/dec/sf1/variables':

- Total population (P004001)
- Hispanic or Latino population (P004002)
- White population (P004005)
- Black or African American population (P004006)

From '/data/2000/dec/sf3/variables':

- Population with a Bachelor's degree, male (P037015) and female (P037032)
- Unemployed population, male (P043007) and female (P043014)

B 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

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

I calculate a histogram of the treatment doses of $IMCMktShr_{z,04}$ for the counties used in the regression analysis. I find that $IMCMktShr_{z,04}$ is symmetric and close to normally distributed. I 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 12 about here.]

If strong parallel trends does not hold and "selection bias" was likely to be higher at higher treatment levels, even having the population weights that are similar to the TWFE will not eliminate bias. This is because there still may be bias in the treatment response at each dose. In this 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. I 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. I conduct the regression 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.

B.0.1 Effect of Income Growth on Additional Mortgage Products

In Table 2 I plot the regression results from Equation 5 for additional mortgage products. Although the coefficients are not significant, following the increase in credit post-BAPCPA, Table 2 documents 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. The fraction of ARM mortgages increases, consistent with a total increase in ARM mortgages in all zip codes post-policy change.

[Table 2 about here.]

B.0.2 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, I use loan-level HMDA data to identify the differential effect of BAPCPA on mortgage approval rates by race. I 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. I estimate the following regression:

$$\begin{aligned} Accepted_b = \alpha post_t + \delta IMC_b + \lambda RACE_b \\ +\rho IMC_b \times post_t + \zeta IMC_b \times RACE_b + \xi post_b \times RACE_b \\ +\beta IMC_b \times \%Race_b \times Post_t \\ +\gamma_c + \eta_{s,t} + \epsilon_b. \end{aligned} \tag{21}$$

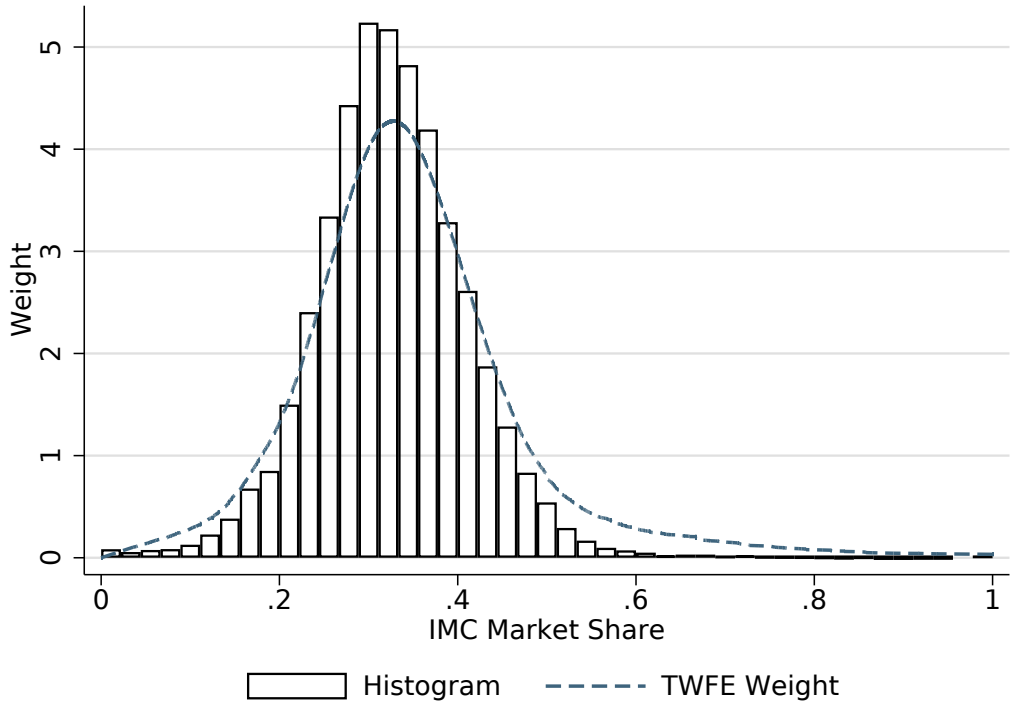
Where $Accepted_b$ is an indicator variable equal to one if the mortgage application is approved. The public HMDA data is only available at the annual frequency. $Post_b$ is an indicator variable set equal to one for 2005 and later. IMC_b is an indicator variable set

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. I 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 3 presents the results of Equation 21. 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 3 about here.]

Figure 12: Continuous DID Weights



Notes: The figure plots the distribution of the actual treatment variable, $IMCMktShr_{z,04}$ against the weights applied in the continuous difference-in-differences or two-way fixed effects specification.

TABLE 2: Differential Effect of Treatment on Low Income Growth Zip Codes

	Additional Product Types			
	(1) FracARM	(2) FracNoDoc	(3) FracLowDoc	(4) FracFullDoc
$Post_t \times IMCMktShr_{z,04}$	-0.0498***	0.0111**	-0.0370**	-0.0555***
	(0.0153)	(0.0048)	(0.0157)	(0.0194)
$Post_t \times IncGrowth_z$	-0.0965**	0.0073	0.0454	-0.0731
	(0.0485)	(0.0152)	(0.0485)	(0.0607)
$Post_t \times IMCMktShr_{z,04} \times IncGrowth_z$	0.2712*	-0.0388	-0.0978	0.1426
	(0.1428)	(0.0465)	(0.1415)	(0.1804)
Cons	0.2460***	0.0176***	0.2536***	0.4474***
	(0.0037)	(0.0012)	(0.0038)	(0.0047)
ZipFE	Yes	Yes	Yes	Yes
StatexMonthFE	Yes	Yes	Yes	Yes
r2	0.2849	0.0923	0.1406	0.1402
N	491817	491817	491817	491817

Notes: Table reports the response of housing market characteristics in a given zip as a function of the interaction term between 2004 market share of independent mortgage companies (IMCs) × income growth between 2001 and 2004 in that zip × the post period. I estimate the triple difference regression in Equation 5. The coefficients measure the change in the dependent variable if $IMCMktShr_{c,04}$ increased from 0% to 100%. I use the Public HMDA data to compute the 2004 zip level IMC market share. I use CoreLogic LLMA data to study mortgage product types and characteristics.

TABLE 3: 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