The Impact of Collateral Value on Mortgage Originations

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February 14, 2025

Abstract

This paper establishes that high income-volatility, minority dominant zip codes were disproportionately exposed to the expansion of credit following the BAPCPA 2005 policy change, which granted preferred bankruptcy status to mortgage backed collateral in the sale and repurchase market. This change only affected the collateral value of risky private-label mortgages, not of agency mortgages, and caused the disproportionate expansion of alternative mortgage products. These alternative products featured artificially low initial payments that would reset to much higher payments, exposing vulnerable borrowers to synchronized mortgage payment shocks and higher levels of default during the Global Financial Crisis. These products deviated from the traditional mortgage contract. A model of mortgage lending illustrates that an increase in collateral value, which decreases lenders' cost of capital, triggers this change in contract type. This paper provides insights on how to increase stability of private-label mortgages, which substituted for FHA/VA mortgages in the 2000s, if they increase again in volume, as they did in 2019.

Keywords: collateral, contract types, repo safe harbor, bapcpa, mortgage backed securities, 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 and government initiatives have 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), Down Payment Toward Equity Grant, DOJ False Claims Act lawsuits against mortgage originators). However, it remains an open question of why minority borrowers were the hardest hit by foreclosures during the GFC. In this paper, I document how granting preferred bankruptcy status in the sale and repurchase ("repo") market, a large wholesale funding market, allowed the private market to extend credit to high income volatility borrowers via an increasingly fragile internal capital market structure in the run-up to the Global Financial Crisis.

As background, the typical repo transaction involves the borrowing institution pledging securities as collateral to borrow a short-term loan from the lending institution. In this way, a repo agreement serves the same economic function as a collateralized loan, except it is considered an outright sale followed by a repurchase of the collateral. Certain types of repo collateral receive preferred bankruptcy status, or safe harbor, which grants the collateral exemption from automatic stay. Exemption from automatic stay means that upon a bankruptcy event, the final creditor may take immediate control of the collateral without waiting in bankruptcy court. In a downturn, exemption from automatic stay can facilitate fire sales of collateral, since counterparties may take immediate control of collateral and sell it in the market. To mitigate the risk of fire sales, the collateral must maintain its price in a crisis. Typically, safe assets such as Treasuries and agency mortgage collateral, which will maintain their price in a crisis, were granted exemption from automatic stay. However, in 2005, Congress passed the Bankruptcy Abuse Prevention and Consumer Protection Act which granted exemption from automatic stay to private-label mortgage collateral, which is not backed by the US Government and therefore need not maintain its price in a crisis. Given the lack of government backing, the quality of collateral becomes very important to ensure that the collateral will maintain its price in a crisis to prevent market destabilizing fire sales.

The exemption from automatic stay increased creditor rights and thus could potentially lead to an increase in collateral value, however, Duffie and Skeel (2012) argue that exemption from automatic stay may lead to a deterioration of the underlying repo collateral quality. In this paper, I study whether the expansion of repo safe harbor to private-label mortgages weakened the quality of the collateral by changing the types of mortgage contracts origi-

nated and by increasing correlation in mortgage payment resets that borrowers faced. Thus making the funding pipeline increasingly fragile for private-label mortgages (PLS), which Davis et al. (2023) and Adelino et al. (2020) show, during 2005-2006, became a substitute for Federal Housing Administration (FHA) and Veterans' Affairs (VA) mortgages – mortgages which play a key role in providing access to homeownership for households with limited financial means. By granting PLS collateral preferred bankruptcy status, BAPCPA allowed the collateral to be more easily securitized in the private market with limited oversight and government backstops.

I use Congress's passage of the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA), in April 2005, to isolate a plausibly exogenous strengthening of creditor rights for mortgage collateral in the repo market. Centering the empirical setting around BAPCPA isolates the role that stronger creditor rights play in the expansion of alternative mortgage products and the type of borrowers exposed to those products. The mortgage funding market that I study features independent mortgage companies (IMCs), which are not deposit taking institutions and which rely on credit lines to fund themselves. Large dealer-banks fund these mortgage companies with repo warehouse lines of credit known as "Master Repurchase Agreements." The BAPCPA policy change exempted the repo mortgage collateral, which backed these warehouse lines, from automatic stay. In this paper, I assert that the change 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 (Lewis (2023)). Since these IMCs rely on repo warehouse lines of credit from the large dealer-banks, they were more heavily exposed to dealer-bank's lower cost of capital following BAPCPA. Importantly for my research design, the change only affected private-label, or risky, mortgage collateral since agency mortgage collateral had already been granted exemption from automatic stay by the Bankruptcy Amendments Act of 1984. Prior to the GFC, independent mortgage companies made up close to one third of the mortgage lending market. Post crisis, their market share has increased to approximately half of the market and their funding structure largely remains the same. Given that the market share and funding structure of IMCs remains very similar to the pre-GFC era, the findings in this paper have important implications for how future use of private-label mortgage collateral could be made safer while BAPCPA's repo safe harbor remains in effect.

To begin, I document new stylized facts around the policy change. First, I document that the policy change leads to an explosion of risky alternative mortgage products such as balloon, negative amortizing mortgages (which increase indebtedness overtime), interest only, and two-step mortgages, which crashed in 2008, and that these mortgage products were disproportionately originated to higher-income-volatility, minority-dominant zip codes. These

alternative products featured artificially low introductory payments and negative amortizing structures, suggesting that the mortgages originated in response to BAPCPA lowered near term mortgage payments, making them more affordable for borrowers with higher income variability at the cost of decreasing borrower home equity. Next, I document that early payment defaults and total defaults, by month of origination, increased following the policy change and more than doubled their pre-2005 levels leading up to the GFC. These defaults were disproportionately experienced by higher-income-volatility, minority dominant zip codes.

To causally document that BAPCPA drove an expansion of alternative private-label mortgages to higher-income-volatility, minority dominant borrowers, I set up a treatment intensity difference-in-differences (DiD) research design where I define treated areas to be zip codes with a higher market share of IMCs in 2004, the year prior to the change. I estimate the DiD by racial subgroup to study the differential originations 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 document that following the policy change, a 10% increase the pre-period treatment measure, IMC market share, leads to a relative increase in originations for majority white and Latino zip codes, but a sharp decline in originations in majority Black zip codes.

While minority zip codes did not experience a significant increase in overall mortgage originations their number of alternative mortgage products increased disproportionately relative to white zip codes. Specifically, a 10% increase in pre-period IMC market share increased balloon mortgages by 42% for Latino zip codes, 31% for Black zip codes, and 20% for white zip codes. The same increase in treatment exposure increased negative amortizing mortgages by 21.5% for Latino zip codes, 10% for Black zip codes, and 10% for white zip codes, and it increased two-step mortgages by 29% for Latino zip codes, 8% for Black zip codes, and 2% for white zip codes. For a subset of private-label mortgages, I merge novel loan level data to originator type in HMDA. This allows me to create a loan level indicator for loans originated by IMCs at the monthly frequency. Consistently, in this loan level data, IMCs disporoportionately increase originations of balloon and negative amortizing mortgages in response to BAPCPA and especially so in minority zip codes.

Following BAPCPA, I find that average credit scores increased in Black, Latino, and white zip codes, with large increases in majority Black and Latino zip codes and near zero increases in white zip codes. Although credit scores increased, even the relatively large in-

creases in minority zip codes was likely too modest to offset the increased risk associated with the alternative mortgages.[1] Additionally, I find that full documentation mortgages increased statistically significantly for majority white zip codes, showed no significant increase for Latino zip codes, and decreased significantly for majority Black zip codes. Lower documentation indicates that asset and income are not fully verified, which allows borrowers to be poorly equipped to handle future mortgage payment resets, creating implications for default.

In order to study the consequences of receiving alternative mortgage products, I study both early payment default and total default using a similar difference-in-differences research design but including controls for home equity and unemployment. I find that a 10% increase in IMC market share in the pre-period leads to a 0.71 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 experienced a 0.24 and 0.09 percentage point increase for an equivalent increase in pre-period IMC market share. When I turn to total defaults, I find that majority white zip codes experience a 3.3 percentage point increase in total defaults following BAPCPA in response to a 10% increase in pre-period treatment. For the same increase in treatment, Black zip codes experienced a 3.8 percentage point increase in total defaults, and Latino zip codes experience a 5 percentage point increase, which is statistically significantly higher than the increase for white zip codes.

To test whether IMCs increase lending to borrowers with higher income volatility following BAPCPA, I estimate the DiD by subgroups for the top and bottom income growth quartiles. Since income growth is highly correlated with income volatility, I proxy for income volatility using income growth between 2001 to 2004. I estimate the differential impact of high versus low IMC market share in zip codes in the top and bottom income growth quartile. Following the policy change, a 10% increase in pre-period IMC market share drives up originations in high income growth zip codes and drives down originations in low income growth zip codes. However, both high and low income growth zip codes received relatively similar increases in alternative mortgages. In response to a 10% increase in pre-period IMC market share, the highest income growth zip codes experience a 31% increase in balloon mortgages and the lowest experience a 30% increase. The same increase in pre-period treatment exposure increases negative amortizing mortgages by 17% in the highest and 11% in the lowest income growth zip codes, and it increases two-step mortgages by 21% for the highest and by 6.3% for the lowest income quartile zip codes. These results are consistent with borrowers in

[1]For example, the 0.22% credit score increase for Latino zip codes increases credit score 1 point, from 690 to 691. These were mainly purchase originations, as I find that second homes did not experience statistically significant increases over this time period.

all income growth quartiles receiving an increased amount of Alt-A originations. However, it is worth noting that the lowest income growth zip codes received an increasing number of these products at the same speed as high income growth zip codes, despite the fact that low income growth zip codes were receiving a relative overall decrease in originations.

Following the policy change, I find that average credit scores increased in both the highest and lowest income growth quartile zip codes, with the largest increases in the lowest income growth zip codes. Again, although credit scores increased, even the relatively large increases were likely insufficient to offset the increased risk associated with the alternative mortgages. Mirroring the case with racial subgroups, I find that the number of full documentation mortgages increased significantly in the highest income growth zip codes and decreased significantly in the lowest income growth zip codes. These documentation results are consistent with higher-income-volatility borrowers receiving mortgages with less well documented income and assets following the policy change, which has implications for default. A 10% increase in pre-period treatment increases post-period early payment defaults by 0.32 pp in the lowest and 0.28 pp in the highest income growth zip codes, and it increases total defaults in the post period by 4 pp in the lowest and 3.7 pp in the highest income growth zip codes.

The burst in alternative mortgages, with low introductory mortgage payments, following BAPCPA created timing coordination on the payment reset dates. I estimate a DiD regression where I limit to mortgages that experience an interest rate reset and I create a payment shock indicator, equal to one if a mortgage payment increases by 10% or more at the time of the first reset. The probability of experiencing a payment shock disproportionately increases, beginning six months after the policy change, if the mortgage was originated in a zip code with higher IMC market share. This timing is consistent with an influx of adjustable rate mortgages immediately following BAPCPA, which led to synchronized payment shocks beginning 6 months later. LTN, BLK, and WHT borrowers all experience an increase in the probability of experiencing a payment shock in the post-period. However, borrowers with lower full documentation rates may be less well equipped to handle these large payment resets since their ability to repay the mortgage had not been fully verified even at the low introductory payment.

To explain the mechanism through which an increase in secondary market collateral value stimulates lending of new mortgage products in the primary market, I propose a stylized model. The model features a competitive lender and two types of borrowers: those with high-income-variability and less than full documentation, and those with low-income-variability or fully documented income. The model represents the nonbank (or IMC) funding market, where a dealer bank funds mortgage originations by providing warehouse lines of

credit, takes collateral ownership of the mortgages originated, and repledges the collateral (borrows against the collateral) to lower funding costs. As a simplification of this structure, I model the dealer-bank as originating and controlling the mortgages directly. The low-income-variability/fully documented borrowers borrow conforming mortgages in the agency mortgage market. The high-income-variability borrowers borrow alternative mortgages (as in Piskorski and Tchistyi (2010)) in the private-label-mortgage market. This set up is consistent with the private-label market becoming a substitute for the FHA/VA market, which funded borrowers who often could not qualify for conforming loans.

Lenders value a mortgage that they create because it serves as collateral for them to borrow against in the repo market. I model the collateral value as an additional interest rate that the dealer receives on the mortgages that it originates, since value of collateral is in part determined by the ability to repledge collateral.[2] When BAPCPA strengthens the creditor rights on the on private-label mortgage collateral, it increases dealers' ability to borrow against the collateral and thus decreases their cost of capital.[3] When the dealers' cost of capital required to originate mortgages decreases, they lower the interest rate that they charge borrowers on private-label mortgages. In my framework, this implies that the agency mortgage contract and the alternative private-label contract offered would not change, but the price offered on the alternative private-label contract would fall. If the price falls below the borrowers' reservation price, the lender expands into the market for high-income-variability and less than fully documented borrowers. Consistently, I find that following BAPCPA, IMCs differentially lower their initial interest rates. This mechanism helps to explain why, although alternative mortgage products had existed since the 1980s, we had not seen them originated at the scale they reached just prior to the GFC.

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-

[2]The interest that the dealer typically receives on a line of credit maps to the interest rate that it charges an IMC on a repo loan, which the IMC passes through to the borrower in the form of the interest rate. Additionally, dealers offer IMCs lower interest rates if the IMC allows the dealer to repledge the mortgages in the repo market, suggesting that dealers have a valuation for ability to repledge collateral that can be expressed as an interest rate.

[3]Note, this act of borrowing against collateral would usually take the form of dealers repledging, or rehypothecating, the collateral that they received from an IMC, which they funded via a repo warehouse line of credit. However, to simplify the model, dealers lend directly to the mortgage borrowers and then pledge mortgage collateral created from the mortgages.

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. This paper helps to reconcile Adelino et al. (2018) with Mian and Sufi (2009) by showing that although low income growth zip codes were heavily impacted by the credit expansion post-BAPCPA, the higher credit score borrowers receiving alternative mortgages, which were recorded as prime or near-prime in Corelogic, received the bulk of this increase.

In this paper, I present evidence that rather than a single wave of the housing boom, there were two waves. As is well documented in the literature, the first wave involved originations of subprime mortgages with below 660 credit score[4] but fully amortizing mortgage structures between 2000 and 2004. However, it remains an open question why the 2005-2007 cohort mortgages performed much worse than the 2000-2004 cohorts controlling for borrower characteristics (Gerardi et al., 2008; Haughwout et al., 2008; Mayer et al., 2009; Demyanyk and Van Hemert, 2011; Krainer and Laderman, 2011; Bhardwaj and Sengupta, 2012; Davis et al., 2023).

Palmer (2024) finds that negative equity increases borrower likelihood of default when exposed to even small aggregate shocks to home price declines and unemployment. This paper provides evidence that 2005-2007 borrowers are more likely to have negative equity not only because they had less time to build equity before the financial crisis, but also because post-BAPCPA, the number of negative amortizing originations spiked. BAPCPA paired these risky alternative mortgage products with increased fragility in their funding structure. Controls for home equity and the monthly identification around the month of passage of BAPCPA, which shows that mortgages originated in May 2005 were more likely to default than those in March 2005, strengthen the evidence that BAPCPA drove an expansion of alternative products that were more precariously positioned to default.

Piskorski and Tchistyi (2010) show that income volatility determines the optimal mortgage product for a borrower. 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. Derenoncourt et al. (Forthcoming); Morduch et al. (2018); Gupta et al. (2023); Kermani and Wong (2021) show that

[4]Palmer (2024) states that that there is no agreed upon definition of subprime loans. Popular classification methods include mortgages originated to borrowers with a credit score below certain thresholds, mortgages with an interest rate that exceeds the comparable Treasury rate by three percentage points, certain mortgage product types, mortgages made by lenders who self-identify as predominantly making subprime mortgages, and mortgages serviced by firms that specialize in servicing subprime mortgages. However in this paper, I propose that there were actually two waves of the housing boom: one that featured mortgages below 660 FICO but fully amortizing origination structures, and one that featured near prime credit scores but alternative amortization structures. Adelino et al. (2016) states that 660 corresponds to a widely used FICO cutoff for subprime borrowers.

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 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 Data and Institutional Background

1.1 Data

Dealer Repo Financing Data. I use the Federal Reserve Bank of New York's weekly survey of primary dealers (FR 2004) to measure primary dealers' aggregate trading activity by

collateral class. Due to their role making the market for US Treasuries, the primary dealers are required to report trading data to the Federal Reserve. There is no external data dictionary identifying financing positions and collateral classes for these data outside the Federal Reserve. To overcome this, I hand match the FR 2004 variables to the survey instructions given to the survey respondents in order to create a weekly time series of total dealer holdings and secured financing by collateral class. Matching the FR 2004 variables to the survey instructions allows me to establish that prior to 2013 the data included dealers' trading in private-label mortgage collateral in the line item *corporate securities*, as discussed in Lewis (2023) online appendix A.1. In this online appendix, I decompose corporate securities into the collateral classes that comprise it.

These data allow me to study whether primary dealers' trading in the repo markets using private-label collateral increased post BAPCPA. The key variables that I utilize are *securities out* and *securities in*. Securities out reports dealers' secured borrowing (cash received) and securities in reports dealers' secured lending (cash lent).[5] The FR 2004 data report the primary dealers' aggregate activity in both the tri-party and bilateral repo markets. Copeland, Martin and Walker (2014) states that primary dealers made up 79% of all dealer activity in the tri-party repo market in July and August 2008 and assumes that this percentage holds across both the bilateral and tri-party repo markets. Therefore, the FR 2004 trading activity is likely to be representative of trading activity in the repo markets as a whole during 2005-2007.

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, in this dataset I do

[5] *Securities out* and *securities in* include repos/securities lending and reverse repos/securities borrowing, respectively. See: FR 2004 and Infante (2019) p. 46.

not observe the originator of a mortgage, prohibiting comparison of the individual mortgages originated directly by IMCs versus non-IMCs, pre- and post-BAPCPA. To overcome this in the main analysis, I aggregate all variables to the zip code level and merge them with the 2004 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..

I also utilize the Non-Agency Residential Mortgage Backed Securities (NARMBS) data. These data cover private-label mortgages and include originator name. I conduct a fuzzy merge to HMDA data which allows me to identify originators as IMCs for a subset of the data. I describe the merge in Appendix G. I utilize these data to study mortgage payment shocks and to verify that patterns in the zip code level regressions remain consistent in the loan level data.

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.

1.2 Institutional Details of the Sale and Repurchase "Repo" Market

The sale and repurchase market, or "repo," markets are large short-term funding markets where securities are sold and repurchased, creating short-term loans collateralized by financial assets.[6] 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

[6]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).

repledge, rehypothecate, or reuse the collateral they receive. The dealer will typically offer 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 varies by contract but they are often repayable either when the financed mortgages are sold or on the maturity date of the contract.[7]

Repo Market Functioning 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.[8] 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. 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. 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 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

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

[8] 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.

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 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 an exemption from the automatic stay. This grants the holder of the underlying collateral super-senior bankruptcy status, or safe harbor, since the collateral is exempt from the hold on a firm's assets when the firm enters bankruptcy proceedings.

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)). For example, the court decided against the safe harbor of Lombard Wall (1982) and Criimi Mae (2000) repo collateral. This shocked the market and led to a steep contraction, implying that immediately upon the court's decision, the collateral was less valuable than previously perceived. The market response to these court cases suggests that collateral must be legally exempt from automatic stay in the bankruptcy code in order for it to unequivocally receive preferred bankruptcy status. 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.[9] The law expanded the definition of repurchase agreements in the Bankruptcy Code to

[9]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))

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 the automatic stay, giving the final creditor super senior bankruptcy status or safe harbor. 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. Consistent with tri-party market lenders increasing their willingness to lend against private-label mortgage collateral, Srinivasan (2017) finds that, following BAPCPA, haircuts on private-label mortgage collateral in the tri-party market fell from 20% to 3%.

The 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.[10]

BAPCPA's Expansion of Repo Safe Harbor This section sets up a simple example depicting the effect that BAPCPA had on the repo market. I propose that prior to BAPCPA, the reuse of the mortgage collateral was limited. The collateral was held – with limited reinvestment capability – to protect dealers from the default risk of the mortgage companies. Following BAPCPA, Lewis (2023) shows that dealers' reuse of mortgage collateral expanded, allowing them to expand credit supply through 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 pre-BAPCPA versus post-BAPCPA in dealers' ability to reuse the warehoused mortgage loans posted by an IMC. Panel (a) depicts pre-BAPCPA and panel (b) depicts post-BAPCPA.[11] In (b), I propose that the policy change increased dealers' ability to repledge the collateral by increasing the tri-party market's willingness to accept it. The steep decrease in haircuts that Srinivasan (2017) finds is consistent with this view.[12] This argument would go through if dealers were able

[10] 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.

[11] 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.

[12] The drop in haircuts is consistent with the collateral being considered safer and more likely to be held in the tri-party market. Adrian et al. (2009) discusses the increased use of private-label mortgage collateral in the tri-party market saying: originally focused on the highest quality collateral - Treasury and Agency debt - repo transactions by 2008 were making use of below-investment- grade corporate debt and equities

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.[13]

[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%.[14]

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.

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

and even whole loans.

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

[14] 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.

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.[15]

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 (Adelino, Gerardi and Hartman-Glaser (2019)). Therefore I use one month as the interval of the rounds of lending that generate the bilateral/tri-party haircut differential.[16] Given the quarterly haircut differentials between 2005Q4-2006Q4,[17] 15 rounds of lending across 15 months would create a multiplier equal to:

[15]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 Figure 1 (a) would be $r = \$100 \times i^{IMC}$. While in Figure 1 (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.

[16]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.

[17]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.

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

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.[18] 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.

1.3 Effect of BAPCPA on Collateral Reuse

In this section, I illustrate the effect of the BAPCPA policy change on dealers' collateral reuse, which is an indicator for their ability to generate the money multiplier effect discussed above. I plot dealers' securities out (borrowing) collateralized by agency[19] and by private-label[20] mortgage collateral each as a fraction of total securities out (total dealer borrowing) in Figure 2, recreated from the online appendix of Lewis (2023). The figure shows that prior to BAPCPA a relatively constant fraction of dealers' total borrowing was collateralized each by private-label and by agency collateral. After BAPCPA the fraction of dealer borrowing collateralized by private-label collateral nearly doubled, from about 6% to close to 12%, while the fraction backed by agency collateral remained almost constant at about 22%. This is consistent with an increase in dealers' ability to borrow against private-label mortgage

[18] There are 15 month of lending. The haircut differential is assumed to reset every 3 months because this is how often I see the haircut charged by the dealer in the bilateral market change. The value of the haircut in the tri-party market is assumed constant. This is reasonable given the similar estimates in Copeland et al. (2014); Krishnamurthy et al. (2014); Srinivasan (2017). The value of credit supplied to the IMC each round is calculated by multiplying the previous rounds' haircut differentials by each other. The total amount of credit that the dealer can supply to the economy is equal to the sum of lending across all rounds.

[19] Agency MBS is comprised of Federal Agency and GSE MBS in the FR 2004 data.

[20] Private-label MBS is comprised of Corporate Securities Total from 7/4/2001 to 3/27/2013. From 4/3/2013 to 6/6/2018 it is comprised of: (1) Non-Agency Residential MBS, (2) Other CMBS, (3) Corporate Securities Commercial Paper, (4) Corporate Securities Investment grade bonds, notes, and debentures of various maturities, (5) Corporate Securities Below investment grade bonds, notes, and debentures of various maturities, (6) State and Municipal Government Obligations of various maturities, (7) Credit card-backed, Student loan-backed, Automobile loan-backed, Other Asset Backed Securities.

collateral in the tri-party market, both since Infante (2019) states that dealers are likely to be borrowers in the tri-party market and lenders in the bilateral market and since Srinivasan (2017) finds that haircuts dropped 20% in the tri-party market. The value of PLS collateral used to borrow also almost doubled, jumping from $247 billion in March 2005 to $466 billion in July 2007, before crashing in late 2007, consistent with the timing of the GFC.

[Figure 2 about here.]

To test the statistical significance of dealers' increased use of private-label collateral to borrow following BAPCPA, I estimate the regression in Equation 2 from January 1, 2001 through July 31, 2007 to compare both the log value of securities out and the fraction of total securities out pre versus post BAPCPA for agency versus private-label mortgage collateral:

$$Y_{i,t} = \omega Post_t + \nu PLS_i + \beta Post_t \times PLS_i + \epsilon_{i,t}. \quad (2)$$

$Y_{i,t}$ is set equal to both the log value of securities out and the fraction of total securities out (fraction of total dealer borrowing). For collateral class i at time t, $Post_t$ is an indicator equal to zero prior to April 15, 2005 and equal to one on this date and later. PLS_i is an indicator equal to one for private-label mortgage collateral and zero for agency mortgage collateral. $Post_t \times PLS_i$ is the interaction of interest. The coefficient on this term measures the difference in borrowing backed by private-label and agency mortgage collateral after BAPCPA, less the difference between the two prior to the shock.

Table 1 reports the regression results. The coefficient on the interaction term, $Post \times PLS$, estimates a statistically significant 18.6% increase in private-label securities out relative to agency securities out in the post period, consistent with an increase in dealers' ability to borrow against private-label mortgage collateral.

[Table 1 about here.]

Dealer's increased borrowing collateralized by PLS indicates increased ability to generate a money multiplier effect discussed above, creating a credit supply increase that began in the repo market. The credit supply increase pertains to the mortgage market because BAPCPA created a repo haircut differential specific to private-label mortgage collateral. Lewis (2023) Figure 7 establishes that dealers pass this credit supply increase on to the independent mortgage companies that they fund. In this paper, I use IMC market share as a treatment measure to capture zip code level exposure to the policy change and study the effects on mortgage borrowers.

1.4 Institutional Details of 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 by using $IMCMktShr_{z,04}$ as my treatment variable.

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 3, 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 the principal owed on the loan increases and 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. These were one of the main types of negative amortizing mortgage products originated in the lead up to the Global Financial Crisis.[21] These alternative mortgage products offered an artificially low mortgage 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 after origination. As I discuss later in the paper, close to 40% of the loans at this time had the first reset clustered 6 months, 1, and 2 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.

Figure 3 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 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. In the appendix, I provide a discussion of the correlation between income volatility at the zip code level and income growth.

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, the annual reports of mortgage

[21] Piskorski and Tchistyi (2010) finds 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, and two step mortgages. These products all feature artificially low introductory monthly payments early in the life of the loan that deferred interest payments to later periods of the mortgage. The mortgages then reset to higher payments later in the life of the loan.

companies state that mortgage originators determined the mortgage affordability based on the initial scheduled monthly payment rather than on future monthly payments after the interest rate reset date, allowing borrowers to qualify for larger mortgages than they may otherwise qualify.

Independent mortgage company, HomeBanc, states in its 2005 annual report 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"
>
> "When evaluating a mortgage loan application from a prospective borrower, ... many mortgage originators determine the amount of loan that the **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"[22]

[FIGURE 3 about here.]

In Figure 3 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.[23] 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

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

[23] 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 for these descriptive plots, plotting the fraction of alternative mortgages better captures the disproportionate exposure that minority zip codes had to alternative mortgage products.

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[24] 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 GFC, whereas white borrowers seemed to know that it was time to retreat from the mortgage market. Consistently, Davis et al. (2023) and Adelino et al. (2020) show that during 2005-2006, PLS became a substitute for Federal Housing Administration (FHA) and Veterans' Affairs (VA) mortgages, which play a key role in providing access to homeownership for households with limited financial means.[25]

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 4 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. [26] Historically, mortgages that are underwritten well are unlikely to default in the first

[24] Alternative mortgages include negative amortizing and interest only mortgages plotted in Figure 3 as well as other mortgage types shown later in regressions.

[25] The Department of Justice (DOJ) brought unprecedented law suits against FHA lenders under the False Claims Act. Several billion dollars of claims were also brought against IMCs for their lending in the PLS market. These lawsuits in the PLS market are consistent with the PLS mortgages targeting a similar demographic as FHA mortgages and regulators enacting penalties on the PLS market similar to the FHA market as a warning to lenders operating in these markets.

[26] Early payment defaults reported using the Federal Housing Administration (FHA) methodology flags

year of origination (Mayer, Pence and Sherlund (2009)). Figure 4 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. Following 2005, the early payment defaults increased at a faster rate for borrowers in the lowest quartile of income growth. By 2007, this number more than tripled such that nearly 3.0% of loans originated entered early payment default.

In panel (b), I plot the fraction of total defaults by income quartile. Total defaults also increased dramatically following 2005. The fraction of 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.

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. EPDs in Black zip codes 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 2.8% 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 at 1.7% of mortgages 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.[27] This plot reveals that in all years, majority Black zip codes experienced the highest levels of default. Following 2005, total defaults in majority Black and Latino zip codes significantly outpaced defaults in majority white zip codes. 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 33% 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 25% and peaked in 2007 at close to 29%. The large increase in total default ratio in majority Black and Latino zip codes relative to majority white zip codes is consistent with the increase in

whether a loan enters 60 day delinquency within the first six months since origination. The FHA measure is consistent with the GSE measure.

[27]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.

risky alternative products that these zip codes received, as shown in Figure 3. 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 13% and peaked in 2006 at 17%.

[FIGURE 4 about here.]

3 Effect of BAPCPA on Mortgage Lending

3.1 Effects by Racial Subgroups

In this section, I empirically test whether dealer-banks originate more mortgages via IMCs, consistent with an expansion of their lending on the left hand side of Figure 1, and whether they increased alternative mortgages to high-income-volatility minority dominant zip codes. I use a treatment intensity difference-in-differences (DiD) research design. The market share of IMCs in 2004, or $IMCMktShr_{z,04}$, is the treatment variable. It captures the exposure of a zip code to the IMCs in 2004, the year prior to BAPCPA. Since IMCs were directly linked to the dealers who were affected by the BAPCPA credit supply increase, the underlying assumption is that $IMCMktShr_{z,04}$ captures exposure to the credit supply shock. This variable is calculated using the number of IMC mortgage originations relative to all mortgage originations in the HMDA data:[28]

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

This research design captures the idea that IMCs will pass on increased funding to borrowers at a faster rate than banks because they were linked to the dealers who received a credit supply increase from BAPCPA (Lewis (2023)). Figure 1 illustrates how dealers experience a credit supply shock by being able to repledge their collateral more easily. Figure 2 shows that indeed dealers increased their repledging out of their collateral following BAPCPA. In this section, I use $IMCMktShr_{z,04}$ as a treatment measure because Lewis (2023) shows that dealers are funding the IMCs and therefore, zip codes that have a higher market share of IMCs should increase their mortgage originations at a faster rate following BAPCPA relative to zip codes that have a higher market share of banks. I study whether the IMCs differentially increase alternative product types following the policy change, and whether they do so disproportionately in low income growth, high minority zip codes.

Figure 5 panel (a) 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

[28] 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.

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. The insight of the research design however is that BAPCPA was a national policy change so to the extent that it affected borrower behavior, this would have been internalized by both bank and IMC lenders. Therefore, the way banks lend to minority versus non-minority or high- versus low-income growth areas pre- versus post-BAPCPA is an economic barometer for trends in lending. The effect associated with IMCs over and above that associated with banks, captures the effect of BAPCPA increasing secondary market collateral value on primary market lending.

[FIGURE 5 about here.]

In Table 2, I report summary statistics for above versus below median $IMCMktShr_{z,04}$ zip codes. The higher IMC zip codes have a slightly higher fraction of BLK and LTN inhabitants. However, later in the paper, I create subgroups for majority BLK, WHT, and LTN zip codes and I find that all three groups demonstrate pre-period parallel trends. This suggests that high and low IMC zip codes move in parallel within each of these racial groups, mitigating the concern that race or other covariates are correlated with differences in trends between treated and control zip codes in the pre-period.

[TABLE 2 about here.]

To 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 BAPCPA repo safe harbor lowers dealers cost of capital and leads them to lower their interest rates in the primary market in response, then new borrowers should enter this markets.

I estimate the following 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. I estimate the regression separately for each racial subgroup.

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

Where $Y_{z,t}$ is $\log(Originations_{z,t})$, $\log(Balloon_{z,t})$, $\log(NegAm_{z,t})$, $\log(TwoStep_{z,t})$, $\log(CreditScore_{z,t})$, and $\log(FullDoc_{z,t})$ in zip code z, at month t, and log is the natural logarithm. γ_z denotes zip level fixed effects, and $\eta_{s,t}$ denotes $state \times month$ 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 coefficient on 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.

I exploit a narrow window pre- and post-BAPCPA from August 1, 2004 to October 31, 2006 to help ensure that the pre-period is a valid counterfactual for the post-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 since 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. 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. Lewis (2023) develops method to test this. I follow this methodology in Appendix B and 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.

To study whether minorities were disproportionately impacted by IMCs' expansion of credit following BAPCPA, I estimate Equation 4 separately for subgroups of zip codes categorized by race. $\%RACE_z$ 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:

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

Figure 5 contains a U.S. heat map that documents, for each zip code, the proportion of Black inhabitants in panel (b), the proportion of Latino inhabitants in panel (c), and the proportion of white inhabitants in panel (d).

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, using an empirical design similar to that in 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. I estimate the difference-in-differences regression separately in Black, Latino, and white zip codes. This allows me to study how originations responded to BAPCPA in high-IMC areas relative to low-IMC areas while comparing the effect in Black and Latino areas each relative to white areas, holding fixed the IMC market share in each. If BAPCPA increased lending, zip codes with a higher proportion of IMCs should increase their mortgage originations relative to zip codes with a lower proportion of IMCs. This regression specification tests whether IMCs have a larger origination response post-BAPCPA in minority zip codes relative to white zip codes. Taking Latino relative to white zip codes as an example, holding fixed the market share of IMCs in a zip code, if Latino zip codes experience a larger increase in originations relative to white zip codes in response to BAPCPA it implies that Latino zip codes received a disproportionately large effect of the credit supply increase.

Measuring the difference between non-IMC originations and IMC originations in the pre-period constructs a counterfactual world with the pre-shock differences in lending patterns between more versus less treated zip codes. The difference-in-differences specification measures the average affect of the shock on areas with 0% IMC market share in the post-period and layers on the pre-period effect of moving from a zip code with 0% IMC market share to 100% IMC market share. The null result expects that in the post-period, the high-IMC zip codes will maintain their pre-period difference in trend relative to low IMC zip codes. 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.

Estimating the difference-in-differences specification by subgroup controls for pre-existing differences in lending in high-IMC relative to low-IMC areas separately in Black, Latino, and white zip codes. The regression coefficients for Black and Latino zip codes are each plotted relative to those for white zip codes. Comparing Black and Latino coefficients to those for white borrowers yields the same coefficient as a triple difference regression specification that interacts $\%RACE_z \times IMCMktShr_{z,04} \times Post_t$ (where $Post_t$ is an indicator variable equal to 1 on April 2005 and later). 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 all 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. 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.

3.2 Effects by Racial Subgroups - Results

Figure 6 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 0.7% and 0.6% increase in originations for white and Latino zip codes respectively post BAPCPA, with the increase in originations for white zip codes being statistically significant. However, a 10% increase in pre-period IMC market share leads to a statistically significant 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 zip codes with high IMC market share receive fewer mortgages relative to Black low-IMC zip codes post-BAPCPA relative to pre-BAPCPA, and this pattern is the opposite for white and Latino zip codes.

[Figure 6 about here.]

[Table 3 about here.]

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, in Figure 6 I plot balloon (panel (b)), negative amortizing (panel (c)), and two step mortgages (panel (d)) as outcome variables. Negative amortizing, balloon, and two step 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 fully amortizing

mortgages. However, this introductory mortgage payment would reset, usually to a much higher payment.

Following BAPCPA, the results document a disproportionate increase in originations of alternative mortgages in minority zip codes. Figure 6 panel (b) shows that a 10% increase in pre-period IMC market share leads to a 20% increase in balloon mortgages in white zip codes, a 31.9% increase in Black zip codes, and a 42.9% increase 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 the increase for white zip codes. This t-test tests whether there was a disproportionate increase of alternative products in minority zip codes by testing whether the difference between post- versus pre-policy change effect for each race is statistically significantly different from white zip codes. The panels in Figure 6 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 Figure 6 panel (c) shows that relative to the pre-period, a 10% increase in pre-period 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. In panel (d), I study two step mortgages which increased by 24.4% for Latino zip codes and this number is statistically larger than the 0.01% increase that white zip codes experienced. I do not find a statistically significant increase for Black zip codes post-BAPCPA.

In Appendix F of the appendix, I estimate these specifications using a Poisson model and find that the results remain consistent. In Appendix G, I utilize loan level data to estimate the increase in probability of originating alternative mortgage products in the post-period relative to the pre-period. For a subset of private-label mortgages, I am able to merge originator type to the originator name using a fuzzy name merge. Using this loan level data, I find that post-BAPCPA, IMCs were more likely to originate negative amortizing and balloon mortgages than they were pre-BAPCPA.[29] These results are also more prevalent in Black and Latino zip codes. These results are consistent with minority zip codes receiving

[29]I am not able to estimate the effect for two-step mortgages due to lack of two-step originations in this merged subsample.

disproportionately more alternative mortgages post-BAPCPA.

[FIGURE 7 about here.]

[TABLE 4 about here.]

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

I plot the results in Figure 7 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 pre-period IMC market share led to a 1.0% increase in full documentation mortgages for white zip codes and 3.8% 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.

I also estimate Equation 4 with $\log(CreditScore_{z,t})$ as an outcome variable, separately by racial group. I plot the results in Figure 7 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, 0.37% for Black zip codes, and 0.22% for Latino zip codes. Following BAPCPA, the credit score increase in Black zip codes is nearly statistically significantly higher than the increase in white zip codes. This is consistent with the result in appendix E which shows that acceptance rate on IMC originations in the post period decreases statistically significantly for Black and Latino applicants, while it increases for white applicants. This result is consistent with borrowers entering from the extensive margin, since second home purchases are decreasing during this time period (Lewis (2023) appendix B.4) and taking on additional debt via a purchase mortgage 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 consistent with lenders attempting to compensate for the increased risk of alternative amortization structures and

lack of full documentation by requiring higher credit scores. However, this increase in credit scores was likely too modest to sustain the increased risk of these mortgage products. For example, a 0.22% increase in credit score for Latino borrowers equates to about a one point increase from 690 to 691.

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 Government Sponsored Entity's definition of early payment default, which calculates if a borrower becomes 90 or more days delinquent within the first twelve 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 assessed 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.

$$Y_i = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMktShr_{z,04} \times \mathbb{1}_{t=T} + \Gamma_{z,t} + \epsilon_i. \tag{6}$$

Where Y_i is EPD_i and $Defaulted\ Loan_i$ and $\Gamma_{z,t}$ includes a control for the unemployment of a zip code in 2001 interacted with $Post_t$ (an indicator equal to one in and after April 2005, and zero before), and the equity value of the home at the time of default. [30] All other variables are defined the same as in Equation 4. I estimate this regression separately by racial subgroup and standard errors are clustered at zip code level.

I find that a 10% increase in pre-period IMC market share leads to a 0.7 percentage point (pp) increase in early payment default (EPD_i) for Black zip codes. This increase is statistically significantly higher than that for white and Latino zip codes, which experienced a 0.2 and 0.09 pp increase in early payment default, respectively, for an equivalent increase in pre-period IMC market share. Additionally, I find that a 10% increase in pre-period IMC market share leads to a 5 percentage point increase in total default for Latino zip codes. This number is statistically significantly larger than the 3.3 percentage point increase for white zip codes. Black zip codes experienced a 3.8 percentage point increase for the same increase in pre-period treatment, though it is not statistically different from the increase in white zip codes.

[30] To calculate negative equity, I first calculate $HomePrice = \frac{CurrentHomePriceIndex}{OriginationHomePriceIndex} \times OriginalPriceOfLoan$. I then calculate $HomeEquity = \frac{HomePrice - Balance}{HomePrice}$.

Combined with the results for full documentation originations, the increased defaults in minority dominant zip codes are consistent with these zip codes receiving disproportionately more alternative mortgages with risky amortization schedules, and lower income documentation. 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. The mortgage products likely made these mortgages more affordable for borrowers with higher income variability, without proper assessment of the borrowers' ability to repay the mortgages over the longer term.

3.3 Effects by Income Growth (Income Volatility)

In this section, 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.[31]

I estimate Equation 4 separately for zip codes in the top (Quartile 4) versus bottom (Quartile 1) quartile of income growth, where $IncGrowth_z$ is the income growth in a zip code from 2001 to 2004. I study whether areas with higher exposure to BAPCPA ($IMCMktShr_{z,04}$) began originating differentially more alternative mortgages to high income variability borrowers post BAPCPA. All variables are defined the same and standard errors are clustered as in Equation 4. The empirical design measures the differential effect on mortgage originations of moving from 0% to 100% IMC market share, post- versus pre-shock separately for zip codes in the top quartile of income growth and for zip codes in the bottom quartile of income growth.

The insight behind this regression specification is that 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, borrowers may value 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 achieve this payment flexibility by lowering introductory monthly payments and delaying the fully amortizing principal and interest payments to a later point in the life of the loan. This made these products appear

[31] See for example: the January 9, 2025 Brookings article "Low-income workers experience-by far-the most earnings and work hours instability." I also test the correlation between income growth and income volatility both at the zip code level and find that they are statistically significantly positively correlated.

affordable at the peak of the housing boom when the Federal Reserve was raising interest rates and home prices were near peak. If high income volatility borrowers valued alternative products, these mortgages would be disproportionately originated among higher- relative to lower-income-volatility zip codes and the β coefficient on the interaction term would be larger in lower-income-growth zip codes.

3.4 Effects by Income Growth (Income Volatility) - Results

Figure 8 panel (a) plots the coefficient on β_T that measures the effect of the pre-period IMC market share on $\log(Originations_{z,t})$ each month relative to March 2005. In the pre-period, there was no differential change in lending between treated and control zip codes for either subgroup. Following the policy change, a 10% increase in pre-period IMC market share leads to a statistically significant 1.3% decrease in originations to the lowest income growth quartile and a 2.0% increase in originations to the highest income growth quartile. To understand the role that BAPCPA played in the disproportionate expansion of alternative mortgage products in these subgroups, in Figure 8 I plot statistically significant results for balloon (panel (b)), negative amortizing (panel (c)), and two step mortgages (panel (d)) as outcome variables. In panel (b), a 10% increase in pre-period IMC market share leads to a 31% increase in balloon mortgages in the lowest income growth quartile and a 30% increase in balloon mortgages in the highest income growth quartile. In panel (c), a 10% increase in pre-period IMC market share leads to an 11% increase in negative amortizing mortgages in the lowest income quartile and a 17% increase in the highest income growth quartile. In panel (d), a 10% increase in pre-period IMC market share leads to a 6% increase in two-step mortgages in the lowest income quartile and a 21% increase in the highest income quartile.

The results in Figure 8 show that although low income growth, high income variability, borrowers receive a decrease in overall mortgage originations, they receive an increase in the number of alternative mortgages, which is comparable to high income growth zip codes. Together, these results indicate that low income growth borrowers receive a higher fraction of alternative mortgage products following the passage of BAPCPA. In the appendix, Table 7 shows that for a zip code with 100% market share of IMCs, post policy change, a 10% decrease in income growth statistically significantly increases the fraction of negative amortizing originations by 1.1 pp, the fraction of balloon originations by 0.48 pp, and the fraction of interest only (IO) originations by 1.7 pp. The fraction of two-step originations also increased 0.13 pp more in zip codes with lower income growth, however not statistically significantly at the 95% level.[32] These results indicate that in low income growth, or high in-

[32]Following the increase in credit post-BAPCPA, Table 8, in the appendix, documents a higher fraction of no documentation and low documentation originations in areas with lower income growth, or higher income

come volatility, areas IMCs were disproportionately originating alternative mortgages, which gave borrowers artificially low initial mortgage payments.

[FIGURE 8 about here.]

[TABLE 5 about here.]

These results are consistent with BAPCPA lowering dealer-banks' cost of capital in the secondary market for private-label mortgages and in response, dealer-banks decreased the interest rate on these mortgages in the primary market. 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).

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 for the top and bottom income growth quartiles, and all variables are defined as in the previous section. I plot the results in Figure 9 panel (a) and report the static coefficients in Table 6. Prior to the policy change, both subgroups move in parallel to each other. Post policy change, a 10% increase in pre-period IMC market share leads to a 2.1% increase in full documentation mortgages for white zip codes and 2.8% decrease in full documentation mortgages for Black zip codes. These results are both statistically significantly different from zerp and significantly different from each other. These results are consistent with borrowers receiving disproportionately fewer full documentation mortgages in low income growth zip codes.

I also estimate Equation 4 with $\log(CreditScore_{z,t})$ as an outcome variable, separately by income growth quartile. I plot the results in Figure 9 panel (b) and report the static coefficients in Table 6. 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, a 10% increase in pre-period IMC market share leads to a significant increase of 0.52% for low income growth zip codes and 0.37% for high income growth zip codes. These results are both statistically different from zero and from each other. As we saw in the previous section, the increase in credit score is consistent with lenders attempting to compensate or increased risk of alternative amortization structures and lack of full documentation by requiring higher credit scores. However, this increase in credit scores was likely too modest to sustain the increased risk of these mortgage products.

To study the consequences of these alternative products on borrowers, I use to study early payment default and total loan default by subgroups for the top and bottom income

volatility, and an increase in the fraction of full documentation loans in zip codes with high-income growth, or low-income volatility, although the coefficients are not significant.

growth quartile, utilizing the same variable definitions as in the previous section. Standard errors are clustered at the zip code level. I plot the results in Figure 9 panels (c) and (d) and report the static coefficients in Table 6. Studying early payment default (EPD_i) in panel (c), I find that a 10% increase in pre-period IMC market share leads to a statistically significant 0.33 pp increase in early payment default for the lowest income quartile zip codes and a 0.27 pp increase for the highest income quartile zip codes. Studying total loan default in panel (d), a 10% increase in pre-period IMC market share leads to a statistically significant 4.0 pp increase in total default for the lowest income growth quartile and a 3.7 pp increase for the highest income growth quartile. Table 6 reports the static coefficients from the dynamic DiD. It reports the results with zipFE only as well as with both zipFE and StatexMonthFE as the most saturated specification. The most saturated specification is the preferred specification as zip codes within the same state and month and therefore controls for housing market conditions.

[Figure 9 about here.]

[Table 6 about here.]

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. In the Appendix H, I test whether controlling for income growth quartile in the the regressions by racial subgroup eliminates the effect of racial make up of a zip code on the increase in alternative mortgages originations, credit score, and defaults, and the decrease in loan documentation. I find that significance and magnitude by racial make up of each zip code remains the same as in the regressions in subsection 3.2.

4 Payment Shocks

To establish the effect of alternative mortgages on borrower outcomes, I study mortgage payment shocks. I define a payment shock to be a mortgage payment reset that is $\geq 10\%$ above the initial mortgage payment, at the first time of reset. I estimate the following regression specification:

$$PayShock_{z,t} = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMktShr_{z,04} \times \mathbb{1}_{t=T} + \Phi_{z,t} + \epsilon_{z,t} \tag{7}$$

Where $PayShock_{z,t}$ is the average fraction of loans that experience a payshock in a given zip code out of all loans that experience a reset in that month, where the month records

the month of the payment reset. The dataset is limited to all loans that experience a mortgage reset. Φ_l represents control variables comprising of $Post \times avgLTV_{z,04}$, $Post \times avgCreditScore_{z,04}$, $post \times avgDTI_{z,04}$. This regression specification controls for similar borrower and mortgage characteristics, allowing a differential trend in the post period. It studies the remaining effect that being originated in a high versus low IMC market share zip code has on whether a mortgage experiences payment shock.

The regression results shown in Figure 10 indicate that, in the post period, mortgages originated in zip codes with high IMC market share are statistically significantly more likely to experience pay shocks relative to mortgages originated in low IMC zip codes. I limit the sample to zip codes that are categorized as majority BLK, LTN, and WHT and estimate the regression separately by subgroup. Comparing the response in BLK and LTN zip codes to WHT zip codes, I find that, on average in the post-period, a 10% increase in pre-period treatment leads majority WHT zip codes to experience a statistically 4 pp increase in likelihood of experiencing a payment shock when their mortgage payment resets. The average increase in payment shock likelihood for the majority LTN zip codes in the post period is 3.3 pp, and is not statistically different from the 4 pp increase in WHT zip codes. The average increase in payment shock likelihood for the majority Black zip codes in the post period for a 10% increase in pre-period treatment is a statistically significant 2.5 pp. In Figure 13 in the appendix, I also document that the initial interest rate decreases disproportionately in zip codes with high IMC market share, which is consistent with high IMC zip codes experiencing larger payment shocks when interest rates reset.

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 on default rates - reducing the payment size by 50% decreases the default rate by 55%. If the response is symmetric, increasing payment size by 10% should increase default rates by 11%. Additionally Fulford and Low (2024) find that expense shocks significantly affect households' financial fragility. Thus in high income variability and minority dominant zip codes, correlated mortgage payment shocks are poised to have a large effect on borrower default.

[Figure 10 about here.]

The timing of the payshock-likelihood increase is also important. It begins to increase in high IMC market share zip codes about eight months after the policy change and becomes increasingly common through October 2006. These results are consistent with a sudden onset of IMC alternative mortgage origination, with artificially lower mortgage payments beginning in April of 2005, directly following BAPCPA – creating a coordination device for IMCs to originate alternative mortgages. Since alternative mortgage products have reset

dates that cluster around 6 months, 12 months, and 24 months[33] the reset dates on these mortgage products are clustered in time, demographic, and geographic regions.[34]

5 Model

5.1 Model Set-up

In this section, I develop a model of mortgage lending. There are two separate markets. One for private-label (PL) mortgage borrowers, and one for agency (A), or conforming, mortgage borrowers. The borrowers in each type of market do not consider mortgages of the other type; they are not mobile across markets. This set up is consistent with the private-label market becoming a substitute for the FHA/VA market, which funded borrowers who often could not qualify for conforming loans. In both markets, the lender and borrower solve the same objective functions, so I set up the model using notation for the private-label market.

I shut down frictions between the dealer and the IMC. The IMCs can be thought of as originating mortgages on behalf of the dealers. Thus I call the dealers "dealer-banks" to denote that they function both as dealers operating in the repo market as well as mortgage originators. 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.

The market for private-label (PL) mortgages indicates alternative or alternate-A mortgage products, to study the increase in alt-A mortgage products following BAPCPA. The borrowers in the alt-A market can be thought of as borrowers who fulfill lower documentation requirements to verify income and assets, yet have more volatile income, and a higher cost of repaying their mortgage payment (θ). I utilize the insight from Piskorski and Tchistyi (2010) 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. In the theory, alt-A 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.

I use the model to study the impact of increasing the value that dealers receive by repledging private-label mortgage collateral (c^{PL}) and its effect on the interest rate dealers charge to the private-label borrowers, r^{PL}. The value that the dealer-bank receives from repledging collateral (c^{PL}) is exogenous. I consider a one-period model of a mortgage lender

[33] 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.

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

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^{PL} where $r^{PL} \geq 0$)

$$u = v(h) - \frac{1}{\theta}(1 + r^{PL})M \times h, \quad h \in \{0,1\}. \tag{8}$$

Since $v(0)$ and $v(1)$ are constant, the household maximizes utility 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^{PL}. 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 $\frac{1}{\theta}$. θ reflects credit worthiness, in the sense that higher θ indicates borrowers for whom it is less costly to repay the mortgage payment.

$$\theta \sim F \ \text{ on } \ [\underline{\theta}, \overline{\theta}] \tag{9}$$

Borrowers choose $h = 1$ if

$$v(1) - \frac{1}{\theta}(1 + r^{PL})M > v(0). \tag{10}$$

For every mortgage originated, the lender gains utility from the mortgage payment received, inflated by the shadow value of collateral, c^{PL}, generated by repledging the mortgage as collateral. A feature of the model is the choice to model the value of repledging collateral as analogous to the interest earned on the collateral. This construct is motivated by the fact that securities dealers offer their debtors a lower interest rate if the dealer has permission to repledge the collateral, consistent with dealers having a interest rate valuation for the repledgeability of collateral. p is the dealer-bank's fixed, exogenous, funding cost to provide the money necessary for the mortgage. Thus the dealer-bank's total cost of originating a mortgage varies linearly with the value of M and is the same whether the dealer is funding a private-label mortgage or an agency mortgage. The 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 accordingly and meets demand based on that interest rate:

$$u = (1 + r^{PL})(1 + c^{PL})M - pM = 0. \tag{11}$$

5.2 Model Results

The lender's break even condition gives:

$$r^{PL} = \frac{p}{1 + c^{PL}} - 1. \tag{12}$$

The main result follows from this break even condition:

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

$$\frac{\partial r^{PL}}{\partial c^{PL}} < 0. \tag{13}$$

Ceteris paribus, taking a comparative static of r^{PL} with respect to c^{PL}, as c^{PL} increases, r^{PL} falls. From the borrower's problem, there is a threshold borrower type – everyone with $\theta > \theta^*(r^{PL*})$ will borrow:

$$\theta^*(r^{PL*}) = \frac{(1 + r^{PL*})M}{v(1) - v(0)}. \tag{14}$$

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*}.

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

This yields 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 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 (r^{PL}) set by the lender requires a θ that is higher than $\overline{\theta}$, the upper bound of the support of θ, the interest rate charged is higher than any interest rate that borrowers are willing to pay. This can be seen from Equation 15, holding fixed $v(1)$, $v(0)$, and M. This can occur when the collateral c^{PL} is low, as can be seen by combining Equation 12 and Equation 15:

$$\theta^*(r^{PL*}) = \frac{(1+r^{PL})M}{v(1)-v(0)} = \frac{p}{1+c^{PL}} \times \frac{M}{v(1)-v(0)}. \tag{16}$$

When the value of c^{PL} increases[35], 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 some borrowers in this market choose to take out a mortgage at this price. The treated zip codes' increase in credit score and decrease in the introductory interest rate offered on mortgages with adjustable rate structures (balloon ARM, negative amortizing (option ARM), two step, etc.), shown in (Figure 13) in the appendix, are consistent with the model's prediction.

6 Discussion & Conclusion

θ reflects the borrower's credit worthiness. The interest rate that the lender is willing to charge the borrower for alternate-A products with low documentation is based on the lender's break even condition. The interest rate determines the threshold value of borrowers who would take on the mortgage, which implicitly sets the average credit risk of borrowers who receive one of these product types, given the distribution of θ in the economy. The p in

[35]The collateral value increases following BAPCPA because the policy change increases the recovery value of the collateral to a repo lender if a counterparty defaults.

the model can be thought of as capturing default risk in the economy. Since the market is competitive, other dealer-banks will have priced in the cost of originating mortgages given the distribution of θ and default risk in the economy.

The lender's cost of capital (or value of rehypothecating collateral) offsets the borrowers' credit worthiness in pricing the mortgage. Equation 12 shows that once BAPCPA increases the value of repledging the collateral (c^{PL}), the interest rate that the dealer levies on a borrower decreases, while the average credit worthiness of the borrowers, and the cost (p) associated with originating the mortgage do not change. Feeding the interest rate back into Equation 14 shows that the decrease in interest rate decreases the threshold value of θ at which borrowers will take out an alt-A mortgage.

Imagine for example, prior to BAPCPA, p and c^{PL} were such that the dealer-bank would charge a 6% interest rate, and only borrowers with a 750 credit score and above would take out the mortgage, such that $h_\theta = 1$. Note, here credit score indicates willingness to pay which reflects borrowers' ability to make mortgage payments. Post-BAPCPA, p does not change[36], however c^{PL} increases, which lowers the interest rate that dealer-banks charge to 4%. At 4%, both the 750 and 690 credit score borrowers are willing to take out the mortgage ($h_\theta = 1$).

Mortgage Price and Demand by Credit Score

	750	h_{750}	690	h_{690}
$BeforeBAPCPA$	6%	1	6%	0
$AfterBAPCPA$	4%	1	4%	1

If the $\overline{\theta} = 700$ then prior to BAPCPA, no borrowers would demand this product. Following the policy change, when the interest rate drops to 4%, all borrowers with a 690 to 700 credit score will demand the mortgage. This creates a demand stimulating mechanism that appears as if the dealer-bank is lending a new product (alt-A) mortgages to high income volatility, low documentation borrowers. However, according to the model, these alternative products always existed, however the price at which dealer-banks were willing to originate these products was above borrowers' reservation price.

As borrowers enter the alt-A market, the fraction of borrowers with alt-A mortgages increases relative to conforming mortgages. As a result the average credit score in the economy increases. However, post-BAPCPA, the credit scores required in the alt-A market are lower than those required prior to BAPCPA. In this sense, the increase in credit scores

[36] p does not adjust because dealers do not have time to learn about the default rate at a lower threshold θ, which brings new borrowers into the market. The dealer-banks do not have time to learn due to the speed of credit supply increase caused by the explosiveness of the repo money multiplier in Lewis (2023).

observed in the economy in the post-period was not sufficient to account for the increased risk of alt-A mortgages.

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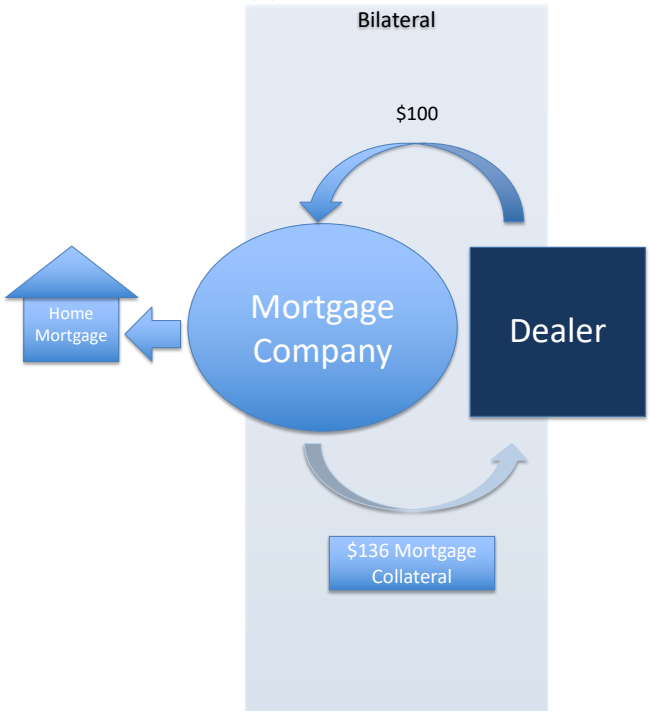
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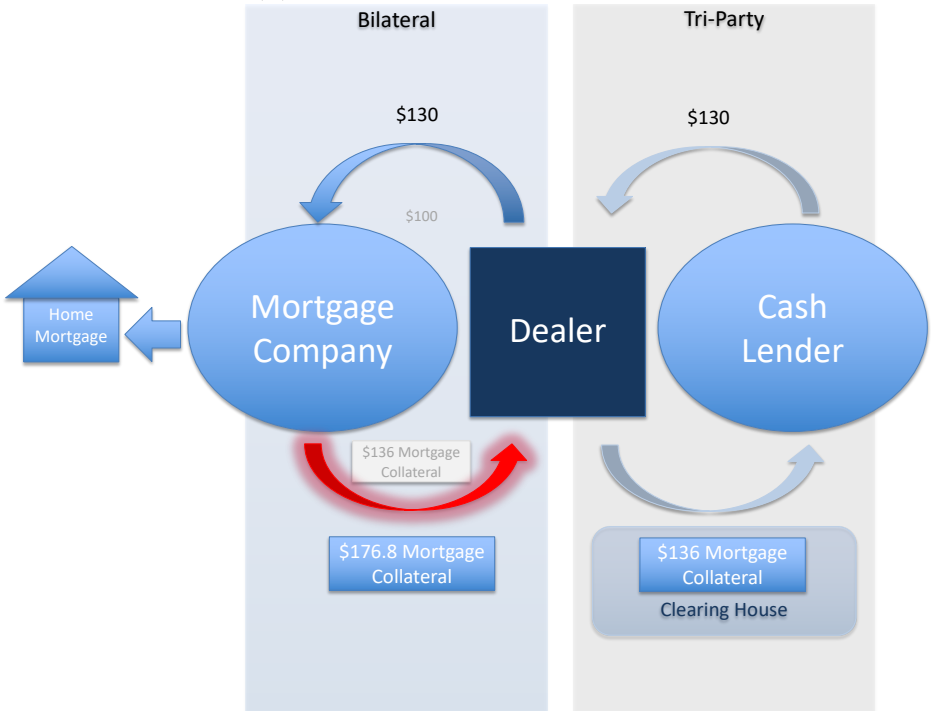
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FIGURE 1: REPO MARKETS BEFORE AND AFTER BAPCPA 2005

(a) Repo markets before BAPCPA

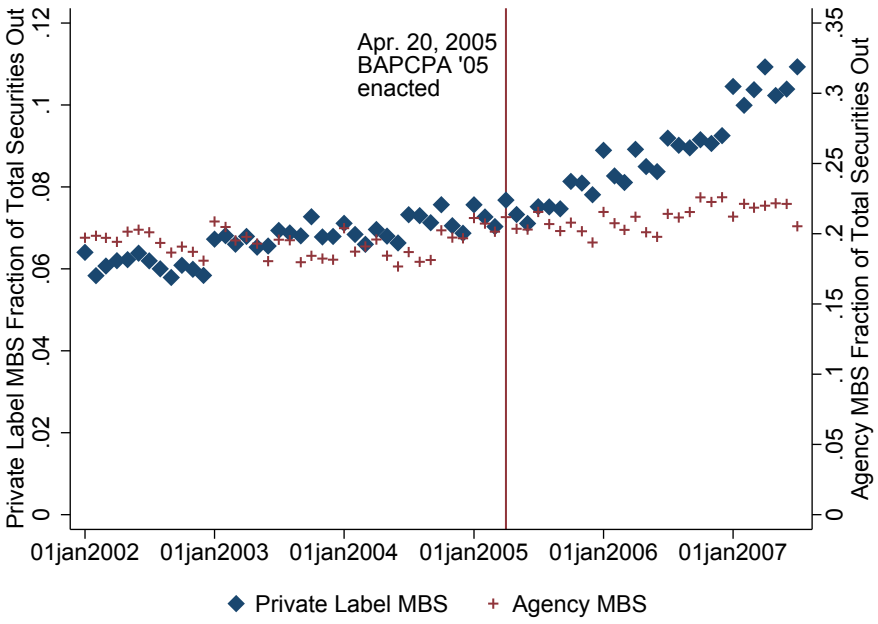


(b) Repo markets after BAPCPA



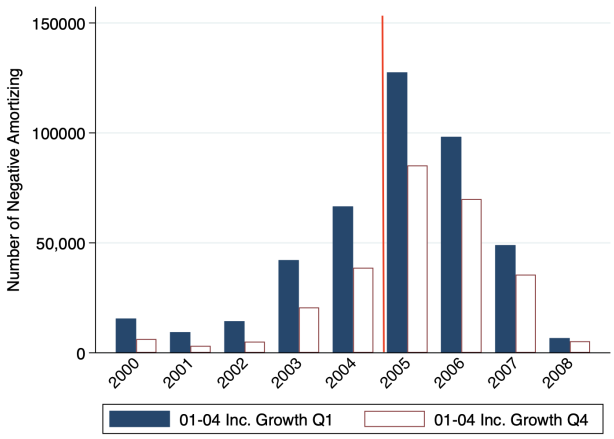
Notes: Figures depict the process by which a dealer can borrow and lend funds via the tri-party and bilateral repurchase market respectively, using the same underlying private-label mortgage collateral provided by the cash borrower for both contracts. Figure (a) depicts the "first round" of lending from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

FIGURE 2: DEALER BORROWING BACKED BY PRIVATE-LABEL VS. AGENCY MORTGAGE COLLATERAL

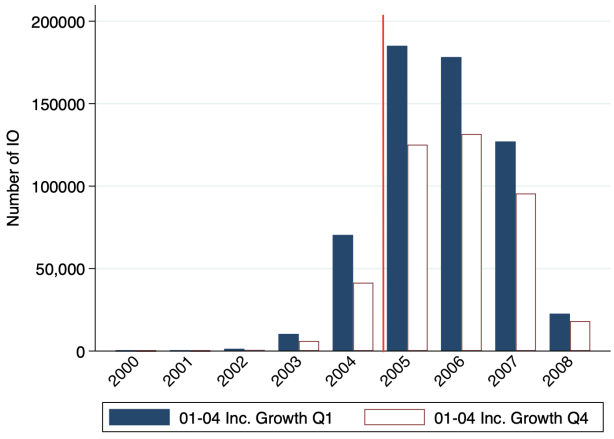


Notes: Figure plots the fraction of total primary dealer securities out that was made up of private-label MBS versus agency MBS pre and post BAPCPA. The variable corporate securities in the FR 2004 proxies for private-label MBS. Agency MBS is comprised of Federal Agency and GSE MBS in the FR 2004 data. Directly after BAPCPA, private-label MBS as a fraction of securities began to increase significantly relative to agency MBS. The evidence is consistent with dealers increasing their use of private-label mortgage collateral to borrow funds following BAPCPA.

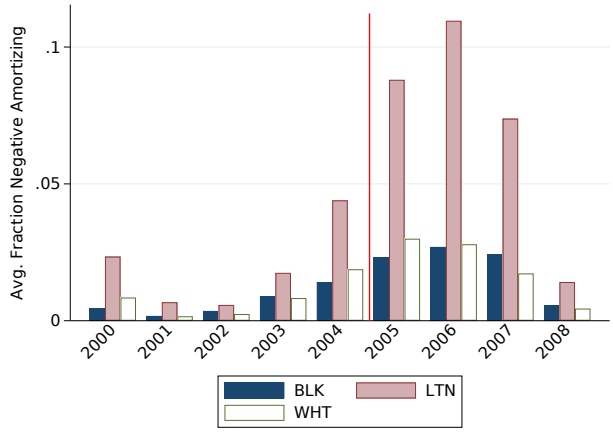
FIGURE 3: MORTGAGE PRODUCTS BY ZIP CODE INCOME QUARTILE AND RACE



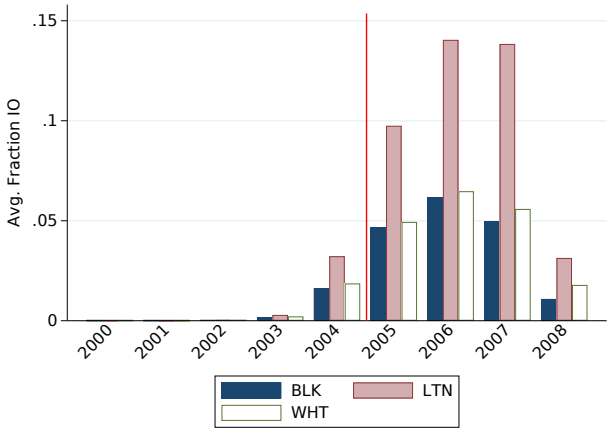
(a) Num. Negative Amortizing – Income Quartile



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



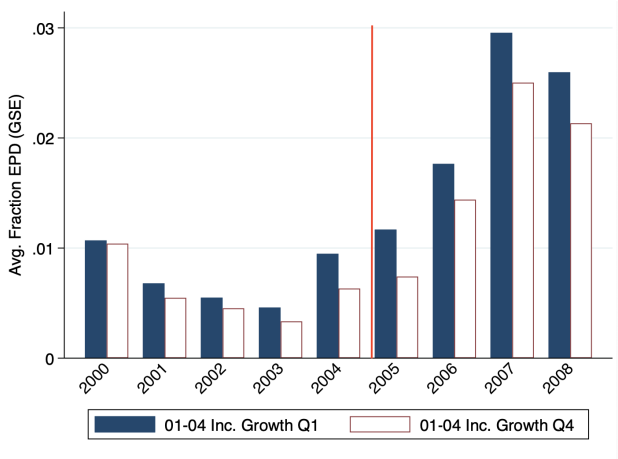
(c) Frac. Negative Amortizing – Race



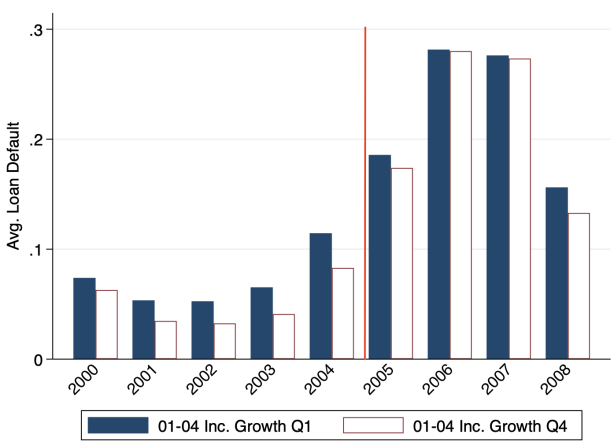
(d) Frac. Interest Only (IO) – Race

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.

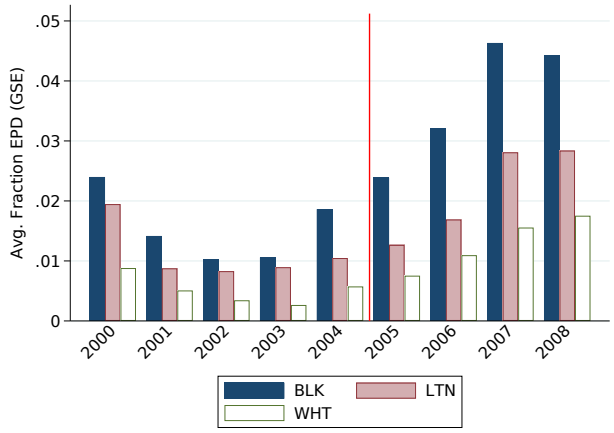
FIGURE 4: MORTGAGE DEFAULTS BY ZIP CODE INCOME QUARTILE AND RACE



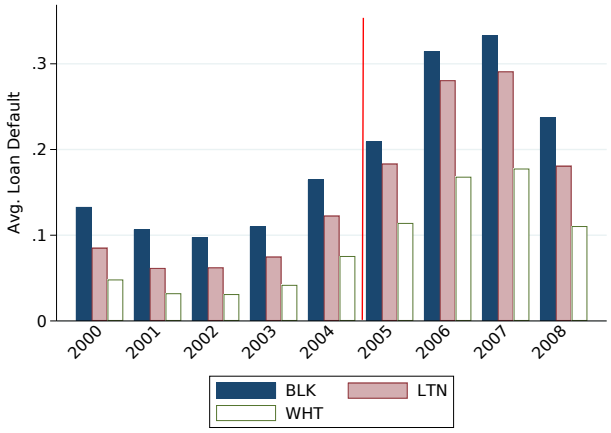
(a) EPD (GSE Measure) – By Income Quartile



(b) Total Defaults – By Income Quartile



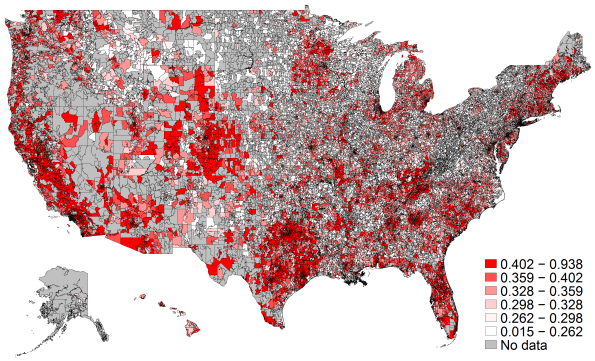
(c) EPD (GSE Measure) – By Race



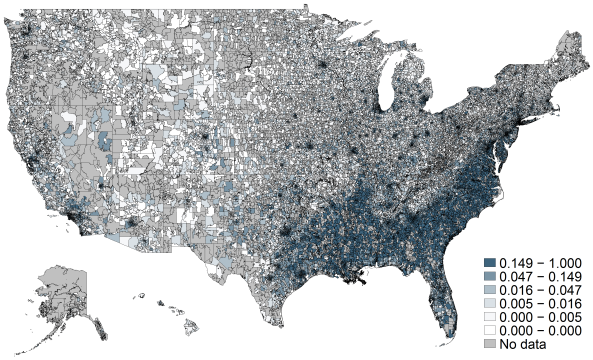
(d) Total Defaults – By Race

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 (Q1) and the highest quartile of income growth (Q4) between 2001 to 2004 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.

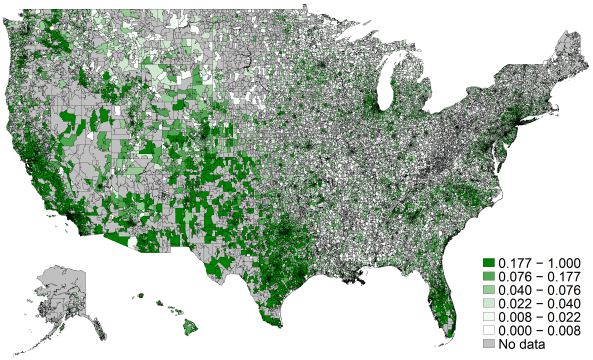
FIGURE 5: HEATMAPS



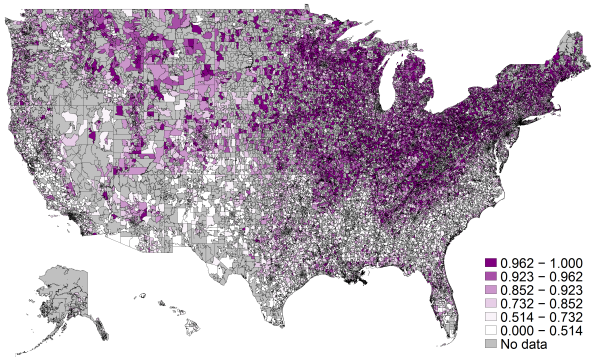
(a) Independent Mortgage Company (IMC) Market Share



(b) Population of Black Inhabitants



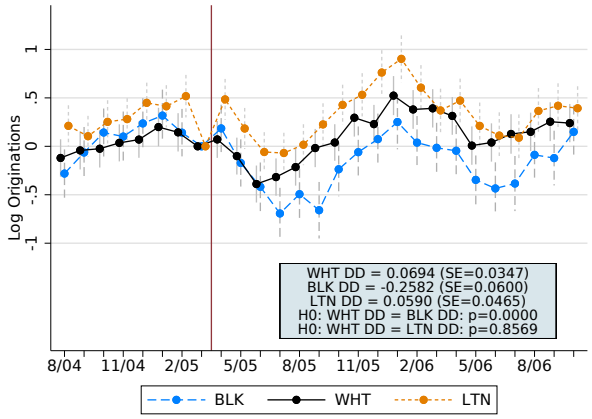
(c) Population of Latino Inhabitants



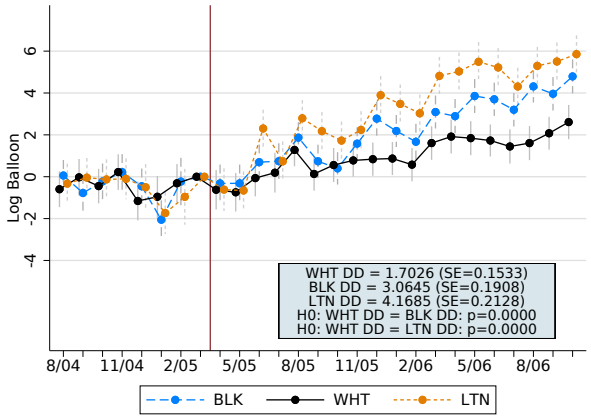
(d) Population of White Inhabitants

Notes: Panel (a) 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. Panels (b)-(d) depict 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.

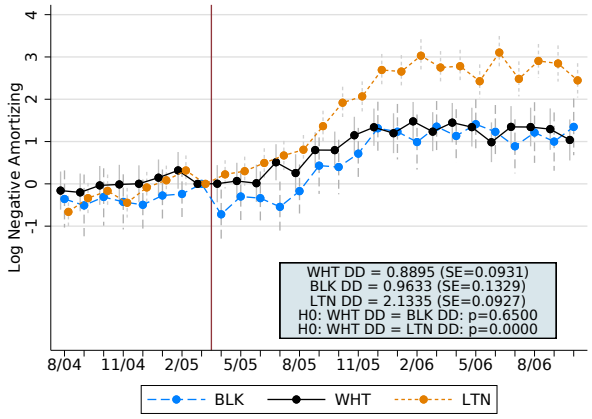
FIGURE 6: DIFFERENCE-IN-DIFFERENCES (DID) BY RACE SUBCATEGORIES - ORIGINATIONS & MORTGAGE PRODUCTS



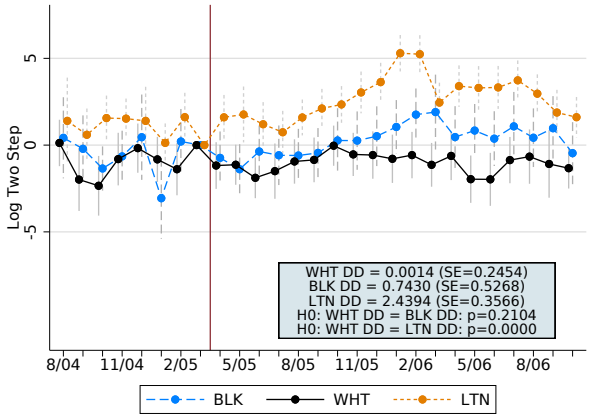
(a) Originations



(b) Balloon



(c) Negative Amortizing

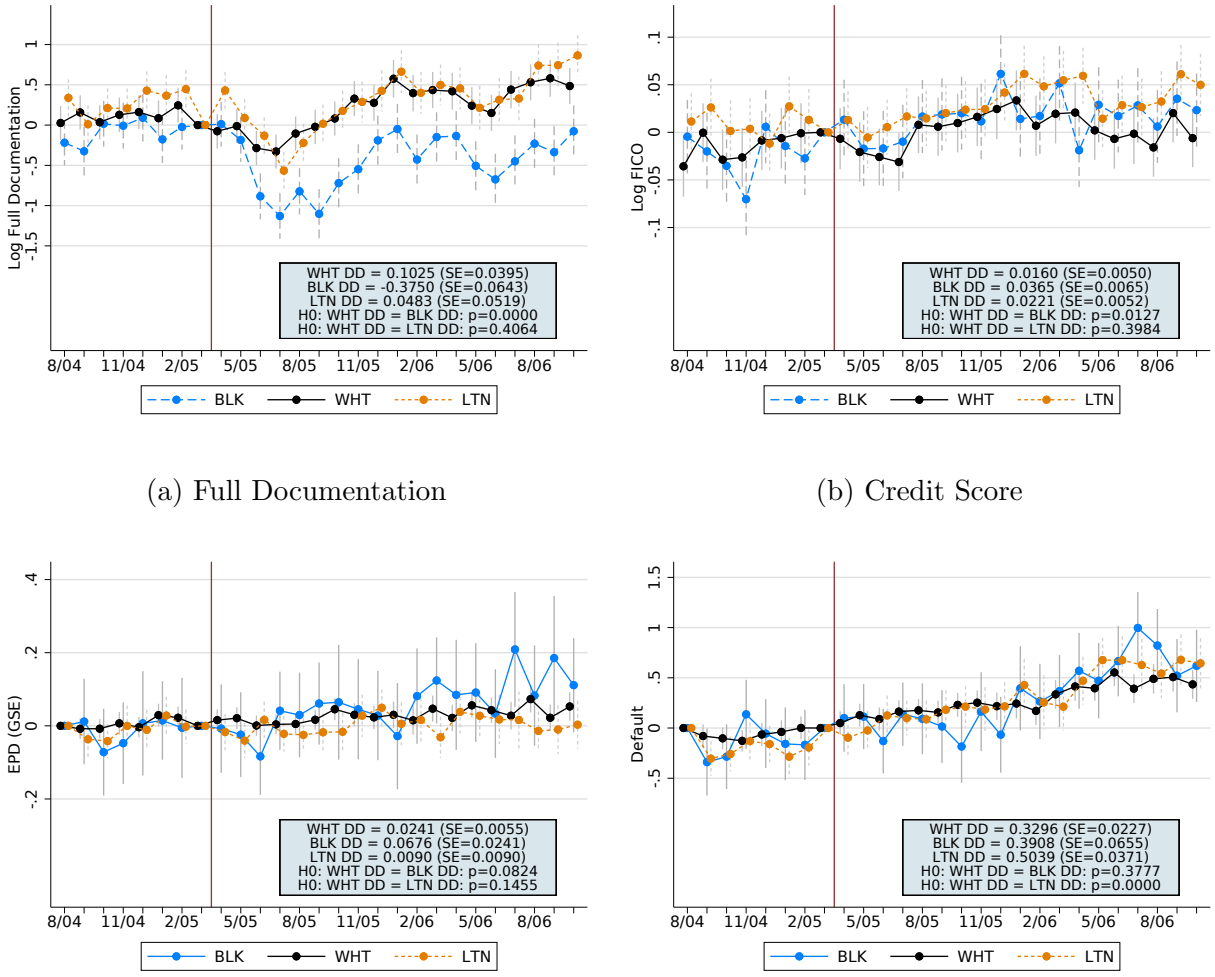


(d) Two Step

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

$$Y_{z,t} = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCMktShr_{z,04} \times \mathbb{1}_{t=T} + \epsilon_{z,t}. \tag{17}$$

FIGURE 7: DIFFERENCE-IN-DIFFERENCES (DID) BY RACE SUBCATEGORIES - BORROWER CHARACTERISTICS



(a) Full Documentation

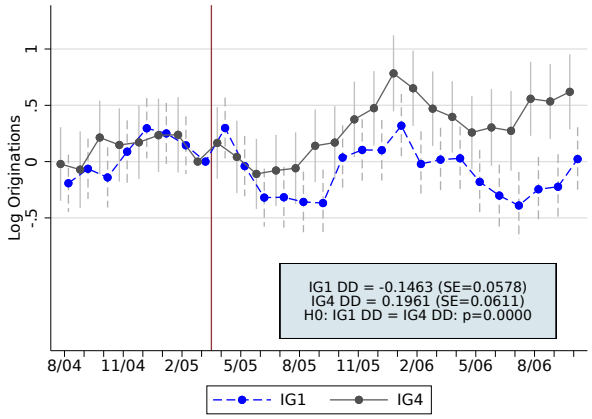
(b) Credit Score

(c) Early Payment Default

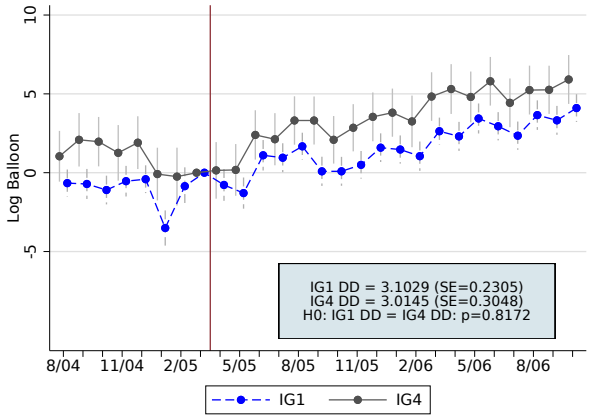
(d) Total Default

Notes: Panels a and b plot the dynamic response of the coefficient of interest β_T from Equation 4 by race subcategory. While panels c and d plot the dynamic response of the coefficient of interest from subsection 3.4. Where $\Gamma_{z,t}$ includes a control for the unemployment of a zip code in 2001 interacted with $Post_t$, and a measure of the home equity of the loan at the time of default.

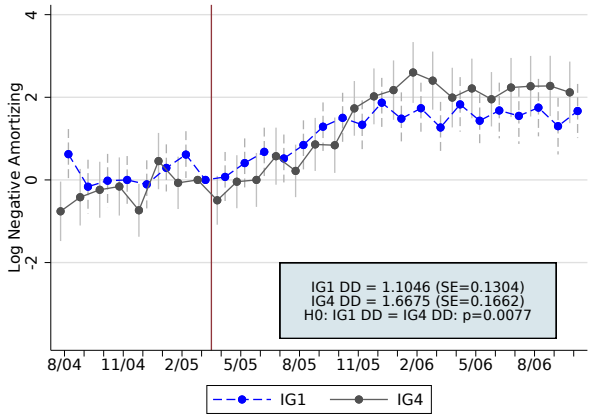
FIGURE 8: DIFFERENCE-IN-DIFFERENCES (DID) BY INCOME GROWTH SUBCATEGORIES - ORIGINATIONS & MORTGAGE PRODUCTS



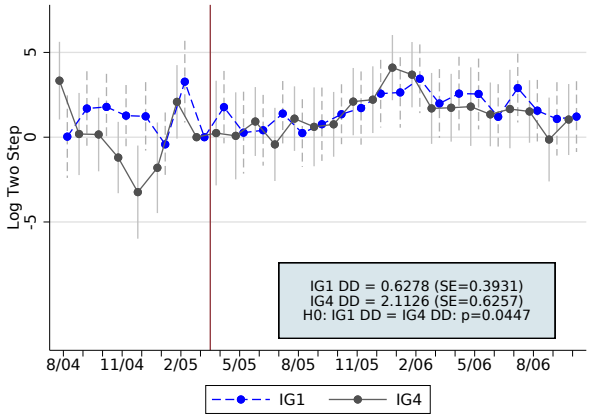
(a) Originations



(b) Balloon



(c) Negative Amortizing

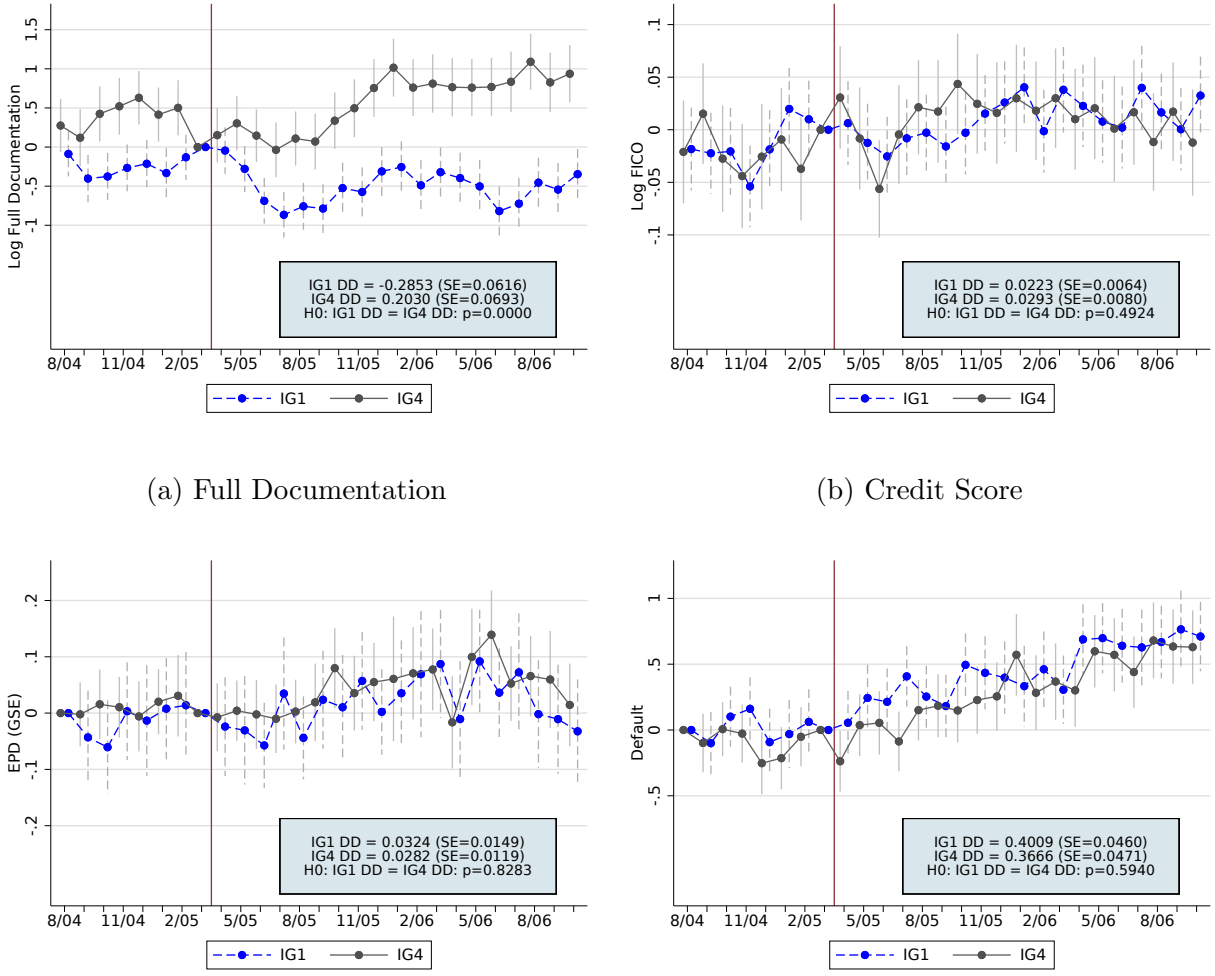


(d) Two Step

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 INCOME GROWTH SUBCATEGORIES - BORROWER CHARACTERISTICS



(a) Full Documentation

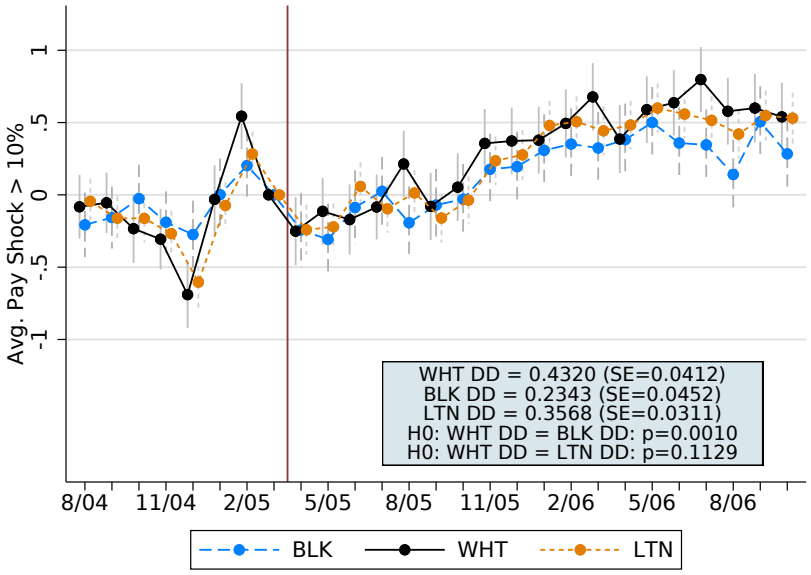
(b) Credit Score

(c) Early Payment Default

(d) Total Default

Notes: Panels a and b plot the dynamic response of the coefficient of interest β_T from Equation 4 for the top and bottom income growth quartile. While panels c and d plot the dynamic response of the coefficient of interest from subsection 3.4. Where $\Gamma_{z,t}$ includes a control for the unemployment of a zip code in 2001 interacted with $Post_t$, and a measure of the home equity of the loan at the time of default.

FIGURE 10: 10% PAY SHOCK



Notes: The figure depicts the likelihood of pay shocks for mortgages originated in zip codes with higher IMC market share pre- versus post-BAPCPA in majority Black, Latino, and white zip codes.

Table 1: Dealer Secured Borrowing using PLS Collateral

	(1) Fraction of Total Securities Out	(2) log(Securities Out)
Post	0.018***	0.423***
	(0.001)	(0.014)
PLS	-0.126***	-1.063***
	(0.001)	(0.020)
Post × PLS	0.004**	0.186***
	(0.002)	(0.027)
r2	0.9788	0.9172
N	582	582

Notes: Table reports the results from Equation 2. Regression is run on the FR 2004 data data from January 1, 2002 through July 31, 2007, where April 15, 2005 and after is considered the post period.

Table 2: Summary Statistics

	All	Above Median IMCMktShr	Below Median IMCMktShr
	(1)	(2)	(3)
Numbers of ZIP codes	36,092	18,046	18,046
Income	37,690	36,351	39,079
	(16,852)	(14,710)	(18,720)
%IncomeGrowth	7.79	7.41	8.20
	(8.43)	(8.53)	(8.30)
%HousingPriceGrowth(01-04)	25.99	28.51	22.99
	(19.73)	(20.87)	(17.80)
AverageHousingPrice	193,942	171,506	220,487
	(162,749)	(96,960)	(213,088)
%CollegeEducated	7.91	7.18	8.63
	(6.00)	(5.01)	(6.78)
%Unemployed	2.71	2.86	2.55
	(2.51)	(2.48)	(2.54)
%Black	7.23	10.00	4.46
	(15.76)	(18.83)	(11.28)
%Hispanic	6.69	9.37	4.02
	(14.56)	(16.47)	(11.76)
%White	81.54	75.72	87.35
	(23.85)	(26.36)	(19.37)

TABLE 3: Originations by Race

WHT

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Orig)		log(Balloon)		log(NegAm)		log(TwoStep)	
Post × IMCMktShr$_{z,04}$	0.004	0.069**	2.587***	1.703***	1.220***	0.889***	1.168***	0.001
	(0.026)	(0.035)	(0.134)	(0.153)	(0.070)	(0.093)	(0.223)	(0.245)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.92	0.93	0.34	0.47	0.81	0.83	0.12	0.29
N	502127	502058	66304	66055	150434	150245	12990	12460

BLK

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Orig)		log(Balloon)		log(NegAm)		log(TwoStep)	
Post × IMCMktShr$_{z,04}$	0.062**	-0.258***	2.096***	3.065***	0.817***	0.963***	0.481**	0.743
	(0.026)	(0.060)	(0.116)	(0.191)	(0.076)	(0.133)	(0.208)	(0.527)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.91	0.92	0.23	0.35	0.68	0.70	0.03	0.11
N	505314	505267	56352	56186	123375	123278	7661	7019

LTN

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Orig)		log(Balloon)		log(NegAm)		log(TwoStep)	
Post × IMCMktShr$_{z,04}$	0.021	0.059	3.264***	4.169***	1.580***	2.133***	1.566***	2.439***
	(0.023)	(0.047)	(0.128)	(0.213)	(0.063)	(0.093)	(0.201)	(0.357)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.92	0.93	0.34	0.47	0.81	0.83	0.12	0.29
N	502127	502058	66304	66055	150434	150245	12990	12460

TABLE 4: Characteristics and Performance by Race

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(FullDoc)		log(FICO)		loanEPDgse		loanDefault	
WHT								
Post × IMCMktShr$_{z,04}$	-0.072**	0.102***	0.024***	0.016***	0.024***	0.024***	0.443***	0.330***
	(0.031)	(0.040)	(0.003)	(0.005)	(0.004)	(0.006)	(0.021)	(0.023)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.88	0.89	0.22	0.22	0.01	0.02	0.09	0.11
N	430578	430492	484723	484655	736653	736514	736653	736514
BLK								
Post × IMCMktShr$_{z,04}$	-0.085***	-0.375***	0.029***	0.036***	0.030***	0.068***	0.433***	0.391***
	(0.029)	(0.064)	(0.003)	(0.007)	(0.005)	(0.024)	(0.022)	(0.065)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.87	0.88	0.23	0.23	0.01	0.02	0.09	0.11
N	431083	431051	486377	486336	736653	736514	736653	736514
LTN								
Post × IMCMktShr$_{z,04}$	-0.251***	0.048	0.024***	0.022***	0.023***	0.009	0.551***	0.504***
	(0.027)	(0.052)	(0.003)	(0.005)	(0.004)	(0.009)	(0.019)	(0.037)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.88	0.89	0.22	0.22	0.01	0.02	0.09	0.11
N	430578	430492	484723	484655	736653	736514	736653	736514

TABLE 5: Originations by by Income Growth Subcategories

	Income Quartile 1							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Orig)		log(Balloon)		log(NegAm)		log(TwoStep)	
Post × IMCMktShr$_{z,04}$	-0.036	-0.146**	2.710***	3.103***	1.244***	1.105***	1.138***	0.628
	(0.034)	(0.058)	(0.173)	(0.231)	(0.101)	(0.130)	(0.264)	(0.393)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.92	0.93	0.30	0.44	0.77	0.79	0.10	0.24
N	246182	246182	38624	38253	80326	80078	6869	6180
	Income Quartile 4							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Orig)		log(Balloon)		log(NegAm)		log(TwoStep)	
Post × IMCMktShr$_{z,04}$	0.125***	0.196***	3.058***	3.015***	1.600***	1.667***	1.398***	2.113***
	(0.036)	(0.061)	(0.188)	(0.305)	(0.104)	(0.166)	(0.278)	(0.626)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.92	0.93	0.30	0.44	0.77	0.79	0.10	0.24
N	246182	246182	38624	38253	80326	80078	6869	6180

TABLE 6: Characteristics and Performance by Income Growth Subcategories

	Income Quartile 1							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(FullDoc)		log(FICO)		loanEPDgse		loanDefault	
Post × IMCMktShr$_{z,04}$	-0.275***	-0.285***	0.030***	0.022***	0.021***	0.032**	0.464***	0.401***
	(0.039)	(0.062)	(0.004)	(0.006)	(0.007)	(0.015)	(0.031)	(0.046)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.88	0.90	0.25	0.26	0.01	0.02	0.09	0.11
N	217937	217935	239706	239706	306645	306595	306645	306595
	Income Quartile 4							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(FullDoc)		log(FICO)		loanEPDgse		loanDefault	
Post × IMCMktShr$_{z,04}$	-0.142***	0.203***	0.032***	0.029***	0.029***	0.028**	0.557***	0.367***
	(0.042)	(0.069)	(0.004)	(0.008)	(0.007)	(0.012)	(0.032)	(0.047)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.88	0.90	0.25	0.26	0.01	0.02	0.09	0.11
N	217937	217935	239706	239706	306645	306595	306645	306595

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

IMC Market Share 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 11 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.

2001-2004 Income Growth I also include the income growth distribution plotted against the two way fixed effects weights used in the estimation command. The distribution of income growth is relatively similar to the weights used in the twfe command, which demonstrates that the interpretation of the beta coefficient calculated is the average treatment effect.

[Figure 12 about here.]

C Difference-in-Differences Results for All Zip Codes

I estimate the treatment intensity research design in Equation 4 for all mortgages in the Corelogic LLMA data in a single regression. This analysis acts as foundation for the analyses that study distributional differences in the impact of these mortgages on different borrowers.

I estimate the regression for the following $Y_{z,t}$ variables: $\log(PurchaseOriginations_{z,t})$, $\log(Balloon_{z,t})$, $\log(NegAm_{z,t})$, $\log(TwoStep_{z,t})$, $\log(Initial\ Interest\ Rate_{z,t})$, and $\log(AvgFICO_{z,t})$ in zip code z, at month t, log is the natural logarithm. [37] γ_z denotes zip level fixed effects, and $\eta_{s,t}$ denotes $state \times month$ 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 coefficient on 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.

Figure 13 reports the regression results. As shown in Figure 13 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 13 panel (b) shows that a 10% increase in pre-period 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 13 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% average decrease 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 13 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

[37] This is the zip code level equivalent of the county level regression in Lewis (2023). 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 alternative mortgages at the zip code level and study differences in demographic groups in the body of the paper.

the policy change, a 10% increase in pre-period 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.[38] 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. 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 13 about here.]

D Triple Difference by IMC Market Share and Income Growth (Income Volatility)

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:

$$\begin{aligned} Y_{z,t} &= \mu\ IMCMktShr_{z,04} \times Post_t \\ &+ \nu\ IMCMktShr_{z,04} \times IncGrowth_z + \tau\ IncGrowth_z \times Post_t \\ &+ \beta\ IMCMktShr_{z,04} \times IncGrowth_z \times Post_t \\ &+ \gamma_z + \eta_{s,t} + \epsilon_{z,t}. \end{aligned} \tag{19}$$

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

[38] For IMCs, this could have been canabalizing FHA originations, and not be completely new borrowers who otherwise would not have received mortgages.

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. The triple difference measures the differential effect on mortgage originations of moving from 0% to 100% IMC market share, post- versus pre-shock, for zip codes with 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 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, borrowers may value 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 and 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. If high income volatility borrowers valued alternative products, these mortgages would be disproportionately originated among higher- relative to lower-income-volatility zip codes and the β coefficient on the triple interaction term would 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 IMC lending in high versus low income growth zip codes between the pre-period as well as in the post-period. It then calculates the difference between the pre-period versus the post-period and compares it to the analogous difference for bank lending. In Appendix B, I show that the population weighted doses of income growth are close to normally distributed and thus the TWFE estimator closely approximates the population weights, making any bias in the regression small.

D.1 Effects by Income Growth (Income Volatility) - Results

The results in Table 7 show that low-income growth, high-income variability, borrowers are statistically significantly more likely to receive alternative mortgage products following the

passage of BAPCPA. These results 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).

Table 7 shows 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 1.1 pp, the fraction of balloon originations by 0.48 pp, the fraction of hybrid originations by 1.3 pp, and the fraction of interest only (IO) originations by 1.7 pp. The fraction of two-step originations also increased 0.13 pp 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.

Following the increase in credit post-BAPCPA, Table 8, 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, although the coefficients are not significant.

[Table 7 about here.]

D.2 Effect of Income Growth on Additional Mortgage Products

In Table 8 I plot the regression results from Equation 19 for additional mortgage products. Although the coefficients are not significant, following the increase in credit post-BAPCPA, Table 8 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 8 about here.]

E Mortgage Acceptance Rates

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:

$$\begin{aligned} Accepted_b = \alpha post_t + \delta IMC_b + \lambda RACE_b \\ +\rho IMC_b \times post_t + \zeta IMC_b \times RACE_b + \xi post_b \times RACE_b \\ +\beta IMC_b \times \%Race_b \times Post_t \\ +\gamma_c + \eta_{s,t} + \epsilon_b. \end{aligned} \tag{20}$$

Where $Accepted_b$ is an indicator variable, for borrower b, 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.

While BAPCPA increased credit score (modestly) for Alt-A originations, it lowered credit score for subprime mortgages – which were fully amortizing mortgages with a credit score below 660. Traditional subprime mortgages would allow borrowers who were were able to make the full mortgage payment of a fully amortizing loan to receive mortgages at lower credit scores. 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 and requiring higher credit standards on these products and originating Alt-A products which required

modestly higher credit standards in minority zip codes. 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 more binding for minority households than for white households, conistent with the higher originations of Alt-A products depicted in Figure 6.

Table 9 presents the results of Equation 20. 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/income constraint.

[Table 9 about here.]

F Poisson Regressions

In this section, I estimate the Poisson regressions of the form:

$$Y_{z,t} = \gamma_z + \eta_{s,t} + IMCMktShr_{z,04} \times Post_t + \epsilon_{z,t}$$

Where $Y_{z,t}$ is the number of balloon, negative amortizing, two step, and interest only mortgages originated in a given zip code in a given month. γ_z are zip code fixed effects and $\eta_{s,t}$ are state $\times$ origination month fixed effects. $IMCMktShr_{z,04}$ is the market share of independent mortgage companies operating in a given zip code in 2004 and $Post_t$ is an indicator equal to 1 in April 2005 and after, and equal to zero otherwise.

I estimate each of these regressions separately by racial subgroup. I am estimating a difference-in-differences research design within each racial subgroup. This means that the coefficient of interest is capturing the differential increase in mortgage originations of a given product type in the post-period, over and above the pre-period level within zip codes of a different racial subgroup. In the following figures, I find that in all of the specifications, the number of these alternative products originated in Latino zip codes outpaced the number of originations in majority white or Black zip codes.

[Table 10 about here.]

G Matching the CoreLogic NARMBS Originators to HMDA

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 broadly 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. The data then use HMDA's definition of an IMC. A detailed description of the matching process is below.

The matching process for originators in CoreLogic NARMBS and HMDA used an algorithm that generated best matches based on name similarity and the years in which each entity operated. The matching utilized the crosswalk maintained by Robert Avery, which matches subsidiaries operating in the HMDA data to their parent. Year an entity operated was determined using the year the mortgage was originated in CoreLogic and matching it to the year an entity operated in the Avery file. Matching was performed in several rounds: first on the originator name in CoreLogic to the HMDA NAME column in the Avery file, then the HMDA NAMES column for any unmatched CoreLogic orignators, and then using the HMDA NAMEOR column etc. After all rounds were completed, a manual check was conducted.

The matching algorithm for each round proceeds as follows. First, all originator names from both NARMBS and HMDA were capitalized. Then the `matchit` command in Stata was used to compile a list of possible matches between each originator name in NARMBS and the corresponding column in HMDA (either NAME, NAMES, NAMEOR or PARENT). For these possible matches (multiple HMDA originators could be matched to a single NARMBS originator), matches were dropped if the first word of the NARMBS originator name did not match the first word of the HMDA originator name, if the years in which the matched originators operated differed more than 3 years, and if the second words for the originator names did not match for cases where there were over 200 HMDA orginators matched to one NARMBS originator. Matches were marked for later manual checks at this round if there was only 1 word in the NARMBS originator name and there were more than 99 HMDA matches. Then, matches were further filtered through if the name was an exact match, if the second word matched, or if the match was one of the top 5 matches based on the metric produced by `matchit`, similscore. Finally, if there was an exact name match available, the exact name closest to the NARMBS origination year was used. If there was no exact name match available, the match closest to the NARMBS origination year with the highest similscore was used.

After all the rounds of matching were completed, the matches generated by the algo-

rithm were inspected by hand. Matches were dropped if the names differed significantly (for example "Associated Mortgage Center, Inc" and "Associated Mortgage, Inc") or if the NARMBS originator name was too ambiguous or common to link it to another entity in HMDA (for example "First Bank"). After this final manual inspection, 2,148 originators in NARMBS were matched to an originator in HMDA. This represents 10.3% of the originators in NARMBS.

Using the NAMRBS data, I estimate the following regression by racial subgroups:

$$Y_l = \gamma_z + \eta_{s,t} + \mu IMCoriginator_l + \beta IMCoriginator_l \times Post_t + \epsilon_{z,t}$$

Where Y_l represents an indicator variable equal to one if the mortgage is a balloon mortgage or a negative amortizing mortgage. I find that both balloon and negative amortizing mortgage originations increase disproportionately post BAPCPA if the mortgage was originated by an IMC. The effects are strongest in minority dominant zip codes.

[FIGURE 14 about here.]

H Controlling for Income Growth Quartile in the Racial Subgroup Regressions

As a robustness to Equation 4, I estimate the following DiD specification comparing zip codes with high- versus low-2004 market share of IMCs pre- versus post-policy change including a control for income growth of a zip code from 2001 to 2004 interacted with the post period. I estimate the regression separately for each racial subgroup:

$$Y_{z,t} = \gamma_z + \eta_{s,t} + \beta Post_t \times IMCMktShr_{z,04} + \delta Post_t \times IncGrowth_z + \epsilon_{z,t}. \quad (21)$$

Where all variables are defined as in the main draft. I interact $Post_t$ with $IncGrowth_z$ to allow areas with high- versus low-income-growth to behave differently following the policy change. I estimate that regression separately in the majority WHT, BLK, and LTN zip codes and report the results in Table 11 and Table 12. I find that majority BLK and LTN zip codes still experience a statistically significant increase in alternative mortgages that is larger than the increase for WHT zip codes, even controlling for income growth (proxying for income volatility). These results are consistent with racial makeup of a zip code differentially affecting the types of mortgages originated post BAPCPA, which cannot be explained by income volatility alone.

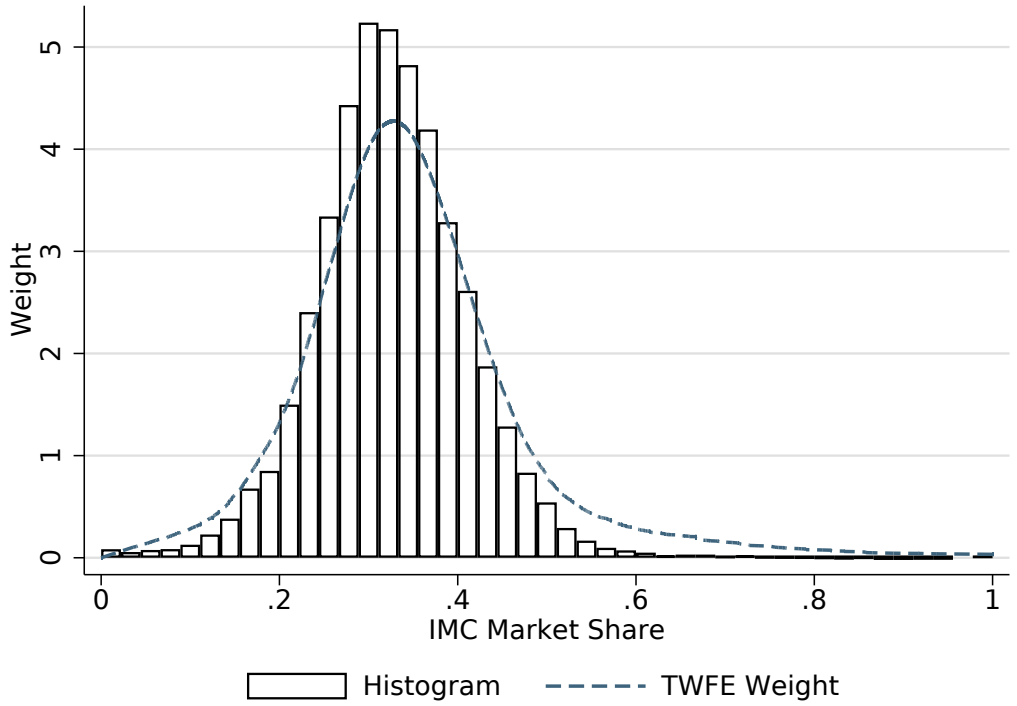
[Table 11 about here.]

[Table 12 about here.]

[Table 13 about here.]

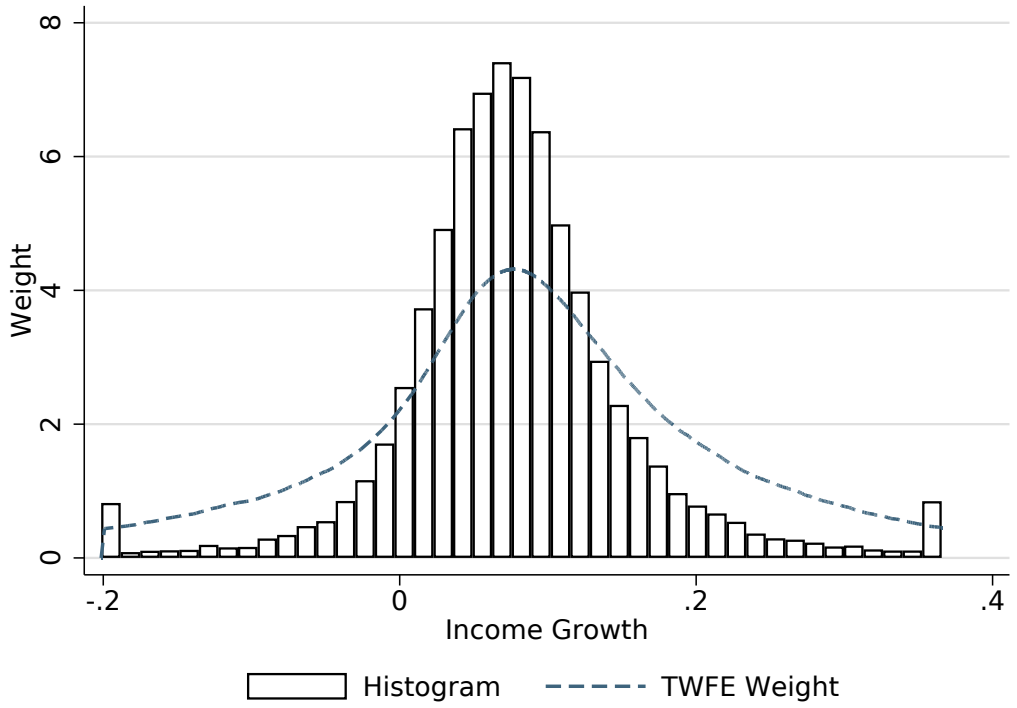
[Table 14 about here.]

Figure 11: Continuous DID Weights - IMC Market Share



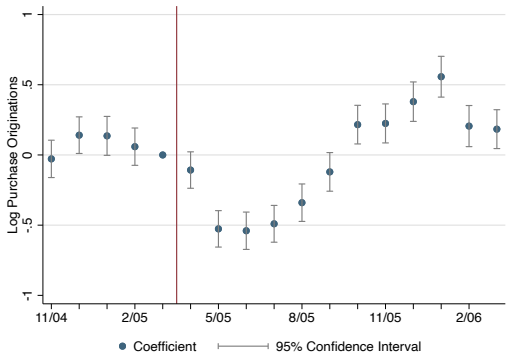
Notes: The figure plots the distribution of the actual treatment variable, $IMCMktShr_{z,04}$ against the weights applied in the continuous difference-in-differences or two-way fixed effects specification.

FIGURE 12: CONTINUOUS DID WEIGHTS - INCOME GROWTH

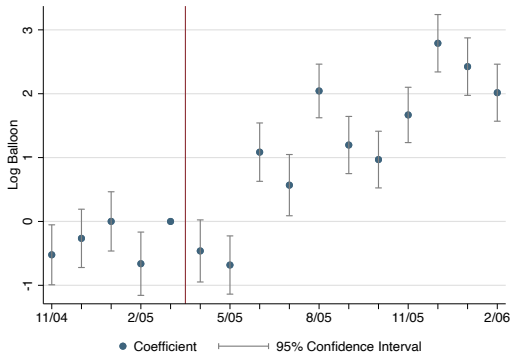


Notes: The figure plots the distribution of the actual treatment variable, income growth in a zip code from 2001 to 2004 ($IncGrowth_z$) against the weights applied in the continuous difference-in-differences or two-way fixed effects specification.

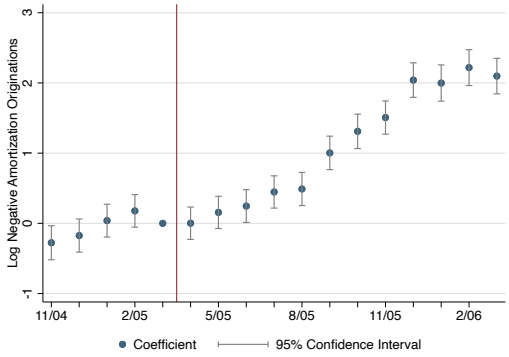
FIGURE 13: ZIP IMC MARKET SHARE EFFECT ON MORTGAGE ORIGINATIONS



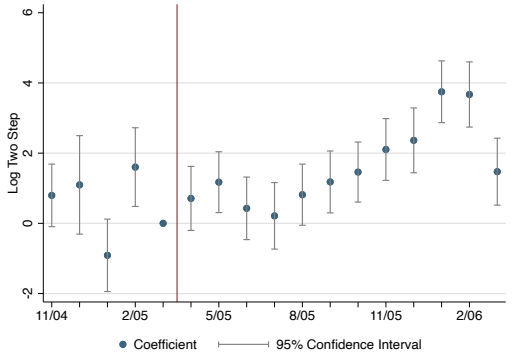
(a) Total Purchase Originations



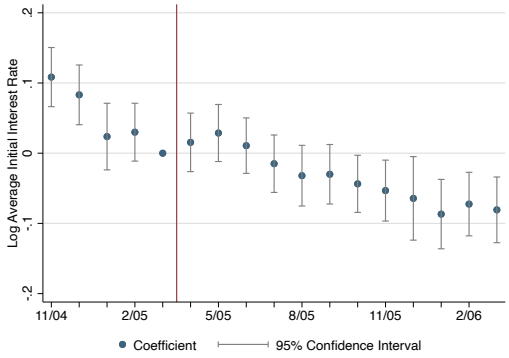
(b) Balloon Originations



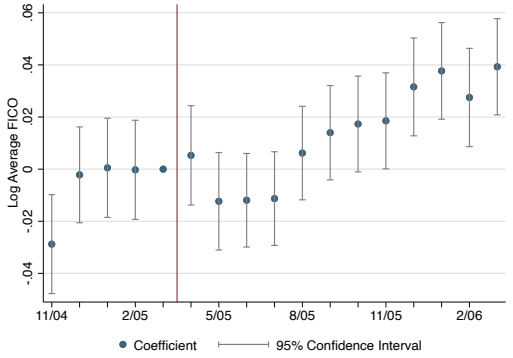
(c) Negative Amortizing Originations



(d) Two Step Originations



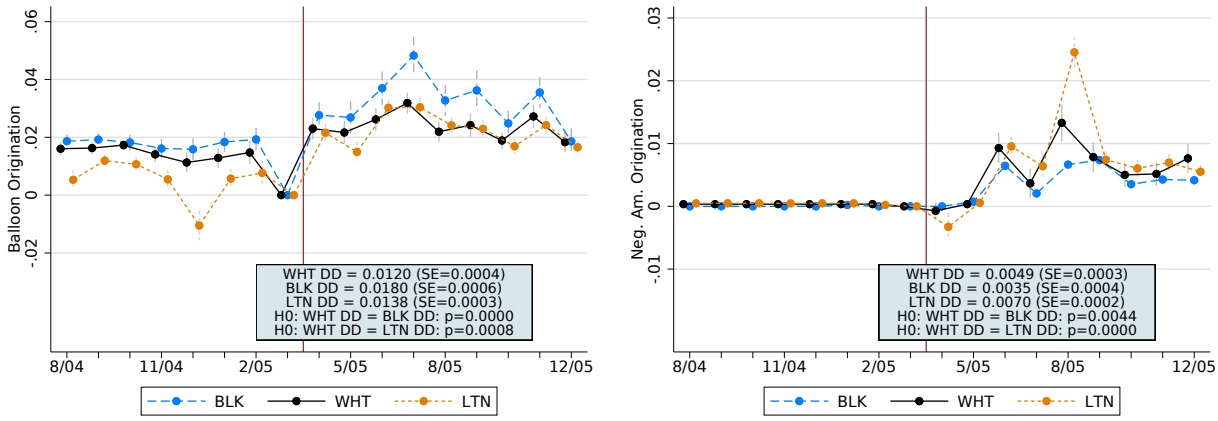
(e) Initial Interest Rate



(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 on the entire sample, not by racial or income growth subgroup. 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 with higher credit score and lower initial interest rate, relative to less exposed regions.

FIGURE 14: LOAN LEVEL DID BY RACE SUBCATEGORIES - BORROWER CHARACTERISTICS



(a) Balloon

(b) Negative Amortizing

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

$$Y_l = \gamma_z + \eta_{s,t} + \sum_T \beta_T IMCoriginator_l \times \mathbb{1}_{t=T} + \epsilon_l. \tag{22}$$

TABLE 7: Differential Effect of Treatment on Low Income Growth Zip Codes

	Product Types				
	(1) logorig	(2) fracballoon	(3) fracnegam	(4) fractwostep	(5) fracio
Post × $IMCMktShare_{z,04}$	-0.1596***	0.0450***	0.0467***	0.0031***	0.0270***
	(0.0377)	(0.0023)	(0.0061)	(0.0011)	(0.0064)
Post × $IncGrowth_z$	-0.5505***	0.0093	0.0374*	0.0045	0.0600***
	(0.1110)	(0.0062)	(0.0216)	(0.0036)	(0.0212)
Post × $IMCMktShare_{z,04}$ × $IncGrowth_z$	1.8982***	-0.0481**	-0.1109*	-0.0130	-0.1738***
	(0.3276)	(0.0192)	(0.0649)	(0.0115)	(0.0641)
cons	2.4852***	-0.0027***	0.0168***	0.0002	0.0407***
	(0.0091)	(0.0006)	(0.0015)	(0.0002)	(0.0015)
ZipFE	Yes	Yes	Yes	Yes	Yes
StatexMonthFE	Yes	Yes	Yes	Yes	Yes
r2	0.9274	0.0968	0.3896	0.0742	0.3227
N	491717	491717	491717	491717	491717

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 19. 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 8: Differential Effect of Treatment on Low Income Growth Zip Codes

	Additional Product Types			
	(1)	(2)	(3)	(4)
	fracarm	fracnodoc	fraclowdoc	fracfulldoc
Post × $\text{IMCMktShare}_{z,04}$	-0.0496***	0.0111**	-0.0368**	-0.0557***
	(0.0153)	(0.0048)	(0.0158)	(0.0194)
Post × IncGrowth_z	-0.0965**	0.0070	0.0461	-0.0724
	(0.0484)	(0.0152)	(0.0486)	(0.0608)
Post × $\text{IMCMktShare}_{z,04}$ × IncGrowth_z	0.2685*	-0.0377	-0.1004	0.1407
	(0.1428)	(0.0465)	(0.1416)	(0.1806)
cons	0.2459***	0.0176***	0.2535***	0.4475***
	(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	491717	491717	491717	491717

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 19. 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 9: HMDA Mortgage Acceptance Rates by Race

	Acceptance Rate		
	(1)	(2)	(3)
	BLK	LTN	WHT
Race	-0.066***	-0.010*	0.250***
	(0.005)	(0.005)	(0.005)
$IMC_{z,04}$	-0.129***	-0.135***	-0.070***
	(0.006)	(0.005)	(0.004)
$IMC_{z,04}$ × Race	0.079***	0.128***	-0.049***
	(0.006)	(0.005)	(0.004)
Post × Race	0.021***	0.022***	-0.018***
	(0.002)	(0.002)	(0.002)
$IMC_{z,04}$ × Post	0.111***	0.111***	0.073***
	(0.003)	(0.003)	(0.003)
Race × $IMC_{z,04}$ × Post	-0.055***	-0.066***	0.030***
	(0.004)	(0.004)	(0.003)
Constant	0.471***	0.466***	0.315***
	(0.002)	(0.001)	(0.002)
StatexYearFE	Yes	Yes	Yes
CountyFE	Yes	Yes	Yes
$r2_a$	0.02	0.02	0.07
N	185792947	185792947	185792947

TABLE 10: Originations by Race (Poisson)

WHT

	(1) Negative Amortizing	(2) Balloon	(3) Hybrid	(4) Two Step	(5) Interest Only
Post × $\text{IMCMktShr}_{z,04}$	2.355***	8.644***	-3.486***	-2.341***	1.780***
	(0.145)	(0.214)	(0.182)	(0.480)	(0.160)
StatexMonthFE	Yes	Yes	Yes	Yes	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes
$r2_p$	0.62	0.42	0.49	0.18	0.73
N	1352431	1645281	2058357	418095	1457832

BLK

	(1) Negative Amortizing	(2) Balloon	(3) Hybrid	(4) Two Step	(5) Interest Only
Post × $\text{IMCMktShr}_{z,04}$	2.086***	6.773***	-2.541***	-3.086***	1.486***
	(0.202)	(0.303)	(0.178)	(0.478)	(0.174)
StatexMonthFE	Yes	Yes	Yes	Yes	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes
$r2_p$	0.64	0.42	0.54	0.24	0.76
N	429004	536114	622693	187644	432426

LTN

	(1) Negative Amortizing	(2) Balloon	(3) Hybrid	(4) Two Step	(5) Interest Only
Post × $\text{IMCMktShr}_{z,04}$	4.665***	14.122***	-3.252***	1.193**	2.172***
	(0.098)	(0.244)	(0.137)	(0.468)	(0.100)
StatexMonthFE	Yes	Yes	Yes	Yes	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes
$r2_p$	0.75	0.47	0.58	0.39	0.83
N	470190	539949	611401	242151	501909

TABLE 11: Originations by Race (Robustness)

WHT

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Orig)		log(Balloon)		log(NegAm)		log(TwoStep)	
Post × IMCMktShr$_{z,04}$	-0.036	0.039	2.710***	1.541***	1.127***	0.653***	1.251***	-0.262
	(0.031)	(0.042)	(0.156)	(0.175)	(0.086)	(0.123)	(0.245)	(0.327)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.91	0.92	0.36	0.49	0.81	0.83	0.12	0.30
N	389530	389461	55925	55673	117263	117084	10769	10225

BLK

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Orig)		log(Balloon)		log(NegAm)		log(TwoStep)	
Post × IMCMktShr$_{z,04}$	0.043	-0.276***	2.197***	2.860***	0.797***	0.974***	0.619***	0.733
	(0.029)	(0.063)	(0.128)	(0.204)	(0.086)	(0.144)	(0.238)	(0.555)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.90	0.91	0.24	0.36	0.65	0.68	0.04	0.11
N	407411	407365	49816	49625	101110	101011	6581	5913

LTN

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(Orig)		log(Balloon)		log(NegAm)		log(TwoStep)	
Post × IMCMktShr$_{z,04}$	-0.011	-0.030	3.414***	4.377***	1.550***	2.246***	1.638***	2.515***
	(0.026)	(0.057)	(0.146)	(0.267)	(0.076)	(0.119)	(0.223)	(0.390)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.91	0.92	0.36	0.49	0.81	0.83	0.12	0.30
N	389530	389461	55925	55673	117263	117084	10769	10225

TABLE 12: Characteristics and Performance by Race (Robustness)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WHT	log(FullDoc)		log(FICO)		loanEPDgse		loanDefault	
$IncGrowth_z \times Post$	0.117***	0.066**	0.003	0.005	0.014***	0.005	0.172***	-0.042**
	(0.031)	(0.030)	(0.003)	(0.003)	(0.004)	(0.005)	(0.022)	(0.019)
$Post \times IMCMktShr_{z,04}$	-0.177***	0.000	0.026***	0.018***	0.028***	0.026***	0.488***	0.293***
	(0.036)	(0.048)	(0.004)	(0.006)	(0.005)	(0.008)	(0.024)	(0.030)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$r2_a$	0.87	0.88	0.21	0.21	0.01	0.02	0.09	0.11
N	345595	345515	379557	379486	613420	613289	613420	613289
BLK	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(FullDoc)		log(FICO)		loanEPDgse		loanDefault	
$IncGrowth_z \times Post$	0.146***	0.001	0.001	0.004	0.014***	0.005	0.172***	-0.042**
	(0.031)	(0.031)	(0.003)	(0.003)	(0.004)	(0.005)	(0.022)	(0.019)
$Post \times IMCMktShr_{z,04}$	-0.133***	-0.430***	0.030***	0.032***	0.035***	0.071***	0.492***	0.335***
	(0.032)	(0.069)	(0.003)	(0.007)	(0.006)	(0.027)	(0.024)	(0.070)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$r2_a$	0.86	0.87	0.22	0.23	0.01	0.02	0.09	0.11
N	359643	359604	395930	395889	613420	613289	613420	613289
LTN	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	log(FullDoc)		log(FICO)		loanEPDgse		loanDefault	
$IncGrowth_z \times Post$	0.117***	0.066**	0.003	0.005	0.014***	0.005	0.172***	-0.042**
	(0.031)	(0.030)	(0.003)	(0.003)	(0.004)	(0.005)	(0.022)	(0.019)
$Post \times IMCMktShr_{z,04}$	-0.326***	-0.071	0.025***	0.021***	0.027***	0.005	0.600***	0.446***
	(0.031)	(0.066)	(0.003)	(0.007)	(0.005)	(0.011)	(0.022)	(0.044)
StatexMonthFE	No	Yes	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$r2_a$	0.87	0.88	0.21	0.21	0.01	0.02	0.09	0.11
N	345595	345515	379557	379486	613420	613289	613420	613289

TABLE 13: Pay Shock $\geq 10\%$ by Race

	(1)	(2)	(3)	(4)	(5)	(6)
	WHT		BLK		LTN	
Post $\times$ IMCMktShr$_{z,04}$	0.216***	0.432***	0.236***	0.234***	0.053**	0.357***
	(0.028)	(0.041)	(0.026)	(0.045)	(0.024)	(0.031)
StatexMonthFE	No	Yes	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes	Yes	Yes
r2$_a$	0.16	0.24	0.15	0.23	0.16	0.24
N	235027	234938	223741	223693	235027	234938

TABLE 14: Pay Shock $\geq 10\%$ by Income Group

	(1)	(2)	(3)	(4)
	IG1		IG4	
Post $\times$ IMCMktShr$_{z,04}$	0.204***	0.340***	0.054*	0.339***
	(0.031)	(0.047)	(0.032)	(0.054)
StatexMonthFE	No	Yes	No	Yes
ZipFE	Yes	Yes	Yes	Yes
r2$_a$	0.16	0.25	0.16	0.25
N	128025	127929	128025	127929