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A Changing Credit Environment and Its Impact on Low-Income and Minority Borrowers and Communities

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A. Introduction

The recent tumult experienced by residential mortgage markets in the United States has left many struggling to determine what caused the crisis; what can be done to prevent a future crisis; and what can be done to mitigate the consequences of the crisis that resulted. These are big and important questions, and accurately resolving them requires a clear and precise understanding of what actually transpired over the past several years.

This paper provides an empirical analysis of a key five-year period—2004 through 2008—that was characterized by changing credit standards and, potentially, varying use of risk-based pricing ("RBP"). We broadly explore these changes in the market's "management" of credit risk, and the impact that these changes have had on low-income and minority borrowers and neighborhoods.

Some have speculated that the current crisis has its roots in the expansion of risk-based pricing to residential mortgage markets and, but for that expansion, we would not be in the predicament we are in today. Our view is that the roots of the crisis are far more complex, and that, more importantly, risk-based pricing is just one aspect of market risk management. In the United States in recent years, default and credit risk has been broadly managed through the use of submarkets/channels (prime versus FHA versus subprime), with different credit standards and pricing guidelines adopted within each submarket. We explore this dynamic, and attempt to assess its impact on overall market outcomes.

Our data include information on all mortgage originations for a sample of top-twenty lenders from 2004 through 2008. Our measure of default- or credit-risk for each loan is its cumulative default rate ("CDR"), estimated as the probability that a loan will ever go into default over its lifetime (i.e., ever become REO or ever go into a foreclosure alternative status). Our measure of each loan's price is its reported annual percentage rate ("APR"). We assess the extent of the adoption of RBP by looking at the relationship between APR and CDR—the more that APR increases with CDR, the greater the adoption of RBP.

Using these metrics we compare how changes over the years 2004 through 2008 have differentially affected the access and cost of credit for low-income and minority borrowers and neighborhoods. We also attempt to decompose the impacts of changing submarket shares and the differing credit standards (access to credit) and pricing of default risk within each submarket. We conclude with a discussion of the policy implications of our empirical findings. We note,

among other things, that the period 2004 to 2006 experienced a real "democratization" of credit, and that risk-based pricing, at least in our analysis, is far from the unmitigated evil it is sometimes portrayed to be.

B. Background and Relevant Literature

The expansion of credit during the last decade resulted from a confluence of changes. Public policy emphasized the benefits of a general growth of home ownership rates, and focused on the specific reduction of homeownership gaps between minority and non-minority households and between higher- and lower-income populations. Mortgage market changes also reflected the impact of low credit spreads and an influx of capital in search of a high return. Without reduced credit spreads, which provided potential profitability from the expansion of lending, the policy goals of expanding homeownership may not have been so readily adopted. It was this coincidence of the alignment of tightened spreads and homeownership-focused public policy that encouraged and supported the movement into higher risk lending.

The expanded availability of credit was rapid, with just a few voicing any contemporaneous concerns about that expansion. Critics included Collins, Belsky and Case (2004), who stated that "The emergence of risk assessment tools, particularly regarding an applicant's willingness to pay, in theory can help overcome inefficiencies due to imperfect information available to lenders. This has the potential to complete an otherwise truncated market, add to allocative efficiency, and potentially increase the positive externalities of homeownership. Each of these gains, however, is conditional on how the subprime industry matures and on prevailing consumer and lender practices. Mis-pricing, principal agent distortions and asymmetric information are all potential threats."[1]

Change in residential mortgage markets was facilitated by key developments in four broad areas—regulation, technology, securitization, and innovative homeownership-qualifying products. Developments in these four areas changed the entire structure of mortgage markets, as evidenced by a shift toward risk-based pricing, an increased reliance on non-agency securitization, and changes in the market share of different financial institutions (particularly the shares of federally regulated depositories compared to the shares of independent mortgage

[1] See Collins, Belsky and Case (2004).

companies.) Each of the four areas of development impacted, in some ways, the homeownership outcomes for low-income and minority borrowers.

On the regulatory front, both the Community Reinvestment Act ("CRA") and the Federal Housing Enterprises Financial Safety and Soundness Act of 1992 ("the 1992 GSE Act") focused efforts on serving the needs of low- and moderate-income borrowers and providing liquidity for housing markets.[2] The CRA directs the federal banking regulatory agencies to encourage the institutions they regulate to meet the credit needs of their entire communities, including low- and moderate-income areas, to the extent consistent with safe and sound banking practices. The 1992 GSE Act established income-based and geographically-targeted housing goals for the purchase of mortgages by each GSE. The housing goals were intended to ensure that an appropriate share of GSE mortgage purchases was targeted to low- and moderate-income families and neighborhoods underserved by the mortgage market.

On the technology front, advances along several dimensions have affected access to mortgage credit by reducing costs associated with applying for a mortgage and by impacting the structure of the mortgage market.[3] These technological developments have included improved access to consumer credit information; adoption of credit scoring, automated underwriting, and automated appraisal technologies; advances in financial modeling; and innovation in secondary market debt instruments. Adoption of credit scoring, automated underwriting, and automated appraisal technologies increased the accuracy of credit risk measurement, encouraging and enabling the increased use of RBC and the introduction of new mortgage products. These technological developments, along with advances in financial modeling and the design of new debt instruments, also reduced the costs of securitization and facilitated the growth of a secondary market outside of the GSEs. In turn, growth in non-GSE securitization increased the liquidity available to mortgage lenders for serving higher risk or non-traditional borrowers.

Risk-based pricing has its roots in the seminal article by Stiglitz and Weiss (1981).[4] They suggest that credit rationing is the result of imperfect information regarding the risks of loan

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[2] The GSEs, or government sponsored enterprises include Fannie Mae and Freddie Mac.

[3] See Gates, Waldron and Zorn (2002) and Lax, Manti, Raca and Zorn (2005) for a discussion of the impacts of automated underwriting on the expansion of credit to underserved populations.

[4] See Stiglitz and Weiss, American Economic Review, 1981.

applicants. Because borrowers know their credit risk, but lenders only know it with uncertainty, lenders must ration the availability of credit.

In a special volume on subprime lending (*Journal of Real Estate Economics and Finance*, 2005), several authors look at early segmentation in the United States mortgage markets. Chinloy and MacDonald (2005) consider the advent of subprime as a "completion" of the mortgage market and state, "With a subprime market, there is a more complete credit supply schedule with the market pricing for poorer credit quality in the mortgage rate. By completing the capital market, subprime lenders reduce borrowing constraints. The result is a social welfare gain. Low-credit applicants otherwise denied funding are able to qualify by paying higher interest rates in exchange for offering more equity or lower loan-to-value ratios."[5] Crews Cutts and Van Order (2005) similarly discuss the economics of the subprime sector, laying out models for option-based pricing of mortgages, with different options in subprime leading to different contracts and terms in subprime. They also consider asymmetric information between borrowers and lenders and between lenders and the secondary market.[6] Deng and Gabriel (2006) look at the differences in default and prepayment risks of borrowers with FHA loans and suggest that pooling and RBP with respect to FHA loans can substantially reduce housing finance costs and increase homeownership among underserved populations.[7]

In a paper presented at a conference sponsored by the Joint Center for Housing Studies at Harvard, Collins et al (2004) lay out the tradeoffs between the gains or potential losses from RBP. They state, "The potential for efficiency gains from subprime lending and risk-based pricing are real. If risk can be more accurately measured, the benefits to low income and low credit score households and to society as a whole are great. Consumer choice is enhanced, risk is more efficiently priced, capital is increasingly allocated to highest and best use, while numerous households that would have been denied credit, find access to the ownership market. A major source of asymmetric information and adverse selection may be reduced as we gather increasingly accurate and reliable predictors of default. Other households are given the incentive to generate positive neighborhood externalities. On the other hand, if the risks of subprime lending are underestimated, the result may be very costly and inefficient."[8]

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[5] See Chinloy and MacDonald, Journal of Real Estate Finance and Economics, 2005.
[6] See Crews Cutts and Van Order, Journal of Real Estate Finance and Economics, 2005
[7] See Deng and Gabriel, Journal of Money, Credit and Banking, 2006.
[8] See Collins, Belsky and Case, Joint Center for Housing Studies, 2004.

C. The Management of Default Risk

There has been, as discussed, research pertaining to the application of RBC to credit markets. However there has been little explicit recognition that the evaluation of credit risk and responses to those risks is multi-dimensional. In some research (for example, Chinloy and MacDonald (2005)), RBP refers simply to pricing up for higher loan-to-value ("LTV") loans. In other research (for example, Collins, et al (2004)) there is recognition that RBP incorporates pricing for risk characteristics in addition to LTV, including, for example, recognition that FICO scores, debt-to-income ratios ("DTI") and other factors may influence default risk. In this paper, we explicitly recognize the multi-dimensional characteristics of risk, as well as the several and simultaneous methodologies that lenders and markets employ to manage higher default risks.

In the United States, in the past decade, there were three separate submarkets, or channels, through which mortgages were originated—prime, which generally originates the lowest risk loans; subprime, which generally originates the highest risk loans; and FHA, which focuses on originating loans to first time home owners and low- and moderate-income borrowers, and generally has risk tolerances between prime and subprime. Lenders tend to limit their efforts to one submarket and, especially between prime and subprime, the business, marketing and borrower demand characteristics can vary quite substantially across submarkets. Within each submarket, lenders manage their risks, and, indirectly, the market share across submarekts, by setting credit standards for the loans that they will originate and by differentially charging for the default risks of those loans they do originate (i.e., through RBP). As a consequence, the market "manages" default risk through a combination of the share of originations across submarkets, and pricing and credit standards within submarkets.
All three of these components changed, at times dramatically, between 2004 and 2008. Much of our empirical effort is directed towards identifying and assessing the separate impacts of these changes. Moreover, because low-income and minority neighborhoods and borrowers tend disproportionately to have higher-risk credit characteristics, they also are likely to be disproportionately affected by changing submarket shares, credit standards and movement towards, or away from, RBP. Our other empirical effort is directed towards assessing and decomposing these impacts.

D. Data and Methodology

The data used in our analysis include information on all mortgage originations for a sample of top-twenty lenders from 2004 through 2008. In combination, these lenders originated prime, FHA and subprime loans, and all of the lenders in our data originated loans in most states. As a consequence, we believe our data are representative of loans originated in each submarket over our period of study.

Our primary focus is on the overall market, which we define as the sum of the prime, FHA and subprime origination submarkets. Lenders are defined as either prime or subprime on the basis of their self-assessment. The non-FHA loans originated by each lender are therefore all labeled either prime or subprime, consistent with the self-designation of the lender. Regardless of lender designation, however, all FHA loans are considered FHA.

Because our lender data are a convenience rather than random sample from each submarket, we are concerned that simply adding together our data will give an inaccurate total market view. To address this concern we use HMDA-derived origination shares of the three submarkets (prime, FHA and subprime) to construct weights that we then use to aggregate our lender data into the "total market." We believe, therefore, that if the lenders in our sample are representative of their submarket, our HMDA-weighted aggregate total market analysis will also be representative of the overall market.

Our lender data are rich in information for each loan. In particular, they include commonly used underwriting variables (e.g., FICO score, LTV, DTI, etc.), loan terms and characteristics (e.g., fixed versus adjustable, loan purpose, documentation type, etc.), APR, property location (state, county and census tract), and key borrower demographics (race/ethnicity and income). These data enable us to conduct detailed ex ante analysis, however the lack of any performance information (e.g., delinquency or default rates) prevents us from conducting any ex post analysis.

Critical to our analysis is assessing separately the ex ante distributions of default risk and mortgage prices, as well as the relationship between default risk and price (interpreted as the extent of RBP). We use APR as our measure of mortgage price. APR has the advantage of being a single price that combines contract rates with the amortized value of points and fees paid at closing, as well as being part of standard loan disclosures and directly available in our data. However, APR is not without its problems. Most critical among these is the assumption

embedded in the APR calculation that loans will last until maturity, an assumption that is often not met, and which can therefore understate the annual "cost" of upfront points and fees. That said, APR is the best measure of all-in price that we have available, and so it is what we use.

We believe the CDR, the expected probability that a loan will ever go into default over its lifetime, is a reasonable measure of default risk, where default is defined as becoming "real estate owned" or going into a foreclosure alternative status. The attraction of the CDR as a metric is that it simply summarizes the complex interactions of multiple risk factors. It is also intuitive to interpret and representative of the metric that underwriting processes are designed to manage.

Unfortunately, CDR is not directly included in our data. To address this lacuna we use a proprietary model to estimate CDR from available variables. The variables used in our CDR prediction include the mortgage product type (adjustable, balloon, fixed rate or interest only), loan purpose (purchase or refinance), documentation type (no-, low-, or full-documentation), property type (single-family or manufactured housing), occupancy type (investment, owner occupied, second home), number of units (1, 2, 3 or 4), DTI, LTV and FICO score.[9] The CDR model we use gives a time-invariant view of default risk, meaning that loans with identical observable characteristics originated in different years have identical CDRs. In all likelihood, however, CDR models used at the time of origination were not time-invariant because expectations about future house price paths and other default determinants evolved over time, affecting views of default risk for otherwise identical mortgages. While these contemporaneous and changing views of default risk would be interesting to study, the appropriate CDR models for doing so are unavailable to us. Our time-invariant CDR approach is nonetheless useful, because holding constant for changing expectations helps to isolate and identify the role of other factors affecting the default trends from 2004 through 2008.

With APR and CDR available for each loan, our first step is to consider how the distributions of these characteristics vary in the total market for the years 2004 through 2008. We use box and whiskers plots to compactly present this information. The "box" in the box and whiskers plot demarcates the interquartile range (the values that encompass the 25th through 75th percentile of the distribution), and the "whiskers" extend "down" to the first fifth percentile of

[9] A significant number of loans in our data have missing DTI. We impute DTI for loans where it is missing to avoid dropping these observations from our analysis. Details of this imputation are available on request to the authors.

the distribution and "up" to the 95th percentile of the distribution. Side-by-side placement of the box and whiskers plots allows for easy assessment of the changing distributions over time.

Our next step is to assess the adoption of RBC. We do this by considering the relationship between APR and CDR. The assumption made is that the more that price (APR) increases with default risk (CDR), the greater is the "adoption" of RBP. First, we provide a scatter plot of loans in CDR-APR space.[10] We then illustrate the central tendency of the relationship between APR and CDR by plotting a LOESS smooth fit through the scatter plot.[11] The more upward sloping the LOESS fit, the greater the adoption of RBP. The "slopes" of the LOESS fit lines can therefore be compared across time to determine trends in the adoption of RBP.

We next turn to the question of whether and how these trends affect key policy-targeted subpopulations—borrowers in low-income tracts (defined as tracts with median incomes equal to 80 percent or less of area median income ("AMI")), borrowers in minority tracts (defined as tracts where 30 percent or more of the population are not non-Hispanic Whites), low-income borrowers (defined as borrowers with incomes less than or equal to 80 percent of AMI) and minority borrowers (defined as borrowers who are not non-Hispanic Whites). We consider impacts across two separate dimensions—accessibility to credit, and the prices paid by borrowers who obtain credit.

We assess accessibility to credit by comparing CDR distributions across time. The CDR distribution of loans originated in a given year depends on the risk distribution of actual and potential loan applicants and the underwriting standards adopted by lenders in the granting of credit. Our observed CDR distributions commingle both impacts, and we are sensitive to the reduced form nature of our empirical analysis. Our belief, nonetheless, is that the CDR distributions of potential mortgage applicants have remained relatively constant over time, and that the primary factor affecting any observed time trend in CDR distributions is changes in lenders' credit standards (both directly, and through its impact on the mortgage characteristics/risks "chosen" by potential applicants).

Consistent with this belief, we argue that years in which CDR distributions are lower (i.e., years when fewer loans with high CDRs are originated) are years when lenders imposed

[10] To make the scatter plots more easily interpretable, we group loans into "buckets" of 100 loans with similar CDR and APR values, and plot each bucket based on the average CDR and APR for the 100 included loans.
[11] A LOESS smooth provides a semi-parametric fit of the relationship between APR and CDR.

"tighter" credit standards, and years when CDR distributions are higher are years when lenders imposed "looser" credit standards. Relying on this framework, we conduct the conceptual experiment of imposing the "tightest" credit standards, which occurred in 2008, on all other years. Specifically, we identify the borrowers in earlier years that would not have received loans under the tighter standards of 2008, and then compare the composition of these "excluded" borrowers in terms of the subpopulations of interest.[12] So, for example, if 22 percent of low-income borrowers in an earlier year are excluded under the tighter credit standards of 2008, while only 15 percent of non-low-income borrowers are excluded, we say that low-income borrowers are disproportionately impacted by 7 percentage points (22 percent minus 15 percent).

We compare the prices of borrowers who receive credit by looking at APR distributions. Specifically, for each year we compare the APR distributions of each key subpopulation and its complement. For example, we compare the APR distribution of low-income borrowers to non-low-income borrowers, and compare minority borrowers to non-minority borrowers. We first do this non-quantitatively by simply comparing the box and whisker plots of APR distributions for each subpopulation. More quantitatively, we compute the Kolmogorov-Smirnov ("KS") statistic for the distributions of each key subpopulation and its complement.[13] In our data the subpopulations of interest always have higher APR distributions than their complements, so we interpret the magnitude of the KS statistic as a measure of the disproportionate impact on subpopulations of interest—the larger the KS statistic, the more disproportionately subpopulations of interest face higher APRs. We compare trends in KS statistics across time to assess trends in the disproportionate impact on policy-targeted subpopulations.

We first apply these various techniques and metrics to the total market, and then apply them separately to each submarket (prime, FHA and subprime). Finally, we attempt to attribute the variously observed affects and impacts to changing submarket shares (primarily the rise and then fall of subprime) and/or to changing credit standards.

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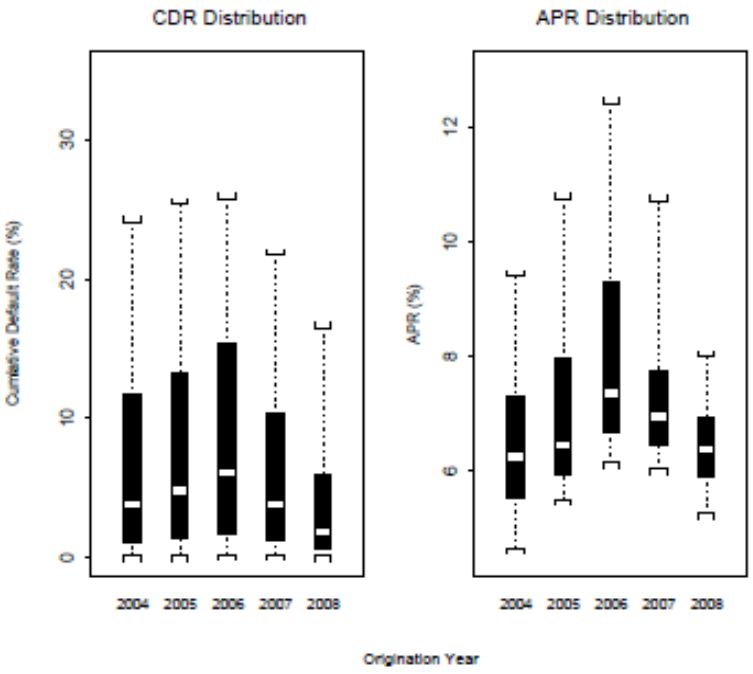
[12] We assume that the 95th percentile in CDR represents the implicit/effective credit limit in the "tightest" year, and apply this standard to all other years. We use the 95th percentile rather than the maximum because we judge that the top five percent of default risk are more likely to represent loans that "slipped through the cracks" rather than truly reflecting contemporaneous credit standards. To conduct our experiment we calculate the percent of originated loans above this tightest-year 95th percentile CDR value, subtract five percent, and interpret the remaining value as the percentage on borrowers in "looser" credit standard years that would have been denied credit had the tighter-year credit standards been applied.

[13] The KS statistic is a commonly used statistic for testing whether two distributions are identical. In intuitive terms, the KS statistic calculates the difference between the CDFs of two distributions at the point when this difference is at a maximum. Under the null hypothesis these distributions are identical. If the KS statistic is large enough the null is rejected, implying that the distributions are significantly different. A common application of the KS statistic in mortgage finance is as a test of the effectiveness of underwriting (default) models. Models with KS statistics above 30 are often considered to do a "good" job of distinguishing between well- and poorly-performing loans.

E. Empirical Analysis

Our first step is to assess the time trends in the CDRs of originations for the total market, provided in the left panel of Figure 1. The box and whisker plots show significant changes from 2004 though 2008. The overall trend indicates increasing CDRs from 2004 to 2006 (illustrated by increasing medians, 75th percentiles and 95th percentiles), and then dramatically declining CDRs in 2007 and 2008. This trend is not surprising. The 2004 through 2006 time period were the height of the credit "bubble," and 2007 and 2008 reflect the tightening credit standards imposed after the financial crisis. Other sources, for example the survey of OCC examiners, have documented the same loosening and then tightening of credit standards during this period.[14]

Figure 1
Total Market Trends in Default Risk and Pricing Distributions



The uniqueness of these data is the quantification of this trend. For example, our data suggest that even in 2006, the period of most relaxed credit standards, 75 percent of originations had a 15 percent or lower expected probability of going into default. Moreover, roughly 95 percent of originations had CDRs less then 25 percent, meaning that about seven in ten

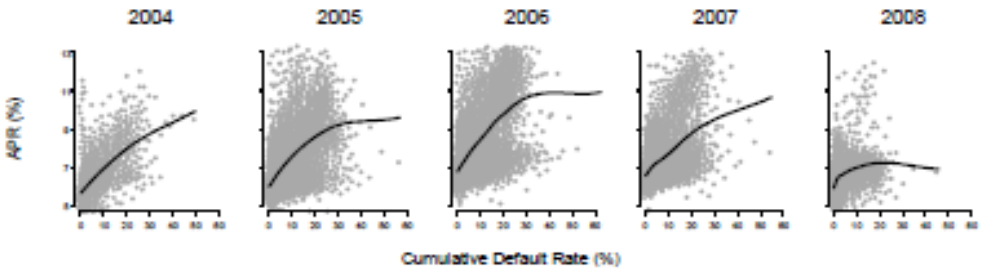
[14] See http://www.occ.treas.gov/survey/2008UnderwritingSuvey.pdf

borrowers were expected to pay back their loans. Obviously, these same data suggest that roughly three out of ten were expected to go into default, and this may be an unacceptable cost for increased access to mortgage credit. Moreover, as demonstrated in Figure 6 below, the CDR distributions vary greatly across the submarkets. Nonetheless, these data show that credit standards were not completely abandoned during this period, an opinions to the contrary sometimes expressed in the popular press and by critics of the mortgage industry.

The right panel of Figure 1 shows the accompanying time trends in APR distributions. Here we see a similar pattern to the time trend in CDR distributions—APRs increased from 2004 through 2006, and then declined in 2007 and 2008. Another trend worth noting is the expansion of the high-side tail of APRs through 2006 and even 2007, and then its dramatic contraction in 2008. The relatively tight APR distribution in 2008 is reflective of the virtual absence of subprime originations. But, as shown in Figure 7 below, the high-side APR tail in 2006 was not due solely to subprime, but was a prime phenomenon as well. Wider APR distributions, not surprisingly, are a broad trend in a market with loose credit standards and risk-based pricing.

Figure 2 addresses the issue of RBP more directly. Here scatter plots of loan originations in CDR-APR space (the grey dots) are used to assess the tendency of APR to increase with CDR, and we highlight this relationship by fitting a LOESS smooth (the dark line drawn on top of the scatter plot). A greater "adoption" of RBP is defined as an increasingly steep LOESS fit, and the plotted fits are provided separately by year, 2004 through 2008.

Figure 2
Total Market Trends in Risk-Based Pricing



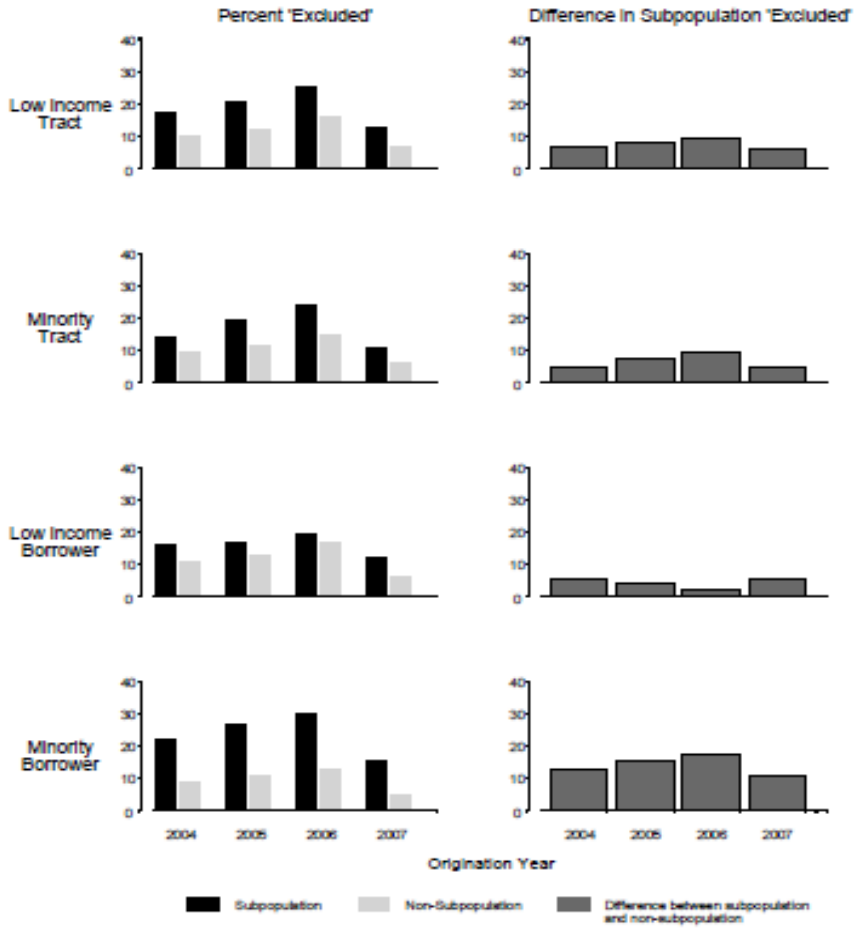
The scatter plots echo the trends in the box plot distributions of Figure 1. Specifically, credit expands and then contracts (as shown by the increasing number of dots further to the right on the CDR axis in years 2004 through 2006, and then by the decline in dots in years 2007 and

2008) and the accompanying increase and then decrease of APRs (shown by the increasing number of dots further up the APR axis in years 2004 through 2006, and then by their declining numbers in years 2007 and 2008). The LOESS plots show the relationship between APR and CDR. We focus on the "slope" of these plots in the 0 to 20 percent CDR range, because this is where the bulk of originations are located.

The plots show a clear and persistently strong relationship, illustrating that the market as a whole strongly embraced RBP during this time period. Nonetheless there is an apparent trend to this adoption. Specifically, the slope of the LOESS fit in the relevant range increases between 2004 and 2006, and then declines in 2007 and 2008. This suggests that, at least in terms of an overall tendency, the total market most strongly embraced risk-based pricing in 2006, precisely the time when it was most lenient in its credit standards.

Next considered is the question of how these overall market trends affected low-income and minority neighborhoods and borrowers. First measured is the impact of changing access to credit, followed by a comparison of the percent of each policy-targeted subpopulation (and its complement) that would have been denied credit in 2004 through 2007 under the tight credit standards of 2008.

Figure 3
Total Market Impacts of Changing Default Risk Distributions



The first column of Figure 3 shows for each policy-targeted subpopulation and its complement, the percent of borrowers that would have been excluded under 2008 underwriting standards. That is, the percent of each subpopulation that "benefited" from the expanded access to credit of earlier years. The second column of Figure 3 provides a measure of the extent to which the target subpopulations disproportionately received this benefit. This measure is calculated as the difference between the impacts on the targeted subpopulation and its complement, which are plotted in the first column.

The first row of Figure 3 focuses on borrowers in low-income tracts. Borrowers in low-income tracts benefited substantially from relaxed credit standards. At the peak in 2006, roughly 25 percent of all borrowers from lower-income tracts obtained mortgages because credit standards were significantly looser than in 2008. Borrowers not in low-income tracts benefited

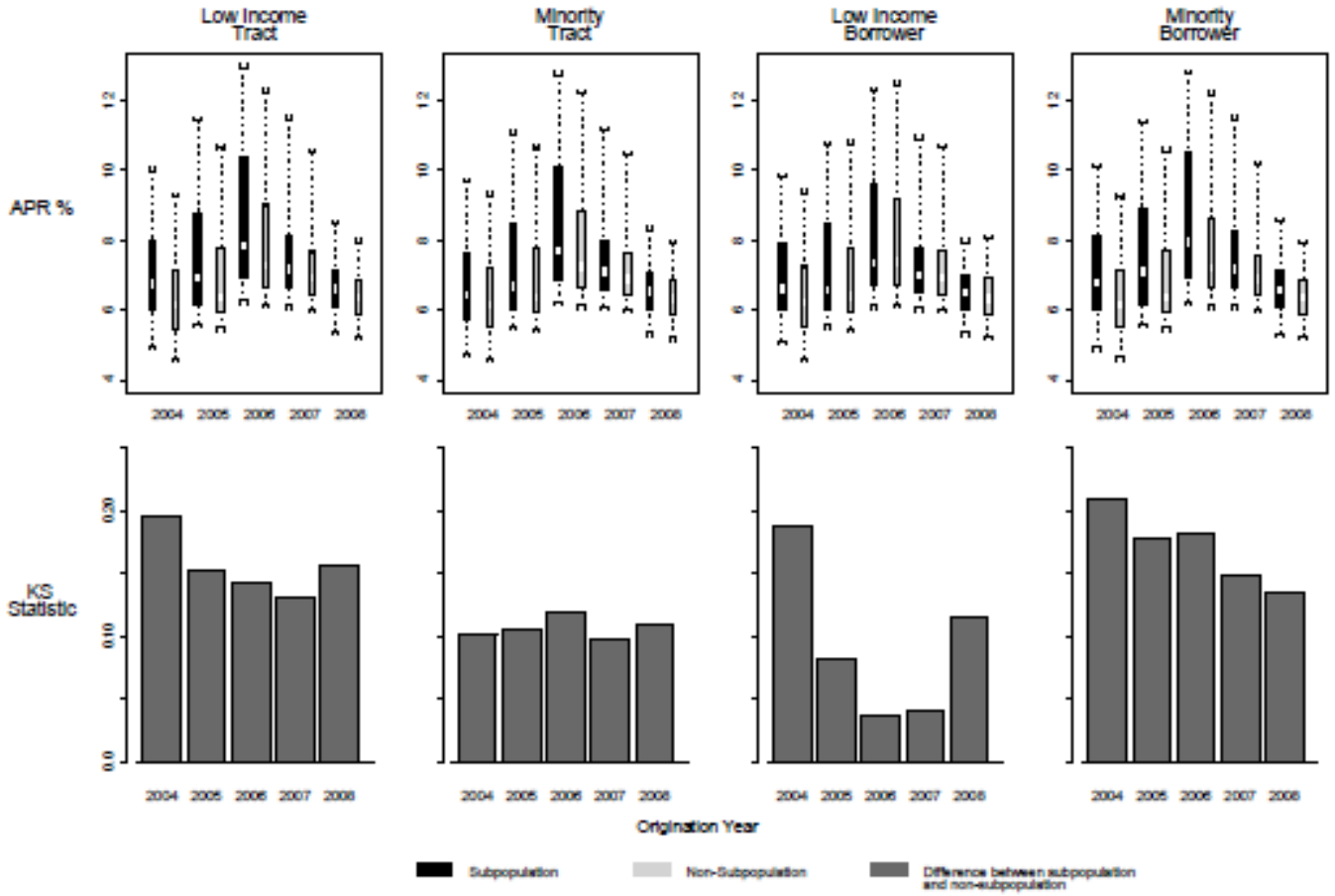
as well, however, and the right column shows the extent that borrowers in low-income tracts disproportionately benefited. Borrowers from policy-targeted subpopulations uniformly disproportionately benefited from the increased access to credit relative to 2008, so all the bars in the second column are positive.

Two overall trends are worthy of note. First, borrowers from low-income and minority tracts, as well as minority borrowers, obtained an increased benefit as credit standards loosened from 2004 through 2006, and then a smaller benefit in 2007 as credit standards tightened. This reflects the tendency of policy-targeted subpopulations to disproportionately have higher risk characteristics, and so, as a consequence, to disproportionately benefit from relaxed credit standards.

Second, the trends for low-income borrowers are in stark contrast to the other policy-targeted subpopulations. This may reflect a fundamental issue with our data rather than a ”real” market trend. Specifically, the incomes available in our data are those reported for mortgage underwriting. For fully documented loans, the lender as part of the underwriting process verifies this income. For low- and no-documentation loans, however, income is less frequently or even infrequently verified, and the reported income is simply whatever the borrower provides at application. Although we have no direct evidence from our data, we believe that this process results in an over-statement of incomes for low- and no-documentation loans, and therefore an under-reporting of low-income borrowers. Low- and no-documentation loans are most prominent in the middle years of our analysis (2005 through 2007), so we are inclined to discount the analysis of low-income borrowers for those years and concentrate, where appropriate, on overall trends from years 2004 and 2008. In Figure 3, of course, that leaves only one data point (2004), and so trend analysis is impossible.

We conclude our initial analysis of the total market by assessing whether the changing distribution in the prices paid by borrowers who received loans disproportionately impacted policy-targeted subpopulations. The top row of Figure 4 provides box and whisker plots of the APR distributions of each policy-targeted subpopulation and its complement, separately for years 2004 through 2008. The bottom row of Figure 4 provides the KS statistic, a metric measuring the differences in these APR distributions in each year.

Figure 4
Total Market Impact of Changing Pricing Distributions



The APR distributions clearly show that in each year policy-targeted subpopulations face higher APRs than non-targeted subpopulations. This relationship is consistent in each year, regardless of comparison—the 5th percentile, 25th percentile, 50th percentile, 75th percentile and 95th percentile of each policy-targeted subpopulation in each year are almost always greater than its complementary non-targeted subpopulation. Intriguingly, the second row providing the KS statistic shows that borrowers from low-income tracts, and low-income and minority borrowers

disproportionately tend to face higher APRs in 2008 than in 2004.[15] Simplifying a little, therefore, there appears to have been a mitigating trend in the disproportionately high APRs faced by borrowers from low-income tracts, and low-income and minority borrowers throughout a period when credit standards first relaxed and then tightened. Specifically, increased access to credit did not appear to exacerbate pricing differentials for these policy-targeted subpopulations—2006, the clear high point of looser credit standards, is not the year when borrowers from low-income tracts and low-income and minority borrowers most disproportionately faced higher APRs. In contrast, however, there is not a strong trend for minority borrowers over time and, in particular, 2006 is the year when minority borrowers disproportionately faced higher APRs. This, as shown in Figure 10, seems primarily to reflect an FHA effect.

The next step in the analysis is to compare submarket (prime, FHA, and subprime) shares over time, and to conduct parallel analyses to Figure 1 through 4 separately for each submarket. The focus is on comparing differences across prime, FHA and subprime mortgages, and to assess how these differences may contribute to outcomes in the total market.

Figure 5
Time Trends in Submarket Shares

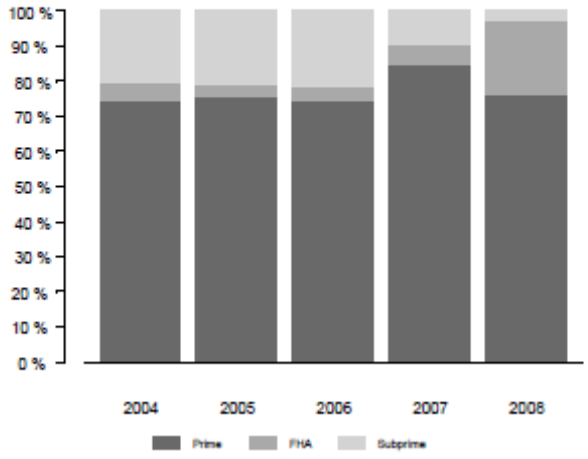


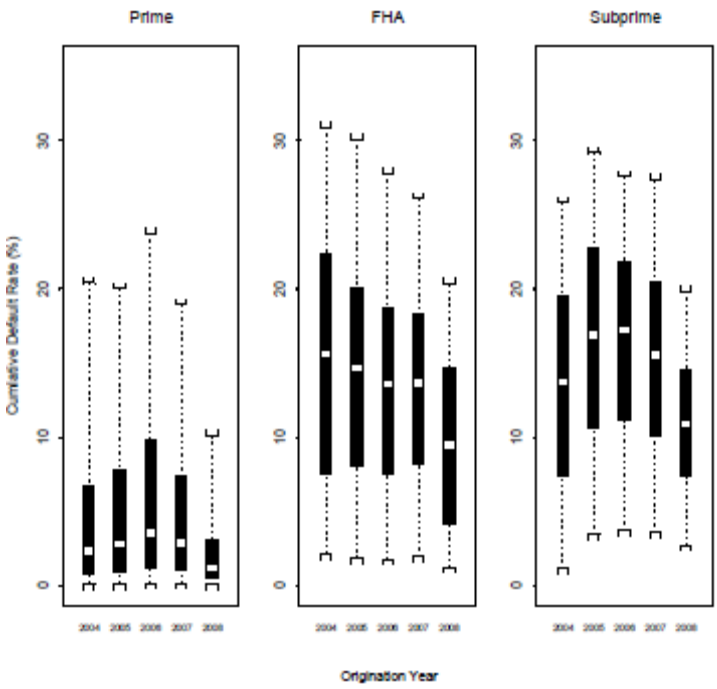
Figure 5 uses stacked bar charts to show changes in the prime, FHA and subprime shares over time. The Figure clearly illustrates a growth in subprime share from 2004 through 2006,

[15] Recall that while we are not confident in our low-income borrower results in 2005, 2006 and 2007, we are relatively confident in them for 2004 and 2008.

primarily at the expense of FHA. This changed dramatically in 2007, when subprime share declined by more than 50 percent, resulting in a growth in FHA share and a disproportionate growth in prime share. The 2008 origination year saw significant further eroding in subprime share, and an accompanying dramatic increase in FHA share and a return of prime share to its previous-years' level. These changes are not trivial, and could have important impacts on market outcomes if there are significant differences across submarkets.

Figure 6 provides the CDR box plots for prime, FHA and subprime originations. Not surprisingly, given that prime accounted for over 70 percent of originations during this period, the prime distribution of CDRs closely mirrors that of the total market. In particular, the prime market shows the same overall relaxation of credit from 2004 through 2006, followed by tightening in 2007 and 2008.

Figure 6
Time Trends in Submarket Default Risk Distributions



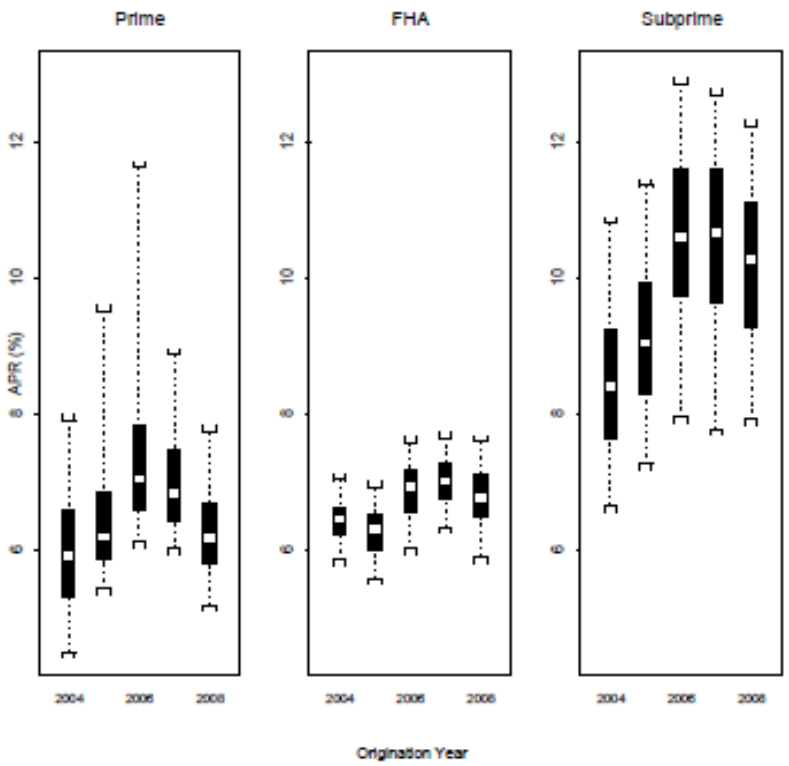
Subprime CDR distributions follow roughly the same trends as prime, but with two important distinctions. First, the peak credit relaxation in the subprime market occurs in 2005, a year before it occurs in the prime market. Second, the tightening of credit in the subprime market is arguably more dramatic in 2008.

More dramatically different trends occurred in FHA. In particular, the FHA market appears to exhibit a relatively monotonic tightening of credit standards throughout the period, with a significant tightening in 2008. However careful interpretation of this trend is required. Importantly, FHA itself does not originate mortgages, but instead guarantees mortgages that fit within their programs and meet their underwriting standards. Moreover, FHA made no obvious and significant efforts to tighten its underwriting standards over this period. Instead, the apparent tightening in standards from 2004 through 2006 likely is primarily due to the growth in subprime share disproportionately taking higher-risk borrowers from FHA.

The tightening in 2008 likely reflects overall credit tightening among market participants, including those originating FHA mortgages. Even with FHA's credit guarantee, loan originators are not completely free of default risk when originating an FHA mortgage. Faced with some residual risk of recourse and/or the loss of FHA-delegated underwriting privileges, originators likely imposed their own across-the-board tightening in credit standards in 2008 (including their FHA originations) and so resulted in a reduction in FHA CDRs without explicit credit tightening by FHA.

Figure 7 shows the box plots of APRs separately for each submarket. Again, the overall market trend is echoed in prime—APR distributions increased from 2004 through 2006, and decreased thereafter. Subprime roughly followed the trends of prime. Moreover, although the trend for FHA is less dramatic and less consistent than for either prime or subprime, it is roughly similar.

Figure 7
Time Trends in Submarket Pricing Distributions

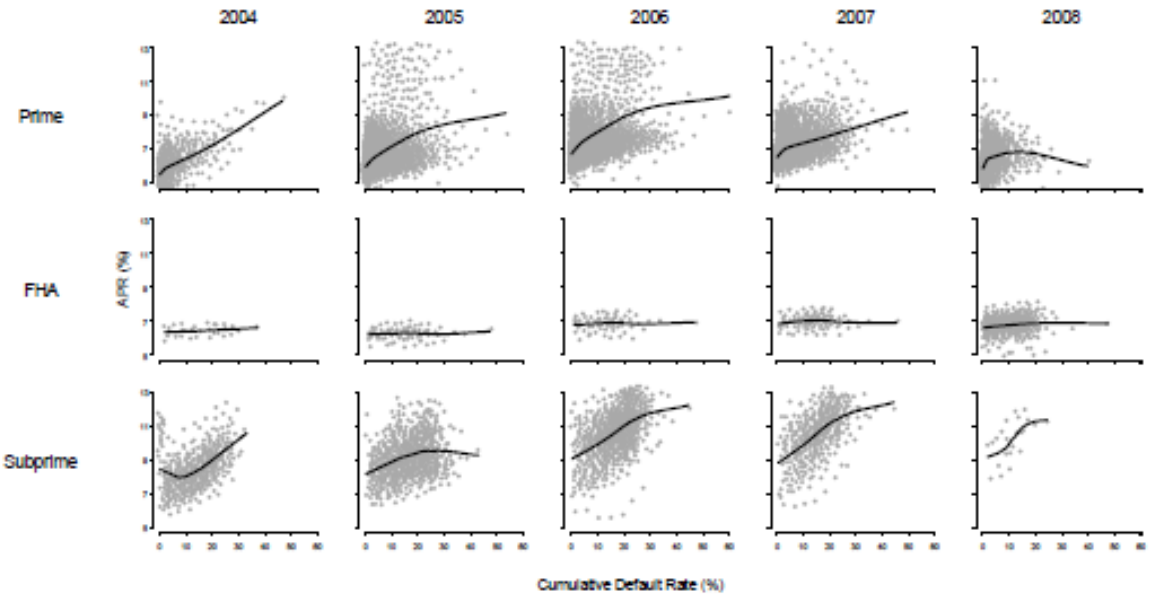


Four points from these data are worth noting. First, the loosening of credit in 2006, and the associated expansion of the high-end tail of the APR distribution, is arguably more dramatic for subprime than prime, and the tightening of credit in 2008, and the associated decrease in the high-end tail of the APR distribution, is arguably more dramatic for prime than subprime. Second, the APR distribution for FHA is dramatically tighter relative to either prime or subprime. This reflects the relatively stable pricing of FHA over this time period, as well as the lack of any significant RBP on the part of FHA (we illustrate this in Figure 8 below). Third, generally the range of prime APRs is tighter than that of subprime, consistent with the tighter CDR distribution evidenced in Figure 6. Fourth, despite prime's overall tighter APR distribution relative to subprime, this was not true in 2006, the year of prime's weakest credit standards. It appears, therefore, that although prime lenders significantly relaxed their credit standards in 2006, they did so while charging up for this higher risk.

This latter point is illustrated in Figure 8, which uses LOESS smooth plots to illustrate the relationship between APR and CDR separately for each submarket. Prime CDRs are disproportionately in the range of zero to 10 percent, so this is the segment of the LOESS plot on which we focus. Because of its dominant share, prime trends closely mirror those of the total

market. In particular, the slopes of these lines suggest that risk-based pricing increased somewhat in 2004 through 2006, and then showed a minor decline in 2007 and 2008.

Figure 8
Submarket Time Trends in Risk-Based Pricing

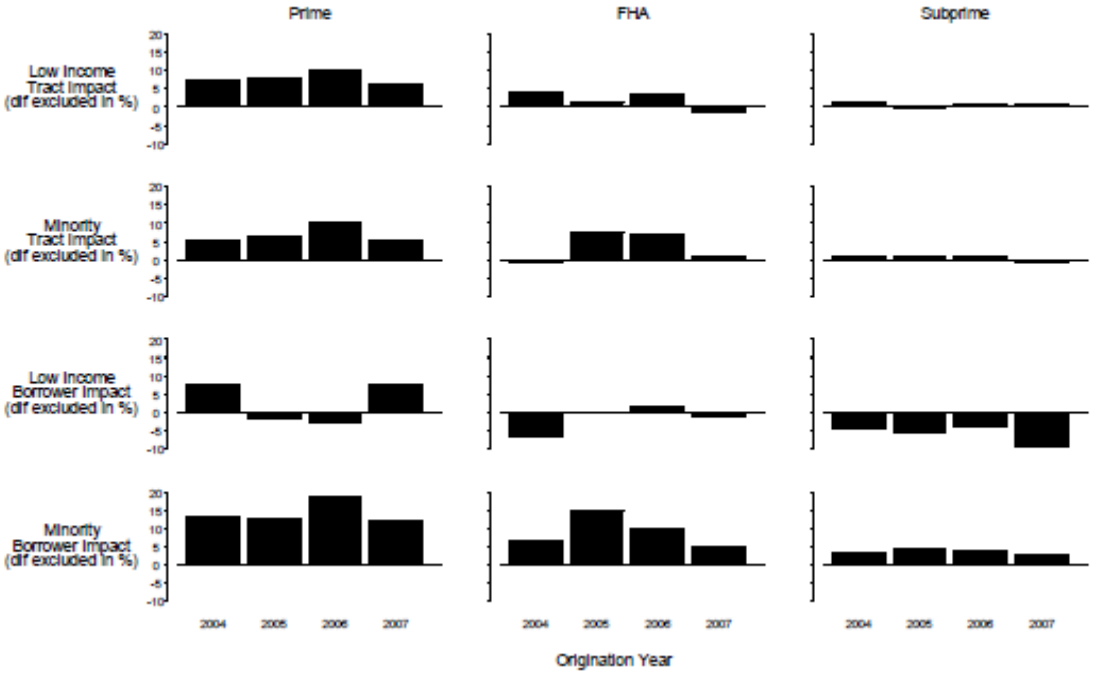


The bulk of the subprime CDRs are in the 10 to twenty percent range, so this where we focus in the subprime LOESS plots. There appears to be increasing reliance on RBP in subprime lending from 2004 through 2006, but unlike in prime, there is no lessening in that focus in 2007 and 2008.

FHA evidences a dramatic difference—there is no significant indication of a risk-based component to FHA pricing over this time period. As a consequence, as FHA's market share grew in 2007 and 2008, it tended to mitigate any RBP effect observed in the total market.

Figure 9 shows the impacts of looser credit standards (in the earlier years relative to 2008) on policy-targeted subpopulations. Prime time trends again closely follow those of the overall market. In particular, the expanding access to credit in 2004, 2005 and especially 2006, disproportionately benefited policy-targeted subpopulations. Similarly, the time trends for low-income borrowers are suspect because of concerns regarding the reporting of income for low- and no-documentation loans.

Figure 9
Submarket Impacts of Changing Default Risk Distributions



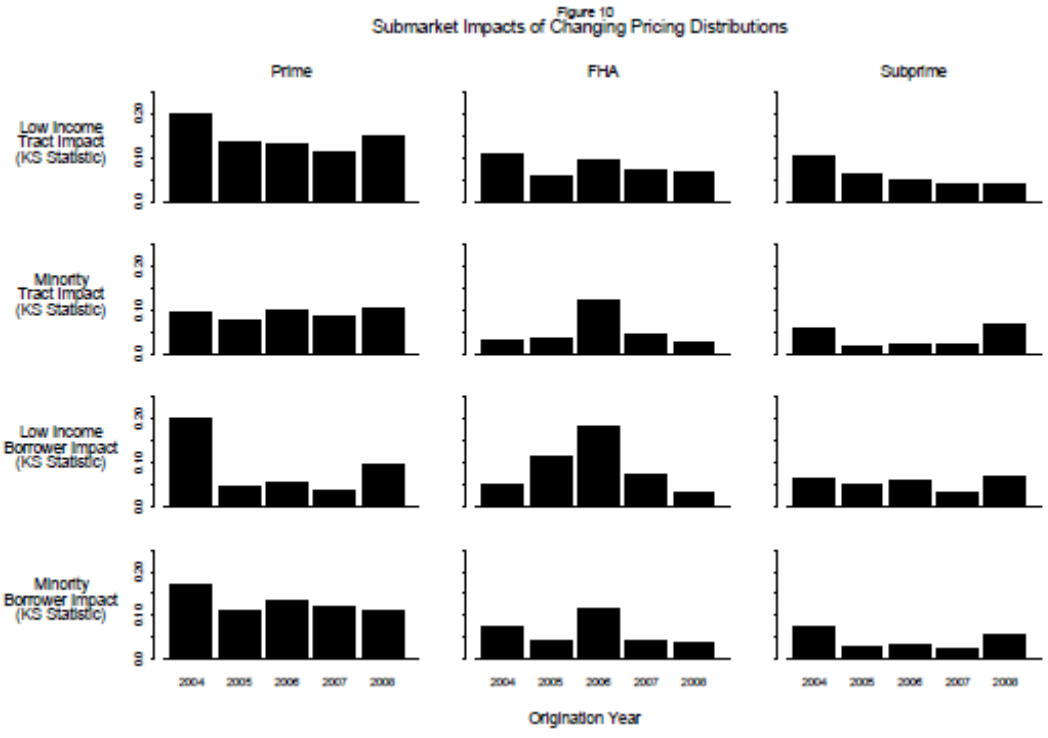
The trends in the subprime market, however, are dramatically different. In particular, there appears to be almost no evidence that changing credit standards had any disproportionate impact on borrowers from either low-income or minority tracts. This is consistent with the view that subprime mortgages disproportionately are push-marketed to specific neighborhoods where borrowers are more likely to be credit-impaired. A relaxation in subprime credit standards, therefore, is likely to simply increase loans in all "served" neighborhoods, and so not disproportionately benefit any subset of neighborhoods/tracts.

The subprime minority borrower impact seems to follow the basic trend in the prime market, albeit at a lower level and with the biggest disproportionate impact occurring in 2005 rather than 2006. This latter point, again, is consistent with the observation from Figure 6 that maximum loosening of credit in the subprime market was a year earlier than it was for prime.

In general terms the FHA results are somewhere between those of prime and subprime. However, unlike the situation for the prime and subprime markets, the greatest beneficial impacts on policy-targeted subpopulations do not occur when credit standards appear lowest for FHA (i.e., in 2004). It is nonetheless generally true that greater access to FHA lending disproportionately seems to help borrowers from low-income and minority tracts, and minority borrowers.

The FHA low-income borrower impacts deserve special mention. As noted earlier, anomalies with the low-income borrower impact in prime and subprime are expected because of issues regarding borrower over-statement of incomes for low- and no-documentation loans. However, there are fewer low- or no-documentation FHA loans, so the low-income borrower impacts in this submarket should be more reliable. Not inconsistent with FHA's focus on low-income borrowers, looser FHA credit standards have no appreciable disproportionate impact on these borrowers in 2005, 2006 and 2007. The disproportionate benefits to non-low-income borrowers in 2004 is surprising, but may reflect the more heterogeneous income mix of FHA borrowers in the time before subprime's dramatic growth.

Figure 10 shows the differential impact of changing pricing distributions on policy-targeted subpopulations, separately for each submarket. The prime market shows the greatest overall disparity in the prices faced by low-income and minority neighborhoods and borrowers, but it is everywhere the case that policy-targeted subpopulations face higher APRs.[16] As with the overall market, there is a reduction in the differentially higher APRs faced by policy-targeted subpopulations from 2004 to 2008.



[16] As noted earlier, such a differential impact should not be taken as evidence of discrimination, but likely reflects differences in the underlying distributions of credit characteristics.

The subprime market shows the least evidence of differential APR distributions for policy-targeted subpopulations, although here, too, low-income and minority neighborhoods and borrowers disproportionately tend to face higher APRs. The limited differential in APR distributions may reflect the subprime market's overall focus on higher-risk lending, and therefore indicate less systematic difference in the overall credit characteristic distributions of its borrower subpopulations.

FHA again shows different time trends than either prime or subprime. A salient characteristic of the FHA results is that the greatest disproportionate impact appears to occur in 2006. Regardless, and not surprisingly, low-income and minority neighborhoods and borrowers disproportionately face higher prices under FHA, but less disproportionately than in prime.

Finally, we attempt to assess the separate impact that changing credit standards and submarket shares had on total market impacts. We assess the effect of changing submarket shares by recalculating impacts while applying constant prime, FHA and subprime shares to each year when aggregating to represent the total market (we use five-year averages). To account for changing credit standards, we apply 2008 credit standards to earlier years, and reassess the impacts. Obviously this approach makes sense when comparing pricing distributions (APRs), but not when comparing the impact of changing credit standards.

Figure 11 makes this assessment for CDR distributions. In this case, we can only hold constant submarket shares. To ease comparisons, the left-hand side graph reproduces the observed CDR box plots from Figure 1. The right-hand side graph shows the impact of holding constant submarket shares over time. The impact of this change is very small, suggesting that changing submarket shares are not importantly responsible for changes in the overall distributions of total market CDRs. This is not surprising because prime and subprime combine to make up the far disproportionate share of the market, and as illustrated in Figure 6, follow roughly the same basic time trends.

Figure 11
Decomposition of Total Market Default Risk Distributions

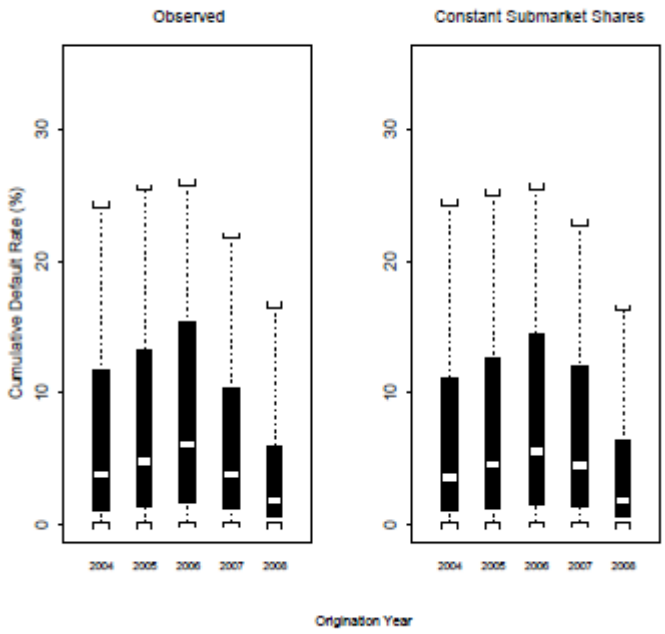
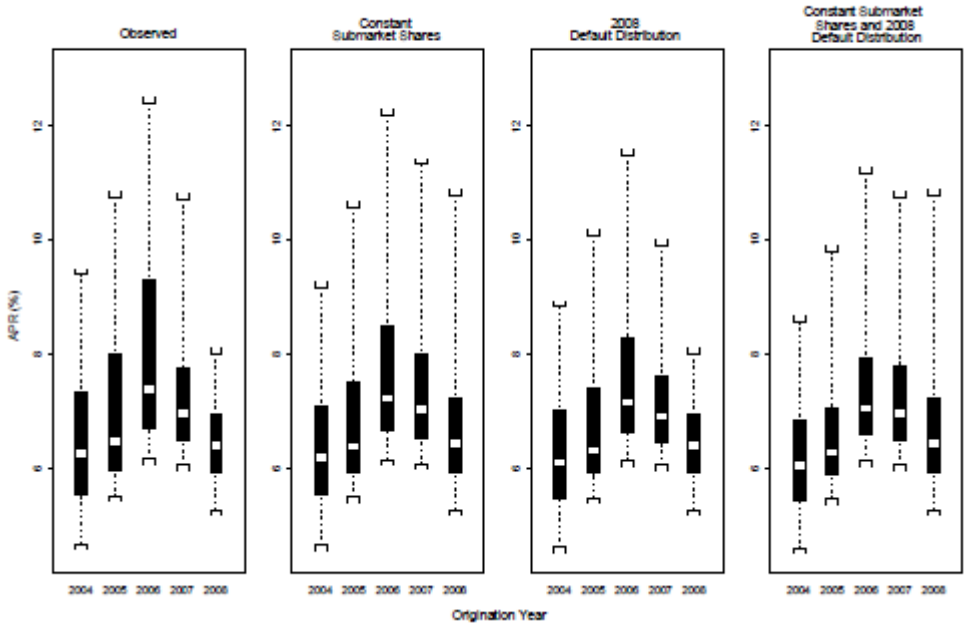


Figure 12 shows the more complete decomposition for APR distributions. For comparison purposes, the first graph on the left reproduces the observed box plots from Figure 1. The second graph shows the effects of holding constant for submarket shares. In this instance there is an observable impact. In particular, while the same basic trends hold with constant submarket shares, we do see a trimming of the "box" in 2006 and a lengthening of the "whiskers" in 2007 and 2008. This is not surprising, and reflects the fact that holding constant subprime shares reduced its impact in 2006, tightening the "box," while significantly increasing its contribution in 2007 and 2008, lengthening the "whisker."

Figure 12
Decomposition of Total Market Pricing Distributions



The third graph shows the effects of imposing the tighter 2008 credit standards on earlier years. By construction, therefore, the box plot for 2008 is unchanged. The box plots of earlier years again reflect the observed trend of the overall market, but in this case with tighter CDR distributions throughout.

The fourth and final graph combines the impact of both effects—holding constant submarket shares and imposing 2008 credit standards. While imposing both effects appears to significantly mitigate the overall observed impacts, the impacts are by no means eliminated. This is not necessarily unexpected. Figure 2 illustrated that the adoption of RBC was relatively unchanged throughout this period, so the remaining impacts shown in the right-most graph of Figure 12 are due primarily to changes over time in the distributions of borrowers with CDRs below the 2008 credit cutoffs. Preliminary analysis not presented here confirms that fully holding constant for these changing credit distributions almost completely explains the observed trends in the total market distributions of CDRs.

We conclude, therefore, that it is neither changing submarket shares nor changing credit standards per se that primarily explain the time trends in APR distributions. Rather, the impacts we are analyzing likely are subtler and more complex than have thus far considered. In particular, it suggests that loosening credit standards does not simply "open the doors to credit" for borrowers who were excluded, but that it may actually encourage borrowers to submit riskier

applications even if they would previously have been included/approved. That is, a more permissive credit environment does not just encourage applications from borrowers who likely otherwise would have been denied. A more permissive credit environment also encourages the applicants who might have qualified under tighter standards to "choose" more risky mortgage characteristics (such as, for example, lower downpayments and/or larger loan amounts), increasing applications from potentially higher-risk borrowers who likely would have been granted credit in a tighter underwriting environment. In essence, looser underwriting standards includes borrowers previously excluded and also may encourage those otherwise not excluded to take out mortgages with riskier terms.

Figures 1 and 6 provide support for the above contention. It is clear from the CDR box and whisker plots that simply truncating the high-end tails of earlier years at 2008 credit boundary levels will not equate the CDR distributions across years. Not only do the CDR distributions of 2004 through 2007 have substantially higher tails than that of 2008, their medians and interquartile ranges are all also significantly higher. That is, there is a substantial upward shift to the CDR distributions in years when credit standards were looser. This observation is consistent with the view that a more permissive credit environment encourages an overall shift towards higher-risk borrowing. This analysis cannot determine, however, the extent to which this shift results from borrower or lender "choices."

Figure 13 examines whether holding constant submarket shares affects our assessment of the disproportionate benefit received by policy-targeted subpopulations from the loosening of credit standards. Comparing the left-hand side column (observed) to the right-hand side column (constant submarket shares) shows very little change. This is expected given the finding demonstrated in Figure 11 that holding submarket shares constant had little effect on overall CDR distributions. Clearly, therefore, the disproportionate benefit received by low-income and minority neighborhoods and households does not result primarily from changing subprime, or other submarket shares.

Figure 13
Decomposition of Total Market Default Risk Impacts

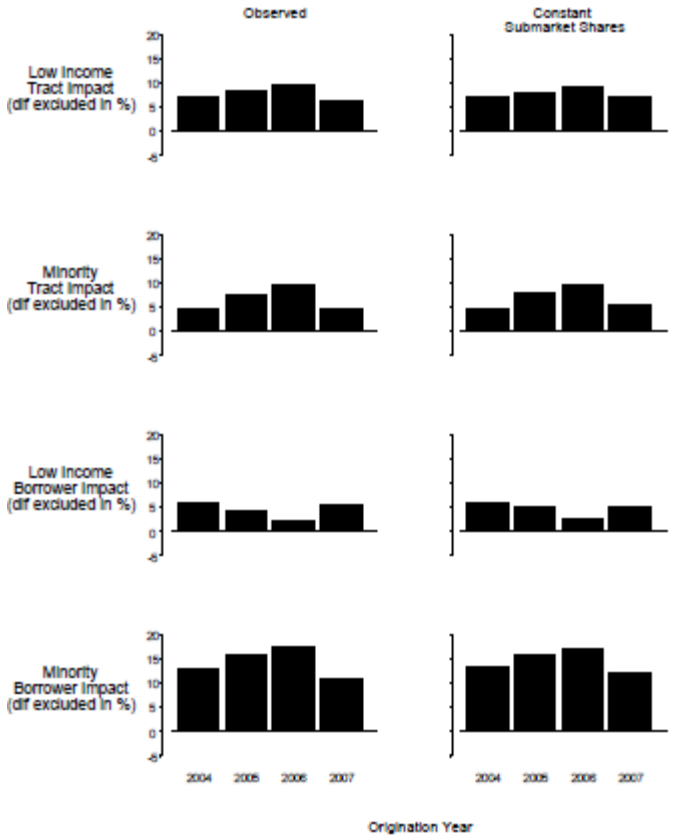
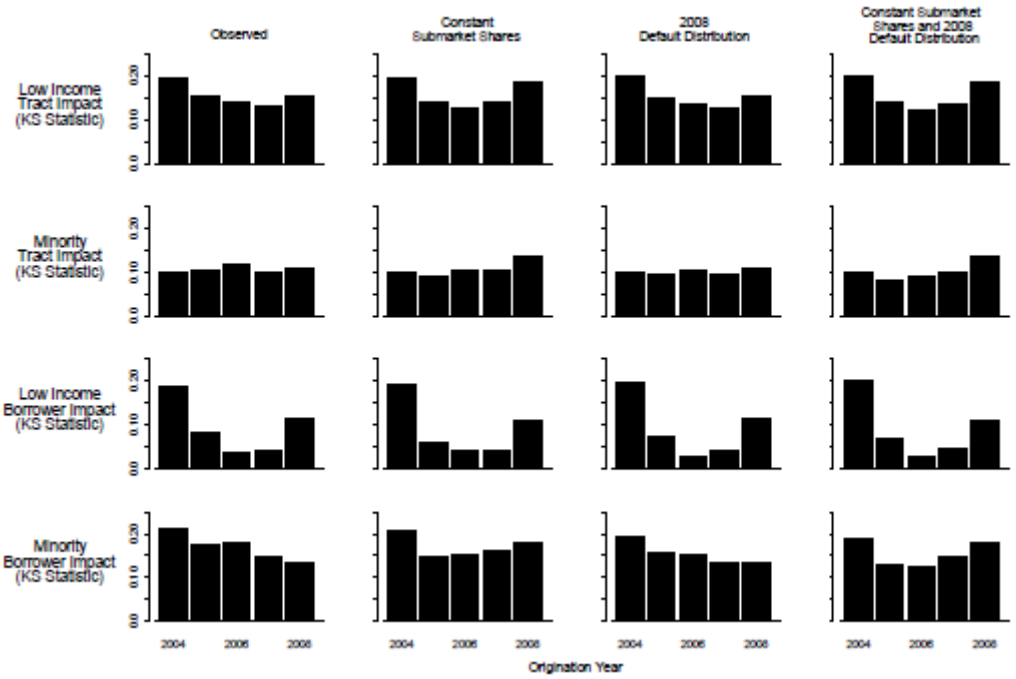


Figure 14 decomposes the separate impacts that submarket shares and loosened credit standards have on the disproportionately high APRs paid by low-income and minority borrowers and neighborhoods. The first column, the left-most, repeats the observed trends shown in Figure 4. The second column holds constant submarket shares, the third column holds credit standards at the tighter 2008 levels, and the fourth column shows the impact of combining both constant submarket shares and the tighter 2008 credit standards.

Figure 14
Decomposition of Total Market Pricing Impacts



The results of this exercise mirror those of Figure 12. Specifically, neither holding constant for submarket share trends nor imposing the tighter 2008 credit standards on earlier years fully explains the time trends in the disproportionate impact faced by low-income and minority households and borrowers. The remaining trends in column four, after controlling for both shares and credit standard, necessarily must be due to changes in pricing over time and/or changes in the distributions of credit risk characteristics holding constant for underwriting standards. Figure 8 suggests it is more the latter than the former, and as noted earlier this view is supported by our preliminary research where we hold constant for the full CDR distributions. This again suggests important secondary effects to relaxed credit standards—looser standards not only encourage applications from the now acceptable higher-risk borrowers, but also encourage borrowers to take a more leveraged or otherwise more risky mortgage position and encourage applications from potential borrowers in the "grey area" near the previous credit cutoff border.

Finally, a commonality in the time trends in column four is the fact that disproportionate impacts on the key policy-targeted subpopulations tend to be lowest in 2006, the time of the most lax underwriting standards. With this preliminary research in mind, it is tempting to posit that the explanation for this relationship is that the loose credit standards of this period disproportionately encouraged higher-income and White non-Hispanic borrowers to take out mortgages. However Figure 4 does not appear to support this view.

F. Interpretation and Conclusions

It has been argued that the loosening of credit standards and, especially, the embracing of risk-based pricing has "democratized" credit markets by disproportionately expanding access to credit markets for low-income and minority neighborhoods and borrowers.[17] Our study of the years 2004 through 2008 strongly supports the view that these policy-targeted subpopulations benefited from the relaxing of credit standards that peaked in 2006. The role of risk-based pricing in this democratization, however, is less clear.

From a twenty-year perspective, it is plausible to argue that mortgage lending has made a significant shift from average-cost to risk-based pricing, but there is no evidence of such a trend in the overall market for the years 2004 through 2008. Instead, we see strong evidence of RBP throughout the period. The mild trend we do see—a slightly increased adoption of RBC from 2004 through 2006 followed by a slight decline in RBC--primarily reflects the changing market shares of subprime and FHA lending. Subprime lenders throughout this period have consistently embraced risk-based pricing, but FHA has not. The shrinking of FHA throughout the early years of our study period is therefore associated with an increased tendency towards RBP in the overall market. Conversely, the dramatic shrinking of subprime shares in 2007 and 2008 is associated with a slight decline in the evidence of risk-based pricing in the overall market.

Within submarkets themselves, the use of risk-based pricing remained relatively constant throughout our study period—extensive in both the prime and subprime submarkets, and almost non-existent in FHA. In our view, therefore, there was no dramatic change in the adoption of RBP throughout the years 2004 through 2008. For this reason risk-based pricing does not appear to have caused the relaxation of credit standards from 2004 to 2006, although it certainly may have helped to enable them.

It is also worth noting that the expansion of credit and the adoption of risk-based pricing can have contradictory impacts on low-income and minority neighborhoods and borrowers. Because policy-targeted subpopulations tend to have higher credit risk characteristics, a relaxation of underwriting standards will disproportionately provide them with increased access to credit. At the same time, however, the higher credit risk characteristics of policy-targeted subpopulations means that they disproportionately face higher mortgage rates in a world of risk-

[17] See, for example, Gramlich (2007).

based pricing. So, while relaxed underwriting standards will tend to provide increased access to credit disproportionately to low-income and minority neighborhoods and borrowers, it likely also will aggravate the tendency for policy-targeted subpopulations to disproportionately pay higher prices for their mortgages they do get based on their higher default risk.

This dynamic played out in a manner that was surprising, at least to us, in the years 2004 through 2008. Specifically, although credit standards first loosened and then tightened, and risk-based pricing was relatively constant, there was an overall decline throughout the period in the disproportionate prices that policy-targeted subpopulations paid for their mortgages. That is, we expected the credit loosening of the 2004 through 2006 period to exacerbate the differentially high APRs paid by low-income and minority neighborhoods and borrowers, but it did not.

We believe this unexpected result reflects the complex impact that loosening credit standards can have on the overall market. Relaxed underwriting grants credit to those who previously were denied. Our analysis also suggests that a more permissive credit environment results in an overall increase in the default risk of mortgage originations, due, perhaps to a greater acceptance or encouragement for higher leveraging (lower downpayments) and greater "stretching" (higher DTIs). This latter factor seems to have mitigated the differentially higher rates paid by policy-targeted subpopulations in our period of analysis.

We conclude with two broad policy implications from our analysis. First, our data suggest that there was a significant "democratization" of credit in the years 2004 through 2006. Specifically, the relaxation of underwriting standards throughout this period disproportionately increased access to credit for low-income and minority neighborhoods and borrowers, and this simultaneously occurred with a reduction in the extent to which policy-targeted subpopulations disproportionately paid higher APRs for their mortgages. This does not mean, of course, that these benefits came without costs; clearly the ex post performance of these loans raises suitability and sustainability concerns. It does suggest, however, that all policy dimensions should be fully considered when searching for causes and/or solutions to the recent crisis in mortgage lending.

Second, at least over this period, risk-based pricing does not appear to be the market evil that it is sometimes portrayed to be. Risk-based pricing was relatively consistently utilized over the 2004 through 2008 period by both prime and subprime lenders, but not at all by FHA. Despite this difference, the time trend of impacts on low-income and minority neighborhoods

and borrowers was fairly similar for all three submarkets. Arguably, in fact, it was subprime and not FHA that faired the best in its overall impact on policy-targeted subpopulations. Again, of course, we have not considered either mortgage suitability or sustainability, and this could tip the balance the other direction. Our analysis nonetheless suggests that risk-based pricing may not be the cause for concern that some seem to feel it is.

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