

The Attractions and Perils of Flexible Mortgage Lending

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Abstract

A mortgage program that offered borrowers greater flexibility in the timing of repayments increased a bank's volume by over 35%. Loans in the program exhibited superior performance. Despite this, a regression discontinuity analysis shows that the causal impact of offering flexibility was to attract borrowers to the bank who experienced quadruple the average delinquency rate. These contrasting findings are driven by the fact that the bank engaged in ex post sorting of stronger borrowers into the flexible program. This sorting masked the ex ante adverse selection effects that offering flexibility had on the entire borrowing pool.

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Financial flexibility, the ability of a borrower to exercise some control over the amount and timing of repayments, is a central feature of many loans made to both consumers and commercial borrowers. The value of financial flexibility for corporations has been the focus of a burgeoning literature (Jagannathan, Stephens and Weisbach 2000, Graham and Harvey 2001, Gamba and Triantis 2008 and Sufi 2009). Less is known, however, about the importance of flexibility to consumers. Mortgages, in particular, commit households to long-term streams of repayments, typically in the face of both labor income uncertainty and limited access to additional borrowing. Flexible mortgages should help alleviate the severity of these problems. They allow borrowers to make limited payments when circumstances demand it, compensating in other periods when their resources are more abundant (Cocco 2013). In this paper I empirically assess the effects of offering financial flexibility to households on a bank's origination volume and loan performance. I consider a specialized mortgage program marketed by a U.S. bank to certain borrowers during 2004 and 2005. Two central points emerge from the empirical analysis. First, flexibility is very attractive to households: I estimate that offering the program increased the bank's volume of originations by over 35%. Second, though borrowers in the program exhibited good loan outcomes controlling for observable risk characteristics, I find that offering the program attracted borrowers with very negative unobservable qualities. Eligible borrowers drawn to the program were four times as likely to experience subsequent delinquency as an average borrower.

The bank in this study originated different versions of option adjustable rate mortgages (Option ARMs) that allowed for negative amortization. These loans offer significant flexibility to borrowers, and they became quite popular during the housing boom, rising by 2006 to over 12% of all originations and close to 40% of mortgages in some well-performing markets (Piskorski and Tchistyi 2010 and Krainer and Laderman 2013). In fact, Barlevy and Fisher (2011) show that across U.S. cities, the frequency of back-loaded mortgages allowing for lower upfront payments was strongly associated with subsequent speculative housing bubbles. This paper therefore aims to enhance our understanding of the broader role of flexible mortgage products by elucidating the attractions and

risks to banks of providing these financial contracts.

During the program period, the bank offered two Option ARM mortgage programs that I label Standard and Flexible. Standard loans could be offered to any borrower, but only high credit score applicants were supposed to be granted Flexible loans, though exceptions were made. Both programs provided floating rate loans at essentially identical rate spreads. The main distinction was in the repayment terms. Initially, Flexible mortgages required slightly lower payments, but the difference grew over time. Standard loans could experience a payment increase annually, but Flexible loans had their payments fixed for three, five or ten years (depending on the specific loan contract). Consequently, Standard loan borrowers faced a schedule of increasing required payments over time, while Flexible borrowers could choose to make only the initial low payment for an extended period. Given that the underlying rate spreads were largely the same, Flexible program borrowers were not paying less overall but simply had more discretion over when to pay. Formal eligibility for the Flexible program required that borrowers exceed a credit score threshold. In the post-program period the Flexible program was closed and only Standard loans were made available.

The formal eligibility threshold and the termination of the Flexible program in the post-program period allow me to assess, using a regression discontinuity difference-in-differences design, the causal impact on a bank's volume and loan performance of offering financial flexibility to households. The underlying pool of potential borrowers just above and below the eligibility cutoff should be expected to be quite similar in both the program and post-program periods. I examine discontinuities in outcomes around the eligibility criterion, and consider how these discontinuities differ across the two periods. Changes in these discontinuities provide evidence that outcomes for below- and above-threshold borrowers differ depending on whether the Flexible program is being made available by the bank. Given the essential similarity of the two sets of potential borrowers, any such difference in outcomes can be attributed to the offering of the Flexible program itself.

Using this method, an analysis of the volume of originations shows that there is a surge of borrowers with above-threshold credit scores during the program period that disappears after

program termination. Quantifying this effect, I find that the program led to an increase of 36-42% in volume, providing clear evidence that loan products with flexible features can increase banks' business.

Offering flexibility does come with significant loan performance costs for the bank, though this is not immediately apparent from a casual analysis. Flexible loans exhibit lower delinquency risks, controlling for observable borrower and transaction characteristics. This result, however, may be driven by unobserved borrower characteristics. A proper assessment of the impact of the Flexible program on performance requires comparing outcomes for borrowers who were formally program-eligible with those who were not. Exploiting the discontinuous impact of the credit score threshold on eligibility, I find that program-eligible borrowers were 22.8 percentage points more likely to become delinquent, relative to a sample mean delinquency rate of 7.3%. This is strong evidence that offering flexibility to households led to very bad outcomes for the lender.

How can the negative causal effect of the Flexible program be reconciled with the strong performance of Flexible mortgages? I show that the bank made use of soft information other than formal credit scores and loan features to direct only the very best borrowers into the Flexible program, while weaker borrowers were granted Standard loans. This ex post sorting led to good outcomes for Flexible loans and masked the negative ex ante effects that offering flexibility had on the entire borrowing pool. The effectiveness of the bank's sorting procedure does raise the question of why worse risks were not simply denied credit. I show that the negative performance is concentrated in the sample of loans on properties that subsequently experienced quite negative price changes. Without these likely unexpected large price declines, the overall performance of weaker borrowers would have been reasonably good and the bank would probably have benefited from making these additional loans.

The strong negative impact of offering flexibility may be driven by either selection or treatment effects. Adverse selection could arise from the desire of worse borrower types to defer payments for as long as possible. I consider two potential forms of treatment effects. In the first, the Flexible

loans may cause default because of the large payment “shock” borrowers experience when the fixed payment period eventually ends (though rational borrowers should anticipate this). In the second, the smaller payments of Flexible borrowers will give them lower (and possibly negative) equity in their homes, which may lead them to optimally decide to default. To isolate the impact of selection, I consider loan outcomes only in the period before the first payment adjustment and I control for the borrower’s home equity. In other words, this test compares program-eligible and ineligible borrowers during a period in which the Standard loan payments are uniformly higher and it also accounts for the borrower’s equity. In this specification I again find that the program-eligible borrowers are much more likely to become delinquent. This result is consistent with the argument that the negative effect of offering flexibility that I observe is driven by adverse selection, rather than either of these treatment effects. Previous research has also found strong negative selection effects in the consumer finance market for credit cards (Calem and Mester 1995, Ausubel 1999) and mortgages (Ambrose and LaCour-Little 2001).

I also find that the effect is stronger during a narrow three-month window around the program closure, suggesting that the announcement of program termination led to even worse selection as weak eligible borrowers rushed to secure flexible loans before it ended. This finding also provides support for the argument that it is the program itself, not events in the general competitive environment, that led to worse loan performance for borrowers who qualified for the Flexible program.

The bank I study is of medium size, originating about \$2 billion worth of mortgages per year. While banks of this size clearly operate in ways that are quite different from mega-banks, they are responsible for a significant part of mortgage activity in the U.S. For example, in 2006 banks with volume of \$2 billion or less together originated mortgages worth \$593 billion, representing 30% of all conventional mortgage lending.¹ Medium size banks are typically local lenders who continue to serve a key function in providing mortgages. This bank operated in thirty four Metropolitan Statistical Areas, but the median distance of financed properties from the bank headquarters is only

¹Source: MortgageDataWeb.com, based on Home Mortgage Disclosure Act filings

117.6 miles. The Option ARMs offered by the bank were, in general, particularly popular with the medium-high credit score clientele it serviced: in 2005 over 20% of the non-conforming mortgages made nationally to borrowers with credit scores in the range of 660-719 were Option ARMs (Frankel 2006). Option ARMs were available from a variety of medium-large banks.²

Households, like firms, are subject to liquidity shocks (Holmstrom and Tirole (1998)), and consumption smoothing considerations suggest that the ability to control the timing of their payments, as under flexible mortgages, should be valuable to them. Financial flexibility in their loan contracts would loosen the liquidity constraints that bind many consumers (Gross and Souleles (2002)). In the face of this demand for flexibility, the development of new mortgage products offering borrowers discretion over the timing of repayments would appear to represent a useful financial innovation. Moreover, Piskorski and Tchisty (2010) show that elements of Option ARM contracts can be optimal in supplying borrowers with flexibility. The strong demand for Flexible mortgages that I document is consistent with these arguments. As the loan outcome findings make clear, however, the benefits of this innovation may be severely limited by the types of adverse selection considerations that were central to the financial crisis (Tirole 2012). These products must be offered in a manner that mitigates the information effects I find here. Broadly, these results suggest that selection issues should be a first-order consideration in the design of any form of household credit product (such as credit cards or personal lines of credit) that supplies payment flexibility.

1 Data

The data in this paper describe 23,093 residential single-family mortgage loans originated by a U.S. financial institution in the period January 2004- October 2008. Loans made to insiders are excluded. These loans were retained by the bank and not securitized. The bank originated approximately

²For example, in March 2008, of the thirty-three banks with Call Report data specifying that they held over \$5 billion in fixed term 1-4 family residential mortgages, eleven stated that some of these loans carried negative amortization features. Of the twenty banks holding \$5-\$20 billion in mortgages, five offered negative amortization loans. Source: ffiec.gov.

\$2 billion of mortgages annually during the sample period, and it specialized in deposit-taking and residential mortgage lending. As described in Table 1, the data include pricing information and details on borrower and property attributes. This bank offers floating rate mortgages, and the mean spread between the loan interest rate and the underlying index is 3.53 percentage points (various indices are used, including the prime rate, the Treasury bill rate and LIBOR). The spread is determined by objective factors such as the loan amount and borrower credit score, and the loan officer is also able to make an adjustment to the spread that is called the exception pricing. The mean loan-to-value (LTV) ratio is 73% and the mean borrower FICO credit score is 714.9. Many of the loans allow borrowers to make payments less than the current interest rate, thereby causing negative amortization. This relatively high mean FICO score reflects the fact that the bank made almost no subprime loans (e.g., only 0.3% of borrowers had FICO credit scores below 620). That these loans were made to high-quality borrowers and not securitized suggests that this bank was not directly affected by key drivers of default emphasized in other research (Mian and Sufi 2009 and Keys, Mukherjee, Seru and Vig 2010). Data is also provided on the purpose of the loan (home purchase, cash out refinance or rate/term refinance). In common with broader market trends, the bank experienced significant delinquencies in its residential lending. Specifically, 7.3% of the loans in the data are delinquent (90 or more days past due).

1.1 The Standard and Flexible Programs

The bank offered two broad loan programs during the sample period, the Standard program and the Flexible program. Both programs offered floating interest rate terms that adjusted each month. The central distinction between the programs was that under the Standard program the borrower's initial payment rate was kept constant for a period of one year, after which the loan reamortized and the payment was adjusted to allow for full loan payoff at the end of the maturity period (subject to a 7.5% annual cap on the adjustment) . Under the Flexible program, the initial payment rate was maintained for a period of five years (in a small number of cases the payment rate was held constant

for three or even ten years). During the fixed payment period interest continued to accrue, so the loans offered the possibility of negative amortization. The payment rates specified the minimum required payment, which was detailed in both the loan documents and the monthly statements, so borrowers under the Flexible program essentially had the option to back-load payments if they wished to. Both Standard and Flexible loans had maximum levels of negative amortization after which the payment adjusted automatically. The Standard and Flexible programs were essentially variations on what is known in the industry as an Option ARM, with the Flexible program offering a substantially longer period of potentially lower payments. The following is a summary of the key terms of the loans in the two programs.

Interest rate: Both programs offered floating rate loans, adjusting each month. No initial teaser rate was available.

Payments: Initial low payment under both programs. For the Standard program, this payment adjusted after one year, for the Flexible program it was kept fixed for five years (or three or ten years, in a small number of cases) before adjusting. After adjustment, the mortgage switched to the fully amortized payment, subject to an annual increase cap of 7.5%.

Negative amortization cap: Present for both programs, and typically set at either 110% or 125% (with roughly equal frequency) of the original principal balance. If a loan achieved the maximal negative amortization, this would trigger a shift to fully amortized payments, even if the time period specified above had not yet elapsed.

Offer period: Standard loans were offered during the entire sample period. Flexible loans were offered from January 2004 until December 2005. The Flexible program closure was announced several weeks before it was terminated.

During the sample period, 74% of Standard loans and 6% of Flexible loans experienced a shift to a higher payment. (Loans originated towards the end of the sample period and loans that either defaulted or were paid off before the constant initial payment period expired would not have time

to experience such a shift.) When there was a payment increase, it was equal to the 7.5% cap for more than 99% of borrowers.

The mortgages differ in their level of documentation: a borrower chooses how much documentation to supply and receives a rate that depends on this choice. It is clear that for a fixed set of loan terms (e.g. interest rate, maturity, etc.) a Flexible mortgage should be more appealing to a borrower than a Standard mortgage; the Flexible loan simply offers an additional option of paying a lower amount for some time. On the other hand, Flexible mortgages were not made available to all applicants: borrowers had to exceed a credit score threshold to be formally eligible for the Flexible program or could be denied a Flexible loan for other reasons. As I describe in Section 2, the empirical strategy in this paper makes use of the formal eligibility thresholds for the Flexible program. There was no such threshold for the 4,003 no-documentation loans (they were not eligible for Flexible loans), so I exclude them from the analysis. Sixty percent of the remaining loans were high documentation and the rest were low documentation. In Section 3.2 below, I provide some evidence on variation in loan terms (loan-to-value ratio, loan amount, etc.) across the two programs.

1.2 Origination Process

The bank sold almost all of its loans through networks of independent mortgage brokers. Prospective borrowers would approach their brokers, who would describe a variety of possible mortgage options. Borrowers who wished to proceed would begin completing paperwork and the broker would seek a credit report on the borrower. After an application to the bank was made, the borrower would be responsible for various fees (e.g., application fee, processing fee, appraisal fee, etc.). Borrowers could choose to apply to either the Standard or Flexible programs, though it was made clear that formally ineligible borrowers would require a special exemption to be approved for the Flexible program. Further, borrowers knew that not all formally eligible borrowers would be granted a Flexible loan (or any loan at all). The bank would evaluate the application over a period of 35-

60 days and then return to the borrower with an offer of either a Flexible mortgage, a Standard mortgage or no financing. The borrower would then choose whether to accept the loan on the specified terms.

2 Empirical Specification

The empirical analysis considers the effects of offering financially flexible loans to borrowers. Borrowers who are granted these loans likely differ in unobserved ways from those who are unable to obtain them, so one cannot simply contrast the outcomes of borrowers who received flexible loans with those who did not. To address this endogeneity problem, I make use of the special feature that only borrowers with a credit score above certain thresholds were formally eligible for the Flexible program. This allows for a regression discontinuity analysis that contrasts borrowers just above and below the formal thresholds for eligibility in both the program and post-program periods. The program created a stark difference in the product offerings of the bank to above- and below-threshold borrowers, and this difference disappeared in the post-program period. Comparing the program and post-program periods, a change in the difference between above- and below-threshold borrowers can therefore be attributed to the Flexible program itself. In essence, this is a regression discontinuity difference-in-differences design.

The formal threshold for eligibility during the program period was a FICO score of 680 for low documentation loans and 640 for high documentation loans. The indicator variable I_C denotes mortgages originated to borrowers with credit scores above the formal threshold.

$$I_C = \begin{cases} 1 & \text{if credit score} \geq 680 \text{ and low documentation} \\ 1 & \text{if credit score} \geq 640 \text{ and high documentation} \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

The indicator variable I_P denotes mortgages issued by the bank during the period in which the Flexible program was in place.

$$I_P = \begin{cases} 1 & \text{if originated during program period} \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

I define mortgages to be *Program-Eligible* if the borrower's credit score exceeded the formal threshold and the mortgage was originated during the program period.

$$Program-Eligible = I_C * I_P \quad (3)$$

To analyze the impact of the flexible program, I estimate the following formal model:

$$LoanCharacteristic_{i,t} = \alpha + \beta Program-Eligible_{i,t} \quad (4)$$

$$+ \eta I_{C_{i,t}} + \sum_{j=1}^4 \omega_j^C C_{i,t}^j + \sum_{j=1}^4 \xi_j^C I_{C_{i,t}} C_{i,t}^j$$

$$+ \pi I_{P_{i,t}} + \sum_{j=1}^4 \omega_j^{CP} C_{i,t}^j I_{P_{i,t}} + \sum_{j=1}^4 \xi_j^{CP} I_{C_{i,t}} C_{i,t}^j I_{P_{i,t}}$$

$$+ \gamma * controls_{i,t} + \lambda_t + \epsilon_{i,t},$$

where $LoanCharacteristic_{i,t}$ is a transaction or borrower attribute for loan i originated in month t , $C_{i,t}$ is the borrower credit score centered around the threshold, $controls_{i,t}$ is a vector of loan and property controls including documentation type, λ_t is a month fixed effect for each of the 57 months in the sample (excluding one month to avoid collinearity) and $\epsilon_{i,t}$ is an error term. The controls may include fixed effects for other mortgage characteristics, depending on the specification.

In this specification the main coefficient of interest is β , which measures the differential impact of an above-threshold credit score in the program period, relative to the post-program period. A significant estimated coefficient for β indicates that the threshold discontinuity in credit scores has a differential impact in the program period.

The pool of borrowers formally eligible for the program differed in quality from the pool of those who were not eligible. By focusing on borrowers in a narrow band around the formal threshold, however, specification (4) controls for general quality differences between eligible and ineligible borrowers. Macroeconomic conditions differed significantly in the program and post-program periods. The month-of-origination fixed effects account for variation in general market conditions over time.

I estimate (4) using OLS, despite the binary nature of some of the *LoanCharacteristic* variables, due to the large number of fixed effects along several dimensions and the resulting incidental parameters problem in non-linear maximum likelihood estimation (Abrevaya, 1997). OLS coefficients are estimated consistently even with multiple fixed effects. This approach is similar to the one used in the models of Card, Dobkin, and Maestas (2004) and Matsudaira (2008). The specification allows loan characteristics to be continuous in the borrower's credit score, with the shape of the probability function permitted to be different on either side of the eligibility threshold.

For underlying variables (such as credit score) that take on only discrete values, Card and Lee (2008) suggest clustering at the level of the variable itself, and I adopt this recommendation. In various specifications, I also double-cluster at other levels (e.g., month-of-origination), as appropriate. For some cross-sectional tests I contrast the estimate of β in two samples, and examine the possibility that program eligibility matters more in certain contexts than in others.

As I will discuss in the analysis below, differences in outcomes between above- and below-threshold borrowers may arise from either selection (e.g., eligible borrowers who are attracted to the Flexible program will be more likely to apply) or treatment (e.g., the Flexible program has a causal

effect on borrowers), and I will attempt to distinguish these effects. There may also be selection at a second level, as low documentation borrowers who fall just below the high threshold may in some cases have the ability to submit high documentation and become eligible, but have chosen not to. It is presumably costly to present high documentation or else all borrowers would do so, as it results in better terms. Indeed, the nature of a borrower's employment may determine his ability to submit a high documentation application. As a robustness test, however, I also consider a specification that does not condition the eligibility threshold on the documentation level. In this specification, the contrast between eligible and ineligible borrowers may be thought of as the contrast between borrowers who must pay either low or high costs to access the program. In either case, however, the key point is that borrowers who present just above-threshold applications are granted easier access to the Flexible program than the largely similar borrowers who are just below-threshold.

2.1 Credit Score Manipulation

Borrowers can clearly influence their credit scores. Does the possibility that they do so in an attempt to meet the formal Flexible program requirement invalidate the regression discontinuity design? Lee (2008) shows that if borrowers have an effect on their scores but the manipulation is to some degree imperfect and noisy, then the regression discontinuity model is identified. All that is required is that there be a noisy random chance component, even if it is only slight, that prevents the borrowers from exercising precise and complete control over their credit scores.

Borrowers do not know the exact methodology for computing credit scores and certainly have less than absolute control over the timing of the reports of their creditors. Even borrowers who check their scores regularly and take actions to improve them are unable to precisely target a specific score, as the impact on scores of credit events is both lumpy and unpredictable in magnitude and timing. This generates the local noise that is necessary for identification. On the other hand, the potential for manipulation does suggest that the clearest identification will arise from estimates that contrast outcomes in quite narrow bands around the eligibility thresholds. For example, if the credit score

cut-off is 680, then quasi-random variation is most likely to hold for comparisons between borrowers with scores of 679 and 680. Borrowers with scores of 690 may be quite different from those with scores of 670, and the former group may well contain more borrowers who influenced their scores to exceed the threshold. The empirical approach in this paper therefore emphasizes contrasts between above- and below-threshold borrowers in quite narrow windows around the formal cut-offs.

3 Results

3.1 Flexible Program

I begin by analyzing the effects of the Flexible Program guidelines on actual loan allocations. While the Flexible Program defined a threshold credit score (680 for low documentation and 640 for high documentation applications) as the formal eligibility requirement, loan officers were granted discretion, under special circumstances, to either disallow formally eligible borrowers or to permit formally ineligible borrowers to participate. (Rules of this kind are not uncommon- see, for example, Bubb and Kaufman 2012.) To what extent were formally eligible borrowers actually more likely to receive loans under the Flexible Program?

To answer this question, I regress an indicator for Flexible loans on a dummy for above-threshold credit scores, separate fourth-degree polynomials in credit score on both sides of the formal threshold, and month of origination fixed effects. As shown in the first column of Table 2, there is a discontinuous jump of 0.244 in the probability of a Flexible loan precisely at the threshold point. This jump is statistically significant (t -statistic= 4.87); reported t -statistics in this table are double-clustered at the levels of the credit score and the month-of-origination. In the overall sample, the frequency of Flexible loans is 32.0%, and the jump is therefore clearly quite large. While loan officers were granted discretion in applying the program guidelines, it is clear that the formal eligibility threshold has a material impact on the type of loan received by a borrower.

The threshold should matter only during the program period. To test this hypothesis, I repeat the previous regression in the program and post-program periods separately. As reported in Table 2, column two, in the program period above-threshold borrowers have a 0.272 higher probability of receiving a Flexible loan (t -statistic=4.90), compared to an overall frequency of 38.0% for Flexible loans. This finding is illustrated in Figure 1, which relates the estimated probability of provision of a Flexible loan to the credit score centered on the eligibility threshold. The polynomial is the fitted curve from the regression specification, and the points represent raw average Flexible loan provision probabilities for buckets of ten points of centered scores. The discontinuity at the threshold is evident in the graph.

The threshold has no impact on the provision of Flexible loans in the post-program period (coefficient=0.0136 and t -statistic=0.78), as detailed in Table 2, column three. The frequency of Flexible loans in the post-program period is 0.8% (a very small number of Flexible loans was originated after the formal program closure). As displayed in Figure 2, there is little Flexible loan provision in the post-program period, and no significant jump at the threshold. These results establish that the eligibility threshold had an impact only during the program period and that Flexible loans were essentially unavailable in the post-program period.

Table 2, column four displays the results from regressing the Flexible loan indicator on the *Program-Eligible* variable, an indicator for the program period, an indicator for above-threshold credit scores, distinct fourth-degree polynomials in credit score for both periods and on both sides of the formal threshold, and month of origination fixed effects. In essence, this specification, as outlined in (4) with the Flexible loan indicator serving as the loan characteristic, combines all the variables from the second and third columns and makes use of the full sample. The coefficient of 0.258 on *Program-Eligible* (t -statistic=4.28) represents the estimated differential effect of formal eligibility on the probability of a Flexible loan in the program period, relative to the post-program period. It combines the information from both periods and supplies a summary measure of the effects of the formal threshold during the Flexible program. The insignificant coefficient on the

Program Period indicator should be interpreted in light of the month-of-origination fixed effects that are included in the specification. This coefficient reflects only the differential probability of a Flexible loan in the whole program period relative to the probability in one particular month (i.e., the omitted month-of-origination dummy). As such, it does not have much meaning for this study.

The inclusion of loan-level controls for the rate spread, the mortgage pay rate, the LTV, the maturity and indicators for refinancings and low documentation loans has little impact on the estimated effect of *Program-Eligible*. As shown in the fifth column of Table 2, the estimated coefficient of 0.263 and *t*-statistic of 4.16 in the specification with these controls vary little from the regression without them.

3.1.1 “Fuzzy” Design

The results in Table 2 clearly establish that formal eligibility had a large and significant impact on the probability that a Flexible loan was supplied. The results also indicate that while Flexible loan provision increases discontinuously at the formal threshold, some formally eligible borrowers received Standard loans and some formally ineligible borrowers received Flexible loans; in other words, this is a “fuzzy” regression discontinuity design. Although it is likely that loan officers made use of unobserved variables in deciding whether to provide a Flexible or Standard loan, this does not invalidate the identification in the empirical design. Identification arises here from a comparison of borrowers just above and below the threshold. These two classes of quite similar borrowers were offered Flexible loans with distinctly different probabilities. I study the impact of formal eligibility on borrowers, not the effect of which loan was ultimately granted (as the latter may be influenced by loan officer information, etc.). All that is required for identification in this “fuzzy” design setting is a discontinuous jump in the probability of Flexible loans at the threshold (Hahn, Todd and Van der Klaauw, 2001), and Table 2 presents clear evidence for that. The subsequent analysis will consider the impact of program eligibility on mortgage terms and loan outcomes.

3.2 Mortgage Terms

The main focus of the Flexible Program was to offer a profile of back-loaded repayments to selected borrowers. In this section I consider whether other loan terms differed between the Flexible and Standard Programs.

Mortgage pricing is a natural first consideration. Using model (4), I regress the rate spread on the loan on *Program-Eligible* and a set of controls consisting of an indicator for whether the borrower centered credit score was zero or above, an indicator for loans generated during the program period, fourth-degree polynomials in credit score for both periods and monthly fixed effects. The result, described in Table 3 Panel A, column 1, shows that Flexible loans do not have significantly different rate spreads (t -statistic=-1.07). The estimated coefficient is not only insignificant, but also small in magnitude (11.5 basis points); there is no evidence of any pricing effects.

As shown in columns two through seven of Table 3 Panel A, *Program-Eligible* loans did not differ in their exception pricing, maturity, overall loan amount, LTV ratio, negative amortization caps or probability of being a refinancing from those that were ineligible.

In the first column of Table 3 Panel B, I display the results from regressing the initial required pay rate on *Program-Eligible* and the controls. The estimated coefficient of -0.268 is marginally significant (t -statistic= -1.74). This reduction of 26.8 basis points in the pay rate (relative to a mean of 2.12%) suggests that the Flexible Program, in addition to fixing the required payments for a longer period of time, also had lower initial payments. Given that the underlying rate spread was the largely the same as in the Standard Program, this represents a second respect in which Flexible Program loans allowed for greater back-loading.

The central impact of the program, however, was to keep the pay rate fixed for a longer period of time. For each loan I calculate whether the pay rate would increase after the first year, under the assumption that the minimum payment was made each month. In the sample of loans that were outstanding for at least one year, I regress an indicator for a pay rate increase on *Program-*

Eligible and the controls. As detailed in Table 3 Panel B, column 2, program-eligible loans were 22.3 percentage points less likely to experience a pay rate increase (t -statistic=-3.00). This is driven by the fact that Flexible loans were designed to be extremely unlikely to experience a pay rate increase after 1 year. This could only happen if the negative amortization cap was achieved in 1 year, which occurred for fewer than 0.5% of Flexible loans. Standard loans were subject to reamortization after 1 year, and this typically resulted in a pay rate increase. The variable *Program-Eligible* is positively correlated with a borrower having a Flexible loan (as discussed above), but this correlation is less than one. The coefficient on *Program-Eligible* in this specification is thus quite similar to its coefficient in the Flexible loan regressions described in the fourth and fifth columns of Table 2.

The bank marketed its loans through a network of independent brokers. Were the terms offered to brokers more attractive for one loan program relative to the other? To test this hypothesis, I regress the rebate paid by the bank to the broker on *Program-Eligible*. As shown in the third column of Table 3, Panel B, *Program-Eligible* loans did not have higher rebates: the coefficient of 3.6 basis points and t -statistic of 0.16 are both very small (the mean rebate is 1.84%).

Overall, *Program-Eligible* borrowers received loans that had prices and terms that were generally the same as those granted to ineligible borrowers, and brokers received similar rebates for originating loans to both types. The only observed difference is flexibility: *Program-Eligible* borrowers enjoyed a significantly longer fixed payment period at a somewhat lower pay rate.

3.3 Volume

A main purpose, presumably, in offering a new financial product is to increase sales volume. What was the impact of the Flexible Program on the bank's origination volume? I consider this question by calculating for each credit score the total number of mortgage originations in the program and post-program periods separately (the sample begins during the program period, so there is no pre-program period). I then scale these frequencies by the total number of originations in each period to generate an empirical density function. If the Flexible program generated increased volume for

the bank, this should manifest itself in different density patterns in the program and post-program periods. In particular, above-threshold borrowers should be observed flocking to the bank during the program period, but not during the post-program period. This should lead to a discontinuity in volume at the eligibility threshold during the program period that disappears in the post-program period.

Testing this hypothesis requires an analysis of the relative discontinuities at the threshold in the scaled frequencies during the two periods. I regress the scaled frequencies on *Program-Eligible* and the usual controls (i.e., I estimate (4) with the scaled frequency as the dependent variable, and I include only one observation per credit score). As shown in the first column of Table 4, Program-Eligibility generates a jump of 0.00134 (t -statistic=2.52) in the scaled frequency. For credit scores in the range from ten below the threshold to ten above it, the average scaled frequency during the program period is 0.0037. This indicates that the Flexible program led to an increase of 36.2% in volume. The end of the program induced a decline in the relative frequency of above-threshold borrowers.

As a second approach, I consider the McCrary (2008) local linear estimate of the discontinuity in the density function at the credit score threshold in both the program and post-program periods. The McCrary method estimates the density separately on both sides of the threshold and supplies an estimate for the log difference in the density heights. Local linear estimators are not appropriate for discrete variables like credit scores, so I transform the data into continuous form by adding random noise in the form of a Uniform([0,1]) random variable to each credit score. This noise does not result in any misclassification of credit scores as above- or below-threshold, so the estimation exhibits very little sensitivity to the particular random draw.

The estimated kernel density of credit scores during the program period is depicted in Figure 3. The thick line represented the density estimate and the surrounding thin lines depict the 95% confidence interval. The circles describe scaled frequencies. The bin size of 0.74 and bandwidth of 30.8 are selected using McCrary's automatic algorithm.

It is clear from Figure 3 that there was a sharp density break at the credit score thresholds during the program period. The bank made substantially more loans to borrowers eligible for the Flexible program. A simulation of 500 random noise draws yields an average estimated log difference in kernel heights of 0.263 and an average t -statistic of 4.66.

In the post-program period, by contrast, there is not a significant discontinuity at the threshold, as described in Figure 4. In the analogous simulation for this sample, the average estimated log difference in kernel heights is -0.089 and the average t -statistic is -0.48. (The bin size of 1.94 and bandwidth of 29.5 are again selected using McCrary's algorithm.) Once the program terminated, there is no evidence that the bank make significantly more loans to above-threshold borrowers, as shown in Table 4. Combining the two coefficients yields an estimated increase in volume of 42.2%. This is somewhat larger than the estimate from the polynomial approach, but both methods make clear that volumes of above-threshold credit score borrowers were much higher during the program period than during the post-program period. The Flexible program was clearly attractive to homeowners and induced eligible borrowers to approach the bank.

The 36%-42% increase in volume that I find is for all originations, irrespective of the particular loan type granted. As I discuss below, the bank did direct some program-eligible borrowers into the Standard program (and some ineligible borrowers into the Flexible program). This sorting is at the discretion of the bank. The analysis in this section, however, documents the causal impact of offering the Flexible program on overall volume. Previous work has shown that financial flexibility creates value for firms (Billter and Garfinkel 2004) and that the desire to retain it can motivate corporate decisions (Sufi 2009, DeAngelo, DeAngelo and Whited 2010 and Kahl, Shivdasani and Wang 2010). The results in this paper establish that flexibility is also important to consumers and intermediaries that offer it can increase their market share.

3.4 Loan Performance

The evidence discussed in the previous section establishes that the Flexible program increased the bank's flow of originations. In this section I analyze whether loan outcomes differed for borrowers in the Flexible program. Did the Flexible program lead to better or worse performance?

I begin by regressing an indicator for delinquency (90 days or more past due) on a dummy for a Flexible loan, the usual polynomials in the borrower credit score, the loan rate spread, the pay rate, LTV, maturity, indicators for refinancings and low documentation and monthly fixed effects. The result, displayed in Table 5, column one, shows that Flexible loans were 3.09 percentage points less likely (t -statistic=-4.15) to become delinquent. (All t -statistics in this table are clustered by both credit score and month-of-origination.) The overall delinquency rate is 7.3%, so Flexible loans appear to have performed noticeably better. As I discuss in Section 3.5, however, the superior outcomes for Flexible loans may be driven by the bank's ex post sorting on unobservables to direct better borrowers to the program.

To better assess the causal impact on loan performance of offering the Flexible program, I estimate (4) with delinquency as the loan characteristic. As described in Table 5, column 2, the coefficient on *Program-Eligible* is 22.1 percentage points and significant (t -statistic=2.40). This indicates that borrowers eligible for the Flexible program were much more likely to experience subsequent delinquency. The endogenous regression in the first column showed that Flexible borrowers were less likely to become delinquent, but the regression discontinuity result in column 2 shows that the causal impact of offering the Flexible program led to much worse outcomes for the bank. As Table 5, column 3 makes clear, including loan-level risk controls in the delinquency specification has little impact on the estimated coefficient on *Program-Eligible* (it is 22.8 percentage points in this regression) and leads to the same conclusion.

The main specification in this paper makes use of the fact that the formal credit score threshold varied with the level of documentation. As a robustness check, I consider a specification that does

not condition the threshold on the documentation level. This also enables me to include the no-documentation loans in the analysis, even though there was no formal eligibility threshold for these loans. Specifically, I define the modified centered credit score as

$$Mod\ Centered\ Score = \begin{cases} score-680 & \text{if credit score} \geq 660 \\ score-640 & \text{if credit score} < 660 \end{cases} \quad (5)$$

This modified centered score simply compares the credit score to the nearest threshold (i.e., either 640 or 680). Scores are defined to be above the modified threshold if they exceed the nearest threshold, and the new variable *Program-Eligible'* describes loans above the modified threshold that are originated during the program period. That is,

$$Program-Eligible' = I_{Mod\ Centered\ Score \geq 0} * I_P \quad (6)$$

I regress an indicator for delinquency on *Program-Eligible'*, an indicator for loans originated during the program period, an indicator for loans with modified centered scores above zero, fourth degree polynomials in the modified borrower credit score in both periods and the usual controls. The results, displayed in column 4 of Table 5, show that the coefficient on *Program-Eligible'* is 12.1 percentage points (t -statistic=3.90). This provides additional evidence that eligible borrowers experienced significantly worse outcomes. This specification contrasts borrowers above and below the thresholds of 640 and 680, even though those cutoffs affected eligibility for Flexible loans only for the subsets of borrowers with low and high documentation, respectively. As a result, it is not surprising that the coefficient estimate is lower for *Program-Eligible'* than for *Program-Eligible*. Nonetheless, the result makes clear that offering a Flexible loan to borrowers led to very poor outcomes for the bank.

3.4.1 Loan Performance in Narrow Windows Around the Threshold

The results from regression discontinuity specifications should be driven largely by observations close to the threshold. I therefore regress an indicator for delinquency on *Program-Eligible* as described in the main specification (4) in various narrow sample windows around the centered credit score cutoff of zero. As detailed in Panel A of Table 6, the coefficient on *Program-Eligible* is positive and significant irrespective of the window size. Indeed, the coefficient tends to be larger in narrow windows, suggesting that the estimate is largely driven by points close to threshold. In narrower windows lower order polynomials may also be used to fit the data and estimate the discontinuity at the threshold. Panel B of Table 6 describes the results from regressions with third order polynomials in the centered credit score. The coefficients on *Program-Eligible* are again positive and significant and increase as the window size narrows.

In Panel C of Table 6, I present estimates of the coefficient on *Program-Eligible* in models that do not include any polynomials at all. In this specification, the window size can be very small. The first column of Panel C, for example, contrasts borrowers with credit scores at the threshold with other borrowers whose credit scores are one point below. For these regressions as well, the coefficient estimates are largest in the narrow windows. They range from 0.16 to 0.44 and are all significant. Moreover, it is notable that the distribution of borrowers is fairly dense close to the threshold, with 200 to 1063 observations in the narrow samples, depending on the precise window.

In an unreported regression, I extend the window to the full sample. This results in a coefficient of 0.065 (t -statistic=2.72) on *Program-Eligible*, which is noticeably smaller than the estimates in the narrow windows. This method essentially reduces the analysis to a difference-in-difference approach that does not exploit the special features of the eligibility threshold that allow for cross-comparisons of above- and below-threshold borrowers who should be quite similar.

As is standard in regression discontinuity designs, the clearest identification arises from observations near the threshold. It is only for these observations that there is quasi-random assignment

of borrowers to either formal eligibility or ineligibility. This is true for regression discontinuity specifications in general, and it may arguably be especially important in this setting due to the possibility of credit score manipulation, as discussed in Section 2.1. Moreover, the presence of a relatively large number of observations close to the threshold suggests that the narrow window findings are meaningful. The results from the narrow window samples are clear: program eligibility has a strong positive effect on delinquency across a variety of windows and specifications.

3.5 What is the Effect of Offering Flexibility to Borrowers?

The result in the first column of Table 5 showing that Flexible loans exhibited superior performance contrast starkly with the results in columns two through four documenting the negative causal effect of offering Flexible loans to borrowers. That is, the results in columns 2-4 show that offering flexibility to borrowers attracts a poor set of borrowers, but the results in column 1 show that Flexible loans have low delinquency rates. How can these findings be reconciled?

The key point is that the bank exercised some discretion over which formally eligible and ineligible borrowers actually received Flexible loans. As I discuss below, the results in Table 5 are consistent with two phenomena: offering Flexible loans results in negative ex ante selection of borrowers (as shown in columns 2-4), but the bank engaged in positive ex post sorting of borrowers into the Flexible program that generated the good performance exhibited in the first column.

To develop these points, it is useful to consider delinquency summary statistics for different time periods and loan programs. Although this is a broad analysis without controls that does not make use of the sharp discontinuities at the thresholds exploited by the regressions in Table 5, it does help develop intuition for those results. As displayed in the second row of Table 7, during the post-program period in which only Standard loans were offered to all borrowers (with only 27 exceptions), above-threshold borrowers had a significantly lower delinquency rate than below-threshold borrowers. This is what one would expect: higher credit quality borrowers had better outcomes.

The first row of Table 7, however, shows that during the program period, above-threshold borrowers who received Standard loans actually had a higher delinquency rate than below-threshold borrowers. This is consistent with the argument that offering formal eligibility for the Flexible program to above-threshold borrowers did indeed lead to ex ante negative selection of worse types, just as indicated in Table 5, columns 2-4. Amongst the Flexible borrowers there is no significant difference between the outcomes for above- and below-threshold borrowers. The much better performance of Flexible loans during the program period suggests that the bank was successful in sorting weaker applicants ex post into Standard mortgages.

The overall picture that emerges is that offering the Flexible program attracted weak borrowers to the bank (i.e., resulted in negative ex ante selection). The bank then shifted some of the worst borrowers to the Standard program, generating good performance for Flexible loans (due to the ex post sorting). This good performance, however, masks the fact that providing the Flexible product actually brought the bank a large pool of unattractive borrowers and led to weak overall performance. Previous work has shown that financial flexibility can be exploited ex post by consumer borrowers who are on the edge of default (Norden and Weber 2010). My findings demonstrate, however, that the ex ante negative selection effects of offering flexibility can be enormous.

3.6 Bank Sorting

By what means was the bank able to sort weaker borrowers into the Standard program? To provide some insight into this question, I begin with a description of the exception pricing on a mortgage. The interest premium on a mortgage was largely determined by objective loan characteristics like the LTV and borrower credit score, but a loan officer was also permitted to make an adjustment to the premium. This adjustment is called the exception pricing, and it is included in the final rate spread. Exception pricing may be positive or negative; it has a mean of 14 basis points and a standard deviation of 36 basis points. Exception pricing was determined by information gleaned by the loan officer in the course of the application review (sample loan officer notes provided in

justification of the applied exception pricing refer to borrower employment trajectories and special features of the house being financed). Were borrowers who received positive exception pricing more likely to be sorted into Standard loans?³

In the first column of Table 8, I show the results from regressing an indicator for a Flexible loan on *Program-Eligible*, exception pricing, fourth degree polynomials in credit score and monthly fixed effects. Two coefficients in this regression are of interest. First, exception pricing carries a negative and significant coefficient of -0.361 (t -statistic=-7.22). A one standard deviation increase in exception pricing results in a 13.0 percentage point reduction in the probability that a Flexible loan is provided. This is strong evidence that the bank routinely shifted borrowers about whom it learned negative information into the Standard program so that they would not have access to excessive flexibility. Second, the 0.268 coefficient on *Program-Eligible* is very similar to the estimated coefficient on this variable in column four of Table 2 for the specification omitting exception pricing. In other words, whatever information the bank is using to determine exception pricing appears to be orthogonal to the negative selection effects of program eligibility. This is further confirmed by the insignificant relationship between *Program-Eligible* and exception pricing that is detailed in column two of Table 3 Panel A.

The second column of Table 8 displays the results from regressing an indicator for delinquency on *Program-Eligible*, exception pricing and the usual controls. The coefficient on exception pricing is 0.0237 (t -statistic=3.12). That is, borrowers with higher exception pricing do experience worse performance; the bank is successfully identifying weaker borrowers. As in the previous regression, however, the coefficient on *Program-Eligible* is essentially unchanged from the specification without exception pricing (the latter is detailed in the third column of Table 5). The bank can uncover some negative borrower risk characteristics, and it shifts borrowers with these characteristics into Standard loans. The information it uncovers, however, is not related to the negative unobserved characteristic of borrowers drawn to the Flexible program. The Flexible program draws a pool of

³Cole, Kanz and Klapper (2011) and Agarwal and Ben-David (2012) discuss loan officer incentives and sorting.

borrowers that is much weaker; ex post sorting enables the bank to distinguish the relatively better and worse borrowers within each pool, but the bank is not able to offset the general negative effects of offering flexibility.

Given the very poor performance of Standard loans during the program period, as documented in the first row of Table 7, it is worth asking, however, why the bank did not simply reject weak applicants and deny them financing rather than sort them into the Standard program.

To analyze this issue, I calculate for each property (using zip code price indices) the total price change realized from the financing date until the close of the sample period. I then divide the sample into mortgages on properties that had subsequent price changes above and below the sample median of -23.6%. The first point is that average delinquency rates are 3.4% in the higher price change sample and 11.2% in the lower price change sample. For Standard loans, average delinquency rates are 4.3% and 15.0% in the high and low price samples, respectively. If realized price changes had been higher than the surely quite unexpected median of -23.6%, then overall delinquency rates would have been low. Further, in the sample with higher price changes, above threshold borrowers during the program period who were sorted into Standard loans have a delinquency rate of 4.9%, which is less than one-third of their rate in the low price change sample. Even these comparisons probably over-state the default rate expected by the bank, as the median price change cut-off of -23.6% is very low. For the 14% of observations with non-negative price changes, the delinquency rate for Standard loans was 1.9%. In other words, under normal historical price change patterns, the weak borrowers sorted into the Standard program would have had much lower delinquency rates, and these loans would have had much more attractive outcomes for the bank. The sorting of weaker borrowers into the Standard program would have enabled the bank to make these additional loans without granting these borrowers excessive flexibility, and without much of a cost in performance.

The third and fourth columns of Table 8 show delinquency regressions for the lower and higher price change samples (using the median price change of -23.6% as the dividing line), respectively. The results make clear that program eligibility only had a markedly negative effect on delinquency

for properties that experienced worse subsequent prices. Exception pricing, as well, is associated with significantly worse outcomes only in the lower price change sample. This again suggests that those borrowers the bank identified as weak only generated higher delinquencies when their properties experienced substantial price drops.

This analysis suggests that offering the Flexible program and sorting weaker borrowers into Standard loans may well have been attractive to the bank from an ex ante perspective. A different question is why borrowers who were sorted into Standard loans were willing to accept them. During the program period, Flexible loans were only granted to 39.8% of the above-threshold borrowers and 17.6% of the below-threshold borrowers. I have argued that above-threshold borrowers were attracted to the bank by the greater possibility of receiving a Flexible loan. If they learned that in the end they were to be offered only a Standard loan, why did these above-threshold borrowers accept it?

For an above-threshold applicant who has been granted a Standard loan at the end of the underwriting process, there are two main issues to consider. The first is cost. During the course of a refinancing, fees in the range of 3%-6% of the principal balance can be incurred (Federal Reserve Board, 2008). While some closing costs may be avoided by declining the loan, the applicant will still be liable for application fees, inspection and appraisal fees, title search fees, etc. If the applicant decides to decline the Standard loan, then s/he would then be required to either pay these fees a second time to a new lender or forego financing altogether. The second consideration is timing. Loan reviews typically take 35-60 days. Declining a Standard loan would now require an applicant to wait an additional period before (possibly) being granted new financing, and market conditions may have changed in the interim. There is, of course, no guarantee that a second application will result in a loan with flexible features. Lastly, the overall pricing on a Standard loan was not generally inferior to that on a Flexible loan, as described earlier.

For these reasons of both cost and timing, an applicant who was hoping for a Flexible loan may have been willing to settle for a Standard loan at the end of the application process. Essentially,

above-threshold borrowers were drawn to the bank by the reasonably high probability that they would be granted a Flexible loan. When this good outcome did not transpire, they were still often better off accepting the Standard mortgage offered to them rather than undertaking a new application.

In the overall sample, what was the effect of the program on bank profitability? The data do not include full information on losses, but White (2008) reports a mean loss ratio on foreclosed mortgages of 38% by mid-2008. Given the small median yield spread of 3.60 percentage points and the program-generated increase of 22.8 percentage points in the delinquency rate, it is clear that the Flexible program loans had negative returns and were not directly profitable for the bank, irrespective of any impact on volume. Any other potential advantages such as increased cross-selling of deposit services would have had to be very large to offset the direct costs.⁴

Could the bank have enjoyed better performance by charging more for Flexible loans, rather than setting the same interest premium as it did for Standard loans? It should be noted that increasing the interest charge can serve to attract worse quality borrowers (Stiglitz and Weiss 1981), thereby exacerbating the already serious problem of adverse selection created by offering Flexible loans. Nonetheless, in setting the rate premium on Flexible loans, the bank did likely face a trade off between profitability per mortgage and volume.⁵

⁴As an example, consider a Flexible mortgage of \$369,550, with a pay rate of 1.95% and a rate spread of 3.60% (all values are sample medians). Assume that a delinquent mortgage ceases payments after the median time to delinquency of 28 months and experiences a 38% loss at that time. Discounting at the average 12 month Treasury rate (which overstates the attractiveness of the mortgage), the bank would experience a loss on a delinquent mortgage in present value terms of about \$115,000. If the loan does not become delinquent, assume that it is repaid in the 18 month median time to full repayment. If offering Flexible mortgage increases the probability of delinquency by 22.8 percentage points from the base level of 7%, then the NPV to the bank is approximately -\$20,000 per mortgage.

⁵The rate spread is generally set endogenously, so it is difficult to directly assess the effect of the interest premium on volume. A regression of daily volume on the average daily rate spread with month fixed effects yields a negative and significant correlation. Based on this regression, a decrease of 190 basis points in the rate spread is associated with a 36% increase in volume, which is the lower bound I estimate for the increase in volume generated by offering the Flexible program. This gives a general sense of the magnitude of the attractiveness of flexible mortgages to borrowers.

3.7 Controlling for Treatment Effects

The negative causal impact on performance of offering Flexible loans that is documented in Table 5 may be explained either by selection (i.e., worse borrowers were attracted to the program) or by a treatment effect (i.e., the program itself induced negative behaviors on the part of borrowers). Selection could be driven by the desire of worse borrower types to defer payments for as long as possible. I consider two kinds of treatment effects. In the first, it may have been the case that borrowers in the Flexible loan program were unable to make the required payments once they achieved their maximal balances (or reached the end of their initial low payment periods) and received the “shock” of an adjustment to a higher payment. A treatment effect of this kind would likely require some non-rational behavior on the part of borrowers, as the Flexible program gave borrowers the right, but not the requirement, to make slower repayments (it is essentially an option), but it might be that some borrowers actually suffered from being given additional discretion (Laibson 1997, Campbell 2006 and Heidhues and Kőszegi 2010). The second treatment effect arises from the fact that borrowers in the Flexible program had the right to make smaller payments and may thereby have achieved less equity (and possibly negative equity) in their homes. As a result of this negative equity, perhaps it was optimal for Flexible program borrowers to default. (Borrowers may have estimated their property value using information on sales of nearby homes.) In this subsection, I analyze the direct selection effect by controlling for treatment factors.

To provide some evidence on the first treatment effect (i.e., payment shock at the time of adjustment), it is useful to consider the performance of loans in the pre-adjustment phase. In this phase Flexible loans typically require uniformly lower payments than Standard loans. For each loan, I calculate the time to the earliest payment adjustment, assuming that only the minimal payments are made. I also calculate the estimated home equity as fraction of the property value at the last month before the payment adjustment period for each borrower using zip code level price indices and assuming that minimal required payments were made each month. (I do not use the equity at the time of delinquency or loan payoff, as this timing decision is clearly endogenous.) I

regress an indicator for delinquency before the earliest payment adjustment on *Program-Eligible*, the borrower's home equity and the standard controls. As shown in the first column of Table 9, lower home equity is associated with a much higher probability of delinquency, as expected. For the purpose of this study, however, the key point is that the coefficient of 0.253 (t -statistic=4.07) on *Program-Eligible* is large and quite similar to the estimated effect on overall delinquency described in Table 5, column three. That is, in considering a period during which the payments under the Flexible program are lower, and comparing mortgages with essentially the same level of (possibly negative) equity, program eligible borrowers are dramatically more likely to become delinquent. This specification controls for both treatment effects: delinquencies are measured before any payment shock for Flexible loans, and the comparison is between loans with the same equity level.

The fact that the delinquency results are similar in the main specification and in the specification controlling for the treatment effects is largely driven by the fact that neither treatment effect had much impact during the sample period. As discussed in Section 1.1, only 6% of Flexible loans were observed to experience a shift to a higher payment. It is also the case, as shown in the second column of Table 9, that during the time of the sample program-eligible borrowers do not have significantly less equity, despite having the ability to make lower payments. Apparently the variation in house prices generates a fair amount of change in equity levels such that the correlation between program eligibility and equity is not statistically significant.

The third column of Table 9 details the results from a Cox Hazard model of delinquency. (In this model each observation is for a given loan in a specific month.) *Program-Eligible* loans have a higher delinquency hazard (coefficient=1.53 and t -statistic=2.17), indicating that they become delinquent more quickly. The Cox Hazard results in the fourth and fifth columns of Table 9 show that the delinquency hazard increases substantially in the month after a payment adjustment, and the delinquency risk grows more for larger payment shocks. All three Cox Hazard specifications make clear, however, that program eligibility results in more likely delinquency, irrespective of changes in equity and payment adjustments.

Overall, these results provide strong evidence that selection drives the very weak performance of program-eligible borrowers that is observable during the sample period. That is not to say that treatment effects will not be important; in fact, the results in Table 9 suggest that the payment shocks and equity deterioration caused by Flexible mortgages may well lead to even worse performance for program-eligible borrowers after the sample period. These treatments, however, have relatively little effect during the early lives that I observe of the mortgages in the sample. It should also be noted that even once these treatments begin to take effect, this setting may not be ideal for measuring their impact, due to the selection and sorting of borrowers into Flexible mortgages that I have documented.

3.8 Loan Performance Around Program Closure Date

The bank announced the impending closure of the Flexible program several weeks before shutting it down. Were selection effects particularly pronounced in this period as weaker types rushed to get access to flexibility? In this section I analyze the change in loan performance in the switch-over period, a narrow 3-month window centered around the time of program termination.

Regressing a delinquency indicator on *Program-Eligible* and the standard controls in switch-over period sample, I find, as detailed in Table 10, column 1, that program-eligible borrowers were 40.5 percentage points more likely to experience subsequent delinquency (t -statistic=2.44). This is almost twice the delinquency effect described in Table 5, and suggests that performance particularly suffers when a flexible program is about to be shut down. It may make sense, therefore, to terminate programs of this kind without notice. The large coefficient on *Program-Eligible* in the pre-adjustment delinquency regression detailed in the second column of Table 10 is also consistent with the argument that the bulk of the performance deterioration during the switch-over period is driven by worse selection of borrowers. Apparently there was a rush of truly terrible eligible borrowers to obtain Flexible loans before the program ended.

While this effect is quite pronounced, it does not drive the overall findings in Table 5. Columns

three and four of Table 10 show that the negative effects of the Flexible program on loan performance, while most severe during the switch-over period, are also evident during the remainder of the sample (labeled here the non-switch-over period).

The strong negative effect of eligibility on performance specifically during the short program termination period itself also suggests that credit score manipulation by borrowers is unlikely to drive the results, as precise score manipulation would have been particularly difficult to effectuate during the short time period between the announcement and completion of the program closure.

3.9 Timing of Program Termination

The results described above show that the Flexible program led to both a surge in volume and significantly worse loan performance for the bank. Could these findings be driven by the timing of the bank's termination of the Flexible program? For example, in the early period of the sample there may have been more originations and riskier loans made simply due to market conditions. The bank is unlikely to have closed the Flexible program for some random exogenous reason. Might it be that the closure was triggered by changing market conditions, and that these changes also drive the findings?

The empirical specification in this paper is designed precisely to address concerns of this type. Specifically, the regression discontinuity difference-in-difference model described in equation (4) includes fixed effects for each month in the sample. The identification is driven by relative comparisons between above- and below-threshold borrowers in the program and post-program periods. Any market-wide changes in overall conditions will be controlled for by the month fixed effects.

While overall volume and performance certainly did change over time (and the bank's termination decision may well have responded to this fact), my approach depends only the assumption that any differences amongst the bank's potential borrowers in a tight band around the formal eligibility threshold should have not changed significantly over time. The fact that I do find such stark

volume and performance changes can be attributed to the one factor that differentiates above- and below-threshold borrowers over time: in the program period the above-threshold borrowers were far more likely to be offered a Flexible loan, while in the post-program period this was no longer true. The findings in Table 10 show that significant changes occurred right at the time of program termination.

4 Conclusion

This paper provides an analysis of the effects of offering consumers financial flexibility in the form of more control over the timing of mortgage payments. Using a regression discontinuity difference-in-difference design, I show that borrowers found the Flexible program quite attractive, and that it boosted volume by over 35%. Though the program experienced good loan outcomes, this was due to the bank's shifting borrowers with better qualities into Flexible loans. The eligible borrowers drawn to the program, however, experienced delinquency at quadruple the average rate, and I find that this was due to very negative selection. This poor performance was especially pronounced during a narrow three-month window around the program closure, suggesting that program termination led to even worse selection.

Although it is beyond the scope of this study, the marked preference by borrowers for flexible mortgages that I document may suggest that the introduction of these products encouraged a broader set of households to enter the home loan market. The implications for house prices could be quite different if these new borrowers had legitimate needs for consumption smoothing or, conversely, if they were motivated by pure adverse selection considerations. The results in this paper may therefore help facilitate an analysis of the potentially causal role that exotic mortgages are sometimes argued to have played in promoting the pre-crisis housing price boom.

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Figure 1: Flexible Loan Provision during Program Period

This figure depicts the estimated probability of Flexible loan provision during the program period for each level of centered credit score. The thick curved lines represent the predicted Flexible loan provision from an OLS regression of an indicator for Flexible loans on a fourth degree polynomial of centered credit scores. The 95% confidence interval is portrayed in thin lines, and the connected points describe the average Flexible loan provision for each of the buckets of 10 points of centered credit scores.

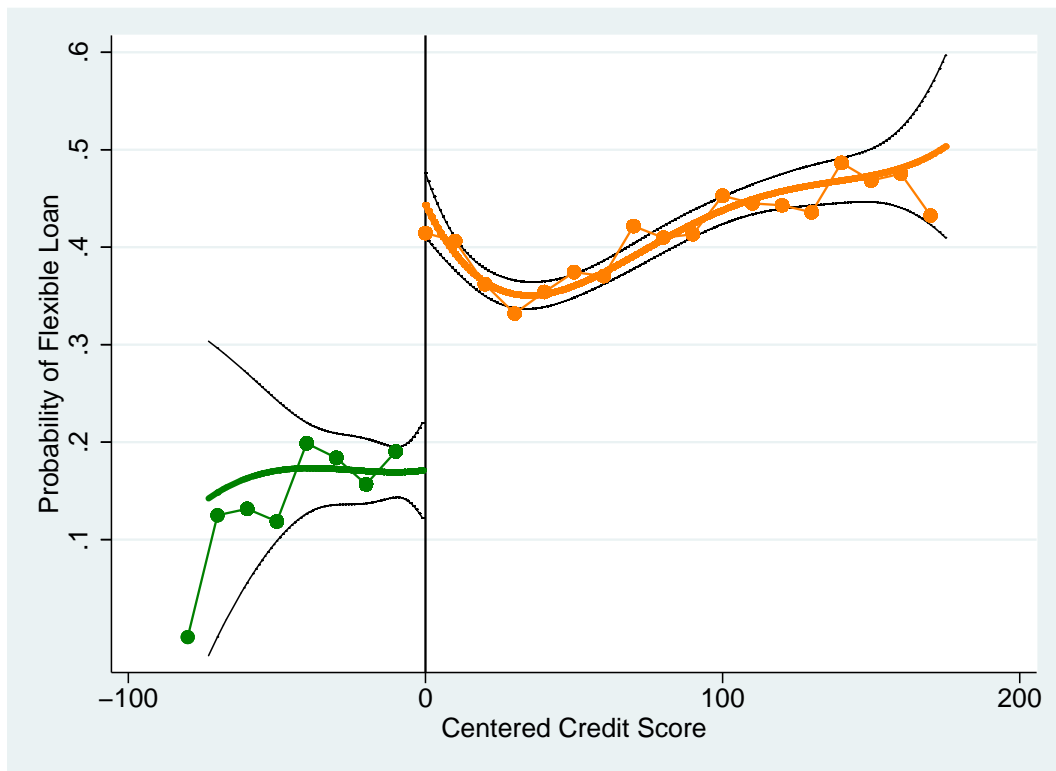


Figure 2: Flexible Loan Provision during Post-Program Period

This figure depicts the estimated probability of Flexible loan provision during the post-program period for each level of centered credit score. The thick curved lines represent the predicted Flexible loan provision from an OLS regression of an indicator for Flexible loans on a fourth degree polynomial of centered credit scores. The 95% confidence interval is portrayed in thin lines, and the connected points describe the average Flexible loan provision for each of the buckets of 10 points of centered credit scores.

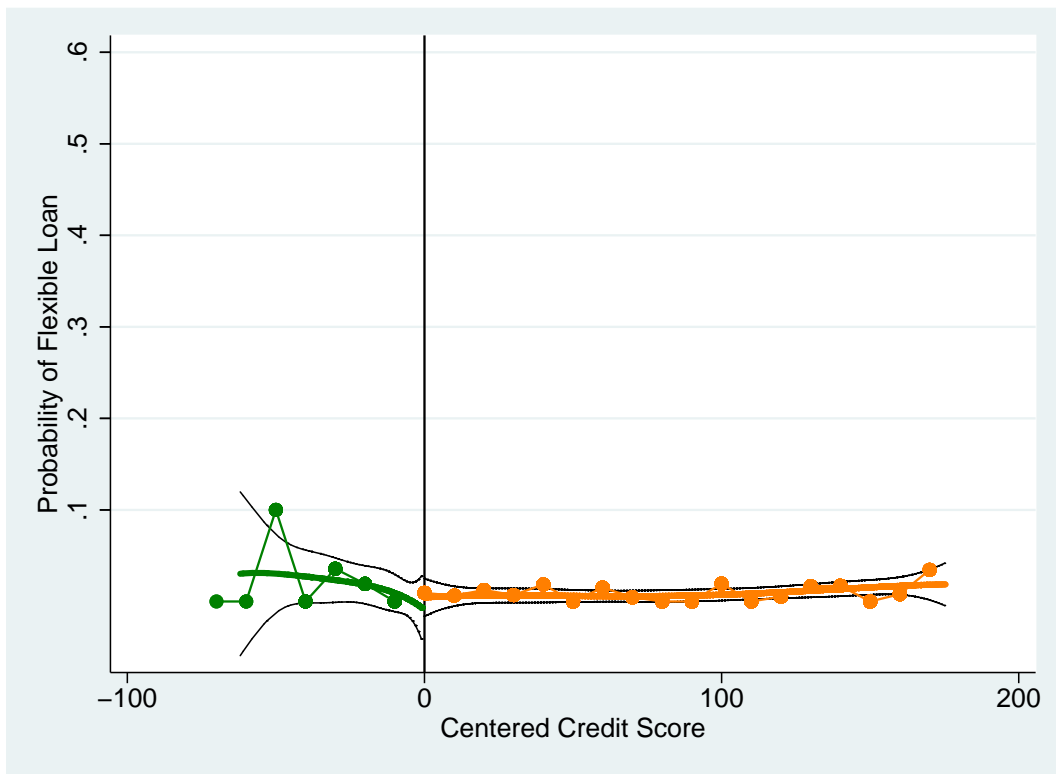


Figure 3: Density of Centered Credit Scores- Program Period

This figure depicts the estimated kernel densities on both sides of zero of centered credit scores plus a Uniform([0,1]) random variable for the sample of borrowers during the program period. The 95% confidence bands are portrayed in thin lines. The circles describe scaled frequencies analogous to histograms. Estimation is via the McCrary (2008) method.

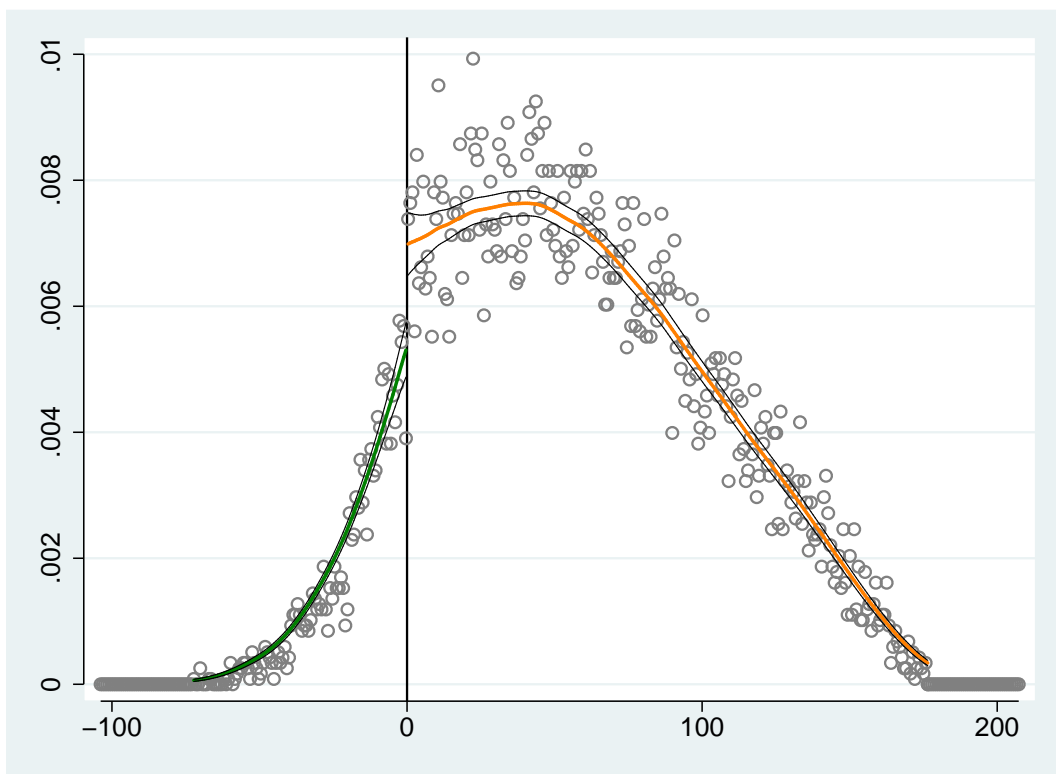


Figure 4: Density of Centered Credit Scores- Post Program Period

This figure depicts the estimated kernel densities on both sides of zero of centered credit scores plus a Uniform([0,1]) random variable for the sample of borrowers during the post-program period. The 95% confidence bands are portrayed in thin lines. The circles describe scaled frequencies analogous to histograms. Estimation is via the McCrary (2008) method.

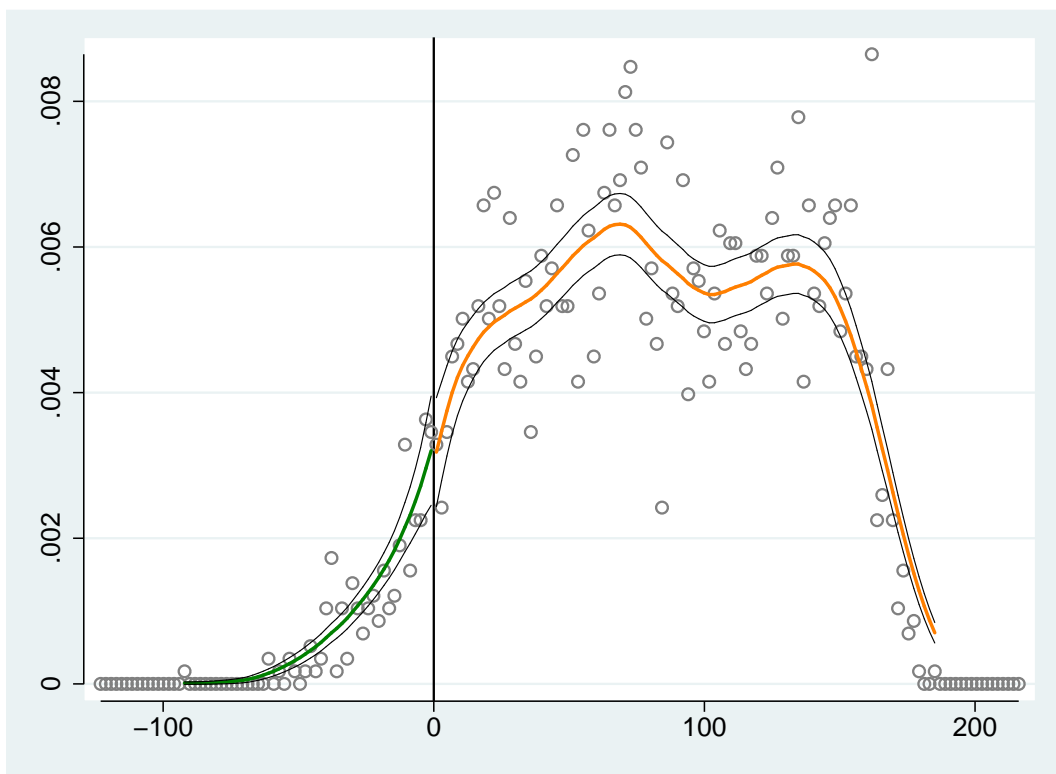


Table 1: Summary Statistics

Panel A describe statistics for the full sample and Panel B provides variable means in various subsamples. Observations are at the loan level. Rate spread is the interest premium paid by the borrower relative to an index. Exception pricing is the adjustment made by the loan officer to the interest premium that is charged, relative to the standard premium (it is included in the rate spread). Maturity is the loan term in months. Credit score is the borrower's FICO score, LTV is the loan-to-value ratio, the loan amount is given in dollars, refinance is an indicator for a refinancing, the negative amortization cap is expressed as a percentage of the original balance, pay rate is the initial payment rate on the loan and flexible is an indicator for flexible loans. Distance describes the borrower's distance from the lender, equity details the borrower's estimated equity at the payment adjustment date, the rebate is the payment from the bank to the broker and broker points is the payment from the borrower to the broker. Documentation describe the level of information verification, delinquency is an indicator for whether a loan was 90 or more days past due. Credit score above threshold is an indicator for borrowers whose credit score exceed the formal eligibility threshold, program-eligible is an indicator for borrowers with above-threshold credit scores during the program period (January 2004- December 2005) and program period is an indicator for loans extended during the program period.

Panel A: Full Sample					
Statistics	Mean	Median	Standard Deviation	1 st %	99 th %
Rate Spread	3.53	3.60	0.53	2.25	4.74
Exception Pricing	0.14	0.00	0.36	-0.45	1.25
Maturity	427.50	480.00	59.60	360.00	480.00
Credit Score	714.88	711.00	44.93	626.00	805.00
LTV	0.73	0.78	0.14	0.28	0.95
Loan Amount	435580.17	369550.00	305523.07	108000.00	1525000.00
Refinance	0.81	1.00	0.39	0.00	1.00
NegAm Cap	112.44	125.00	26.64	0.00	125.00
Pay Rate	2.12	1.95	1.07	0.50	6.05
Flexible Loan	0.32	0.00	0.47	0.00	1.00
Distance	166.18	111.46	139.38	4.81	391.30
Equity	0.05	0.00	0.34	-0.50	1.00
Rebate	1.84	2.00	0.88	0.00	3.25
Broker Points	0.20	0.00	0.45	0.00	2.00
High Documentation	0.60	1.00	0.49	0.00	1.00
Low Documentation	0.40	0.00	0.49	0.00	1.00
Delinquent	0.07	0.00	0.26	0.00	1.00
Credit Score Above Threshold	0.90	1.00	0.30	0.00	1.00
Program-Eligible	0.75	1.00	0.43	0.00	1.00
Program Period	0.84	1.00	0.36	0.00	1.00

Panel B: Subsample Means	Program Period & Flexible Loan	Program Period & Standard Loan	Post-Program & Flexible Loan	Post-Program & Standard Loan
Observations	6023	10076	27	2964
Rate Spread	3.55	3.65	2.66	3.08
Exception Pricing	-0.01	0.23	-0.16	0.13
Maturity	417.69	429.88	440.00	439.22
Credit Score	724.12	705.86	721.33	726.69
LTV	0.70	0.75	0.62	0.70
Loan Amount	384832.35	399311.56	496559.22	661440.57
Refinance	0.87	0.79	0.89	0.77
NegAm Cap	121.87	115.53	114.81	82.32
Pay Rate	2.09	1.93	3.18	2.84
Flexible Loan	1.00	0.00	1.00	0.00
Distance	170.85	168.32	115.65	150.03
Equity	-0.00	0.01	0.19	0.26
Rebate	2.03	1.89	1.49	1.32
Broker Points	0.07	0.18	0.94	0.51
High Documentation	0.46	0.62	0.85	0.81
Low Documentation	0.54	0.38	0.15	0.19
Delinquent	0.03	0.10	0.00	0.06
Credit Score Above Threshold	0.95	0.86	0.89	0.93
Program-Eligible	0.95	0.86	0.00	0.00
Program Period	1.00	1.00	0.00	0.00

Table 2: Flexible Loans

Results from the regressions of an indicator for whether a loan has a Flexible repayment option (i.e., offered back-loaded payments) on borrower and transaction characteristics. The regressors with reported coefficients are a dummy for whether the centered credit score of the borrower was zero or above, an interaction of this dummy with an indicator for whether the loan was originated during the program period (this interaction is labeled “Program-Eligible”) (columns 4-5), an indicator for whether the loan was originated during the program period (columns 4-5), the rate spread on the mortgage (column 5), the initial required pay rate on the mortgage (column 5), the loan-to-value ratio (column 5) and the mortgage maturity (column 5). The regressions also include as controls fourth-degree polynomials in credit score for both periods, monthly fixed effects and indicators for refinancings (column 5) and low documentation loans (column 5). Reported t -statistics are heteroskedasticity-robust and clustered by both credit score and month of origination.

	Flexible?	Flexible?	Flexible?	Flexible?	Flexible?
Above-Threshold Credit Score	0.244** (4.87)	0.272** (4.90)	0.0136 (0.78)	0.0132 (0.76)	-0.0207 (-0.34)
Program-Eligible				0.258** (4.28)	0.263** (4.16)
Program Period				-0.0493 (-0.92)	-0.165** (-2.98)
Rate Spread					-0.269** (-12.88)
Pay Rate					0.154** (7.94)
LTV					-0.413** (-9.88)
Maturity					-0.000162** (-2.01)
Polyn. in Credit Score of Degree	4	4	4	4	4
Monthly F.E.	Yes	Yes	Yes	Yes	Yes
Sample	Full	Program	Post-Program	Full	Full
Observations	19056	16073	2983	19056	18727
Adjusted R^2	0.148	0.078	0.030	0.151	0.315

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$

Table 3: Loan Terms

Results from the regressions of loan characteristics on an indicator (labeled “Program-Eligible”) for whether the loan was originated during the program period to a borrower with a centered credit score of zero or above. The dependent variables in Panel A are the rate spread on the loan (column 1), the exception pricing (column 2), the loan maturity (column 3), the log of the loan amount in dollars (column 4), the loan-to-value ratio (column 5), the negative amortization cap (column 6) and an indicator for a refinancing (column 7). The dependent variables in Panel B are the initial required payment rate on the loan (column 1), an indicator for whether the pay rate increased after the first year of the loan (column 2) and the rebate paid by the bank to the broker (column 3). The regressions also include as controls an indicator for whether the borrower centered credit score was zero or above, an indicator for loans generated during the program period, fourth-degree polynomials in credit score for both periods and monthly fixed effects. Reported t -statistics are heteroskedasticity-robust and clustered by both credit score and month of origination.

Panel A:	Rate Spread	Exception Pricing	Maturity	Loan Amount	LTV	NegAm	Refinance
Program-Eligible	0.115 (1.07)	0.0222 (0.19)	0.319 (0.03)	0.134 (1.17)	0.00557 (0.31)	0.721 (0.28)	-0.0537 (-0.66)
Polyn. in Credit Score of Degree	4	4	4	4	4	4	4
Monthly F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19056	18999	19056	19056	19056	18800	19056
Adjusted R^2	0.255	0.030	0.254	0.153	0.069	0.807	0.050

Panel B:	Pay Rate	Pay Rate Increase	Rebate
Program-Eligible	-0.268* (-1.74)	-0.223** (-2.99)	0.0355 (0.16)
Polyn. in Credit Score of Degree	4	4	4
Monthly F.E.	Yes	Yes	Yes
Observations	18999	14937	19056
Adjusted R^2	0.628	0.130	0.201

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$

Table 4: Volume

Results from the regression of the scaled frequency of originations by centered credit score and period on an indicator (labeled “Program-Eligible”) for whether the loan was originated during the program period to a borrower with a centered credit score of zero or above and from McCrary (2008) kernel density discontinuity estimations. Frequencies of originations are calculated separately for each centered credit score during both the program and post-program periods and scaled by the total number of originations in each period, and these scaled frequencies are labeled “Volume”. The regression in column 1 includes as controls an indicator for whether the borrower centered credit score was zero or above, an indicator for loans generated during the program period and a fourth-degree polynomial in credit score for both periods, as specified in the table. The reported t -statistic is heteroskedasticity-robust. The log-difference in the density heights on either side of the threshold of zero are reported for the program (column 2) and post-program periods (column 3).

	Volume	Volume Density	Volume Density
Program-Eligible	0.00134** (2.52)		
Above-Threshold Credit Score		0.263** (4.66)	-0.089 (-0.48)
Sample	Full	Program	Post-Program
Estimation Method	OLS-Polyn. in Credit Sc.	McCrary	McCrary
Observations	502		
Adjusted R^2	0.896		

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$

Table 5: Loan Performance

Results from the OLS regressions of an indicator for delinquency on borrower and transaction characteristics. The regressors with reported coefficients are an indicator for Flexible loans, an indicator (labeled “Program-Eligible”) for whether the loan was originated during the program period to a borrower with a centered credit score of zero or above, an indicator (labeled “Program-Eligible’”) for whether the loan was originated during the program period to a borrower with a modified centered credit score of zero or above, the rate spread on the mortgage, the initial required pay rate on the mortgage, the loan-to-value ratio and the mortgage maturity. The regressions also include as controls an indicator for whether the borrower centered credit score was zero or above (columns 1-3), an indicator for whether the modified centered credit score was zero or above (column 4), an indicator for loans generated during the program period, fourth-degree polynomials in centered credit score for both periods (columns 1-3), fourth-degree polynomials in modified centered credit score for both periods (column 4), and indicators for refinancings and low documentation loans. Monthly fixed effects are included in all specifications. Reported t -statistics are heteroskedasticity-robust and clustered by both credit score and month of origination.

	Delinquent?	Delinquent?	Delinquent?	Delinquent?
Flexible	-0.0309** (-4.15)			
Program-Eligible		0.221** (2.40)	0.228** (2.47)	
Program-Eligible’				0.121** (3.90)
Rate Spread	0.0267** (5.26)		0.0348** (5.55)	0.0194** (3.44)
Pay Rate	-0.00380 (-1.17)		-0.00839** (-2.24)	-0.0244** (-5.68)
LTV	0.270** (8.61)		0.283** (8.19)	0.423** (8.82)
Maturity	0.000163** (4.48)		0.000168** (4.74)	0.000230** (5.86)
Polyn. in Cred. Sc.	4	4	4	4
Monthly F.E.	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full
Estimation Method	OLS	OLS	OLS	OLS
Observations	18727	19056	18727	23093
Adjusted R^2	0.076	0.038	0.075	0.139

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$

Table 6: Loan Performance- Narrow Windows Around Threshold

Results from the OLS regressions of an indicator for delinquency on borrower and transaction characteristics. Results are provided for various sample windows around the centered credit score of zero; the window sizes are detailed in credit score points. The regressor with a reported coefficient is an indicator (labeled “Program-Eligible”) for whether the loan was originated during the program period to a borrower with a centered credit score of zero or above. The regressions also include as controls an indicator for whether the borrower centered credit score was zero or above and an indicator for loans generated during the program period. The regressions in Panel A also include fourth-degree polynomials in credit score for both periods, monthly fixed effects, the rate spread on the mortgage, the initial required pay rate on the mortgage, the loan-to-value ratio and the mortgage maturity. The regressions in Panel B also include third-degree polynomials in credit score for both periods, monthly fixed effects, the rate spread on the mortgage, the initial required pay rate on the mortgage, the loan-to-value ratio and the mortgage maturity. Reported t -statistics in Panels A and B are heteroskedasticity-robust and clustered by both credit score and month of origination. Reported t -statistics in Panel C are heteroskedasticity-robust.

Panel A:	Delinq.?	Delinq.?	Delinq.?	Delinq.?	Delinq.?
Program-Eligible	0.968** (3.56)	0.606** (3.15)	0.549** (4.17)	0.463** (4.91)	0.326** (2.95)
Polyn. in Cred. Sc.	4	4	4	4	4
Window Size	20	40	60	80	100
Observations	2019	3860	5491	7007	8504

Panel B:	Delinq.?	Delinq.?	Delinq.?	Delinq.?	Delinq.?
Program-Eligible	0.836** (18.04)	0.563** (5.66)	0.359** (3.19)	0.241** (2.26)	0.224** (2.26)
Polyn. in Cred. Sc.	3	3	3	3	3
Window Size	20	40	60	80	100
Observations	2019	3860	5491	7007	8504

Panel C:	Delinq.?	Delinq.?	Delinq.?	Delinq.?	Delinq.?
Program-Eligible	0.440** (2.79)	0.294** (2.36)	0.190** (1.99)	0.164** (2.02)	0.156** (2.28)
Polyn. in Cred. Sc.	No	No	No	No	No
Window Size	2	4	6	8	10
Observations	200	444	657	865	1063

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$

Table 7: Delinquency Summary Statistics

Summary statistics of mean delinquency rates across different time periods, mortgage programs and borrower credit scores. The terms “Ab. Thresh.” and “Bel. Thresh.” refer to borrowers with credit scores above and below the formal eligibility threshold, respectively. The number of observations in each sample is detailed in square brackets.

Loan Type: Borrower:	Standard Ab. Thresh.	Standard Bel. Thresh.	Standard Diff.	Flexible Ab. Thresh.	Flexible Bel. Thresh.	Flexible Diff.
Program Period	10.47% [8642]	8.37% [1434]	-2.10%**	3.08% [5716]	2.28% [307]	-0.80%
Post-Program Period	5.61% [2764]	12% [200]	6.39%**	0 [24]	0 [3]	NA

* $p < 0.10$, ** $p < 0.05$

Table 8: Bank Sorting

Results from the OLS regressions of an indicator for Flexible program loans (column 1) and an indicator for delinquency (columns 2-4) on borrower and transaction characteristics. The regressors with reported coefficients are an indicator (labeled “Program-Eligible”) for whether the loan was originated during the program period to a borrower with a centered credit score of zero or above, the exception pricing on the loan, the rate spread on the mortgage, the initial required pay rate on the mortgage, the loan-to-value ratio and the mortgage maturity. The regressions also include as controls an indicator for whether the borrower centered credit score was zero or above, an indicator for loans generated during the program period, fourth-degree polynomials in credit score for both periods and indicators for refinancings and low documentation loans. The third and fourth columns display results from samples with subsequent price changes below and above the median of -23.6%, respectively. Monthly fixed effects are included in all specifications. Reported t -statistics are heteroskedasticity-robust and clustered by both credit score and month of origination (columns 1-2) or zip code and month of origination (columns 3-4).

	Flexible?	Delinquent?	Delinquent?	Delinquent?
Program-Eligible	0.268** (4.58)	0.226** (2.43)	0.381** (4.06)	-0.0875 (-0.55)
Exception Pricing	-0.361** (-7.22)	0.0237** (3.12)	0.0287** (2.43)	0.0169 (1.60)
Rate Spread		0.0252** (3.65)	0.0394** (4.32)	0.00626 (0.86)
Pay Rate		-0.0129** (-3.18)	-0.0182** (-3.10)	-0.0120** (-3.62)
LTV		0.279** (8.26)	0.431** (10.70)	0.139** (6.82)
Maturity		0.000166** (4.67)	0.000250** (3.93)	0.0000657** (2.24)
Polyn. in Cred. Sc.	4	4	4	4
Monthly F.E.	Yes	Yes	Yes	Yes
Sample	Full	Full	Lower Subseq. Prices	Higher Subseq. Prices
Estimation Method	OLS	OLS	OLS	OLS
Observations	18999	18727	9338	9389
Adjusted R^2	0.229	0.075	0.084	0.040

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$

Table 9: Loan Performance- Early Delinquency and Negative Equity

Results from the OLS regressions (columns 1-2) and Cox hazard models (column 3-5) of various delinquency indicators and homeowner's equity on borrower and transaction characteristics. The dependent variables are an indicator for delinquency before payment adjustment (column 1), homeowner's equity (column 2) and delinquency (columns 3-5). The regressors with reported coefficients are an indicator (labeled "Program-Eligible") for whether the loan was originated during the program period to a borrower with a centered credit score of zero or above, the homeowner's equity (measured in the month before adjustment in column 1 and every month in columns 3-5), an indicator for whether the loan had a payment adjustment (column 4), the amount of the payment adjustment (column 5), the rate spread on the mortgage, the initial required pay rate on the mortgage, the loan-to-value ratio and the mortgage maturity. The regressions also include as controls an indicator for whether the borrower centered credit score was zero or above, an indicator for loans generated during the program period, fourth-degree polynomials in credit score for both periods and indicators for refinancings and low documentation loans. Monthly fixed effects are included in column 1. Reported t -statistics are heteroskedasticity-robust and clustered by both credit score and month of origination (columns 1-2).

	Delinquent Pre-Adj.?	Equity	Delinquent?	Delinquent?	Delinquent?
Program-Eligible	0.253** (4.07)	-0.0532 (-1.45)	1.525** (2.17)	1.457** (2.06)	1.504** (2.14)
Equity	-0.0884** (-6.84)		-0.273** (-11.03)	-0.273** (-10.85)	-0.272** (-10.97)
Payment Adj.?				2.096** (22.79)	
Payment Shock					0.715** (5.15)
Rate Spread	0.00723* (1.82)	-0.0147* (-1.82)	0.876** (12.86)	0.825** (12.29)	0.878** (12.91)
Pay Rate	0.00309 (1.11)	-0.00799** (-2.11)	-0.362** (-9.55)	-0.327** (-8.57)	-0.359** (-9.47)
LTV	0.0230** (1.97)	-1.235** (-32.04)	8.411** (18.91)	8.048** (18.25)	8.389** (18.87)
Maturity	0.0000826** (3.24)	0.0000395 (1.01)	0.00318** (5.63)	0.00249** (4.38)	0.00313** (5.55)
Estimation Method	OLS	OLS	Cox Hazard	Cox Hazard	Cox Hazard
Observations	18709	18709	453968	453968	453968
Adjusted R^2	0.052	0.656			

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$

Table 10: Loan Performance in a Narrow Time Period Around Program Closure

Results from the regressions of an indicator for delinquency on borrower and transaction characteristics in varying time periods. The regressors with reported coefficients are an indicator (labeled “Program-Eligible”) for whether the loan was originated during the program period to a borrower with a centered credit score of zero or above, the rate spread on the mortgage, the initial required pay rate on the mortgage, the loan-to-value ratio and the mortgage maturity. The regressions also include as controls an indicator for whether the borrower credit score was zero or above, an indicator for loans generated during the program period, a fourth-degree polynomial in credit score, monthly fixed effects and indicators for refinancings and low documentation loans. The sample in columns 1 and 2 is a 3-month window around the time of the program closure, and the sample in columns 3 and 4 is the full period excluding this 3-month window. Reported t -statistics are heteroskedasticity-robust and clustered by both credit score and month of origination.

	Delinquent?	Delinquent Pre-Adj.?	Delinquent?	Delinquent Pre-Adj.
Program-Eligible	0.405** (2.44)	0.347** (2.28)	0.213** (1.96)	0.267** (3.25)
Rate Spread	0.0843** (5.65)	0.0574** (3.18)	0.0326** (4.89)	0.00553 (1.48)
Pay Rate	-0.0154** (-2.15)	0.00297 (0.20)	-0.00785* (-1.92)	0.00355 (1.31)
LTV	0.546** (6.60)	0.328** (4.86)	0.257** (7.36)	0.114** (7.52)
Maturity	-0.0000253 (-0.11)	-0.0000122 (-0.07)	0.000179** (5.09)	0.0000848** (3.21)
Polyn. in Cred. Sc.	4	4	4	4
Monthly F.E.	Yes	Yes	Yes	Yes
Period	Switch-over	Switch-over	Non-switch-over	Non-switch-over
Observations	1250	1250	17477	17477
Adjusted R^2	0.097	0.085	0.072	0.037

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$

Data Appendix

Variable Definitions:

Broker points- the payment from the borrower to the broker.

Credit score- the borrower's FICO score.

Credit score above threshold- an indicator for a borrower whose credit score meets or exceeds the formal eligibility threshold.

Delinquency- an indicator for whether a loan is 90 or more days past due.

Distance- the borrower's distance from the lender headquarters.

Documentation- the level of information verification (either high or low).

Exception pricing- the adjustment made by the loan officer to the interest premium that is charged, relative to the standard premium (it is included in the rate spread).

Equity- the borrower's estimated equity at the time of the payment adjustment.

Flexible loan- an indicator for a mortgage extended under the Flexible program, which allowed for payments above the initial pay rate after a period of five years (or three or ten years, in a small number of cases).

LTV- the loan-to-value ratio

Modified time to earliest payment adjustment- for Standard loans, the maximum of the time to the earliest payment adjustment of the Standard loan and the mean time to the earliest payment adjustment for all Flexible loans originated in the same month. For Flexible loans the modified time to earliest payment adjustment is simply the time to the earliest payment adjustment.

Maturity- the loan term in months.

Negative amortization cap- the maximum level of indebtedness the borrower is permitted, expressed as a percentage of the original balance.

Pay rate- the initial required payment rate on the loan.

Payment adjustment time- earliest time at which the mortgage would require the borrower to make payments greater than the pay rate, assuming that only the minimal payments are made.

Program-eligible- an indicator for borrowers with above-threshold credit scores during the program period.

Program period- an indicator for loans extended during the period in which Flexible mortgages were formally available (January 2004- December 2005).

Rate spread- interest premium paid by the borrower relative to an index.

Rebate- the payment from the bank to the broker

Refinance- an indicator for a refinancing (as opposed to a loan used to support a new home purchase)

Standard loan- an indicator for a loan extended under the Standard program, which allowed for payments above the initial pay rate after one year.