BANKING COMPETITION AND SHROUDED ATTRIBUTES: EVIDENCE FROM THE US MORTGAGE MARKET*

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Abstract

Increased competition has a causal effect on banks' pricing strategies to compete for consumers and profits. We test this conjecture using an exogenous shock due to the interstate banking restriction that has been sequentially lifted across states since 1994. We find strong evidence that increased competition leads banks to reduce initial rates offered on the adjustable-rate mortgages (ARMs) to attract borrowers but increase interest rates after the rate reset and thereby exploit consumer inattention in the pricing terms. Different banks design pricing strategies that are optimal to their own profit structures. Consistent with theoretical predictions, we find that banks shroud more with naïve borrowers or less financially sophisticated borrowers, who are more subject to behavioral bias. Subsequently, banks earn more profits from lower default risk and delayed prepayments.

Keywords: Deregulation; competition; shrouding; behavioral bias

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I. INTRODUCTION

It is important to understand market responses to changes in the regulation and deregulation of credit markets and financial intermediaries. A growing literature shows that banking deregulation plays an important role in affecting asset prices through increasing credit supply: It significantly lowers borrowing costs to small firms (Rice and Strahan 2010), increases the credit supply in the mortgage market and thus helps increase housing prices (Chu 2015; Favara and Imbs 2015), and it increases the supply of complex mortgages such as those featuring interest only, negative amortization, and teaser rates (Di Maggio, Kermani, and Korgaonkar 2015). However, little has been done to explore how banks respond in designing their contracts to deregulation and competition. This paper examines whether and how banking competition affects banks' responses in the mortgage market. Specifically, we focus on adjustable-rate mortgage (ARM) contracts in the United States, given that ARM contracts are extremely complex, with different add-on attributes, and consumers are known to pay limited attention to their contract terms in the mortgage market (Amromin et al. 2011; Agarwal, Ben-David, and Yao 2016).

Empirically, it is challenging to identify the causal effect of bank competition on banks' responses because of well-known identification issues. The provision of credit, changes in contracts, and the dynamics of asset prices are endogenous to current and expected market conditions, as well as other exogenous shocks. This paper overcomes these difficulties by exploiting the changes in interstate banking restrictions across state borders generated by the Interstate Banking and Branching Efficiency Act (IBBEA) and uses the deregulation to identify the causal effect of bank competition on contract design. The IBBEA was passed by US Congress in 1994, permitting banks and bank holding companies to expand their lending business across state lines. Even though unrestricted interstate baking was fully allowed once the law took effect in 1995, US states retained the right to erect roadblocks to branch expansion through (i) mandating age restrictions on bank branches and (ii) limiting the amount of total deposits any one bank can hold. This paper evaluates the effects of these time-varying deregulations on banks' design of ARM contracts.

In particular, we are interested in answering three questions: (i) Do banks compete for consumers after deregulation? (ii) Does increased competition lead banks

to shroud some attributes of their contracts and thus exploit consumer inattention in the pricing of ARM contracts after deregulation? (iii) Do banks earn more profits by shrouding? Our analysis uses a difference-in-difference approach on a large sample of mortgage loans that originated between 1994 and 2005. We focus on ARM contracts with many complex features, such as an initial teaser rate, an initial fixed term or teaser period, a reset margin, a reset index, a first reset cap, periodical reset caps, and a lifetime cap,[1] as opposed to fixed-rate mortgages (FRMs), which are characterized by one fixed interest rate over the life of the loan and the amortization term.

Our results show that banks compete for consumers following the deregulations and they fully exploit consumers' inattention in the pricing of ARMs by shrouding the key attributes (add-on prices). The initial teaser rate,[2] initial fixed term, and reset margin in ARM contracts in deregulated states are, respectively, five basis points (bps) lower, 7.6 months shorter, and 11 bps higher than in fully regulated states. The results suggest that increased competition leads banks to reduce initial rates to attract borrowers but increase interest rates after the reset of the ARM.

We explain our findings by the recent theoretical literature that explores optimal supply responses when consumers exhibit behavioral bias. Theory predicts that sophisticated firms can exploit consumer biases by designing exploitative contracts (Gabaix and Laibson 2006; DellaVigna 2009; Koszegi 2014). In our setting, there are two types of price services in the ARM market: The base good is the service in the initial period with a fixed initial teaser rate and the add-on is the service in the adjustable interest rate period after the reset. There are two types of borrowers in the ARM market: myopic borrowers do not consider the terms of an interest rate reset (index and margin) after the fixed period, while sophisticated borrowers consider such terms and can refinance mortgages before interest rate resets with a refinance or substitution cost. The theory predicts the existence of a shrouded price equilibrium with a low initial teaser rate and a high margin under the condition that there is a large proportion of naïve borrowers. It can explain the results that increased competition reduces the initial teaser rate but cannot explain why competition increases margins. One implicit prediction

[1] There are caps on interest rate increases as well as on payment increases. We focus on interest rate caps because they are more common.

[2] The initial teaser is the spread over the rate on fixed-rate 30-year mortgages originating in the same month and same market.

from the theory is that a standard unshrouded price equilibrium can switch to a shrouded price equilibrium after competition if competition also increases the proportion of naïve borrowers. This prediction is consistent with our results that competition reduces initial rates and increases margin. We test the implicit prediction by investigating the impact of banking deregulation on a selection of naïve borrowers and use borrowers' prepayment behavior to proxy for their naïveté. We find that deregulation increases the proportion of naïve borrowers. Banks increase shrouding if there are more naïve borrowers. These results are consistent in the full sample and in subsamples. Therefore, the main channel is deregulation attracting more naïve borrowers and increasing banks' shrouding strategy. We empirically show the proportion of naïve borrowers in the market must increase for competition to increase prices.

We then test banks' responses to the deregulation across different lender characteristics. The profits of mortgage brokers are largely from a base commission off the interest rate at origination and they do not earn any profits from add-on prices in ARM contracts. Therefore, they should have more incentive to compete for borrowers through a competitive initial teaser rate but less incentive to shroud add-on price features. On the other hand, the profits of retail banks are from both the base good and add-on prices because they originate loans to hold on their balance sheet or to service the mortgages. They are expected to have stronger incentives to shroud compared to their broker counterparts. We find that the initial teaser rate of loans originated by brokers in deregulated states is eight bps lower than that in fully regulated states, while that of retail banks is barely 2 bps lower. However, for retail banks, the initial fixed term in deregulated states relative to that in fully regulated states is twice as short as that of brokers' loans and the reset margins of retail loans are three times higher. Different originators have different responses in designing their contracts to the shock of banking deregulation. We also find that, compared to new entrants from out of state following interstate deregulation, incumbent lenders either in the state or local markets all choose to compete more aggressively in the face of increased competition. Their most effective add-on price is the reset margin. Incumbent lenders in the state charge a three times higher reset margin than their new competitors from out state and incumbent lenders in only counties charge almost twice as high a reset margin. Clearly, banks respond to increasing competition by shrouding different attributes.

We further explore banks' shrouding strategies across heterogeneous consumers. Theory predicts that lenders should shroud more when the proportion of naïve borrowers is larger. We identify four types of naïve borrowers in our sample: home purchasers versus refinancing borrowers, first-time homebuyers versus existing homebuyers, borrowers choosing single-lien mortgages to pay for primary mortgage insurance (PMI) versus those taking out piggybacks to avoid paying PMI, and borrowers with a low credit score versus those with a high credit score. Such borrowers are either less financially sophisticated or lack experience in managing their mortgage accounts and are therefore more subject to behavioral bias. We find that, compared to refinance transactions, home purchase mortgages are charged twice as high a reset margin and their fixed period is 28% shorter in deregulated states compared to those in fully regulated states; however, the initial teaser spread is much lower in refinance transactions. Between first-time and existing homebuyers, banks charge the former lower initial teaser rates but a shorter fixed-rate period. Between single-lien mortgages and those with piggybacks, banks exercise much greater discretion in the former by charging a lower initial teaser spread to attract customers and a much higher reset margin and a much shorter fixed period to maximize profits. In contrast, there is virtually no or a very limited difference in pricing in mortgages with piggybacks, whose borrowers are considered to be much savvier and sophisticated (Agarwal, Ambrose, and Yao 2015). Credit score distribution results provide a more complete picture of how banks' pricing strategies vary for different borrowers. As borrower credit score improves from a low below 580 to a high above 780, banks offer longer fixed periods and lower teaser spreads. Because a credit score of 620 and below is considered a rule-of-thumb criterion for identifying subprime borrowers (Keys, Pope, and Pope 2010), we focus on the different pricing strategies employed by banks for prime versus subprime borrowers. The reset margin for subprime borrowers is as high as three times that of prime borrowers and the fixed period is almost twice as short. Banks extract maximum profits from these marginal borrowers because of their limited access to prime mortgages and lack of financial knowledge.

Finally, we explore the impact of banking deregulation on mortgage performance, as well as lender profits. Two types of risks are embedded in mortgage contracts. When borrowers default on their mortgage, banks bear the credit loss from foreclosure, repurchase, and accrued interests. Banks' profits are greater with fewer

defaults and less credit loss. When a borrower prepays a mortgage with a new mortgage, the bank faces the potential risk of reinvestment at a lower return but could also make money from originating the new loan if it retains the borrower. This case is especially true for a mortgage broker who makes money only from origination commissions. We find the overall default risk decreases following banking deregulation and performance improves even more one year after the first reset. Our results suggest that, although lenders steer borrowers by increasing margins after deregulation, steering is not driven by unobservable borrower quality, which is similar to the findings of Gurun, Matvos, and Seru (2013). We also find that prepayments increase following interest rate and payment resets, but 80% of prepayments occur at least one year following the expiration of the fixed term, leaving enough time for banks to reap profits from resetting terms. Based on the actual life of a loan, we calculate the gross total loan payments as a measure of the lender's gross profit. We find a significant increase in lender profits after the fixed term and a significant decrease in profits before the fixed term expires, canceling out each other in the end. The decrease in profits in the early life of the loan is related to the decrease of the teaser rate, while the increase in later life is related to the increase of the reset margin as a result of the lender's shrouding strategy.

It is notable that these are all prime mortgages with no prepayment penalty clause. There is good contrast between incumbent lenders and new entrants following deregulation. The former have been operating in the market for many years and have developed more soft information as well as borrowers and are therefore more likely to retain their business. We observe a decrease in prepayments before the fixed term expires and a greater increase in prepayments at least one year after the fixed term for incumbent lenders. The pattern is reversed for new market entrants. This result demonstrates banks adopt different strategies to exploit their own competitive advantages in local markets.

This paper makes several important contributions to four increasingly related strands of the literature. First, it contributes to the growing literature on the effect of credit supply on real estate markets. Most recently, Favara and Imbs (2015) have studied the effect of interstate banking deregulation on the credit supply in the mortgage market and housing prices. By using independent mortgage companies, thrifts, and credit unions that are not affected by banking deregulation as a placebo, they find

depository commercial banks experienced significantly higher deposit growth and lower rates. In areas primarily operated by these institutions, credit terms improved, more borrowing took place, and demand for housing increased. The appreciation of residential house prices was pronounced in areas where the housing supply was inelastic. We adopt a similar identification but study the effect of the deregulation on banks' competition strategy to exploit different types of borrowers. Chu (2015) provides direct evidence on the positive effect of banking deregulation on commercial real estate prices. Mian and Sufi (2009) find that, from 2002 to 2005, mortgage credit expanded in subprime areas despite sharply declining income growth in these neighborhoods preceding the mounting mortgage defaults during the crisis years.

Second, this paper contributes to the broad understanding of the effects of banking deregulations. We use the same deregulation events as Rice and Strahan (2010) and Favara and Imbs (2015) but study them from the perspectives of different market participants. The key difference between this paper and others in the literature is that, regardless of whether mortgage banks collect deposits or are chartered by federal and state regulators, they are all affected by increased competition and must respond to the shocks. Our results show that different profit structures drive different banks' optimal pricing strategies to serve different borrowers. Di Maggio, Kermani, and Korgaonkar (2015) find that deregulation increases the supply of complex mortgages, such as those featuring interest only, negative amortization, and teaser rates. Our main results, for a different dataset and a difference policy change, are consistent with their findings. The key difference is that we further investigate banks' optimal pricing strategies in ARM contracts, which is implied by the theory of Gabaix and Laibson (2006). Our findings support theoretical predictions and explain the mechanisms through which banks respond to competition with shrouded attributes.

The third contribution of this paper is to provide empirical evidence in the mortgage market for the theoretical literature that explores the optimal supply responses of firms when consumers exhibit behavioral biases and market structure becomes more competitive. For example, firms could shroud add-ons in equilibrium when consumers are myopic (Gabaix and Laibson 2006; Miao 2010) or vary in their tastes for add-ons, given expensive search costs (Ellison 2005). Firms could design contracts for investment goods with lump-sum fees when consumers are hyperbolic discounters and

mispredict their future consumption (DellaVigna and Malmendier 2004). A vast empirical literature has documented that limited attention influences consumer choices. Hossain and Morgan (2006) find that, when shipping is shrouded, raising shipping charges increases both revenues and the number of bidders attracted to a field experiment auction on eBay's US auction site. Chetty, Loony, and Kroft (2009) find that consumer demand falls when sales tax is made salient for consumers in a field experiment. DellaVigna (2009) provides an overview of the empirical evidence on limited attention and individual decisions. The empirical literature on price shrouding mostly analyzes the demand elasticity of consumers to infer profitability and the results suggest that shrouding raises profitability. For example, Ellison and Ellison (2009) find that shrouding add-ons are a profitable strategy for online firms selling computer memory chips. Brown, Hossain, and Morgan (2010) study the interaction between price partitioning and disclosure using both field and natural experiments. They find that increasing shipping charges boosts revenues when shipping charges are shrouded. Our paper provides empirical evidence on how firms design product features and optimal pricing strategies in response to consumers' behavioral bias when. We show that competition can increase add-on prices when the proportion of naïve borrowers increases in the market.

Lastly, our findings are related to the literature about the impact of competition on pricing and firm behavior. Standard equilibrium models imply that competition reduces prices. However, it is well documented that markets with many competing firms sometimes exhibit robustly high markups, such as the mutual fund market (Hortacsu and Syverson 2004) and credit card market (Ausubel 1991; Stango 2000). Gabaix and Laibson (2006) show that firms' optimal response to naïve consumers in the market can explain the high markups. Gabaix et al. (2015) show that idiosyncratic demand shocks driven by standard noise distributions can produce large equilibrium markups that are insensitive to the degree of competition. The authors further show that competition could increase markups for distributions in the heavy-tailed class. We follow the implicit prediction of Gabaix and Laibson (2006) and show that competition can increase add-on prices. We also empirically show that the proportion of naïve borrowers in the market must increase in the market for competition to increase prices. Competition can destroy ethical behavior (Shleifer 2004) and induce firms to take costly productivity-raising actions that they might otherwise not (Syverson 2011). Our

results are consistent with the literature, since we show that competition increases the magnitude of banks' strategy to exploit naïve borrowers.

This paper's findings have important implications for politicians and regulators on how to design banking policies after the financial crisis. In the wake of the crisis, politicians and regulators have implemented various banking and mortgage market policies through the Dodd–Frank Act, the Consumer Financial Protection Bureau, the Federal Reserve, and other agencies. Our results show that these policies have significant implications on credit supply and demand years later and can distort the behaviors of lenders as well as of borrowers.

The remainder of the paper is structured as follows. Section II explains the data as well as the design of our empirical identification and methodology. Section III outlines the theoretical framework. Section IV presents the empirical framework. Section V discusses borrower heterogeneity and Section VI the impact of banking deregulation on ex post performance and lender profits. Section VII explores the transmission channels of these effects. Section VIII concludes the paper.

II. DATA AND IDENTIFICATION

II. A. Data

The data used in this paper are from three sources. First, a proprietary loan-level sample is drawn from the population of all prime conventional conforming mortgages securitized by a national insurer between 1994 and 2005, covering mortgage originations during the sequential deregulations. Borrowers enter into a mortgage contract for one of the following reasons: to purchase a house, to refinance an existing mortgage to lower the payment or rate, to refinance to extract home equity, or to use home equity as a line of credit. Homebuyers can be first timers or existing homeowners. Prime loans are for borrowers with good credit, as opposed to subprime loans, which are intended for those with blemished credit (typically with a credit score below 620). Conventional loans differ from government loans guaranteed by agencies such as the Federal Housing Administration and the US Department of Veteran Affairs. Conforming loans have loan amounts at or below conforming loan limits, which have been $417,000 since 2006 for single-family one-unit properties. Loans with a balance above the limits are called jumbo loans.

Compared to FRMs, ARMs are considered more complex mortgage contracts with many add-on features, although, with floating rates, both types are fully amortized over a total 30-year period. To make ARMs more appealing, borrowers are offered an initial teaser rate for a number of years at a deep discount from the prevailing primary market rate for 30-year fixed-rate mortgage (FRMs). The teaser rate offered by lenders could be bound by their short-term funding cost. Badarinza, Campbell, and Ramadorai (2015) find that the current spread between FRM and ARM rates is an important determinant of consumers' choice of ARMs. The fixed terms are typically one year, three years, five years, seven years, and 10 years and consequently ARMs are labeled 1/1, 3/1, 5/1, 7/1, and 10/1 hybrid ARMs, respectively.[3] Usually, the shorter the fixed period, the lower the teaser rate, since a longer term requires funding under more uncertainty. This scenario is consistent with standard finance theory, where borrowing costs increase with fixed-rate terms to compensate for future uncertainty. Once the fixed term expires, the rates on ARMs are adjusted once a year based on an index plus the margin. Although there are many indexes available in ARM contracts, prime ARM loans are indexed primarily on the 12-month London Interbank Offered Rate (LIBOR) and the constant maturity Treasury rate, using a 50/50 split, which leaves the reset margin as one of the main add-on pricing features lenders can use to make a profit. The shorter the fixed period, the sooner lenders can gain from the reset rate based on the index plus the margin. If lenders have unlimited access to borrowing at LIBOR, they can fund ARM lending with a fixed markup margin.

There are also other add-on features, such as various rate and payment caps and floors that distinguish one ARM product from another. Rate caps are the most common feature, including the initial cap applied to the first reset, periodical caps applied to every cap after the first reset, and a lifetime cap applied to cumulative rate shocks over the life of the loan. For example, 5-2-5 ARMs prescribe that the initial rate shock be no more than 5%, the following rate shock be no more than 2%, and the lifetime rate shock be no more than 5% over the teaser rate.

Each mortgage is then tracked until the borrower exits the loan by either prepaying or defaulting. These prepayment and default decisions are also analyzed. The

[3] The most popular subprime mortgage product is the 2/28 ARM, with the first two years at a fixed rate, but these conditions are not offered in prime mortgages.

prepayment risk of ARM contracts is not as significant as that of FRMs, since borrowers, by design, can automatically receive the benefit of a lower rate. Prepayments usually occur when the floating rate after the reset is above the primary market rate for FRMs. The direct consequence of borrowers experiencing a payment shock due to a higher interest rate is actually the default risk when borrowers cannot survive extra payments.

The second source of data is the US Bureau of Economic Analysis. These data include county-level economic control variables such as the income per capita, population, and median housing price. We also calculate the county-level Herfindahl–Hirschman Index (HHI) at the county level based on the Home Mortgage Data Act between 1994 and 2005. The HHI is a common measure of market concentration. It is calculated as the sum of the squares of the market share of each firm competing in a county. The higher the HHI, the lower the market competition.

The third data source is the time-varying deregulation index calculated by Rice and Strahan (2010). Although the IBBEA authorized free interstate banking in 1994, US states retained the right to oppose out-of-state branching by imposing restrictions on (i) de novo interstate branching, (ii) the minimum age of the target institution in case of mergers, (iii) the acquisition of individual branches without the acquisition of the entire bank, and (iv) statewide deposit caps controlled by a single bank or bank holding company. Rice and Strahan's index captures the differences in regulatory constraints between 1994 and 2005 and takes values between zero and four. The index is reversed so that high values refer to deregulated states.

The variables used in the analysis are summarized in Table I. The sample contains about 1.54 million ARM loans. The average loan amount at origination is $184,476 and the average initial teaser rate is 5.26%. This represents a spread of -0.96% over the prevailing primary market rate for 30-year FRMs in the same month. The average reset margin is 2.55% following an average fixed period of five years. Among all prime ARMs, 5/1 ARMs are the most popular. The index used to price these loans implements a 50/50 split between LIBOR and Treasury rates. The initial, periodical, and lifetime rate caps are 3.35%, 2%, and 5.55%, respectively. The credit quality of prime ARMs is much better than that of prime FRMs, with an average credit score (FICO) of 721, loan-to-value ratio (LTV) of 73%, and backend debt-to-income ratio of

34%. The incomes of prime borrowers are high, with an average of $7,171 monthly, or about $86,000 annually. Of all loans, 14% have at least one piggyback. These loans typically have a combined LTV of more than 80% and subordinated financing helps borrowers avoid paying for PMI as mandated by federal charter to government-sponsored enterprises (GSEs).

In our paper, 58% of transactions in the sample are for refinancing and the other 42% are for home purchases. One-third of these home purchases are made by first-time homebuyers, who do not have a great deal of experience owning a home or managing a mortgage account. A total of 47% of loans in the sample are originated by mortgage brokers, while the other 53% are originated by retail banks. A total of 78% of the lenders in the sample operated in the state prior to the interstate deregulation, while 50% of them operated in the local county prior to the deregulation. These two types of incumbent lenders operated in the state and county prior to deregulation for an average of 7.2 years and 5.7 years, respectively. On average, there are 35 lenders competing in a state and 21 lenders competing in a county market. Including new entrants, the average time in the market is 1.5 years prior to the deregulation. Prime loans typically have a much lower default rate because of the borrower profile. In our sample, for performance as of December 2014, the average default rate is around 5%, including 2% during the fixed period and 3% after that. Our sample period includes an unprecedented refinancing boom induced by a low interest rate in 2003 and extraordinarily stimulating monetary policy interventions after the crisis. As of 2014, 86% of all mortgages were prepaid, including 70% during the fixed period and 16% afterward.

II. B. Identification Strategy

This paper explores the effect of banking deregulation across state borders on banks' pricing strategies. We exploit the changes in interstate banking restrictions across state borders and adopt a difference-in-differences strategy to identify the causal effect of bank competition on contract design. The banks in the deregulated states are the treated group while those in the other states are the control group. Because of the time-varying nature of the deregulations, the estimated effect captures the differences in deregulated states relative to those in states that were still regulated. We estimate

$$Y_{i,t} = \beta_1 D_{s,t-1} + \beta_2 \boldsymbol{Z}_{i,t} + \beta_3 \boldsymbol{X}_{c,t} + \alpha_c + \gamma_t + \epsilon_{c,t} \qquad (1)$$

where $Y_{i,t}$ is the outcome of interest for the ARM spread, fixed term, margin, prepayment, and default; $D_{s,t-1}$ is the dispersion of the deregulation across states (and time), which aggregates the four elements of deregulation as interstate branching; $\boldsymbol{Z}_{i,t}$ represents mortgage-level characteristics, such as the FICO score, the combined loan-to-value ratio, and whether the loan is being refinanced; $\boldsymbol{X}_{c,t}$ summarizes time-varying county-specific controls, which include the log of the income per capita, population, housing prices, and the HHI of loan origination; α_c represents zip code fixed effects; and γ_t represents origination month fixed effects. In all the regressions, standard errors are clustered by state.

III. THEORETICAL FRAMEWORK

In this section, we present our empirical predictions by starting with the theoretical model developed by Gabaix and Laibson (2006). The authors define two types of goods or services: base goods and add-ons. Take a bank account as an example: Most banks prominently advertise the virtues of their accounts but their marketing materials do not highlight the costs of such accounts, including automated teller machine usage fees, bounced check fees, and minimum balance fees, that is, the so-called add-ons. Banks choose to shroud these fees. In this example, the base good refers to opening a bank account, while the shrouded attributes are all the add-on price features. In our setting, the base good refers to a mortgage used to finance a home purchase or refinancing, while the add-ons are the price features of an ARM after the fixed period. Since the interest rate paid after the fixed period is generally higher than the initial teaser rate, banks make more money if the borrowers keep the mortgage.

Consider, in period 0, a firm that has to decide whether an add-on should be shrouded or unshrouded. Gabaix and Laibson (2006) state that shrouding means to hide the add-on cost in the fine print or to publish it in an obscure location. Unshrouding is assumed to be free, so unshrouding a price is equivalent to advertising that price. The firm will have to select prices for the base good *p* and the add-on $\hat{p}$. In the next period, period 1, consumers pick a firm to buy the base good. There are two types of consumers: sophisticated and myopic. Sophisticated consumers (comprising a fraction $1 - \alpha < 1$ of the population) always take the add-on and its price into consideration, whereas myopic

consumers (comprising a fraction α of the population) do not all observe the add-on information. Only a fraction λ of the myopic ones consider the add-on price if the latter is directly stated in the advertisement. In period 1, sophisticated consumers and informed myopic consumers initiate a costly effort *e* that enables them to substitute away from the future use of the add-on, while uninformed myopic consumers will not consider exerting such substitution. The add-on fee $\hat{p}$ is assumed to be bounded by $\bar{p} > e$, where $\bar{p}$ could represent legal and regulatory constraints or the cost of a firm's reputation. Sophisticated and informed myopic consumers will exert a substitution effort only if $e < E\hat{p}$.

In our setting, uninformed myopic borrowers do not consider the terms of an interest rate reset (index and margin) after the fixed period. Sophisticated borrowers, on the other hand, consider such contract terms. They can refinance mortgages before interest rate resets, which incurs a refinance or substitution cost *e*. Myopic borrowers do not indulge in refinance shopping either. The add-on price, such as the reset margin in an ARM contract, is bounded by $\bar{p}$, the legal constraints to an extremely high margin. In the next period, consumers observe the actual add-on price and are given an opportunity to purchase the add-on. Those who previously engaged in substitution efforts have a lower incentive to purchase the add-on.

Let $D(x_i)$ be the probability of a consumer applying for a mortgage, with μ the degree of competition in the banking industry, which equals the average profit per consumer, $\mu = \frac{D(0)}{D'(0)}$. Let X_i refer to the anticipated net surplus from obtaining a mortgage at bank *i* less the anticipated net surplus from obtaining a mortgage at an alternative bank and let $\alpha^+ = \frac{e}{\bar{p}}$ be the ratio of the substitution cost and the upper bound of the add-on price. Gabaix and Laibson (2006) then derive the following proposition.

1) Proposition 1

- Shrouded price equilibrium

Under the condition that the fraction α of myopic consumers is greater than α^+, there exists a symmetric equilibrium in which firms shroud the add-on price. The prices of the base good and the add-on are $p = -\alpha\bar{p} + \mu$ and $\hat{p} = \bar{p}$, respectively.

- Unshrouded price equilibrium

Under the condition that the fraction α of myopic consumers is less than α^+, there exists a symmetric equilibrium in which firms do not shroud the add-on price. The prices of the base good and the add-on are $p = -e + \mu$ and $\hat{p} = e$, respectively.

This shrouded price equilibrium is inefficient, since sophisticated borrowers pay a cost *e* to substitute away from add-on consumption. It also shows that high markups for the add-on are offset by low or negative markups on the base goods, which implies that the add-on will be the "profit center" and the base good will, in turn, be the "loss leader." Sophisticated consumers prefer to give their business to firms with higher prices that are shrouded because these consumers end up with a subsidy from policies designed for myopic customers. This unshrouded price equilibrium is efficient, since all consumers purchase the add-ons and the total profit of the industry is μ.

Proposition 1 emphasizes the conditions about the two price equilibria and the corresponding prices. It does not explicitly specify the relation between firm competitions and equilibrium prices when conditions for different equilibrium conditions change. We build on the work of Gabaix and Laibson (2006) and derive a new proposition implied by Proposition 1 under changing equilibrium conditions.

2) Proposition 2

Consider the impact of banking deregulation on banks' ARM pricing strategies.

- Prediction 1

If the mortgage market is in shrouded price equilibrium before or after the deregulation, the fraction of myopic consumers will always be greater than α^+. Banking deregulation increases the competition for borrowers and thus *p* will decrease but $\hat{p}$ will remain unaffected.

- Prediction 2

If the mortgage market is in unshrouded price equilibrium before or after the deregulation, the fraction of myopic consumers will always be greater than α^+. Banking deregulation increases the competition for borrowers and thus *p* will decrease but $\hat{p}$ will remain unaffected.

- Prediction 3

If there is a switch from an unshrouded price equilibrium to a shrouded price equilibrium, banking deregulation will reduce *p* and increase $\hat{p}$.

Why is there a switch from one equilibrium to another? Based on Proposition 1, the switch depends on the relation between α and $\frac{e}{\overline{p}}$. When the relation changes, equilibrium conditions change and there could be a switch of equilibrium. There are three ways banking deregulation can change the conditions: through an increase in α, the proportion of naïve borrowers; throughout a reduction in *e*, the opportunity costs of refinancing; and through an increase in $\overline{p}$, the regulatory constraints on add-on prices. Which channel is important in our setting is an empirical question. In Section IV, we show our main empirical results that support Prediction 3. In Section V, we use prepayment behavior to analyze the channels of the switch from one equilibrium to another.

IV. EMPIRICAL FINDINGS

IV. A. Baseline Results

The deregulation changes banks' pricing strategies by increasing their competition. We show the first-stage impact of deregulation at the county level in Table II. Column (1) shows that the number of banks increases significantly, by 40% (= 10% × 4), with deregulation and, therefore, banking competition increases, as evidenced by the decrease of HHI in Column (2). Columns (3) and (4) show that the number of loans increases by 14.4% (= 3.6% × 4) and the volume increases by 17.2% (= 4.3% × 4) following the deregulation. These results are consistent with those of Favara and Imbs

(2015) and show a clear first stage in which deregulation increases bank entry and competition and increases loans that originated in more deregulated states.

We now show the results of deregulation on ARM contracts at the individual level. Table III presents the baseline results based on the full sample of loans. Since a deregulation index value of four represents the status of fully deregulated states, we interpret the coefficient multiplied by four as the effect of full deregulation. The first column in Panel A is a regression on the initial teaser spread over the market rate of FRMs in the same month, a more front-loaded pricing feature used to attract borrowers. To provide some basis for the teaser rate, we also regress on the original note rate of the FRMs and their performance metrics. These results are reported in Table A.1 in the Appendix. The second and third columns report the results for the reset margin and years of fixed terms, respectively, which are considered more back-loaded pricing features since these are revealed only after origination. The results suggest that the initial teaser rate, initial fixed term, and reset margin of ARMs in deregulated states are, respectively, five (= 1.35 × 4) bps lower, 7.6 (= 1.9 × 4) months shorter, and 11 (= 2.67 × 4) bps higher than in fully regulated states. These results support Prediction 3 in Proposition 2: Banking deregulation reduces the initial teaser rates and increases margins, suggesting a switch from an unshrouded price equilibrium to a shrouded price equilibrium. The results for FRMs in Table A.2 suggest that the fixed rate in deregulated states is actually four (= 1.8 × 4) bps higher than that in regulated states.

Consistent with Rice and Strahan (2010), the results in Table III suggest that the increased banking competition driven by the interstate deregulation significantly lowers the initial interest rate offered to ARM borrowers. As shown by the summary statistics above, ARM borrowers usually have better credit and a higher income and are considered more confident consumers. Grubb (2009) finds that, when selling to overconfident consumers, both monopolists and competitive firms design an optimal pricing strategy initially charged at zero marginal cost but followed by steep marginal charges. We find that banks significantly increase the price of two back-loaded features, the reset margin and the fixed term, in their favor. Competition makes banks' optimal pricing strategy increasingly back-loaded or hidden to consumers upfront.

We also test the effects of deregulation on other terms in ARM contracts, including various rate caps. These results are reported in Panel B of Table III. There is

little difference in the period caps, suggesting they are not effectively used by banks to compete in the mortgage market. However, the initial cap in deregulated states is 21 (= 5.3 × 4) bps lower than in fully regulated states, while the lifetime cap in regulated states is 48 (= 11.9 × 4) bps higher. The initial cap applies to the first rate reset after the fixed term expires, while the lifetime cap applies to the lifetime of the loans but, in reality, it becomes effective at a much later stage of the loan. These results are consistent with those in Panel A.

IV. B. Responses of Different Types of Lenders

Different lenders can have different profit structures, which allows us to test banks' responses to the deregulation that are optimal to their own business models. The profits of mortgage brokers are largely from a base commission off the interest rate at origination and they do not earn any profits from add-on prices in ARM contracts. They also do not have incentives to originate high-quality loans, since they sell their loans right after closing to the mortgage banks that can exercise the best execution, that is, hold the loans on their balance sheet or securitize them through different channels. Therefore, these lenders should have more incentive to compete for borrowers through competitive initial teaser rates but less incentive to shroud add-on price features. On the other hand, the profits of retail banks are from both the base good and add-on prices, because they hold the loans on their balance sheet or, in the case of securitization, service the mortgages. Retail banks are expected to have stronger incentives to shroud compared to their broker counterparts. We test these predictions by analyzing the heterogeneous effects among different types of lenders. These results are reported in Panel A of Table IV.

We find that the initial teaser rates of loans originated by brokers in deregulated states are eight (= 1.95 × 4) bps lower than that in fully regulated states, while those of retail banks are barely two (= 0.62 × 4) bps lower. However, retail banks charge more back-loaded add-on prices, including the initial fixed term and the margin. The fixed term of loans originated by retail banks in deregulated states is 8.4 (= 2.1 × 4) months shorter than that in fully regulated states, compared to only 4.8 (= 1.2 × 4) months shorter for loans originated by brokers. The reset margin of loans originated by retail

banks in deregulated states is 13 (= 3.16 × 4) bps higher than that in fully regulated states, compared to only four (= 1.11 × 4) bps higher for loans originated by brokers, for a price differential of three to one for these two types of originators.

We also estimate the different responses of new entrants from out of state following the interstate deregulation and the incumbent lenders that had been operating either in the state or the local county prior to the deregulation. We anticipate the incumbent lenders would shroud more in the face of new competition. The results are reported in Panels B and C of Table III. Since not many loans are originated by new entrants in the state's mortgage market, the effect of deregulation on their response should be marginally zero. We consider this group of lenders a natural placebo. Once they operate elsewhere in the state for a while and enter a local county, they start to deploy more competitive pricing strategies: The initial teaser rates, fixed term, and reset margin of the loans they originate in deregulated states are, respectively, three (= 0.66 × 4) bps lower, 7.8 (= 1.84 × 4) months shorter, and six (= 1.6 × 4) bps higher than in fully regulated states. On the other hand, incumbent lenders in the state or local market significantly change their pricing strategies to defend their market share. The initial teaser rates of the loans originated by incumbent lenders in deregulated states are eight (= 1.95 × 4) bps lower and their reset margin is 12 (= 3.05 × 4) bps higher than those in fully regulated states. The effect on fixed terms is not significantly different from zero. Lenders that operated not only in the state but also in the local county have slightly different strategies. Although these lenders' changes in the initial tease rate and margin are not as aggressive as those of the incumbent lenders in the state, they actively offer much shorter fixed terms: The fixed term of the loans in deregulated states is 8.2 (= 2.05 × 4) months shorter than that in fully regulated states.

Altogether, the incumbent lenders significantly lowered the initial interest rate offered to ARM borrowers to compete against the entrants allowed by the interstate banking deregulation. Their most effective add-on price is the reset margin. They increase the reset margin by a steep 10–12 bps to make more profits from more back-loaded price features.

IV.C. Borrower Heterogeneity

Theory predicts that lenders should shroud more when the proportion of naïve borrowers is larger (Gabaix and Laibson 2006; DellaVigna 2009; Koszegi 2014). We test this prediction by analyzing the heterogeneous effects among different types of borrowers. We assume that certain types of borrowers could have a larger proportion of naïve borrowers. We identify four types of naïve borrowers in our sample: home purchasers versus refinancers, first-time homebuyer versus existing homebuyers, borrowers choosing single-lien mortgage to pay for PMI versus those taking out piggybacks to avoid paying PMI, and borrowers with a low credit score versus those with a high credit score (Agarwal, Ambrose and Yao 2015). Borrowers in these transactions are either less financially sophisticated or lack experience in managing mortgage accounts and are thus more subject to behavioral bias. These results are reported in Table V and plotted in Figure I.

In Panel A of Table V, lenders exploit ARM loans for home purchase more than refinance loans, considering that refinancing borrowers have already developed more knowledge and experience in managing homeownership and mortgage tradelines. They are offered relatively less of a discount in the initial teaser rate but are charged a relatively higher margin and offered a much shorter fixed term. The initial teaser rates, fixed term, and reset margin of loans originated for home purchases in deregulated states are, respectively, five (= 1.36 × 4) bps lower, 7.8 (= 1.96 × 4) months shorter, and 12 (= 3.0 × 4) bps higher than in fully regulated states. On the other hand, the initial teaser rates, fixed term, and reset margin of loans originated for refinance transactions in deregulated states are, respectively, seven (= 1.68 × 4) bps lower, 6.1 (= 1.52 × 4) months shorter, and seven (= 1.7 × 4) bps higher than in fully regulated states. These results suggest that lenders exploit homeowners less once the homeowners develop some financial sophistication.

Panel B of Table V reports the results for first-time and existing homeowners. The former are anticipated to be a prime target to exploit, but they could also be more attracted by the front-loaded price discount. The initial teaser rates, fixed term, and reset margin of loans originated for first timers in deregulated states are, respectively, nine (= 2.17 × 4) bps lower, 11.3 (= 2.83 × 4) months shorter, and nine (= 2.4 × 4) bps higher than in fully regulated states. On the other hand, the initial teaser rates, fixed term, and

reset margin of loans originated for existing homebuyers in deregulated states are, respectively, five (= 1.24 × 4) bps lower, 10.6 (= 2.65 × 4) months shorter, and seven (= 1.8 × 4) bps higher than in fully regulated states. These results suggest that lenders' optimal strategy with first-time homebuyers is to lure them into ARM contacts with ultra-low initial rates and then charge much higher back-loaded add-on prices.

In the United States, the federal charters of two GSEs, Fannie Mae and Freddie Mac, require borrowers with an LTV above 80% to pay for PMI coverage to reduce the GSEs' potential losses to an LTV of 80%. The premium charged by PMI companies can be anywhere from 1% to 10% in a single payment or 30–150 bps monthly, with add-on prices for multiple risk layers. As the securitization market expanded rapidly in 2004–2007, lenders bypassed the requirement of PMI coverage by increasingly offering one or more junior mortgages or piggybacks. With piggybacks, borrowers effectively avoided paying for PMI coverage by keeping the first lien at or below an 80% LTV. Lenders gained from the structure by sharing the profits from avoided PMI payments, as well as securitizing the second liens and selling to investors. Agarwal, Ambrose, and Yao (2015) find that, even with comparable risk profiles and combined LTV levels, borrowers who select the piggyback structure perform much better than their counterparts who stick to the single-lien structure. We compare banks' strategies for these two groups, both having a combined LTV above 80%. The results are reported in Panel C of Table V. Because borrowers who choose piggybacks are more savvy and sophisticated, there is virtually no or a limited difference only in the fixed terms in bank pricing on these mortgages after deregulation. In contrast, banks exercise greater discretion to exploit single-lien borrowers. The initial teaser rates, fixed term, and reset margin of single-lien loans that originated in deregulated states are, respectively, seven (= 1.71 × 4) bps lower, 6.7 (= 1.68 × 4) months shorter, and 10 (= 2.62 × 4) bps higher than in fully regulated states.

Our last type of borrowers is measured by their credit score, a widely used measure to gauge borrower creditworthiness in underwriting and pricing decisions. We divide the sample into five bins based on the FICO score to obtain a complete picture of how banks' pricing strategies vary along the spectrum of borrowers' credit quality. These results are plotted in Figure I. Generally, as the credit score improves from a low of 620 to a high of 780, banks offer longer fixed periods and lower teaser spreads to be

commensurate with the expected credit risk. Banks' teaser rate offering is not affected by the deregulation until the borrower's FICO reaches 660 or higher and the offered rate is lower for better credit scores, suggesting banks only compete for borrowers of better credit quality. For example, loans for a FICO of 660–719 originated in deregulated states have initial teaser rates that are only four (= 1.08 × 4) bps lower than those in fully regulated states, while those for a FICO of 780 and above have initial teaser rates only 12 (= 2.94 × 4) bps lower than those in fully regulated states. On the other hand, banks exploit borrowers with worse FICO scores the most by offering them the shortest fixed terms. The fixed term of loans for a FICO of 620 and below in deregulated states is 12 (= 3.03 × 4) months shorter than in fully regulated states, while that of loans for a FICO of 780 and above is six (= 1.61 × 4) months shorter.

A credit score of 620 and below is considered a rule-of-thumb criterion for identifying subprime borrowers (Keys, Pope, and Pope 2010), who are not eligible for prime mortgages and thus have limited access to mortgage credit. We therefore also explore banks' pricing strategies for borrowers with scores below and above 620. It turns out that the reset margin reflects the largest difference in banks' pricing strategies between these two groups. The reset margin of subprime borrowers in deregulated states is 17 bps higher than in fully regulated states, compared to only around 9–12 bps higher for those with a credit score above 620. Subprime borrowers are also offered much shorter fixed terms. Altogether, borrowers with the worst credit quality and who have no alternative loan opportunities are the most adversely affected by banking deregulation and competition.

In sum, we find that the deregulation increases shrouding more in the subsample of four types of naïve borrowers: home purchasers, first-time homebuyers, borrowers choosing single-lien mortgage, and borrowers with a low FICO score. The results are consistent with the theoretical prediction that lenders should shroud more when the proportion of naïve borrowers is larger.

V. TRANSMISSION CHANNELS

How did the banking deregulation affect banks' pricing strategies? By allowing an out-state institution to open branches in a local market, states expected to see an

expansion of the credit supply as well as an increase in competition in the banking industry. Favara and Imbs (2015) show commercial banks expand their credit supply following the deregulation to improve the geographic diversification of their portfolios. Firms in the deregulated states are also more likely to borrow from banks (Rice and Strahan 2010). Therefore, even though banking competition has increased, the incumbent banks can also grow their business as a result of the expansion of the entire market.

Does competition necessarily cause banks to shroud? An important prediction of Gabaix and Laibson's (2006) theory is that the fraction of myopic consumers (α) determines the state of equilibrium, because more sophisticated consumers can always consider the costs and benefits of add-on prices in contracts and refinance before the rate reset by engaging in searches. This suggests that banks increase shrouding if the deregulation causes an increase in naïve borrowers. According to Gabaix and Laibson, the main difference between naïve and sophisticated borrowers is the costly substitution effort (e): Sophisticated borrowers will exert costly substitution efforts early if profitable, whereas naïve borrowers will not. In our case, the substitution effort is the prepayment before the end of the fixed term, since it helps borrowers to avoid paying an expensive reset rate. An extensive literature estimates the optimal time for a borrower to refinance. Initial work in this area uses continuous time option valuation models (Dunn and McConnell, 1981). Later studies relax some of the assumptions of the early models, for example, by allowing borrowers to endogenously choose to default (Hendershott and van Order, 1987). Finally, Agarwal, Driscoll, and Laibson (2013) derive a closed-form solution showing that it is optimal to refinance when the refinancing rate is between 100 bps and 200 bps below the original mortgage rate. The actual behavior of mortgage holders sometimes differs from the predictions of the optimal refinancing model. In the 1980s, when mortgage interest rates fell, some borrowers failed to refinance despite holding options that were deeply in the money (Giliberto and Thibodeau, 1989). Keys, Pope, and Pope (2014) find that borrowers generally refinance their mortgages too late and consequently incur substantial losses. On the other hand, Agarwal, Rosen, and Yao (2015) note that some borrowers err by refinancing too early without obtaining sufficient rate savings.

We thus define different measures of sophistication based on the borrower's inattentiveness: The first measure of naïve borrowers is those who prepay late after the

end of the fixed term; the second is those who wait longer to refinance based on number of months from the first reset date to the prepayment date; the third one measures the opposite of naïve borrowers based on those who refinance with enough rate savings at market rate significantly (at least 50 bps) below their previous rate. Table VI reports the results. Columns (1) to (3) show that deregulation has no effect on prepayment during the fixed term but increases the prepayment by 80 (= 20 × 4) bps and 320 (= 80 × 4) bps, respectively, in the first year and in later years after the fixed term. Columns (4) and (5) show that borrowers wait 0.8 (= 0.2 × 4) and 1.6 (= 0.4 × 4) months longer, respectively, to refinance both over the life of the loan as well as after the fixed rate term expires. Column (6) shows fewer borrowers refinance with savings of at least 50 bps based on the market rate, that is, more borrowers refinance with insufficient savings. All the results in Table VI suggest that there are more naïve borrowers following the deregulation.

Prediction 3 predicts that the deregulation increases the proportion of naïve borrowers and banks increase shrouding accordingly. Our results, based on the full sample, in Table III indicate that banks increase shrouding on add-on prices. Next we explore the heterogeneity of prepayments across lenders and borrowers in Tables VII and VIII, respectively. The results in Table II indicate that retail lenders shroud more than mortgage brokers, since the latter only make money from a commission at origination; incumbent lenders also shroud more but new entrants do not, because the former face competition from the latter. The results in Table VIII show naïve borrowers are shrouded much more than more sophisticated borrowers by refinancing after the fixed term, as well as later. Our measures of naïve borrowers include new home purchases (vs. refinancing), first-time home buyers (vs. existing home buyers), and single-lien loans (vs. piggyback loans). These results, consistent with Table V, provide evidence that naïve borrowers are more subject to banks' shrouding strategy based on ex post mortgage performance.

Nevertheless, there may still be other possible channels for shrouding. Since the threshold for the fraction of naïve consumers is defined as $\alpha^{+} = \frac{e}{\overline{p}}$, the ratio of refinance costs and constraints on add-on prices, a reduction in e or an increase in $\overline{p}$ can also increase shrouding. Our sample period includes an unprecedented refinancing boom in 2003. However, no data are readily available to quantify the change in

refinancing costs. We are not aware of any significant regulatory change that would affect the upper bound of the reset margin. Therefore, assuming that $\alpha^{+} = \frac{e}{\overline{p}}$ was not affected by the deregulation, our results indicate that the increases in the numbers of various naïve borrowers led to more shrouding on the bank side.

Another alternative explanation about the observed changes in ARM spreads as well as margins is borrower selection on the demand side. Since we only observe equilibrium ARM contracts, it is possible that banks always offer two types of contracts: one (contract A) has a higher initial rate and a lower margin and the other (contract B) has a lower initial rate and a higher margin. Consumers may be more likely to choose contract A before deregulation and contract B after deregulation, even without any change in bank contract design. This would also be consistent with the observed effects but driven by demand side. To explore this alternative explanation, we restrict the case to periods when consumers are more likely to choose contract A based on their expectation of future interest rates. Naïve borrowers should always choose contract B because they do not pay attention to the margin and future interest rate. Sophisticated borrowers' choices, however, depend on their expectation of future rates: If they expect the mortgage rate to decrease, they should choose contract B because they can refinance before the reset; in contrast, if they expect the rate to increase, they are more likely to choose contract A because of limited rate savings from refinancing in the future. Therefore, expected rate increases define a market scenario in which both types of consumers choose contract A.

We adopt two methods to define the scenario with an expected rate increase: one based on the household decision rule of Koijen et al. (2009) and the other based on the market rate trend in the past six months, as used by Agarwal, Rosen, and Yao (2015). Koijen et al. (2009) empirically confirm that the long-term bond risk premium explains the bulk of the time variation in aggregate and loan-level mortgage choices between FRMs and ARMs. The authors find that the simple household decision rule based on the spread between the five-year Treasury bond yield and the one-year T-bill averaged over the past three years is the most predictive of the ARM share. We therefore determine that borrowers have more incentives to choose contract A when the spread is greater than zero. Alternatively, Agarwal, Rosen, and Yao (2015) define the up move scenario as the period when the mortgage rate in a given month is at least 50 bps more

than its minimum in the past six months and the *down move* scenario as the period when the rate is at least 50 bps lower than its maximum in the past six months. The borrower selection hypothesis implies that we should observe a decrease in ARM spread and an increase in the reset margin only when the spread is greater than zero, or in an *up move* scenario.

Table IX presents the results. We find that deregulation reduces the ARM spread and fixed term, raising the margin in all scenarios. Therefore, the results are not consistent with the alternative explanation of selection from the demand side.

V. Ex Post Performance and Lender Profits

Finally, we explore the impact of banking deregulation on ex post mortgage performance as well as lender profits. Banks bear the credit loss from foreclosure, repurchase, and accrued interests when borrowers default on a mortgage. Banks' profits are greater with fewer defaults and less credit loss. Based on the life of a loan, we calculate the gross total loan payments a borrower makes to a lender as a measure of the lender's gross profit. We also calculate the net profit by deducting expected losses (assuming an average loss severity of 50%) from the gross profit. Based on when the loan is defaulted or prepaid, we separately regress the defaults as well as lender profits before the fixed term expires, one year after, and more than one year after.

Table X reports the results for the default and gross lender profits. A lender's net profit regressions are very consistent with gross profits of greater magnitude and are not included in the table. The results in Columns (1) to (3) show that the default risk of loans that originated in deregulated states is 112 (= 28 × 4) bps lower during the fixed term and 116 (= (19 + 10) × 4) bps lower after the fixed term than in fully regulated states. The combined effect on default risk is a reduction of 228 bps. This is a considerable improvement, given that the average default risk of loans in the sample is 5%. The results also suggest that the increased margin after deregulation is not driven by an unobservable borrower quality, which is similar to the results of Gurun et al. (2013). Lenders maintain flat profits following the regression. The results in Columns (4) to (6) suggest that a lender's profits over the life of a loan are not significantly different between deregulated and regulated states. This result, however, reflects a

significant increase in lender profits after the fixed term and a significant decrease in profits before the fixed term expires, canceling out each other in the end. The decrease in profits in the early life of the loan is related to the decrease of the teaser rate, while the increase in later life is related to the increase of the reset margin as a result of the lender's shrouding strategy.

Besides the note rate, we also estimate the effect of deregulation on the performance of 30-year FRMs as a placebo test. The results are reported in Table A.2 in the Appendix. They suggest that the lifetime default rate is lower for FRMs originated in deregulated states than in fully regulated states, but not default in the first 36 months after origination. The improvement in default is due largely from the late life of the loan. The prepayments at that time are slightly slower in deregulated states, statistically significant but not economically significant, with a 17-bps difference over 10–20 years.

VI. DISCUSSIONS AND CONCLUSIONS

Increased competition has a causal effect on banks' pricing strategies in competing for consumers and profits. This conjecture is tested using an exogenous shock due to the sequential lifting of the interstate banking restriction across states since 1994. We test the effect of banking deregulation on banks' pricing strategies for ARM contracts, which are known to have complex add-on features. Theory predicts that firms have different optimal supply responses when consumers have behavioral biases and firms could shroud add-on attributes in equilibrium when consumers are myopic. We examine banks' responses to increased competition through shrouding different key pricing terms in ARM contracts.

We find strong evidence that increased competition leads banks to shroud some attributes of ARM contracts and thus exploit consumer inattention in ARM pricing. Banks do so by choosing a pricing strategy that is optimal to their profit structure. Mortgage brokers have more incentive than retail banks do to compete for borrowers through competitive initial teaser rates but less incentive to shroud add-on price features. Incumbent lenders compete more aggressively in the face of increased competition by setting a higher reset margin. Banks' shrouding strategies also differ across different

types of consumers. Consistent with theoretical predictions, we find that banks shroud more with naïve borrowers or less financially sophisticated and inexperienced borrowers, who are more subject to behavioral bias. The results are robust across different groups of naïve borrowers.

How does competition increase shrouding for naïve borrowers? Theory proposes several competing channels. In the absence of a shift in refinance costs and changes in regulatory constraints on add-on prices, our results indicate that the increase in the numbers of various naïve borrowers is the evident channel that leads to more shrouding on the bank side. To rule out a potential demand shock that causes consumers to select different contracts following the deregulation, we explore banks' responses when consumers expect interest rates to increase and are thus more incentivized to select only one type of contract. Our results lend very robust support to shrouding being caused by the credit supply side, not the demand side.

Banks shroud on consumers to earn more profits and they do so by lowering the potential default risk and delaying prepayments. We find the overall default risk decreases following the banking deregulation and performance improves even more one year after the first reset. The majority of prepayments in deregulated states occur at least one year following the expiration of the fixed term, leaving enough time for banks to reap profits from resetting terms.

Finally, some of our results also support the contention that both consumers and institutions learn from doing. For example, we find that if a mortgage is up for refinancing after borrowers buy a home, they are more likely to refinance early to avoid higher rates and payments after the reset. Among lending institutions, incumbent lenders are more experienced in the local market and are clearly better at identifying naïve borrowers and using the shrouding strategy and subsequently make more money than new entrants. Once new entrants operate in a local market for a few years, they gradually become incumbent lenders as well.

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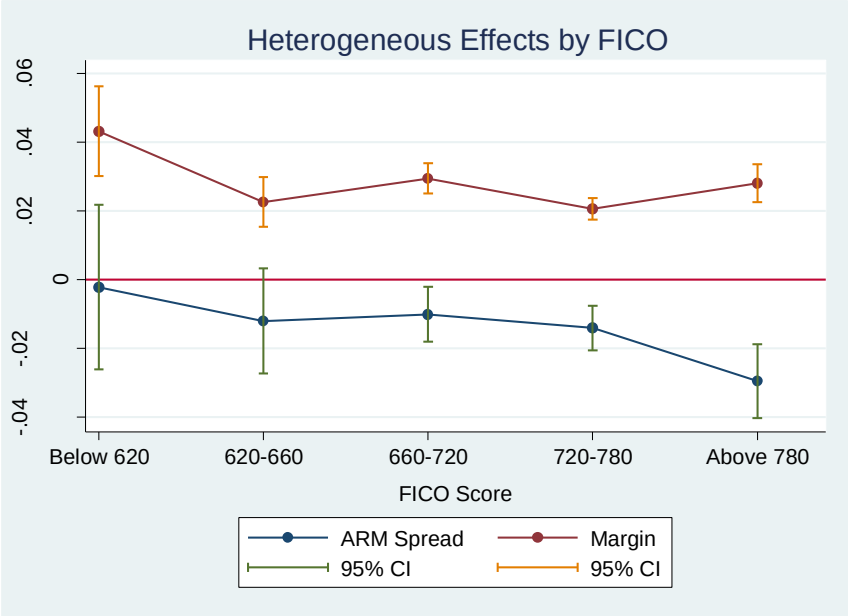
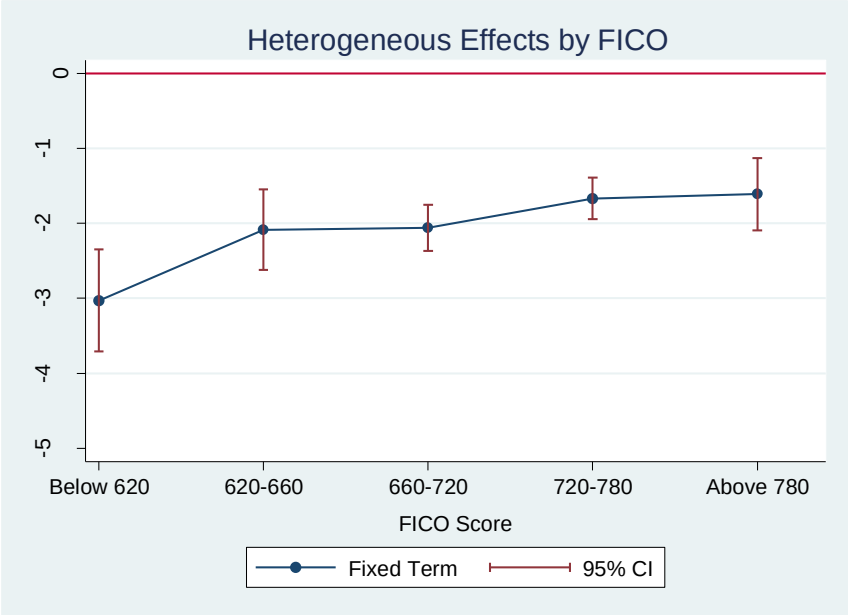
FIGURE I

Heterogeneous Effects of the Deregulation, by FICO Score

Panel A: ARM Spread and Margin



Panel B: Fixed Term



Note: This figure shows the heterogeneous effects of the deregulation by FICO score. The horizontal axis represents different groups of FICO scores. The vertical axis represents the regression coefficients from Equation (1) for each FICO score group. Panel A shows the coefficients for the dependent variables for the ARM spread and margin. Panel B shows the coefficients for the fixed term dependent variable.

TABLE I

Borrower Characteristics for Prime ARMs

	count	mean	sd	min	max
Origination amount	1,538,761	184476.40	75722.17	5,000	720,000
Origination rate	1,538,761	5.26	0.98	1	12.8
Arm Spread	1,538,761	-0.96	0.68	-7.39888	6.91463
Margin	1,538,761	2.55	0.35	0	10.75
Fixed term	1,538,761	59.96	18.43	12	120
Initial Interest Cap	1,538,761	3.35	1.50	1	6.625
Period Cap	1,538,761	1.98	0.14	1	6
Life Cap	1,538,761	5.55	0.81	2	18
LIBOR	1,538,761	0.50	0.50	0	1
Constant Maturity Treasure	1,538,761	0.48	0.50	0	1
FICO	1,538,761	721.31	53.29	300	899
Loan To Value	1,538,761	73.03	16.13	1	149
Combine Loan To Value	1,538,761	76.69	2418.44	1	3,000,000
Second Lien	1,525,339	0.14	0.35	0	1
Backend	1,538,761	33.67	13.84	.368	99.994
Refinance	1,538,761	0.59	0.49	0	1
First Time Home Buyers	1,538,761	0.14	0.34	0	1
Income	1,538,756	7171.17	5089.76	255	271,300
Broker	1,538,761	0.47	0.50	0	1
Incumbent VS Entrance in state	1,538,766	0.78	.0.41	0	1
Incumbent VS entrance in County	1,538,790	0.50	0.50	0	1
Tenure VS Entrance in state	1,538,766	7.17	2.30	1	12
Tenure VS entrance in County	1,538,790	5.65	2.17	1	12
Order VS Entrance in state	1,538,766	3.43	1.93	1	12
Order VS entrance in County	1,538,790	4.93	2.03	1	12
Number of banks in state	1,538,795	35.12	10.95	1	61
Number of banks in County	1,538,795	20.58	8.71	1	48
Year of Entry	1,538,761	-1.50	3.02	-12	10
Default	1,538,761	0.049	0.22	0	1
Default before fixed term	1,538,795	0.020	0.14	0	1
Default after fixed term	1,538,795	0.030	0.17	0	1
Default one year after fixed term	1,538,795	0.025	0.16	0	1
Default within one year of fixed term	1,538,795	0.0048	0.07	0	1
Prepay	1,538,761	0.86	0.34	0	1
Prepay before fixed term	1,538,795	0.70	0.46	0	1
Prepay after fixed term	1,538,795	0.16	0.37	0	1
Prepay one year after fixed term	1,538,795	0.085	0.28	0	1
Prepay within one year of fixed term	1,538,795	0.077	0.27	0	1
Delay in Prepayment	1,328,752	95.91	36.37	20	350

Notes: The results presented in this table are obtained using data from 1994 to 2005. The count refers to the number of datasets. The origination amount reflects how much borrowers borrow from the lenders. The origination rate reflects the initial borrowing rate. The ARM spread refers to the difference between the origination rate and the fixed rate. The results show that the ARM spread is, on average, 1% lower than the fixed rate. The fixed term refers to the ratio of the number of years before the rate change to the sum of the index and margin rates. The initial interest rate cap refers to the maximum amount the interest rate can be adjusted on its first scheduled adjustment date. The period cap refers to the value that limits the amount the interest rate can be adjusted at each subsequent adjustment date. The life cap refers to the limit of the total amount by which the interest rate can be adjusted over the life of the loan. FICO refers to the credit score. The second lien refers to debts that are subordinate to the rights of other debts issued against the same mortgage. The broker refers to the lender, taking on the value of zero if the lender cares

only about the amount of his or her repayment and a value of one if the lender cares only about receiving the commission fee. The value for incumbency versus entrance in the state/county is zero if the bank was not in the state/county before the deregulation and one otherwise.

TABLE II

Impact of Deregulation: First Stage

	(1) Number of Banks	(2) Herfindahl–Hirschman Index (HHI)	(2) Number of originations	(3) Volume
Deregulation Index	0.1017**	-0.0017***	0.0358***	0.0427***
	(0.0486)	(0.0006)	(0.0120)	(0.0135)
Observations	17198	17198	17198	17198
Adjusted R-	0.273	0.039	0.380	0.371
Year FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y
County Level Controls	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the values zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE III

Impact of Deregulation on Borrowers' Loan Contracts

Panel A: Spread, Margin, and Term

	(1) ARM Spread	(2) Margin	(3) Fixed Term
Deregulation Index	-0.0135***	0.0267***	-1.9045***
	(0.0028)	(0.0014)	(0.1004)
Month FE	Y	Y	Y
Zip Code FE	Y	Y	Y
Borrower Controls	Y	Y	Y
Mean of Dep Var	-0.959	2.546	59.957
Observations	1,511,832	1,511,832	1,511,832
R-Squared	0.383	0.255	0.078

Panel B: Rate Caps

	Contract		
	(1) Initial Cap	(2) Period Cap	(3) Lifetime Cap
Deregulation Index	-0.0546***	-0.0000	0.1195***
	(-8.83)	(-0.01)	(15.42)
Observations	1,511,832	1,511,832	1,511,832
Adjusted R-squared	0.183	0.097	0.172
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the values zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE IV

Heterogeneous Effects, by Lender Characteristics

	Lender Characteristics					
	(1)	(2)	(3)	(4)	(5)	(6)
	ARM Spread	Margin	Fixed Term	ARM Spread	Margin	Fixed Term
Panel A: Type of lender						
	Retail lenders			Brokers		
Deregulation Index	-0.0062*	0.0316***	-2.1013***	-0.0195***	0.0112***	-1.2136***
	(0.0034)	(0.0018)	(0.1257)	(0.0039)	(0.0021)	(0.1366)
Observations	796,910	796,910	796,910	714,615	714,615	714,615
R-Squared	0.352	0.283	0.077	0.443	0.277	0.071
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel B: Incumbent VS Entrants in State						
	Entrants			Incumbent		
Deregulation Index	-0.0195**	0.0305***	-0.0292	-0.0048*	0.0254***	-2.0484***
	(0.0089)	(0.0054)	(0.3075)	(0.0028)	(0.0016)	(0.1058)
Observations	321,799	321,799	321,799	1,189,771	1,189,771	1,189,771
R-Squared	0.383	0.272	0.099	0.393	0.272	0.081
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel C: Incumbent VS Entrants in County						
	Entrants			Incumbent		
Deregulation Index	0.0011	0.0105***	0.0320	-0.0066**	0.0160***	-1.8416***
	(0.0069)	(0.0040)	(0.2411)	(0.0030)	(0.0017)	(0.1115)
Observations	743,181	743,181	743,181	768,549	768,549	768,549
R-Squared	0.359	0.271	0.078	0.419	0.286	0.093
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. All columns include month and country fixed effects, as well as controls. The deregulation index takes the value zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. Panel A shows the results by the type of lender: In Columns (1) to (3), the sample includes loans originated by retail lenders and, in Columns (4) to (6), the sample includes loans originated by brokers. Panel B shows the results by whether the lender is the incumbent in the state: In Columns (1) to (3), the sample includes loans originated by a bank/broker that was not in the state before the deregulation and, in Columns (4) to (6), the sample includes loans originated by a bank/broker that was in the state before the deregulation. Panel C shows the results by whether the lender is the incumbent in the county: In Columns (1) to (3), the sample includes loans originated by a bank/broker that was not in the county before the deregulation and, in Columns (4) to (6), the sample includes loans originated by a bank/broker that was in the county before the deregulation. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE V

Heterogeneity of Borrower Characteristics

	Loan Characteristics					
	(1) ARM Spread	(2) Margin	(3) Fixed Term	(4) ARM Spread	(5) Margin	(6) Fixed Term
Panel A: New purchase or refinance						
	New Purchase			Refinance		
Deregulation Index	-0.0136***	0.0302***	-1.9606***	-0.0168***	0.0174***	-1.5227***
	(0.0036)	(0.0018)	(0.1211)	(0.0035)	(0.0018)	(0.1421)
Observations	624,621	624,621	624,621	886,889	886,889	886,889
R-Squared	0.355	0.278	0.088	0.397	0.261	0.07
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel B: First Time Home Buyers						
	First Time Home Buyers			Existing Home Buyers		
Deregulation Index	-0.0217***	0.0283***	-2.4410***	-0.0124***	0.0265***	-1.8179***
	(0.0061)	(0.0035)	(0.2463)	(0.0029)	(0.0014)	(0.1051)
Observations	206,349	206,349	206,349	1,305,088	1,305,088	1,305,088
R-Squared	0.350	0.272	0.089	0.380	0.272	0.074
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel C: Single Lien vs piggyback loan						
	Single Lien loan			Piggyback Loan		
Deregulation Index	-0.0182***	0.0256***	-1.6498***	-0.0007	0.0028	-1.0805**
	(0.0051)	(0.0027)	(0.1643)	(0.0092)	(0.0040)	(0.4853)
Observations	260,389	260,389	260,389	147,202	147,202	147,202
R-Squared	0.357	0.292	0.136	0.458	0.315	0.075
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the value zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. Panel A shows the results for types of loan, where Columns (1) to (3) refer to the refinance variable taking the value of zero, indicating a first-time loan, and Columns (4) to (6) refer to the refinance variable taking the value one, indicating a refinance loan. Panel B shows the results for first-time homebuyers, where Columns (1) to (3) refer to the first-time homebuyer variable taking the value one, indicating a first-time homebuyer receiving the loan, and Columns (4) to (6) refer to the variable taking the value zero, indicating that the loan recipient is not a first-time homebuyer. Panel C shows the heterogeneous effects for piggyback loans in the sample with a combined LTV in excess of 80%, where Columns (1) to (3) refer to the second lien variable taking the value zero, indicating this is a not a second-lien loan, and Columns (4) to (6) refer to the variable taking the value one, indicating it is a second-lien loan. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE VI

Mechanism: Refinance Inattentiveness

	Prepay					
	(1) Prepay before fixed term	(2) Prepay one year after fixed term	(3) Prepay within one year after fixed term	(4) Duration over life	(5) Duration after fixed term	(6) Refinance with at least 50 bps rate savings
Deregulation Index	-0.0032	0.0079***	0.0020*	0.1990*	0.4025***	-0.0116***
	(0.0020)	(0.0014)	(0.0011)	(0.1197)	(0.0724)	-0.0017
Observations	1,511,832	1,511,832	1,511,832	1,511,832	1,511,832	1,511,832
Adjusted R-squared	0.093	0.029	0.013	0.074	0.031	0.385
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the value zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. For Column (1), the dependent variable takes the value one if the period of the prepayment is before the fixed term and zero otherwise. For Column (2), the dependent variable takes the value one if the period of prepayment is one year after the fixed term and zero otherwise. For Column (3), the dependent variable takes the value one if the period of prepayment is within one year of the fixed term and zero otherwise. For Column (4), the dependent variable is the number of months between the prepayment time and the origination time. For Column (5), the dependent variable is the number of months between the prepayment time and the end of the fixed term. For Column (6), the dependent variable takes the value one if the average mortgage rate in the economy in the prepayment month is at least 50 bps below the actual interest rate for the loan and zero otherwise. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE VII

Mechanism: Heterogeneous Effects, by Lender Characteristics

	Prepay					
	(1)	(2)	(3)	(4)	(5)	(6)
	Before fixed term	One year after fixed term	Within one year after fixed term	Before fixed term	One year after fixed term	Within one year after fixed term
Panel A: Type of lender						
	Retail lenders			Brokers		
Deregulation Index	-0.0091***	0.0098***	0.0038***	0.0134***	0.0018	-0.0004
	(0.0022)	(0.0017)	(0.0013)	(0.0035)	(0.0024)	(0.0018)
Observations	796,910	796,910	796,910	714,615	714,615	714,615
Adjusted R-squared	0.084	0.035	0.015	0.110	0.027	0.014
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel B: Incumbent VS Entrants in State						
	Entrants			Incumbent		
Deregulation Index	0.0627***	-0.0136***	-0.0043	-0.0068***	0.0095***	0.0027**
	(0.0072)	(0.0038)	(0.0037)	(0.0020)	(0.0015)	(0.0011)
Observations	321,799	321,799	321,799	1,189,771	1,189,771	1,189,771
Adjusted R-squared	0.077	0.017	0.014	0.100	0.034	0.014
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel C: Incumbent VS Entrants in County						
	Entrants			Incumbent		
Deregulation Index	0.0698***	-0.0119***	-0.0088***	-0.0086***	0.0090***	0.0030**
	(0.0051)	(0.0028)	(0.0030)	(0.0021)	(0.0015)	(0.0012)
Observations	743,181	743,181	743,181	768,549	768,549	768,549
Adjusted R-squared	0.082	0.018	0.013	0.111	0.041	0.015
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the value zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. For Columns (1) and (4), the dependent variable takes the value one if the period of the prepayment is before the fixed term and zero otherwise. For Columns (2) and (5), the dependent variable takes the value one if the period of the prepayment is one year after the fixed term and zero otherwise. For Columns (3) and (6), the dependent variable takes the value one if the period of the prepayment is within one year of the fixed term and zero otherwise. Panel A shows the results by the type of lender: In Columns (1) to (3), the sample includes loans originated by retail lenders and, in Columns (4) to (6), the sample includes loans originated by brokers. Panel B shows the results by whether the lender is the incumbent in the state: In Columns (1) to (3), the sample includes loans originated by a bank/broker that was not in the state before the deregulation and, in Columns (4) to (6), the sample includes loans originated by a bank/broker that was in the state before the deregulation. Panel C shows the results by whether the lender is the incumbent in the county: In Columns (1) to (3), the sample includes loans originated by a bank/broker that was not in the county before the deregulation and, in Columns (4) to (6), the sample includes loans originated by a bank/broker that was in the county before the deregulation Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE VIII

Mechanism: Heterogeneous Effects, by Borrower Characteristics

	Prepay					
	(1) Before fixed term	(2) One year after fixed term	(3) Within one year after fixed term	(4) Before fixed term	(5) One year after fixed term	(6) Within one year after fixed term
Panel A: New purchase or refinance						
	New Purchase			Refinance		
Deregulation Index	-0.0084***	0.0083***	0.0047***	0.0065**	0.0047**	-0.0021
	(0.0024)	(0.0017)	(0.0013)	(0.0029)	(0.0020)	(0.0017)
Observations	624,621	624,621	624,621	886,889	886,889	886,889
Adjusted R-squared	0.106	0.036	0.016	0.089	0.029	0.013
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel B: First Time Home Buyers						
	First Time Home Buyers			Existing Home Buyers		
Deregulation Index	-0.0094*	0.0116***	0.0091***	-0.0023	0.0071***	0.0011
	(0.0049)	(0.0035)	(0.0029)	(0.0020)	(0.0014)	(0.0011)
Observations	206,349	206,349	206,349	1,305,088	1,305,088	1,305,088
Adjusted R-squared	0.106	0.034	0.019	0.092	0.030	0.013
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel C: Single Lien vs piggyback loan						
	Single Lien loan			Piggyback Loan		
Deregulation Index	-0.0059*	0.0092***	0.0059***	-0.0049	0.0049	0.0149***
	(0.0031)	(0.0024)	(0.0020)	(0.0083)	(0.0052)	(0.0045)
Observations	260,389	260,389	260,389	147,202	147,202	147,202
Adjusted R-squared	0.128	0.047	0.021	0.083	0.018	0.014
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the values zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. For Columns (1) and (4), the dependent variable takes the value one if the period of the prepayment is before the fixed term and zero otherwise. For Columns (2) and (5), the dependent variable takes the value one if the period of the prepayment is one year after the fixed term and zero otherwise. For Columns (3) and (6), the dependent variable takes the value one if the period of the prepayment is within one year of the fixed term and zero otherwise. Panel A shows the results for types of loan, where Columns (1) to (3) refer to the refinance variable taking the value of zero, indicating a first-time loan, and Columns (4) to (6) refer to the refinance variable taking the value one, indicating a refinance loan. Panel B shows the results for first-time homebuyers, where Columns (1) to (3) refer to the first-time homebuyer variable taking the value one, indicating a first-time homebuyer receiving the loan, and Columns (4) to (6) refer to the variable taking the value zero, indicating that the loan recipient is not a first-time homebuyer. Panel C shows the heterogeneous effects for piggyback loans in the sample with a combined LTV in excess of 80%, where Columns (1) to (3) refer to the second lien variable taking the value zero, indicating that the loan is a not a second-lien loan, and Columns (4) to (6) refer to the variable taking the value one, indicating that the loan is a second-lien loan. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE IX

Tests for Alternative Explanations of Borrower Selection

	(1) ARM Spread	(2) Margin	(3) Fixed Term	(4) ARM Spread	(5) Margin	(6) Fixed Term
Panel A: decision rule from Koijen et al (2009)						
	Positive long-term bond risk premium			Negative long-term bond risk premium		
Deregulation Index	-0.0220***	0.0202***	-1.9251***	-0.0078**	0.0327***	-2.0610***
	(0.0038)	(0.0018)	(0.1298)	(0.0035)	(0.0020)	(0.1465)
Observations	701,088	701,088	701,088	810,423	810,423	810,423
R-Squared	0.422	0.316	0.079	0.332	0.253	0.084
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel B: down move vs up move						
	Down move			Up move		
Deregulation Index	-0.0186***	0.0263***	-1.1404***	-0.0310***	0.0268***	-2.9923***
	(0.0045)	(0.0023)	(0.1472)	(0.0057)	(0.0028)	(0.2039)
Observations	551,183	551,183	551,183	413,072	413,072	413,072
R-Squared	0.295	0.268	0.06	0.389	0.274	0.082
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the values zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. Panel A reports the results based on the household decision rule of Koijen et al. (2009). In Columns (1) to (3), the sample includes loans originated in months with positive long-term bond risk premium. In Columns (4) to (6), the sample includes loans originated in months with negative long-term bond risk premium. Panel B reports the results by the different trends of average mortgage rates at origination. *up move* is defined as a dummy variable that takes the value one if and only if the market mortgage rate is at least 50 bps more than it was at its minimum in the prior six months. *down move* takes the value one if and only if the market mortgage is at least 50 bps less than it was at its maximum in the prior six months. In Columns (1) to (3), the sample includes loans originated in months with *down move* trend. In Columns (4) to (6), the sample includes loans originated in months with *up move* trend. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE X

Loan Performance

	Default			Gross Loan Payment		
	(1)	(2)	(3)	(4)	(5)	(6)
	Before fixed term	One year after fixed term	Within one year after fixed term	Total	Before fixed term	After fixed term
Deregulation Index	-0.0028***	-0.0019***	-0.0010***	-90.6404	-330.4130***	239.7726**
	(0.0004)	(0.0004)	(0.0002)	(178.1103)	(106.2530)	(104.9301)
Observations	1,490,025	1,490,025	1,490,025	1,490,025	1,490,025	1,490,025
Adjusted R-squared	0.039	0.030	0.007	0.250	0.326	0.083
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the values zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. For Column (1), the dependent variable takes the value one if the period of default is before the fixed term and zero otherwise. For Column (2), the dependent variable takes the value one if the period of default is one year after the fixed term and zero otherwise. For Column (3), the dependent variable takes the value one if the time period of default is within one year of the fixed term and zero otherwise. For Column (4), the dependent variable is the gross loan payment for each loan from loan origination to June 2015. For Column (5), the dependent variable is the loan payment for each loan before the fixed term. For Column (6), the dependent variable is the loan payment for each loan after the fixed term. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE A.1

Impact of Deregulation on FRMs

	FRM Contract and Performance						
	(1) FRM Rate	(2) Default within 24 months	(3) Default within 36 months	(4) Default	(5) Refinance within 24 months	(6) Refinance within 36 months	(7) Refinance
Deregulation Index	0.0181***	0.0003	-0.0001	-0.0043***	-0.0022	-0.0054***	-0.0017**
	(10.56)	(1.49)	(-0.35)	(-6.33)	(-1.41)	(-3.62)	(-2.03)
Observations	1490705	1490705	1490705	1490705	1490705	1490705	1490705
Adjusted R-squared	0.709	0.020	0.043	0.085	0.177	0.217	0.104

Note: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the values zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.

TABLE A.2

Heterogeneous Effects, by FICO Score

	FICO Score		
	(1)	(2)	(3)
	ARM Spread	Margin	Fixed Term
Panel A: FICO score less than 620			
Deregulation Index	-0.0019	0.0436***	-3.0308***
	(0.0122)	(0.0066)	(0.3470)
Observations	51396	51396	51396
R-Squared	0.337	0.291	0.114
Panel B: Fico score including 620 to less than 660			
Deregulation Index	-0.0123	0.0230***	-2.0815***
	(0.0078)	(0.0037)	(0.2741)
Observations	153,474	153,474	153,474
R-Squared	0.35	0.229	0.1
Panel C: Fico score including 660 to less than 720			
Deregulation Index	-0.0108***	0.0298***	-2.0673***
	(0.0041)	(0.0023)	(0.1579)
Observations	474,775	474,775	474,775
R-Squared	0.364	0.293	0.088
Panel D: Fico score including 720 to less than 780			
Deregulation Index	-0.0143***	0.0212***	-1.6750***
	(0.0033)	(0.0016)	(0.1412)
Observations	622,195	622,195	622,195
R-Squared	0.425	0.297	0.077
Panel E: Fico score more than and including 780			
Deregulation Index	-0.0294***	0.0283***	-1.6086***
	(0.0055)	(0.0028)	(0.245)
Observations	208,377	208,377	208,377
R-Squared	0.428	0.285	0.064
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. The deregulation index takes the values zero to four, depending on four important provisions: (1) the minimum age of the target institution, (2) de novo interstate branching, (3) the acquisition of individual branches, and (4) a statewide deposit cap. The FICO scores are between 300 and 899. A higher score indicates lower credit risk. Panels A to E show the results for the different ranges of FICO scores. Robust clustered errors are reported in parentheses. The superscripts ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. All columns include month and zip code fixed effects and borrower controls.