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

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Abstract

We document that increased competition leads banks to reduce initial rates offered on adjustable-rate mortgages (ARMs) to attract borrowers but increase interest rates after the rate reset and thereby exploit consumer inattention in pricing terms. 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. We explore different explanations and find that the fact that deregulation increases the proportion of naïve borrowers can explain that competition reduces initial rates and increases the reset rate, which is consistent with the theoretical predictions . Although competition reduces firm revenues and benefits consumers due to price reduction, the effect is small, since firms respond to competition by increasing add-on prices and loans have lower default rates and delayed prepayments since deregulation. Our results imply that competition might not eliminate firms' exploitation of naïve consumers, it might even intensify firms' exploitation under certain conditions.

Keywords: Deregulation; competition; shrouding; behavioral bias

JEL: G21, G28, R21, R31

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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 (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; Bucks and Pence 2008).

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) What is the impact of deregulation on banks' revenue if banks increase shrouding behavior? Our analysis uses a difference-in-differences 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.

We begin our analysis with 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; Kőszegi 2014; Heidhues and Kőszegi 2015). In our setting, there are two types of price components in ARM contract: the base price is the initial teaser rate constant over the fixed term and the add-on price is the adjustable rate afterwards. There are also two types of borrowers: myopic borrowers do not consider the pricing terms (index plus margin) after the fixed term, while sophisticated borrowers consider such terms and can refinance before interest rate is reset to a higher rate, but subject to certain substitution costs. The theory predicts that a shrouded price equilibrium exists with a lower initial teaser rate and a higher margin when the proportion of naïve borrowers is larger than a threshold.

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 add-on prices. The initial teaser rate,[2] initial fixed term, and reset margin in ARM contracts in deregulated states are, respectively, 5 basis points (bps) (or 6% of the average ARM spread) lower, 8 months (or 13%) shorter, and 11 bps (or 4%) higher than in fully regulated states. Shorter fixed term is used by lenders to offset the sweeteners in the lower teaser rate offered to borrowers. The results suggest that increased competition leads banks to offer reduced initial rates, but within much shorter window, to attract borrowers but increase reset rates in the future. Given loan payments

[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 defined as the spread over the rate on fixed-rate 30-year mortgages originating in the same month and same market.

after the fixed term account for about 40% of gross total in our sample, potential gains from higher margin can be substantial.

We then test the heterogeneity in banks' responses to the deregulation by different lenders and consumers. Mortgage brokers make money largely from a commission at origination and have less incentives shroud on add-on prices than retail banks. We find that the initial teaser rate of broker loans in deregulated states is 8 bps lower while that of retail banks is only 3 bps lower. The impact on fixed term of retail loans in deregulated states is twice as much as that of broker loans and the impact on their reset margins are three times higher. Theory of shrouded attributes predicts that lenders should shroud more where there are more naïve borrowers. We identify four types of naïve borrowers: home purchasers versus refinancing borrowers, first-time versus existing homebuyers, borrowers choosing 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. These borrowers are either less financially sophisticated or lack of experience in managing their mortgage accounts. We find that, in all measures, more naïve borrowers are offered lower teaser rate, but much shorter fixed period and higher reset margin.

We consider a number of possible explanations for the estimated effect of deregulation. The theory of shrouded attributes implies that a shrouded price equilibrium exists with a lower initial teaser rate and a higher margin when the proportion of naïve borrowers is larger than a threshold. The original theory implicitly assumes that the proportion of naïve borrowers is independent to market competition and steady over time. We derive a new prediction by relaxing this assumption: if competition increases the proportion of naïve borrowers above a threshold that an unshrouded price equilibrium switches to a shrouded price equilibrium, competition reduces initial rates and increases the reset rate; if competition reduces the proportion of naïve borrowers below a threshold that a shrouded price equilibrium switches to an unshrouded price equilibrium, competition reduces initial rates and reduce the reset rate. We test this by investigating the impact of banking deregulation on proportion of naïve borrowers and using borrowers' prepayment behavior to measure their naïveté. We find that, based on both the full sample and various subsamples, deregulation increases the proportion of naïve borrowers and banks increase shrouding accordingly. It suggests

that competition may not necessarily eliminate firms' exploitation and, under certain conditions, even increase the exploitation. We also test for other possible explanations, including borrowers' selection, expected increasing income and negative equity. None of these is supported by the empirical results.

Finally, we explore the impact of banking deregulation on mortgage performance, as well as firm revenues and consumer benefits. Two types of risks are embedded in mortgage contracts: default and prepayment. We find the overall default risk decreases following banking deregulation and performance improves even more after the first reset, suggesting that our baseline results are not driven by unobservable borrower quality. We also find that deregulation increases prepayments much more at least one year after the reset than early years and increases the overall duration of loan payment after reset, leaving more time for banks to reap profits from higher reset rate. Overall, there is a significant increase in lender gross revenue after the fixed term and a significant decrease within the fixed term, resulting from higher reset rate and lower teaser rate, respectively. The results suggest that, since firms respond to competition by increasing add-on prices, the overall effect on their revenue is very limited.

This paper makes several important contributions to four increasingly related strands of the literature. First, 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. 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 second contribution of this paper is to provide empirical evidence for the theoretical work that explores the optimal supply responses of firms when consumers exhibit behavioral biases. 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 (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). The empirical literature on price shrouding mostly analyzes the demand elasticity of consumers to infer profitability and the results suggest that shrouding raises profitability (Ellison and Ellison 2009; Brown, Hossain, and Morgan 2010; Ru and Schoar 2015). Less empirical work has focused on firms' responses when competition changes or whether competition can eliminate firms' exploitation behavior. The theory shows that competition does not eliminate firms' exploitation (Gabaix and Laibson 2006). Our results show that competition can increase add-on prices when there are more naïve borrowers, and competition may even intensify firms' exploitation under certain conditions, instead of eliminating it.

Lastly, our findings are related to the literature about the impact of competition on firm behavior. 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 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 competition, and competition could increase markups for distributions in the heavy-tailed class. Our results that competition can increase add-on prices are consistent with the implicit prediction of Gabaix and Laibson (2006). We also empirically show that the proportion of naïve borrowers must increase for competition to increase prices. Moreover, competition can destroy ethical behavior (Shleifer 2004) and induce firms to take costly actions that they might not otherwise (Syverson 2011). Our results are consistent with the literature in that we show that competition increases the magnitude of banks' strategy to exploit naïve borrowers. Standard equilibrium models imply that competition reduces price and thus firm revenues. Our empirical results show that the

overall effect is rather limited since firms respond to competition by increasing add-on prices.

This paper's findings have important implications for public policies regarding how to design banking policies after the financial crisis. In the wake of the crisis, government has 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 outlines the theoretical framework. Section III explains the data as well as the design of our empirical identification and methodology. Section IV presents the empirical results. Section V discusses various transmission channels of these effects. Section VI the impact of banking deregulation on ex post performance and lender revenues. Section VII concludes the paper.

II. THEORETICAL FRAMEWORK

In this section, we present our empirical predictions by starting with the theoretical model developed by Gabaix and Laibson (2006). They 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.

Proposition 1. Shrouded price equilibrium exists under the condition that the fraction α of myopic consumers is greater than α^+, 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 exists 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. The 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 implicitly assumes that the proportion of naïve borrowers is independent to market competition and steady over time. It does not explicitly specify the relation between firm competition 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.

Proposition 2. Consider the impact of banking deregulation on banks' ARM pricing strategies, we have three implicit predictions. *Prediction 1* is that if competition does not change the relationship between the fraction of myopic consumers and α^+, banking deregulation increases the competition for borrowers and thus p will decrease but $\hat{p}$ will remain unaffected. *Prediction 2* is that if competition increases the proportion of myopic consumers above a threshold α^+ that an unshrouded price equilibrium switches to a shrouded price equilibrium, banking deregulation will reduce

p and increase $\hat{p}$. *Prediction 3* is that if competition reduces the proportion of myopic consumers below a threshold α^+ that a shrouded price equilibrium switches to an unshrouded price equilibrium, banking deregulation will reduce both p and $\hat{p}$.

Why is there a switch from one equilibrium to another? Based on *Proposition 1*, the switch depends on the relation between α and $\frac{e}{\bar{p}}$. 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 $\bar{p}$, the regulatory constraints on add-on prices. Note that whether competition increases or reduces α, e, and $\bar{p}$ cannot be predicted by the theory of shrouded attributes. It depends on the market settings. In Section IV, we show our main empirical results support *Prediction 2*.

III. Data and Identification

III.1. 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. 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 FRMs (or fully-index rate). The spread between the two measures the attractiveness of the initial ARM rate and is adopted throughout this paper. Badarinza, Campbell, and Ramadorai (2015) find that the ARM spread is an important determinant of consumers' choice of ARMs. The fixed terms are 1, 3, 5, 7 and 10 years and once the term expires, the rates are adjusted once a year based on an index plus the margin.[3] Usually, the lower teaser rate is offered with shorter fixed term to price for lender's interest rate risk. . Prime ARM loans are indexed primarily on the 12-month London Interbank Offered Rate (LIBOR) and the constant maturity Treasury rate, usually a 50/50 split, which leaves the reset margin as a main add-on pricing feature available to lenders. The shorter the fixed period, the sooner lenders can gain from the full indexed rate at reset.

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 also a 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 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.

[3] ARMs are thus labeled 1/1, 3/1, 5/1, 7/1, and 10/1 hybrid ARMs, respectively. 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.

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 June 2015, the average cumulative 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 June 2015, 86% of all mortgages were prepaid, including 70% during the fixed period and

16% afterward. When we plot the prepayments by months from first reset date, Overall, 25% of loans, including 9% of loans still active as of 2015 and 16% prepaid after the fixed period have been applied the fully indexed reset rates. Total payments after the fixed term account for 37% of total loan payments as of 2015 and potentially much higher over lifetime, suggesting that a significant number of ARM borrowers are affected by add-on prices.

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 (HMDA) 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 takes value of 0 for states free of these restrictions and 1-4 to capture total number of the barriers described above. The index is reversed in regressions so that high values refer to deregulated states. We plot the sample distribution by the state deregulation index over time in Figure A.1 in Appendix. There was no restrictions on interstate branching in 1994 and thus 100% of loans have index values of 0. From 1995, an increasing number of states began to impose more restrictions and about 90% of loans in our sample are located in states with at least one restriction, leaving 10% of loans in deregulated states.

III.2. 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.

IV. EMPIRICAL FINDINGS

IV.1. 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. Consistent with Rice and Strahan (2010), we multiple the coefficient on the index by 4 to calculate the effects of full deregulation. Column (1) shows that the number of banks increases significantly, by 40%, 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% and the volume increases by 17% 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[4], a more front-loaded pricing feature used to attract borrowers. 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, 5 bps lower, 8 months shorter, and 11 bps higher than in fully regulated states. These results support the theory Prediction 2 in Proposition 2 in Gabaix and Laibson (2006): banking deregulation reduces the initial teaser rates and increases margins, suggesting a switch from an unshrouded price equilibrium to a shrouded price equilibrium.

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.

The results implies that potential gains from higher margin can be substantial for banks. In our sample, the average total payment for each loan is 43162 USD and the payment after fixed term is 9095 USD. Thus, the payment after fixed term account for 21% of the gross loan payment. In the sample who prepay after the fixed term, the payment after fixed term account for 37% of the gross loan payment.

[4] 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 results for FRMs in Table A.2 suggest that the fixed rate in deregulated states is actually 7 bps higher than that in regulated states.

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 bps lower than in fully regulated states, while the lifetime cap in regulated states is 48 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.2. Placebo Test

What drives the deregulation index? Interstate branching deregulation cannot be assumed to be exogenous since deregulation occurs through a political process between interest groups, legislators, and constituents. One concern is that contract design may be correlated with demand for credit in the state or with the supply-side bargaining power of interest groups. We offer three pieces of evidence to establish the causal relation between deregulation to contract design.

First, Rice and Strahan (2010) show that there is no contemporaneous correlation across states between economic conditions and the deregulation index. They show that states where large (expansion-minded) banks are strong relative to small (insulated) banks are more likely to deregulate early. Since differences in the relative bargaining power of large versus small banks tends to be very persistent, we follow Rice and Strahan and add fixed effects to control for time-invariant unobservables. Second, Favara and Imbs (2015) explore the idea that, if deregulation is triggered by current or expected economic conditions, then every lender should react and expand credit. However, the deregulation in their study pertained to commercial banks only. The authors show that commercial banks (affected by the deregulation) expand credit, while independent mortgage banks (unaffected by the deregulation) do not expand credit. Hence, it is unlikely that deregulation is triggered by current or expected economic conditions. Third, we use our loan-level data to test the identification assumption of our differences-in-differences strategy. The identification assumption of our estimation strategy is a common trend between the treatment and control states

before deregulation. We add lags and leads of the deregulation index to check the pre-trends in our loan-level dataset. The specification we use is

$$Y_{i,t} = \sum_{\tau=t-4}^{t+2} \beta_{1\tau} D_{s,\tau} + \beta_2 \boldsymbol{Z}_{i,t} + \beta_3 \boldsymbol{X}_{c,t} + \alpha_c + \gamma_t + \epsilon_{c,t} \qquad (2)$$

where $D_{s,\tau}$ includes four lags and two leads of the deregulation index.

Figure I plots the coefficients of $\beta_{1\tau}$ from the regression. The dependent variable is the ARM rate spread, the reset margin, and the fixed term in Panels A to C, respectively. We normalize to zero the coefficient for the year of deregulation and plot the remaining coefficients relative to it. There are two main points from all panels in Figure I. First, there does not seem to be a persistent difference between treatment and control states in the ARM spread, the reset margin, or the fixed term before the deregulation or in the year of deregulation. These results support the common trend assumption. Second, after deregulation, all the coefficients of the ARM spread become significantly negative, all the coefficients of the margin become significantly positive, and all the coefficients of the fixed term become significantly negative. These results support a jump in trends in these outcomes after deregulation.

IV.3. Heterogeneity across Different Lenders and Borrowers

Different lenders can have different profit structures, allowing us to test banks' responses to the deregulation that are optimal to their own business models. The revenues of mortgage brokers are largely from a commission at origination, not from add-on prices in ARM contracts. Therefore, these lenders have more incentive to compete based on based price instead of add-on prices. On the other hand, the revenues of retail banks are from both the base and add-on prices and have more incentives to shroud on add-on prices. The results by these two different lenders are reported in Panel A of Table IV.

We find that the initial teaser rates of broker loans in deregulated states are 8 bps lower than that in fully regulated states, while those of retail banks are only 2 bps lower. However, retail banks charge more back-loaded add-on prices: the fixed term of loans originated by retail banks in deregulated states is 8 months shorter than that in fully regulated states, compared to only 5 months shorter for broker loans. The reset

margin of loans originated by retail banks in deregulated states is 13 bps higher than that in fully regulated states, compared to only 4 bps higher for broker loans, a striking difference.[5]

Theory predicts that lenders should shroud more when the proportion of naïve borrowers is larger (Gabaix and Laibson 2006; DellaVigna 2009; Kőszegi 2014; Heidhues and Kőszegi 2015). We test this prediction by analyzing the heterogeneous effects among different types of 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 IV.

In Panel B, 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, 5 bps lower, 8 months shorter, and 12 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, 7 bps lower, 6 months shorter, and 7 bps higher than in fully regulated states. These results suggest that lenders exploit homeowners less once the homeowners develop some financial sophistication.

Panel C 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, 9 bps lower, 11

[5] We also find that, compared to new entrants from out of state following interstate deregulation, incumbent lenders choose to shroud more aggressively in the face of increased competition.

months shorter, and 9 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, 5 bps lower, 11 months shorter, and 7 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 require borrowers with an LTV above 80% to pay for PMI coverage. The premium charged by PMI companies can be anywhere from 1% to 10% in a single payment or 30–150 bps monthly. 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. 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 those who stick to the PMI structure. We compare banks' strategies for these two groups, both having a combined LTV above 80%. The results are reported in Panel D. Because borrowers who choose piggybacks are savvier and more 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, 7 bps lower, 7 months shorter, and 10 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 II. 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 4 bps lower than those in fully regulated states, while those for a FICO of 780 and above have initial teaser rates only 12 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 months shorter than in fully regulated states, while that of loans for a FICO of 780 and above is 6 months shorter.

A credit score of 620 and below is considered a rule-of-thumb criterion for identifying subprime borrowers (Keys et al. 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

We have documented that deregulation reduces teaser rates and fixed terms and increases margins. Why does deregulation increase bank shrouding? There are several potential explanations. First, banking deregulation increases the proportion of naïve borrowers in the market and, thus, a new equilibrium in the market emerges, with increased shrouding. Second, borrowers choose the shrouding contract due to

expectations about interest rate changes. Third, after deregulation, marginal borrowers prefer lower teaser rates with shorter teaser periods and a higher reset margin due to increasing income profiles. Lastly, our results may be affected by financial crisis when some borrowers experienced negative equity and were unable to refinance timely.

V.1. Banking Competition Increases Naïve Borrowers

Theory predicts that lenders should shroud more when the proportion of naïve borrowers is larger (Gabaix and Laibson 2006; Heidhues and Kőszegi 2015). Gabaix and Laibson's (2006) theory show 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. The original theory implicitly assumes that the proportion of naïve borrowers is independent to market competition and steady over time, which may be true in the liquid markets such as hotel and printer. However, in the less liquid housing market, it's very likely that the composition of buyers/consumers changes over time, where the theory prediction is less unambiguous depending on the direction and the magnitude of the change. If competition increases the proportion of naïve borrowers above a threshold that an unshrouded price equilibrium switches to a shrouded price equilibrium, the theory predicts that competition reduces initial rates and increases the reset margin and therefore reset rate. If competition reduces the proportion of naïve borrowers below a threshold that a shrouded price equilibrium switches to an unshrouded price equilibrium, the theory predicts that competition reduces initial rates and reduce the reset margin and thus reset rate. Therefore, one explanation that banks increase shrouding is that the deregulation causes an increase in naïve borrowers, which is consistent with *Prediction 2*.

According to Gabaix and Laibson, sophisticated borrowers differ from naïve ones in that they exert costly substitution efforts € early while 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 (Dunn and McConnell, 1981; Hendershott and van Order, 1987). Recently, 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. 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 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 the 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 a market rate significantly (at least 50 bps) below their previous rate. Panel A of Table V 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 bps and 320 bps, respectively, in the first year and in later years after the fixed term. Columns (4) and (5) show that borrowers wait 1 and 2 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 adequate savings of at least 50 bps. These results suggest that there are more naïve borrowers following the deregulation. Hence, our results in Table III and Table V support *Prediction 2* based on the full sample.

Next we explore the heterogeneity of prepayments across lenders and borrowers in Table VI. The results suggest that retail loans, new homebuyers, first-time homebuyers, and PMI borrowers are more likely to refinance late. These are also the subsamples where banks increase shrouding on add-on prices following the deregulation. They collectively support the contention that when the proportion of naïve borrowers increases after deregulation in a particular subsample, banks increase shrouding in the subsample as well. Hence, our results based on both overall sample and subsamples support *Prediction 2*.

How can banking competition increase naïve borrowers? Why don't banks target naïve borrowers before deregulation? We want to make clear that whether competition increases or reduces the proportion of naïve consumers cannot be predicted by the theory of shrouded attributes. It depends on the market settings. One possible explanation is that competition pressure reduces price and thus reduce marginal revenue for banks, especially in their home counties. In response, banks would like to search for

places with larger marginal revenue. Although marginal costs of banks are likely larger in new counties, the marginal revenue from naïve borrowers in new counties might be larger due to less competition in new counties. We do not have direct data on the marginal revenue, we can provide some indirect evidence based on subset of loans in new counties where banks have no previous mortgage business.

Table VII presents the results. In Columns (1), the dependent variable is whether borrowers are from new counties. We find that deregulation increases the likelihood of borrowers from new counties. Correlation analysis suggests that new counties are characterized of low income, low homeownership rate and less competition. In columns (2) to (6), we analyze the correlation between the new county and the measurements of naïve borrowers. We find that borrowers from new counties are less likely to refinance before the fixed term and within one year after the fixed term. They are more likely to refinance one year after the fixed term, and wait more months after the fixed term to refinance. Fewer borrowers in new counties refinance with adequate savings. The results show that borrowers from new counties are more naïve than those from existing counties. We find that banks are more likely to enter new counties after deregulation. New counties have average much higher HHI so they are less competitive. We also show that borrowers from new counties are more likely to be naïve, and they make slightly more loan payment. Hence, these results suggest there is a potential higher marginal revenue to expand more in new counties.

Nevertheless, there may still be other channels for shrouding. Since the threshold for the fraction of naïve consumers is defined as $\alpha^{+} = \frac{e}{\bar{p}}$, the ratio of refinance costs and constraints on add-on prices, a reduction in e or an increase in $\bar{p}$ 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 $\alpha^{+} = \frac{e}{\bar{p}}$ 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.

V.2. Effect of Negative Equity

The last possible explanation is that mortgages originated in 2007 were more affected by financial crisis. Because of decline in home price and negative equity, these borrowers were unable to refinance during the crisis. It is possible deregulated states are affected more by the financial crisis. We show based on analysis below that this is not a valid explanation. First, we restrict our analysis to the subsample with the first rate reset before Jan 2007 when borrowers were not affected by negative equity and results are reported in Panel B of Table V. The results are consistent with Panel A with slightly greater magnitude. We also restrict the sample with interest rate reset before Jan 2006, the results are very similar (not reported). Second, we study the correlation between deregulation index in 2005 and the severity of financial crisis at the state level. We measure the severity of financial crisis by the cumulative decline of FHFA home price from Q1 2007 to Q4 2010. The correlation is only 0.052. There seems no evidence that deregulated states are disproportionally affected by financial crisis.

Besides negative equity, borrowers may fail to refinance due to procrastination or overconfidence, entirely different from bias due to limited attention. Although our data does not allow us to test this directly, Bucks and Pence (2008), based on Survey of Consumer Finances, show that ARM borrowers tend to underestimate or not know how much their interest rates could change. This evidence support that borrowers have limited attention about future rate but not the explanation of overconfidence or procrastination.

V.3. Borrower Selection

Second possible explanation about the increased shrouding 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 the expected future interest rates. Naïve borrowers should always choose contract B because they do not pay attention to the future rate. Sophisticated borrowers' choices, however, depend on expected future rates: if they

expect the rate to decrease, they would choose contract B because they can refinance early; they are more likely to choose contract A if they expect the rising interest rate. 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. Koijen et al. (2009) empirically find that the simple household decision rule based on the spread between the five-year Treasury bond yield and the one-year T-bill 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 VIII presents the results. We find that deregulation reduces the ARM spread and fixed term, raising the margin in all scenarios. Therefore, the results do not support the second explanation of borrower selection.

V.4. ***Borrowers with Expected Rising Income***

Third possible explanation is that, after deregulation, marginal borrowers prefer lower teaser rates and higher reset rate due to their expected rising income. For example, when the supply of credit expands, credit might be allocated to borrowers who are less established but with expected rising income. These borrowers prefer ARMs because lower teaser rates and higher future rates fit well their income growth. We provide the following evidence to rule out this explanation.

First, the explanation relies on the assumption that these marginal borrowers understand the mortgage contract correctly. However, the literature suggests that mortgage borrowers do not have a good understanding of ARM terms, especially lower-income and young borrowers (Bucks and Pence 2008). Second, this explanation predicts that, after deregulation, marginal borrowers should be younger and have lower income. We test this by estimating the impact of deregulation on the age and income of

borrowers. We find no evidence that borrowers become younger after deregulation (β = -0.044, s.e. = 0.054). Borrower income increases slightly after deregulation (β = 39.69, s.e. = 18.86), which is not consistent with the explanation. Third, if marginal borrowers after deregulation are younger and have lower income, we should observe the impact of deregulation on contract terms only in the subsample of younger and lower-income borrowers. We test this by splitting the sample by the median age in Panel A and by the median income in Panel B and estimating heterogeneous effects in Table IX. We find that deregulation reduces the ARM spread and the fixed term, raising the margin not only in the sample with younger and lower-income borrowers, but also in the sample with older and higher-income borrowers. The evidence does not support the third possible explanation of marginal borrowers.

VI. Ex Post Performance and Lender revenue

Finally, we explore the impact of banking deregulation on ex post mortgage performance as well as lender revenues. Banks bear the credit loss from foreclosure, repurchase, and accrued interests when borrowers default on a mortgage. Banks' revenues 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 revenues 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 revenues. A lender's net revenue regressions are very consistent with gross revenues 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 bps lower during the fixed term and 116 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, accounting for 45% of the total default rate 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).

Column (4) show that the total revenue from loan payment reduce by 360 dollars but it is not statistically significant. In column (5), we find that banks lose 1,320 dollars from the payment before the end of fixed term. In column (6), we find that banks receive 960 dollars more from payment after fixed term. Hence, the reduction of loan payment is mainly driven by the payment before the fixed period since they reduce the initial interest rates. However, the increase of margin increase the payment for naïve borrowers who fail to refinance early. Therefore, although competition reduces firm revenues due to price reduction, the effect is small, since firms respond to competition by increasing add-on prices to mitigate the revenue loss.

Our results suggest that, although competition reduces firm revenues and benefits consumers due to an initial price reduction, the overall lifetime effect is very limited, since firms are compensated by increased add-on prices. Banks earn less gross revenue from loan payments but more revenue after the fixed term with the strategy of shrouding. Consumers initially pay less after competition, but the overall difference is insignificant due to firms' 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.

VII. 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 revenues 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. Deregulation increases prepayments after the reset and at least one year after the reset, increases the duration of loan payment after reset, , leaving more time for banks to reap profits from resetting terms. Our results suggest that, although competition reduces firm revenues and benefits consumers due to an initial price reduction, the overall lifetime effect is very limited, since firms get compensated from increased add-on prices.

Banks might take advantage of borrowers due to different biases of borrowers. First, borrowers might have limited attention to future reset margin. Second, borrowers pay attention to reset margin, they plan to refinance the mortgage before reset but fail to do so due to procrastination or overconfidence. Since our data do not have borrowers' knowledge about contract term or plan about refinance, we do not have direct evidence to distinguish different biases of borrowers. Instead, we provide some survey evidence from other sources. For example, Bucks and Pence (2008) use Survey of Consumer Finances (SCF) and show that borrowers with adjustable-rate mortgages appear likely to underestimate or to not know how much their interest rates could change. This evidence support that borrowers have limited attention about future interest rate but not consistent with overconfidence or procrastination.

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.

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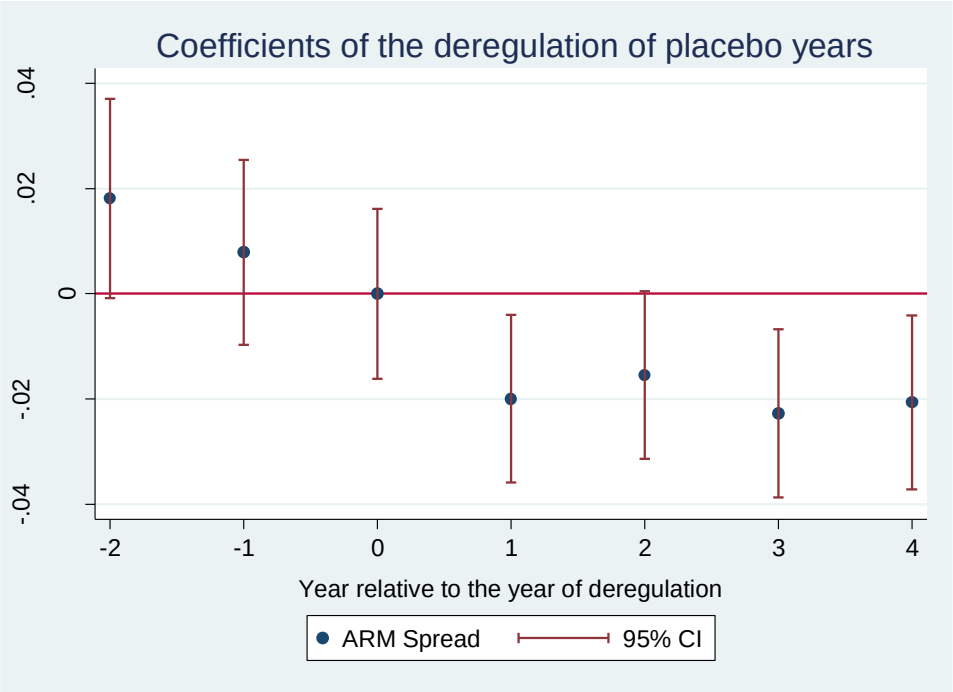
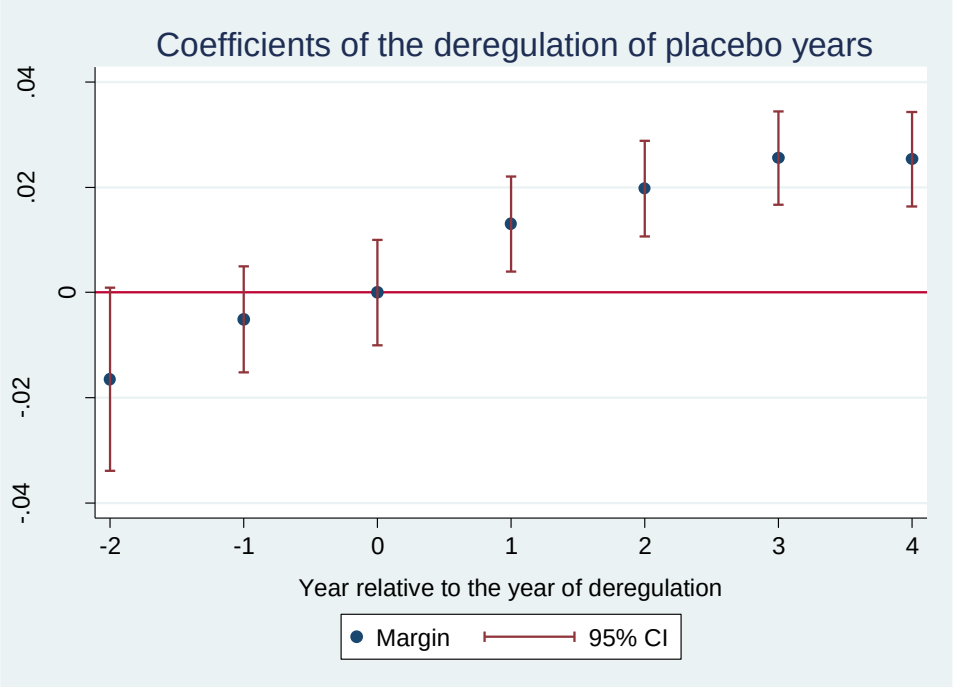
Figure I Coefficients of the Deregulation of Placebo Years

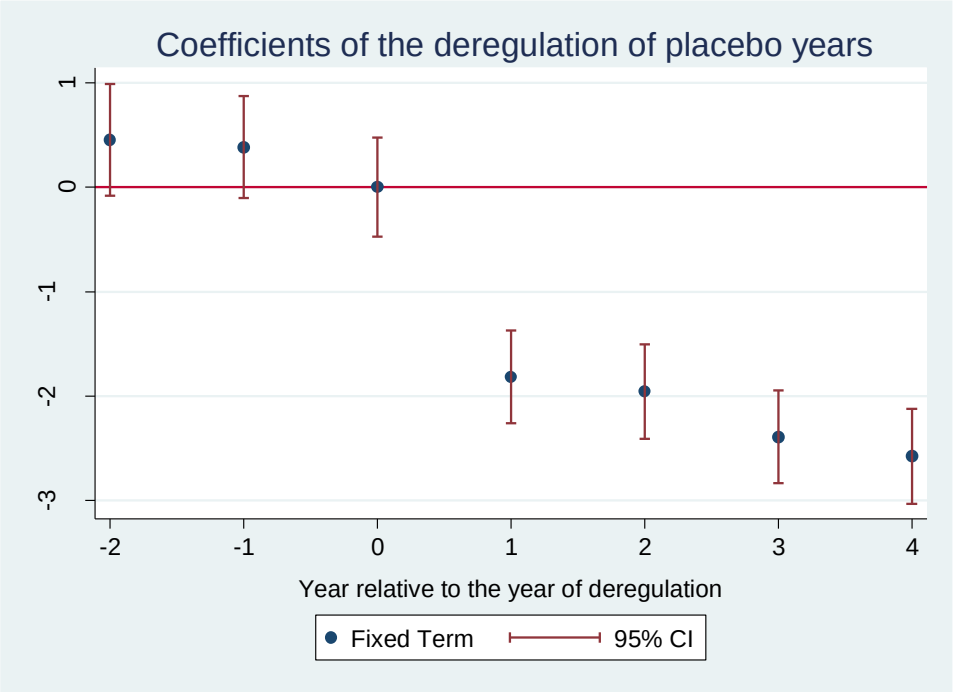
Panel A: ARM Spread



Panel B: Margin



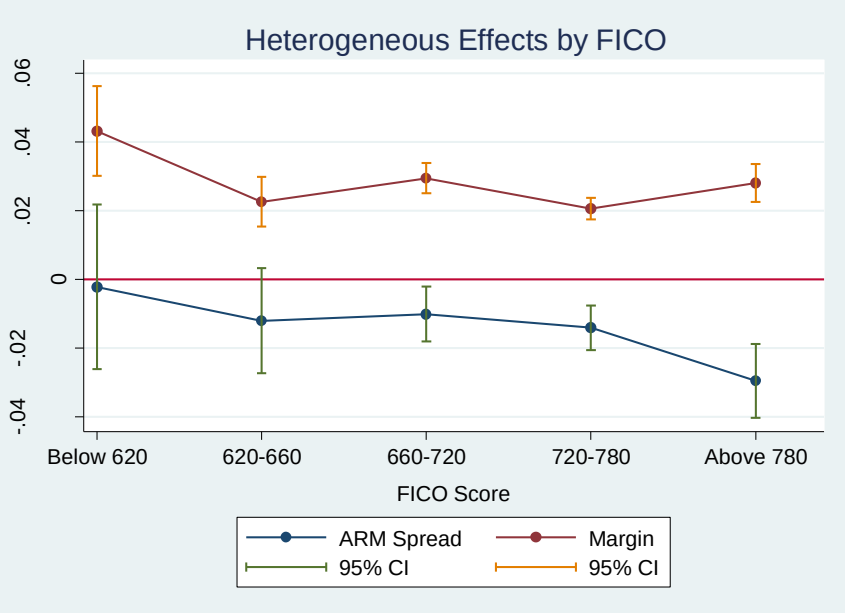
Panel C: Fixed Term



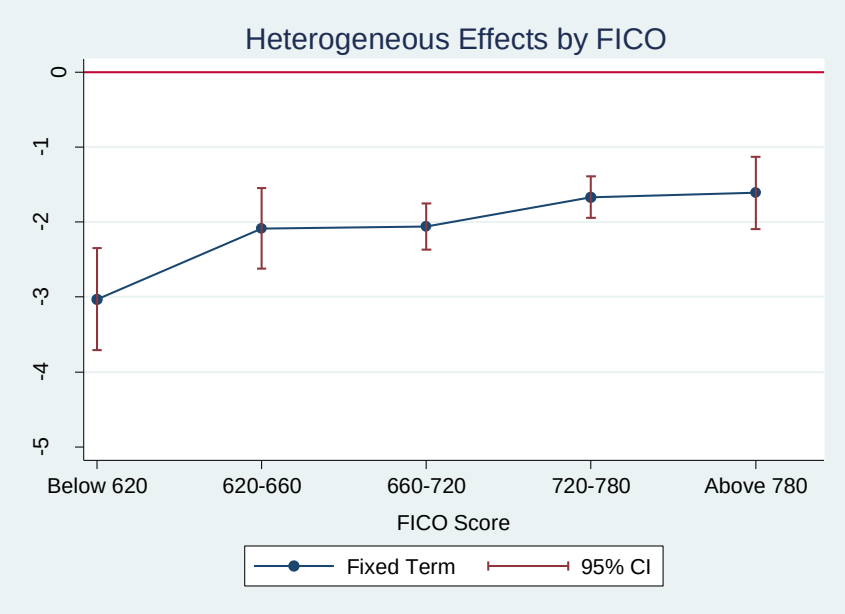
Note: This figure plots the coefficients of deregulation of the placebo years. The dependent variable is the ARM spread, the reset margin, and the fixed term in Panels A to C, respectively. The vertical axis is the coefficients over time. Each panel shows the 95% conference interval. The horizontal axis is the number of years relative to the year of deregulation.

FIGURE II 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 the 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 the 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
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

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) HHI	(3) Number of originations	(4) Volume
Deregulation Index	0.1017**	-0.0017***	0.0358***	0.0427***
	(0.0486)	(0.0006)	(0.0120)	(0.0135)
Implied Effect of Full Deregulation	40%	-0.007	14%	17%
Year FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y
County Controls	Y	Y	Y	Y
Observations	17198	17198	17198	17198
Adjusted R2	0.273	0.039	0.380	0.371

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)
Implied Effect of Full Deregulation	-0.05	0.11	-8
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
Adjusted R2	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***
	(0.0062)	(0.0007)	(0.0077)
Implied Effect of Full Deregulation	-0.218	0	0.478
Month FE	Y	Y	Y
Zip Code FE	Y	Y	Y
Borrower Controls	Y	Y	Y
Observations	1,511,832	1,511,832	1,511,832
Adjusted R2	0.183	0.097	0.172

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 Heterogeneity by Different Lenders and Borrowers

	Loan 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)
Implied Effect of Full Deregulation	-0.025	0.126	-8.4	-0.078	0.045	-4.9
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: 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)
Implied Effect of Full Deregulation	-0.054	0.121	-7.84	-0.067	0.07	-6.09
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 C: 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)
Implied Effect of Full Deregulation	-0.087	0.113	-9.76	-0.05	0.106	-7.27
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 D: PMI vs piggyback loan						
	PMI 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)
Implied Effect of Full Deregulation	-0.073	0.102	-6.5	-0.003	0.011	-4.32
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. 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. Different Panels are results by different subsamples. 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 Refinance Inattentiveness

	Prepay					
	(1)	(2)	(3)	(4)	(5)	(6)
	Before fixed term	One year after fixed term	Within one year after fixed term	Duration	Duration after fixed term	Sophistication
Panel A: Overall Sample						
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)
Implied Effect of Full Deregulation	-0.013	0.032	0.008	0.796	1.61	-0.046
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
Panel B: Restrictive sample with first reset before Jan 2007						
Deregulation Index	-0.0144***	0.0104***	0.0029*	0.0636	0.5337***	-0.0133***
	(0.0023)	(0.0020)	(0.0016)	(0.1434)	(0.1073)	(0.0022)
Implied Effect of Full Deregulation	-0.058	0.042	0.012	0.254	2.13	-0.053
Observations	371868	371868	371868	371868	371868	371868
Adjusted R-squared	0.146	0.082	0.039	0.245	0.090	0.396
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. 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. Panel A is based on overall sample while Panel B exclude loans with their first reset since 2007 that may be affected by negative equity during financial crisis. 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 Refinance Inattentiveness by Subsamples

	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)
Implied Effect of Full Deregulation	-0.036	0.039	0.015	0.053	0.007	-0.002
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: 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)
Implied Effect of Full Deregulation	-0.034	0.033	0.019	0.026	0.019	-0.008
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 C: 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)
Implied Effect of Full Deregulation	-0.038	0.046	0.036	-0.01	0.028	0.004
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 D: PMI vs piggyback loan						
	PMI 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)
Implied Effect of Full Deregulation	-0.024	0.037	0.024	-0.02	0.02	0.06
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. All the columns are similar to Table V. Different Panels are regressions by different subsamples. 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 Competition Increase Naïve Borrowers?

		Prepay						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	New County	Before fixed term	One year after fixed term	Within one year after fixed term	Duration	Duration after fixed term	Sophist-ication	Total Loan Payment
Deregulation Index	0.0017***							
	(0.0006)							
HHI	0.6184***							
	(0.0376)							
New County		-0.0664***	0.0368***	-0.0178*	-1.3089	3.0493***	-0.0523***	1082.5304
		(0.0134)	(0.0125)	(0.0098)	(1.0910)	(0.8075)	(0.0143)	(1110.2908)
Implied Effect of Full Deregulation	0.007							
Observations	1,511,832	1,511,832	1,511,832	1,511,832	1,511,832	1,511,832	1,511,832	1,490,025
Adjusted R-squared	0.532	0.093	0.029	0.013	0.074	0.031	0.385	0.250
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y	Y	Y

Notes: The results presented in this table are obtained using data from 1994 to 2005. For Columns (1) and (2), the dependent variable takes the value one if borrowers are from new counties where banks do not have previous mortgage business and zero otherwise. Results in Column (2) are based on county-level data while those in other columns are based on loan-level sample. For Column (3), the dependent variable takes the value one if the period of the prepayment is before the fixed term and zero otherwise. For Column (4), the dependent variable takes the value one if the period of prepayment is one year after the fixed term and zero otherwise. For Column (5), 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 (6), the dependent variable is the number of months between the prepayment time and the origination time. For Column (7), the dependent variable is the number of months between the prepayment time and the end of the fixed term. For Column (8), 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 VIII Tests for 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)
Implied Effect of Full Deregulation	-0.088	0.081	-7.7	-0.031	0.131	-8.24
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: Interest rate 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)
Implied Effect of Full Deregulation	-0.074	0.105	-4.56	-0.124	0.107	-11.97
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. 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 a positive long-term bond risk premium. In Columns (4) to (6), the sample includes loans originated in months with a negative long-term bond risk premium. Panel B reports the results by the different trends of average mortgage rates at origination. The variable *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 a *down move* trend. In Columns (4) to (6), the sample includes loans originated in months with an *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 IX Tests for Borrowers with an Increasing Income Profile

	(1) ARM Spread	(2) Margin	(3) Fixed Term	(4) ARM Spread	(5) Margin	(6) Fixed Term
Panel A: Heterogeneous effects by median age						
	Below median age			Above median age		
Deregulation Index	-0.0190***	0.0224***	-1.9398***	-0.0202***	0.0242***	-2.1700***
	(0.0038)	(0.0017)	(0.1335)	(0.0032)	(0.0017)	(0.1284)
Implied Effect of Full Deregulation	-0.076	0.09	-7.76	-0.081	0.097	-8.68
Observations	695,161	695,161	695,161	692,433	692,433	692,433
R-Squared	0.408	0.243	0.093	0.397	0.258	0.07
Month FE/ Zip Code FE/ Borrower Controls	Y	Y	Y	Y	Y	Y
Panel B: Heterogeneous effects by median income						
	Below median income			Above median income		
Deregulation Index	-0.0191***	0.0269***	-2.1561***	-0.0080***	0.0255***	-1.6389***
	(0.0036)	(0.0017)	(0.1272)	(0.0034)	(0.0020)	(0.1374)
Implied Effect of Full Deregulation	-0.076	0.108	-8.62	-0.032	0.102	-6.56
Observations	758,227	758,227	758,227	753,265	753,265	753,265
R-Squared	0.374	0.26	0.089	0.403	0.262	0.074
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. Panel A reports the heterogeneous effects by median age. In Columns (1) to (3), the sample includes borrowers below the median age. In Columns (4) to (6), the sample includes borrowers above the median age. Panel B reports the heterogeneous effects by median income. In Columns (1) to (3), the sample includes borrowers below the median income. In Columns (4) to (6), the sample includes borrowers above the median age. 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)
Implied Effect of Full Deregulation	-0.011	-0.008	-0.004	-363	-1322	959
Observations	1,490,025	1,490,025	1,490,025	1,490,025	1,490,025	1,490,025
Mean of Dep Var	0.02	0.025	0.0048	43162	34067	9095
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. 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.

FIGURE A.1 Distribution by Deregulation Over Time

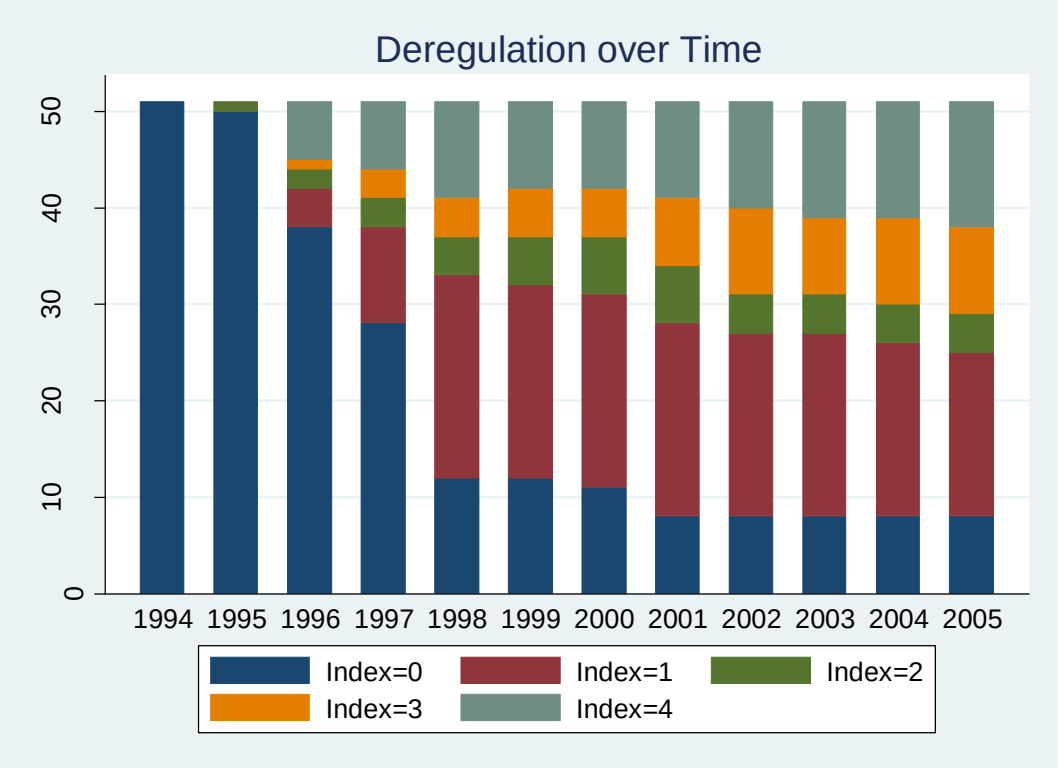


FIGURE A.2 Prepayment Speed

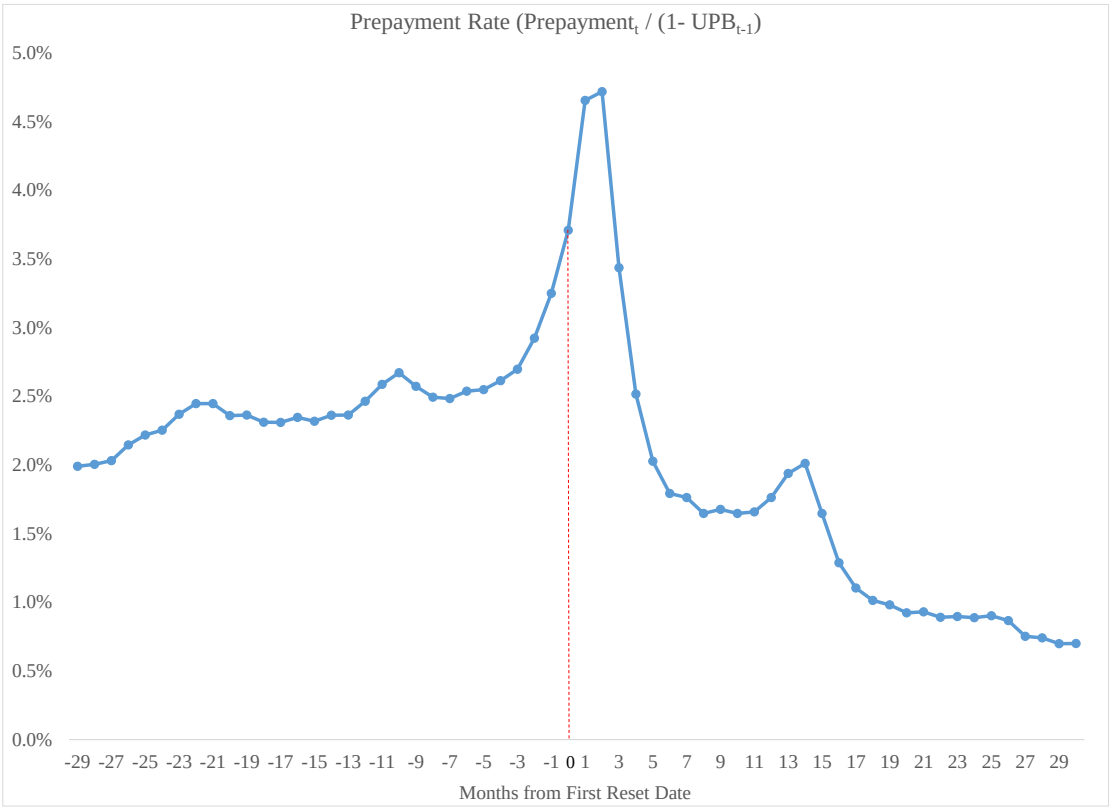


TABLE A.1 Impact of Deregulation on FRMs

	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.