A Online-only Appendix (Supplemental Material)

Private Information and Price Regulation in the US Credit Card Market

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This appendix first proves the consistency of my estimates of consumers' private types. I then, in sections A.2 through A.4, present additional institutional details and background, details about the datasets I use, and descriptive results. Sections A.5 through A.8 provide additional details and results related to the model and its estimation. Finally, in Sections A.9 through A.10 I elaborate more on details of the counterfactuals and my counterfactual estimates.

A.1 Estimation of Consumer Private Types

This appendix section proves the consistency of my estimates of consumers' private types.

Primitives and definitions. Let $\chi^{x,l}_{\text{iso}} : \mathbb{R}^+ \mapsto [\underline{\chi}^{x,l}, \overline{\chi}^{x,l}] \subseteq [0,1]$ denote estimates from the isotonic regression of default onto prices for lender l at credit score x. For each x, cover the set $\cup_l[\underline{\chi}^{x,l}, \overline{\chi}^{x,l}]$ using K segments with endpoints $\{\chi^x_{k-1}, \chi^x_k\}$ such that $\chi^x_0 = \min\left(\cup_l[\underline{\chi}^{x,l}, \overline{\chi}^{x,l}]\right)$, $\chi^x_K = \max\left(\cup_l[\underline{\chi}^{x,l}, \overline{\chi}^{x,l}]\right)$, and the endpoints χ^x_k for $k = 1 \dots K-1$ are defined recursively as,

$$\chi^x_k = \sup\left(\chi : \sum_{i\,:\,x_i = x} \mathbf{1}\{\chi^{x,l_i}_{\text{iso}}(p_i) \in [\chi^x_{k-1}, \chi)\}/N^x \;\leq \sum_{i\,:\,x_i=x} \frac{1}{K}\right) \tag{A.1}$$

where l_i and p_i denote the lender of, and the price paid by, borrower i respectively, and N^x denotes the number of borrowers for which $x_i = x$. At any credit score (public type) x, a borrower's estimated private type $\hat{\psi}_i$ is then,

$$\hat{\psi}_i(p_i) = k \;:\; \chi^{x,l_i}_{\text{iso}}(p_i) \in [\chi^x_{k-1}, \chi^x_k] \tag{A.2}$$

Whereas estimated private types are discrete, I allow true private types ψ_i to be continuously distributed. Suppose ψ_i has full support on an interval $[\underline{\psi}, \overline{\psi}]$ with probability mass function $\mu_x(\psi_i)$, while default probabilities $\chi(x_i, \psi_i)$, prices $p_{1l}(x_i, \psi_i)$, and the demand parameters of Section 4.1 are all continuous with respect to ψ_i at each x_i.

Suppress conditioning on x to ease notation. Using $\hat{\mathbb{E}}_S$ to write an empirical expectation over

observations in some set S, the estimated default rate of borrowers for whom $\hat{\psi}_i = k$ is then

$$\overline{\chi}_K(k) = \hat{\mathbb{E}}_{\{i\,:\,\hat{\psi}_i = k\}} \left[\chi^{l_i}_{\text{iso}}(p_i)\right] \tag{A.3}$$

Claim. The claim to be proved is that $\overline{\chi}_K(\hat{\psi}_i)$ is consistent for $\chi(\psi_i)$. Formally, with $N = MK$ denoting sample size and M being the number of observations in each interval of the partition defined in equation A.1, for each i and for any $\epsilon > 0$,

$$\lim_{K\to\infty} \lim_{M\to\infty} P\left(|\overline{\chi}_K(\hat{\psi}_i) - \chi(\psi_i)| > \epsilon\right) = 0 \tag{A.4}$$

Proof. For fixed K, define $D_K(i)$ as an indicator for whether borrower i's true default probability $\chi(\psi_i)$ lies in the interval $I_K(i)$ corresponding to i's estimated private type,

$$D_K(i) \equiv \mathbf{1}\{\chi(\psi_i) \in I_K(i)\} \qquad I_K(i) \equiv [\chi_{\hat{\psi}(p_{1l}(\psi_i))-1}, \chi_{\hat{\psi}(p_{1l}(\psi_i))}] \tag{A.5}$$

Then,

$$\begin{aligned} P\left(|\overline{\chi}_K(\hat{\psi}_i) - \chi(\psi_i)| > \epsilon\right) \leq\, & P\left(\left|\overline{\chi}_K(\hat{\psi}_i) - \chi(\psi_i)\right| > \epsilon \,|\, D_K(i) = 1\right) P\left(D_K(i) = 1\right) \\ & + P\left(D_K(i) = 0\right) \end{aligned} \tag{A.6}$$

Take the limit as $M \to \infty$. For any lender l, by assumption 4.8 and by the consistency of isotonic regression, isotonic fitted values converge (in probability) to true default probabilities,

$$\chi^l_{\text{iso}}(p_{1l}(\psi)) \xrightarrow{p} \chi(\psi) \tag{A.7}$$

Two applications of this convergence will be useful. First, noting that $\chi^l_{\text{iso}}(p_{1l}(\psi_i)) \in I_K(i)$ by monotonicity of $\chi^l_{\text{iso}}(\cdot)$ and by construction of the interval endpoints, it follows from expression A.7 that, for any $\tilde{\epsilon} > 0$,

$$\lim_{M\to\infty} P\left(\min_{d\in I_K(i)} |\chi(\psi_i) - d| > \tilde{\epsilon}\right) = 0 \tag{A.8}$$

which is to say, the distance between $\chi(\psi_i)$ and the nearest point of the interval $I_k(i)$ converges in probability to zero. Thus by definition of $D_K(i)$, we have $\lim_{M\to\infty} P\left(D_K(i) = 0\right) = 0$, and, taking the complement, $\lim_{M\to\infty} P\left(D_K(i) = 1\right) = 1$.

Having taken the limit as $M \to \infty$ for two of the terms in expression A.6, it then remains to show,

$$\lim_{K\to\infty} \lim_{M\to\infty} P\left(\left|\overline{\chi}_K(\hat{\psi}_i) - \chi(\psi_i)\right| > \epsilon \,|\, D_K(i) = 1\right) = 0 \tag{A.9}$$

Taking $M \to \infty$ and applying expression A.7 again, note that the endpoints of the interval $I_K(i)$ converge in probability to default probabilities at the $(k-1)^{\text{th}}$ and k^{th} quantiles q of the

type distribution $\mu(\psi)$,

$$\{\chi_{\hat{\psi}(p_{1l}(\psi_i))-1}, \chi_{\hat{\psi}(p_{1l}(\psi_i))}\} \xrightarrow{p} \{\chi(q_\psi^{(k-1)/K}), \chi(q_\psi^{k/K})\} \tag{A.10}$$

The difference in expression A.9 satisfies the following inequalities when $D_K(i) = 1$,

$$\begin{aligned}
\left|\overline{\chi}_K(\hat{\psi}_i) - \chi(\psi_i)\right| &\leq \left|\chi_{\hat{\psi}(p_{1l}(\psi_i))} - \chi_{\hat{\psi}(p_{1l}(\psi_i))-1}\right| \\
&= \left|\chi_{\hat{\psi}(p_{1l}(\psi_i))} + \chi(q_\psi^{(k-1)/K}) - \chi(q_\psi^{(k-1)/K})\right. \\
&\quad \left. + \chi(q_\psi^{k/K}) - \chi(q_\psi^{k/K}) - \chi_{\hat{\psi}(p_{1l}(\psi_i))-1}\right| \\
&\leq \left|\chi_{\hat{\psi}(p_{1l}(\psi_i))} - \chi(q_\psi^{k/K})\right| + \left|\chi(q_\psi^{(k-1)/K}) - \chi_{\hat{\psi}(p_{1l}(\psi_i))-1}\right| \\
&\quad + \left|\chi(q_\psi^{k/K}) - \chi(q_\psi^{(k-1)/K})\right|
\end{aligned} \tag{A.11}$$

where the first inequality results from both $\overline{\chi}_K(\hat{\psi}_i)$ and $\chi(\psi_i)$ being contained in the interval $[\chi_{\hat{\psi}(p_{1l}(\psi_i))-1}, \chi_{\hat{\psi}(p_{1l}(\psi_i))}]$ when $D_K(i) = 1$, and the final line follows from the triangle inequality. Hence,

$$\begin{aligned}
P\left(\left|\overline{\chi}_K(\hat{\psi}_i) - \chi(\psi_i)\right| > \epsilon \,|\, D_K(i) = 1\right) \leq\ & P\left(\left|\chi_{\hat{\psi}(p_{1l}(\psi_i))} - \chi(q_\psi^{k/K})\right| > \epsilon/3\right) \\
& + P\left(\left|\chi(q_\psi^{(k-1)/K}) - \chi_{\hat{\psi}(p_{1l}(\psi_i))-1}\right| > \epsilon/3\right) \\
& + P\left(\left|\chi(q_\psi^{k/K}) - \chi(q_\psi^{(k-1)/K})\right| > \epsilon/3\right)
\end{aligned} \tag{A.12}$$

Take the limit as $M \to \infty$ of the three probabilities on the right-hand side of the previous expression. Note that the third probability does not depend on M, and expression A.10 shows the first and second probabilities converge to zero. Hence it remains to show only,

$$\lim_{K\to\infty} P\left(\left|\chi(q_\psi^{k/K}) - \chi(q_\psi^{(k-1)/K})\right| > \epsilon/3\right) = 0 \tag{A.13}$$

Yet this result is straightforward: because ψ is continuously distributed with full support on $[\underline{\psi}, \overline{\psi}]$ and default probabilities are continuous in ψ, the distance between adjacent quantiles in A.13 can be made arbitrarily small by taking K sufficiently large.

A.2 Institutional Background

This appendix section reviews details of credit card pricing, credit card lenders' use of private information, and the CARD Act.

Credit card pricing is high-dimensional. Consumers may pay an annual fee for the privilege of holding a credit card, may pay varying interest rates on different balances (for example, the interest rate applied to a balance incurred from an ATM cash withdrawal is typically different from the interest rate applied to purchases), and may pay a number of fees that are triggered

by various behaviors with the card, for example late repayment or making transactions in excess of the card's credit limit. To tractably summarize these prices, I follow Consumer Financial Protection Bureau (2013a) and Agarwal et al. (2015b) and define the *fee-inclusive price of credit* as the ratio of monthly or quarterly fees and interest paid to the average daily balance over a month or quarter, in percentage points annualized. This is a one-dimensional price that is also the appropriate marginal price for a consumer to consider on the extensive margin of either borrowing or not.

Importantly, and consistently with this fee-inclusive price being the marginal price of *borrowing*, I exclude annual fees when calculating this price. An important question to consider therefore is whether this fee-inclusive price fully captures the marginal price of borrowing, or whether some consumers might be able to access a lower fee-inclusive price of borrowing by paying a higher annual fee. Such a two-part tariff to access a low-fee or low-rate loan, as in Benetton et al. (2021), would make various analyses of credit card pricing in this paper more difficult. I find, however, that these two-part tariffs are generally not present in the credit card market: the distribution of both interest rates and fee-inclusive prices on cards *with* annual fees first-order stochastically dominate the corresponding distributions on cards with no annual fee. In other words, while consumers may pay higher annual fees in order to access more generous transactional services on cards (e.g., more generous cash back rewards), annual fees do not offset borrowing costs. These distributions are reported in Appendix Table 2.

Prior to the CARD Act, lenders could use several of these price dimensions to respond to new information learned after origination. First, an account's interest rate, or annual percentage rate (APR), could change "at any time for any reason," according to stock language included in nearly all credit card contracts.[16] Roughly 52% of borrowers annually in pre-CARD-Act data experienced such a discretionary increase.[17] Credit card pricing also responded to borrower behavior through behavior-contingent fees, such as for late payments or over-limit transactions.[18]

The CARD Act placed strong restrictions on how credit card pricing responds to borrower behavior. First, discretionary increases in interest rates on outstanding balances were almost completely eliminated; the two major exceptions that lenders were allowed have, in practice, rarely been used.[19] Second, over-limit fees, which were one of the most common contingent

[16] Consumer Action (2007) provides examples of this stock language, which include "All terms, including the APRs and fees...may change based on information in your credit report, market conditions, business strategies, or for any reason", and "We have the right to change the rates, fees, and terms at any time, for any reason..."

[17] In addition to such discretionary interest rate increases, 36% of borrowers saw a promotional interest rate either be introduced or expire during the year. Promotional rates are especially common at the time of origination; prior to the CARD Act, 35% of originations included some kind of promotional rate, and among accounts used for borrowing, this share reached 71%.

[18] For an average account prior to the CARD Act, revenue from these fees was 32% as large as interest charges, and on subprime accounts it was 46% of interest charge revenue. All major categories of fees were contingent on one or more borrower behaviors revealed after origination, with the exception of annual fees, which made up less than 10% of all fee revenue in pre-CARD-Act data.

[19] These exceptions allow for the upward repricing of balances on accounts that are 60 or more days delinquent

fees prior to the CARD Act, were likewise almost completely eliminated.[20] Third, the other most prevalently used contingent fee, late fees, were effectively capped by a safe-harbor ceiling of $25 (or $39 for subsequent incidences within 6 months). On net, these restrictions strongly constrained lenders from adjusting prices in response to information revealed through borrower behavior over time but placed little to no restriction on the interest rate set at the time of origination. While the CARD Act contained other, non-price regulations as well, industry statements portray the restriction on interest rate increases as "the core, most important provision of the CARD Act" (American Bankers Association (2013)).[21]

These interest rate repricing restrictions and over-limit fee restrictions took effect in February 2010, and late fee restrictions took effect in August 2010.[22] The Act's legislative development also happened relatively quickly. In December 2008, as a precursor to the Act, the Federal Reserve issued a rule (originally scheduled to take effect in July 2010) that would have implemented a weaker version of the Act's interest rate repricing restrictions and fee restrictions; the CARD Act, introduced in Congress a month later in January 2009, superseded these restrictions and strengthened them to their present form; the Act was then passed and signed into law several months later in May 2009. The bulk of my analysis focuses on a pre-CARD-Act period from July 2008 through June 2009, and a post-CARD-Act period from July 2011 through June 2014.

A.3 Data Appendix and Additional Summary Statistics

A.3.1 CCDB Account-Level Dataset

The first dataset I use is the CFPB's Credit Card Database (CCDB), a near-universe of de-identified credit card account data in a monthly panel from 2008 to present. The data include all open credit card accounts held by 17 to 19 large and midsize credit card issuers (lenders) under the supervisory authority of either the OCC or the CFPB, which together cover roughly 90% of outstanding general-purpose US credit card balances. A total of 6 lenders enter or exit at some point in the sample period. Evidence on the data's coverage rate of overall industry balances is presented in Consumer Financial Protection Bureau (2013a). For each account in each month, the data contain totals of all aggregate quantities that would appear on a monthly account statement, including total purchases in dollars, amount borrowed and repaid, interest

or of newly transacted (rather than already outstanding) balances. Using the post-CARD-Act data in Figure 1 Panel (a), I show these exceptions are rarely used in practice.

[20] While in principle these fees are still permitted if borrowers opt-in to allow these fees, they have virtually disappeared from the market (see Appendix Figure 1).

[21] Besides these price restrictions, the CARD Act also included restrictions to make credit card contract terms more transparent for borrowers. Lenders were banned, for example, from changing borrowers' statement due dates from month to month, or from imposing a cutoff time on due dates that came before 5 PM. A full review of these and other restrictions is available in Consumer Financial Protection Bureau (2013a).

[22] A limited number of other provisions, including the requirement of earlier disclosure for account changes, took effect soon after the Act's passage, in mid-2009.

charges and fees by type of interest or fee, payment due dates, and delinquencies.

These data represent a modest superset of the credit card data used in Agarwal et al. (2015b) and Agarwal et al. (2018), including 9 to 10 additional midsize issuers that cover an additional 17% to 23% of outstanding balances. An advantage of using this superset is the inclusion of a more diverse set of firms, especially issuers with relatively concentrated market shares in important submarkets such as subprime or super-prime accounts.

For reasons of panel balance and data availability, I restrict my analysis to a subset of CCDB lenders that hold over 88% of all credit card balances observed in the CCDB in 2008-2009. This subset includes all of the issuers studied previously in Agarwal et al. (2015b) and several additional issuers, including a large issuer with relative specialization in prime lending. Given the presence of some smaller and regional issuers in this sample, I also pool data from the smallest issuers into a single "fringe" issuer, as in Somaini (2019), when estimating my model.

A.3.2 CCP Borrower-Level Dataset

The second database I use is the CFPB's Consumer Credit Panel (CCP), a large, randomly sampled panel of consumer credit reports showing all credit card accounts and other non-credit-card loans for a set of anonymized consumers over time. The non-credit-card-loans in these data include mortgages, auto loans, student loans, lines of credit, and installment loans held by a given consumer. The data also include non-loan items such as a measure of past loan applications, defaulted debts in collection, and public records such as bankruptcies.

The panel is a 1-in-48 random sample, drawn from one of the three nationwide consumer credit reporting agencies. This panel is observed quarterly beginning in 2004. The CCP therefore has the advantages of showing a large representative sample of consumers, following these consumers over a longer time frame than is available in the CCDB, and reporting all credit card and non-credit-card accounts for a given consumer. Additionally, the CCP makes it possible to study borrower entry and exit, as the dataset includes individuals not holding credit cards at any given point in time. Neither accounts nor account-holders can be linked between the CCDB and CCP.

A.3.3 Additional Summary Statistics

This section first describes Appendix Table 1 in greater detail than in the main body. In Panels (a) and (b), each column corresponds to a statistic of credit card pricing, and each row highlights a different market segment. The statistics presented are changes from pre-CARD-Act data (2008Q3 through 2009Q2) to post-CARD-Act data (2011Q3 through 2014Q2). In the table, I

illustrate how the distributions effective interest rates[23] and fee-inclusive borrowing[24] costs both compressed after the Act. There is an interesting pattern in the table where price dispersion actually rises for the very highest credit scores; one possible explanation for this is the post-CARD-Act proliferation in lucrative rewards cards that also tend to have relatively high interest rates (Gray, 2017), which consumers might plausibly only use for borrowing after a particularly adverse shock.

The remaining results in this section largely echo earlier findings from Agarwal et al. (2015b) and other work. They are included here for completeness. In Appendix Figure 1, I show the effects of the Act on two other price dimensions that the Act regulated most directly: over-limit fees and late fees. Over-limit fees affected roughly 7% of accounts in an average *month* prior to the CARD Act, and then fell sharply to nearly zero when the Act's over-limit fee restrictions went into effect. In Panel (b), I show the drop in total late fee revenue at the time the Act's late fee restrictions took effect, a decrease of roughly 40%. Meanwhile, in Appendix Table 3, I show various statistics of credit card pricing in the pre-CARD-Act equilibrium. Consistent with the evidence from the mid-2000s presented in Stango and Zinman (2015), there is substantial price dispersion in both interest charges and fee-inclusive borrowing costs across and within FICO score groups. Furthermore, the prevalence of borrowing is quite high among active accounts: 96% of credit card accounts with subprime FICO scores of 620-639 are used for borrowing at least three months of the year, and even among prime (resp. super-prime) accounts in the 720-739 (resp. 780+), the prevalence of borrowing at least three months of the year is 67% (resp. 42%). As documented previously in Agarwal et al. (2015b), both for interest charges and fee-inclusive borrowing costs there is a notable price gradient with respect to risk, where prices decrease sharply as FICO scores become higher (safer).

A.4 Further Results on the Pricing of FICO Score Changes

This appendix section further discusses and presents robustness results for section 3.2. First, I further discuss specification 3.2. This specification is equivalent to a long-differences specification in price and risk (without controls for origination risk) if the error terms $e_{i,0}$ and $\epsilon_{i,t}$ are independent. The long-differences specification cannot be estimated directly, as $r_{i,0}$ is typically unobserved in the data for accounts originated prior to 2008.

Results are robust to a short-differences specification where the one-quarter difference in $r_{i,t}$ is regressed on the one-quarter difference in $\text{FICO}_{i,t}$, again with the same controls for origination cohort. The results of this specification are presented in Appendix Figure 7.

[23] The effective interest rates presented here are calculated by dividing total interest charges by the average amount borrowed and then annualizing. Because several APRs may be in effect on an account at any given time, for example, a promotional and a standard purchase APR, this measure of effective interest provides the arguably most representative average of these different APRs.

[24] This measure is defined in Appendix Section A.2.

It is notable that the the first-difference specification for $r_{i,t}$ shows a nearly perfectly flat slope in the post-CARD-Act period. This emphasizes how rarely-used in practice were the few exceptions that the CARD Act allowed for account repricing, as discussed in Appendix Section A.2. This also suggests that the modestly non-zero slope in post-CARD-Act emergent-risk pricing in Figure 2 Panel (b) is more likely related to compositional changes – differential attrition as a function of pricing at origination – rather than active repricing in the post-CARD-Act period.

In Appendix Figure 5, I return to the baseline specification and provide an alternative version of Figure 2 that emphasizes the dispersion around the mean in each plot. Note that these upper- and lower-borderlines do not denote confidence intervals for the mean, but rather standard deviations of the population around the mean. In the third panel, because the outcome is binary I report the dispersion in its mean over time. The R-squared of the regressions in equations 3.1 and 3.2 is respectively 26.1% and 6.4%.

A.5 Consumer Choice Probabilities

This appendix section provides further examples of closed-form expressions of consumer choice probabilities using the preferences summarized in Table 2. I use the choice-probability notation $\sigma(l, b, p_l|s, \bar{p})$ developed in section 4.1.3.

The probability of a type-θ consumer choosing to borrow on a mature account with lender l, after holding an account from the same l in the past period and borrowing on that account, is,

$$\sigma(\underbrace{l, \text{debt}}_{=a}, p_l | \underbrace{\theta, l, \text{debt}}_{=s}, \bar{p}) = \frac{\exp\left(\delta_{\theta l} + \xi_{\theta l} - \gamma_\theta p_{1l}(\theta) + \beta \mathbb{E}_\theta \left[V(\tilde{s}) \mid a, s\right]\right)}{\sum_{\hat{a}} \exp\left(u(\hat{a}, s) + \beta \mathbb{E}_\theta \left[V(\tilde{s}) \mid \hat{a}, s\right]\right)} \tag{A.14}$$

The same consumer's probability of instead switching to non-borrowing with lender l is,

$$\sigma(\underbrace{l, \text{no debt}}_{=a}, p_l | \underbrace{\theta, l, \text{debt}}_{=s}, \bar{p}) = \frac{\exp\left(\xi_{\theta l} - \lambda_{\theta l} + \beta \mathbb{E}_\theta \left[V(\tilde{s}) \mid a, s\right]\right)}{\sum_{\hat{a}} \exp\left(u(\hat{a}, s) + \beta \mathbb{E}_\theta \left[V(\tilde{s}) \mid \hat{a}, s\right]\right)} \tag{A.15}$$

On the other hand, if the same consumer had been a non-borrower the prior period, her probability of continuing to be a non-borrowing with lender l is,

$$\sigma(\underbrace{l, \text{no debt}}_{=a}, p_l | \underbrace{\theta, l, \text{no debt}}_{=s}, \bar{p}) = \frac{\exp\left(\xi_{\theta l} + \beta \mathbb{E}_\theta \left[V(\tilde{s}) \mid a, s\right]\right)}{\sum_{\hat{a}} \exp\left(u(\hat{a}, s) + \beta \mathbb{E}_\theta \left[V(\tilde{s}) \mid \hat{a}, s\right]\right)} \tag{A.16}$$

Furthermore, a consumer's probability of opening a new account with lender l and borrowing on that account, after having held no credit card in the past period, is,

$$\sigma(\underbrace{l, \text{debt}}_{=a}, p_l | \underbrace{\theta, 0, \text{no debt}}_{=s}, \bar{p}) = \frac{\exp\left(\delta_{\theta l} + \xi_{\theta l} - \kappa_{\theta l} - \gamma_\theta p_{1l}(\theta) + \beta \mathbb{E}_\theta \left[V(\tilde{s}) \mid a, s\right]\right)}{\sum_{\hat{a}} \exp\left(u(\hat{a}, s) + \beta \mathbb{E}_\theta \left[V(\tilde{s}) \mid \hat{a}, s\right]\right)} \tag{A.17}$$

A.6 Borrower Price Sensitivities

This appendix section provides additional detail supporting the discussion in main body section 4.2.2.

First, I describe the retention rates that are plotted in Figure 5. I calculate lender-by-consumer-type-specific probabilities of existing borrowers continuing to borrow with the same lender; these are the choice probabilities denoted $\sigma(l, \text{debt}, p_l|\theta, l, \text{debt}, \bar{p})$ in section 4.1.3, but here I write just $\sigma_{ld\theta}$ for ease of notation. I then estimate the event-study specification,

$$\log\sigma_{ld\theta} = \alpha_{\theta l} + \sum_{\tau \neq 0} \alpha_\tau \times \mathbf{1}_{t==\tau} + \sum_{\tau \neq 0} \alpha_{A,\tau} \times \mathbf{1}_{t==\tau} + \beta_l t + \epsilon_{j\theta t} \tag{A.18}$$

where τ is event time, where $\alpha_{A,\tau}$ denotes Bank-A-specific fixed effects, and where notation is otherwise as defined in section 4.2.2. The log-retention rates plotted in the right panel of Figure 5 are then the estimated α_τ and $\alpha_{A,\tau}$ fixed effects.

Second, using this event-study specification, I can also test formally for parallel pre-trends prior to the repricing experiment. I test the joint nulls that $\alpha_\tau = \alpha_{A,\tau}$ for all τ in three different sets: in $\{-1\}$; in $\{-1, -2\}$; and in $\{-1, -2, -3\}$. The F-statistic p-values for these three increasingly inclusive joint tests are respectively 0.205, 0.386, and 0.478, all supporting the parallel trends identifying assumption.

Third, I further describe section 4.2.2's comparison between 2SLS-estimated and CRRA-implied price coefficients. Note that when I estimate equations 4.18 and 4.19 at levels of heterogeneity coarser than full types θ – for example, when I estimate a single γ in Table 4, or in the present exercise where I estimate γ_x at the level of credit scores (public types) x – I both restrict the heterogeneity in γ in equation 4.19 and also likewise coarsen the heterogeneity of the instrument interaction terms $\mathbf{1}_\theta$ in equation 4.18, so that the model remains just-identified. This avoids weakening the instruments by adding unnecessary interaction terms (Bound et al., 1995). Estimates of γ_x from this specification are plotted across credit scores (public types) x in the red line in Appendix Figure 3.

To benchmark whether these estimates are consistent with other reasonable models of consumer preferences, I solve for values of γ_x that would be implied by data on average incomes at each credit score, by average credit card balances at each credit score, and by either constant relative risk aversion or constant absolute risk aversion. Specifically, I use average incomes across credit scores as reported in Albanesi et al. (2017), and, for given risk preferences, I calculate CRRA and CARA consumers' marginal utility of (dollar) income at each x. I then use average credit card balances that I estimate in the pre-CARD-Act period to translate these marginal utilities of (dollar) income into price coefficients γ_x; recall that prices $p_{1l}(\theta)$ in the consumer's problem are defined relative to balances (see Appendix Section A.2) so are not in dollar units directly. In Appendix Figure 3, I show the resulting values of γ_x for a constant coefficient of

relative risk aversion of 3 in the dotted blue line, and for a constant coefficient of absolute risk aversion of = 0.00007.

As can be seen in the figure, with CRRA= 3 the two price coefficient series are quite closely comparable, as is the case with CARA= 0.00007. In unreported results, I find that CRRA= 4 would imply a steeper slope of γ_x with respect to credit score than I estimate via 2SLS, whereas CRRA= 2 would imply a shallower slope than I estimate. Similarly, changes in absolute risk aversion of to either 0.00009 or 0.00005 result in clearly worse fit.

Fourth, I present an additional validation of my instrumental variables strategy, where I ask whether credit card borrowers at the lender highlighted in Figure 5, Bank A, are sufficiently comparable to other lenders' credit card borrowers that it is reasonable to use Bank A's repricing campaign to estimate borrowers' price sensitivity more broadly. Evidence in Appendix Table 4 suggests this is the case: within types θ, across lenders, Bank A's borrowers are statistically indistinguishable from other borrowers in terms of their average account age, balance, credit line utilization, and subsequent charge-off rate. I do find differences in terms of these borrowers' credit score at origination, though credit scores are the same across lenders within θ types (by construction) by the time of the repricing event.

A.7 Price Invariance of Default

This appendix section uses the same price variation presented in section 4.2.2 to test whether loan default responds to loan price. While there is of course *some* magnitude of price increase at which any consumer would become unable to pay their outstanding debt, the range of price variation typically seen in the credit card market translates to modest changes in debt service costs, as argued in section 4.1.2 of the main body text. So, it remains an empirical question whether these changes have economically significant effects on default.

In Appendix Figure 12, I present graphical evidence on this question, in a format similar to Figure 5. Recall that the vertical dashed line shows the timing of Bank A's portfolio-wide repricing. As I show in the figure, subsequent to this price increase, Bank A's default rates are broadly unchanged and remain on-trend with their trajectory before the repricing event.

To formalize this analysis, I estimate versions of the 2SLS model in equations 4.18 and 4.19 from the main body, where now the dependent variable is an indicator for either loan default or loan-charge-off. Results are presented in Appendix Table 7. The first column of the table corresponds to Appendix Figure 12. Estimates of the price-effect of default in all specifications are in fact slightly negative, and in the richest, most-precisely estimated model (column 4, which includes lender-specific linear trends), I can reject subsequent charge-off increases of more than 0.04 percentage points at the 10% level.

Granted, this evidence is specific to a particular context, and further research on the price-elasticity of credit card default will be valuable to further explore and test these findings.

A.8 Multihoming and Intensive-Margin Borrowing

This section argues why two modeling choices highlighted in Section 4.1.1 – that consumers single-home over lenders and choose extensive rather than intensive-margin borrowing – do not depart much from realism in the credit card market.

I consider single-homing first. Using CCP data, I find that a large majority of consumers hold only one "primary" credit card, where primary is defined as carrying the majority of a consumer's credit card balances. Depending on FICO score, this share ranges from at least 80% to over 90%. Hence a single-homing model can in many respects be thought of as a model of a consumer's choice of primary card. Additionally, a majority of deep subprime consumers and a large minority of prime consumers indeed hold only one credit card in CCP data.

With regard to intensive-margin borrowing, there is a variety of evidence that firms compete more on the extensive margin using price, and then use credit limits as their preferred instrument on the intensive margin (Trench et al. (2003), Agarwal et al. (2018)). In fact, many credit limits are not disclosed until after a borrower has made the extensive margin choice of whether to open a credit card or not, whereas prices are advertised heavily to consumers considering a new card. Incorporating the intensive margin in the model would therefore require including both prices and credit limits, which would obscure the focus of the model and expand the firms' strategy space to the point of intractability. Finally, the estimates in Agarwal et al. (2015b) suggest that the effect of the CARD Act on credit limits and account balances is nearly zero, which provides further support for abstracting from the intensive margin in this setting.

A.9 Counterfactual Details

This section formally defines the terms $\Pi_{1l,\text{post}}$ and $\Pi_{0l,\text{post}}$ used in expression 5.1. In the below I use "d" as shorthand for "debt," "n" as shorthand for "no debt," and "p" (not italicized) as shorthand for "post." Note also that the state $s = (\theta, l, x_0, b)$ now depends on x_0. Otherwise, these expressions are straightforward to compare with expressions 4.9 and 4.12 in the text.

$$\begin{aligned}\Pi_{1l,\text{p}}(p_{l,\text{p}}, s \mid \bar{p}_\text{p}) = &\underbrace{(p_{1l,\text{p}}(x_0) - c_{1l}(\theta))}_{\text{flow profit}} \\ &+ \sigma(l, \text{d}, p_{l,\text{p}}|s, \bar{p}_\text{p}) \underbrace{\beta(1-\chi(\theta))T_{\theta\theta'}(\theta)\Pi_{1l,\text{p}}(p_{l,\text{p}}, \theta', l, x_0, \text{d} \mid \bar{p}_\text{p})}_{\text{expected continuation profit} \mid \text{borrow}} \\ &+ \sigma(l, \text{n}, p_{l,\text{p}}|s, \bar{p}_\text{p}) \underbrace{\beta T_{\theta\theta'}(\theta)\Pi_{1l,\text{p}}(p_{l,\text{p}}, \theta', l, x_0, \text{n} \mid \bar{p}_\text{p})}_{\text{expected continuation profit} \mid \text{not borrow}}\end{aligned} \tag{A.19}$$

and

$$\Pi_{0l,\mathrm{p}}(p_{l,\mathrm{p}}, x_0 \mid \bar{p}_{\mathrm{p}}) = \sum_{\tilde{s} \in S(x_0)} \Bigg[\mu_{\tilde{s}} \sigma(l, \mathrm{d}, p_{l,\mathrm{p}} | \tilde{s}, \bar{p}_{\mathrm{p}}) \underbrace{(p_{0l,\mathrm{p}}(x_0) - c_{0l}(x_0))}_{\text{flow profit}} + \mu_{\tilde{s}} \sigma(l, \mathrm{d}, p_{l,\mathrm{p}} | \tilde{s}, \bar{p}_{\mathrm{p}}) \underbrace{\beta(1 - \chi(\theta(\tilde{s}))) T_{\theta\theta'}(\theta) \Pi_{1l,\mathrm{p}}(p_{l,\mathrm{p}}, \theta', l, x_0, \mathrm{d} \mid \bar{p}_{\mathrm{p}})}_{\text{expected continuation profit | borrow}} + \mu_{\tilde{s}} \sigma(l, \mathrm{n}, p_{l,\mathrm{p}} | \tilde{s}, \bar{p}_{\mathrm{p}}) \underbrace{\beta T_{\theta\theta'}(\theta(\tilde{s})) \Pi_{1l,\mathrm{p}}(p_{l,\mathrm{p}}, \theta', l, x_0, \mathrm{n} \mid \bar{p}_{\mathrm{p}})}_{\text{expected continuation profit | not borrow}} \Bigg] \tag{A.20}$$

A.10 Model Validation

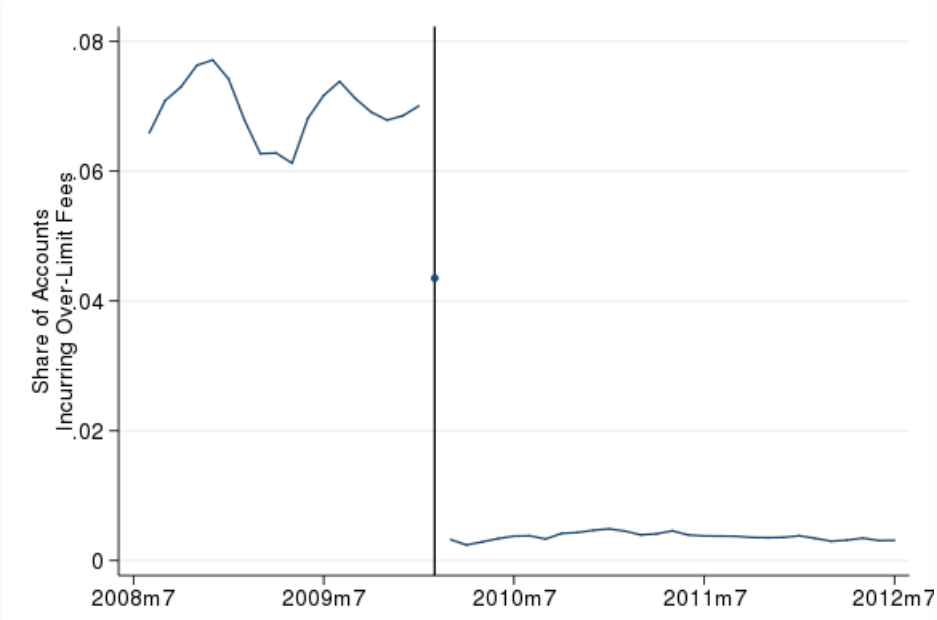
This section helps confirm the reasonableness of the model's estimated price changes by comparing them with other benchmarks. First, the changes in traded prices in Appendix Figure 4 are similar to, albeit higher than, the difference-in-difference estimates of traded price changes in Agarwal et al. (2015b) (see, e.g., their Table VI). Moreover, there are three reasons that likely account for the gap between my estimates and theirs. The first is mechanical: their estimates are balance-weighted and mine weight all borrowers equally. Higher pricing consistently correlates with lower balances, and a back-of-the-envelope exercise using average balances carried by each consumer type suggests that balance-weighting shrinks the gap between Appendix Figure 4 and Agarwal et al. (2015b) by more than half. A second difference between the two papers is similarly mechanical: Agarwal et al. (2015b) include accounts that were originated prior to the CARD Act when estimating price effects after the Act, and these pre-CARD-Act accounts' pricing could reflect interest rate increases that were imposed before the Act took effect. The two papers thus estimate the Act's effects at arguably different horizons, with my analysis focusing on a more long-run effect. The third potential explanation for these differences is that the the two papers hold different factors constant. I estimate the effect of only the CARD Act pricing restrictions, and my exercise holds constant the demand and cost primitives of the pre-CARD-Act period; in contrast Agarwal et al. (2015b) estimate the effect of the Act as a whole in conjunction with other cost shocks to lenders in the pre-CARD-Act environment. As Agarwal et al. (2015b) argue (see also Consumer Financial Protection Bureau (2013a)), the non-price aspects of the CARD Act improved several other features of credit card quality, and thus likely pushed borrowing demand outward; at the same time the Act coincided with other important adverse cost shocks to credit card lenders (Tian and Zhang, 2016). Overall, these outward shifts in both cost and demand that my estimation strategy controls for may be plausible explanations for the remaining differences in the estimates.

A second validation of the strategy is the model's ability to replicate the key economic forces

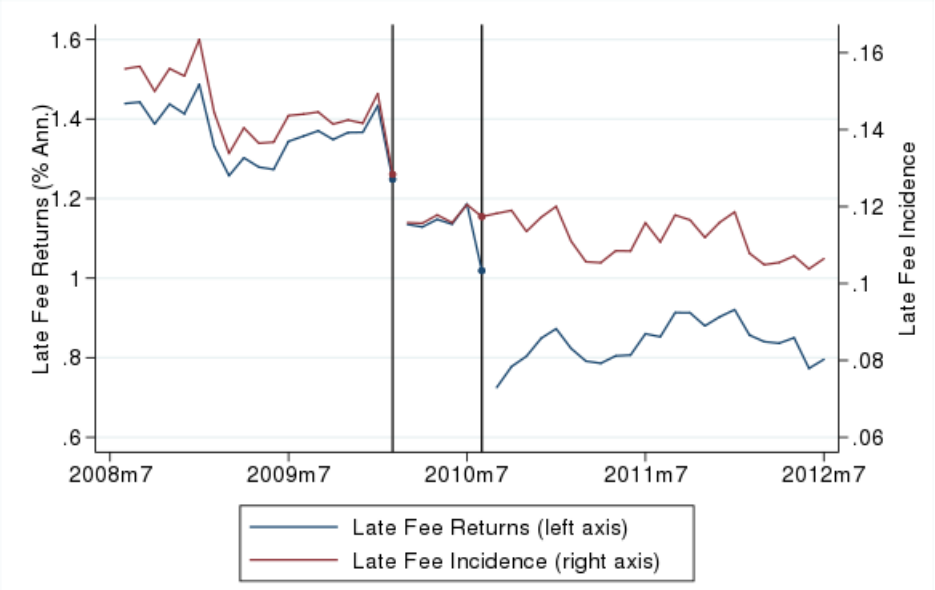
shown earlier in my descriptive evidence. I include one such exercise in Appendix Figure 11, where I create model-implied versions of the graphical evidence from section 3.2 that showed how the Act changed the pricing of emergent risk relative to origination risk. In the appendix figure, I show the model captures these economic forces quite closely.

A.11 Appendix Figures and Tables

(a) Over-Limit Fees

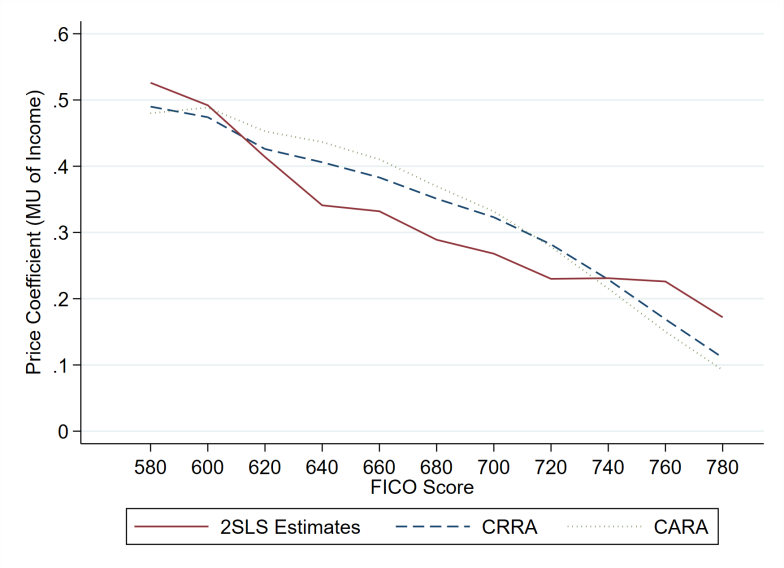


(b) Late Payment Fees



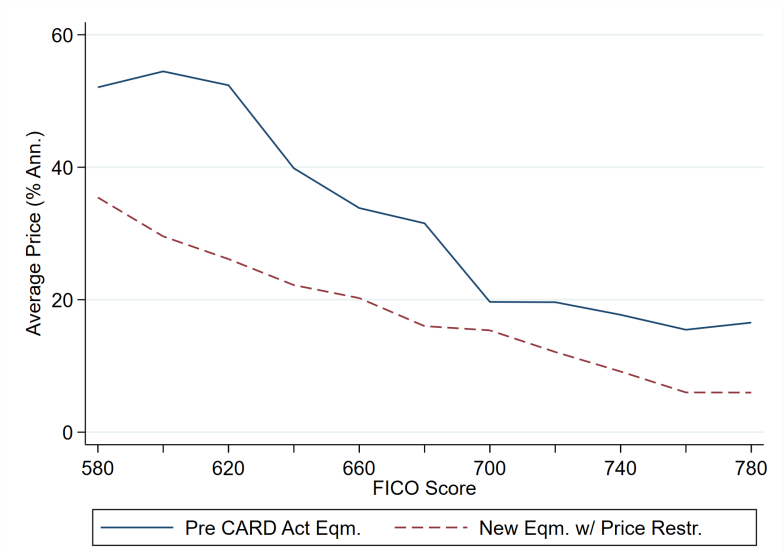
Appendix Figure 1 – CARD Act Effects on Penalty Fees

Notes: Panel (a) shows the monthly incidence of over-limit fees on current borrowers. The implementation date of the CARD Act's over-limit fee restrictions in February 2010 is marked by the vertical black line. Panel (b) shows annualized lender returns from late fees relative to total outstanding balances on borrowing accounts (left axis) and the average incidence of late fees across accounts (right axis). The vertical black lines show the CARD Act's implementation dates for restrictions on interest-rate increases and over-limit fees in February 2010 and for restrictions on late fee amounts in August 2010.



Appendix Figure 3 – 2SLS Estimates and Simulated Price Coefficients

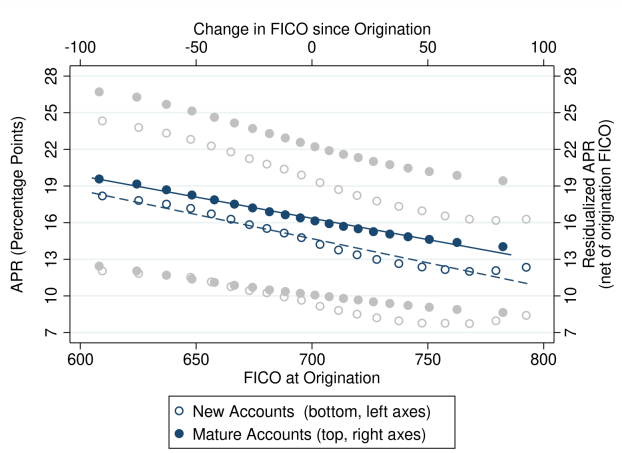
Notes: The figure shows 2SLS-estimated price coefficients γ across FICO Scores and compares them with price coefficients that would be estimated by standard parameterizations of CRRA and CARA preferences, using data on average credit card balances and incomes by credit score. Further details are presented in Section A.6.



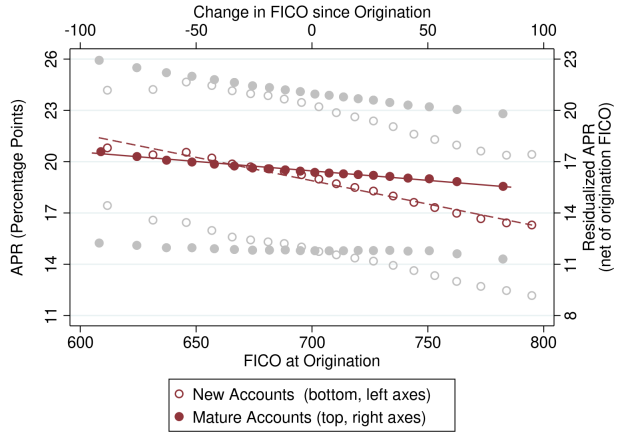
Appendix Figure 4 – Changes in Traded Prices

Notes: The figure shows average traded contract prices in the observed pre-CARD-Act equilibrium and in the estimated equilibrium with CARD Act price restrictions. Traded prices are averages of the actual prices paid at each FICO score among all consumers with that FICO score who choose to borrow. FICO scores across the x-axis refer to consumers' contemporaneous scores rather than scores at the time of contract origination, so traded prices at each credit score include prices retained from some contracts originated at other scores in earlier periods. Prices shown are individual-weighted averages across private types and across lenders; see Section 5.3 for a discussion of individual-weighted versus balance-weighted prices.

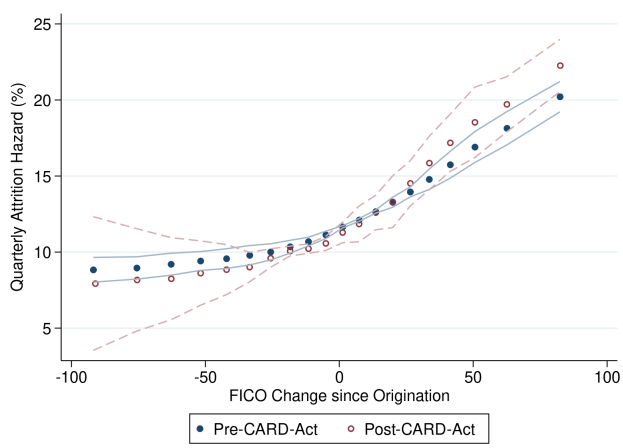
(a) Pre-CARD-Act



(b) Post-CARD-Act



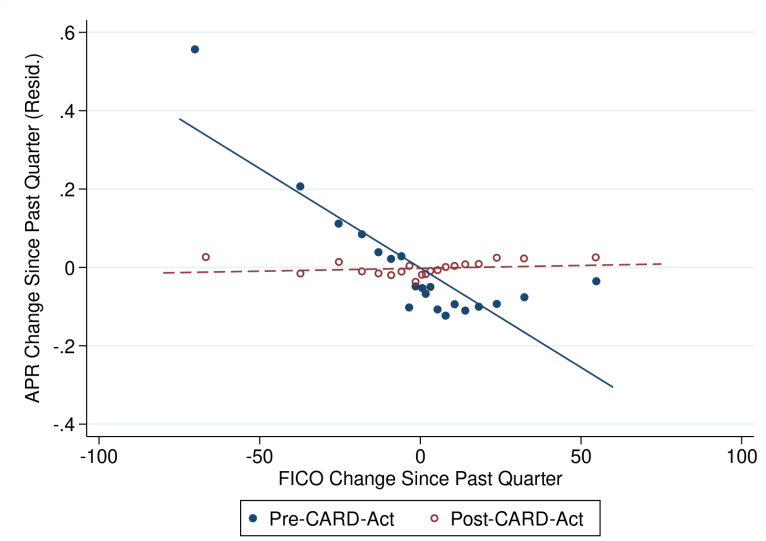
(c) Adverse Retention



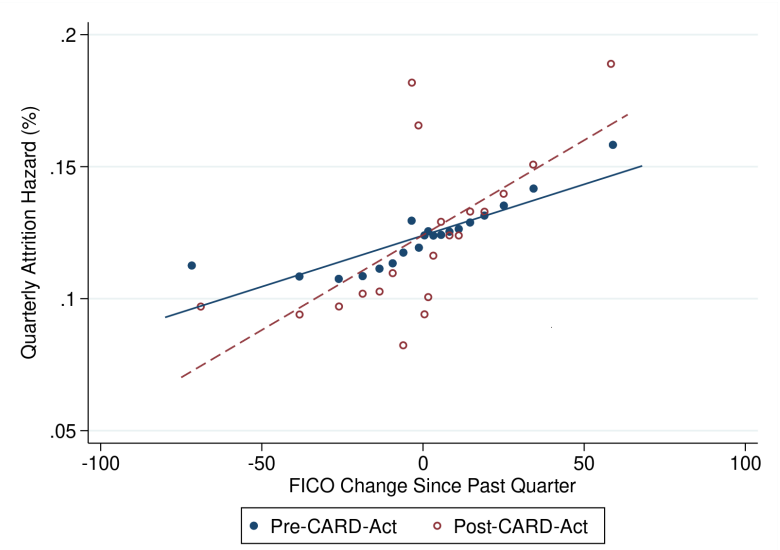
Appendix Figure 5 – Pricing of Origination Risk and Emergent Risk

Notes: These figures repeat those in Figure 2 including upper- and lower-boundary lines that show one-standard-deviation ranges of the y-axis variables. In Panel (c), the reported standard deviations are calculated from time-series variation in the mean.

(a) Pricing of Emergent Risk



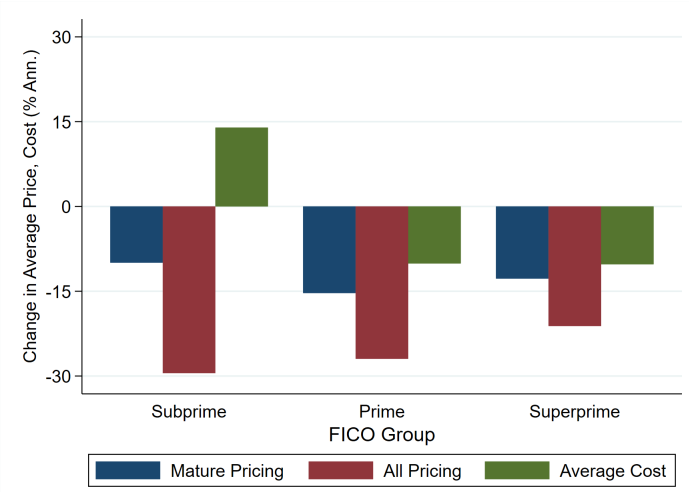
(b) Adverse Retention



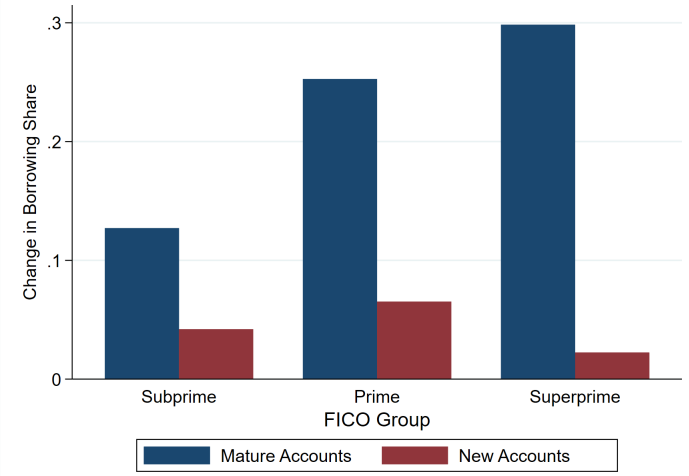
Appendix Figure 7 – First-Difference Pricing of Emergent Risk

Notes: Panel (a) shows gradients of emergent risk analogous analogous to those in Figure 6a and 6b for pre- and post-CARD-Act data using a first-differences specification instead of those in equations 3.1 and 3.2. Panel (b) shows attrition hazards as a function of first-differences in FICO score, analogous to Figure 6b. Appendix Section A.4 provides further discussion of these first-difference specifications.

(a) Pricing and Average Costs

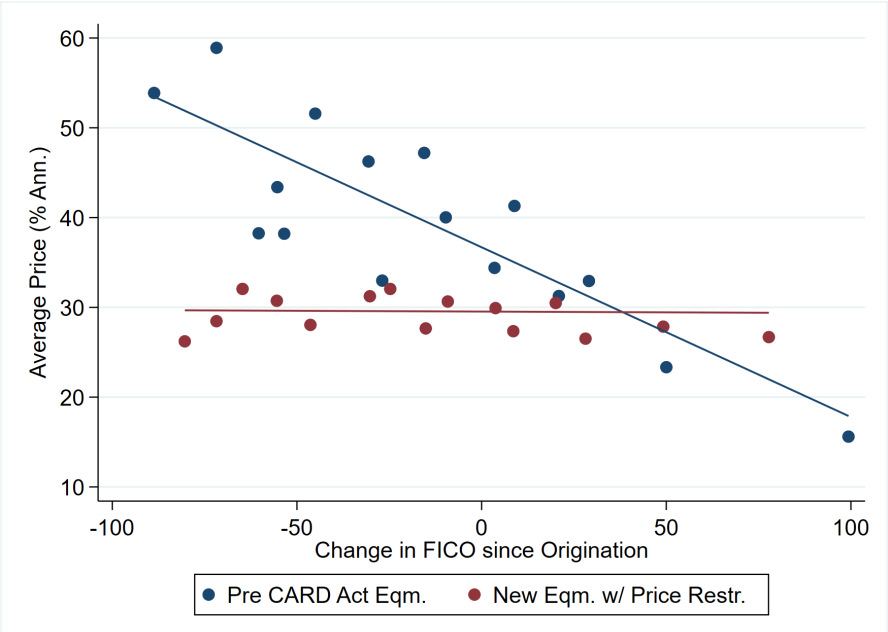


(b) Borrowing Behavior



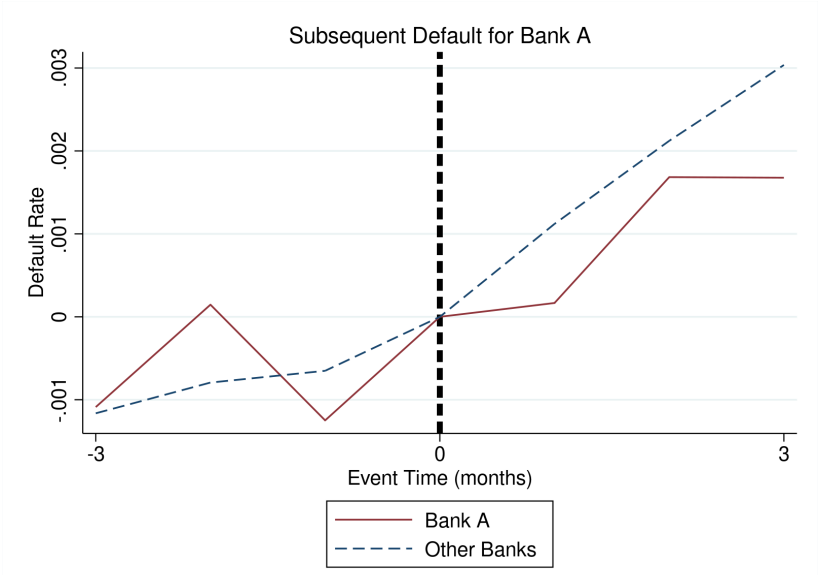
Appendix Figure 9 – Changes in Pricing, Average Costs, and Borrowing Behavior

Notes: Panel (a) shows estimated changes in average mature-account pricing, all-account pricing, and average costs across accounts used for borrowing, from the pre-CARD-Act equilibrium to the new equilibrium found in the model after imposing the CARD Act price restrictions. All-account pricing is a weighted average of mature-account prices and new-account prices. Average cost is the average of marginal costs among borrowing accounts. Panel (b) shows estimated changes in the share of consumers borrowing on credit cards on either mature accounts or new accounts, again from the pre-CARD-Act equilibrium to the new equilibrium found in the model after imposing the CARD Act price restrictions. Subprime refers to accounts with FICO scores below 660; prime refers to accounts with FICO scores of 660 or above but below 720; superprime refers to accounts with FICO scores of 720 and above.



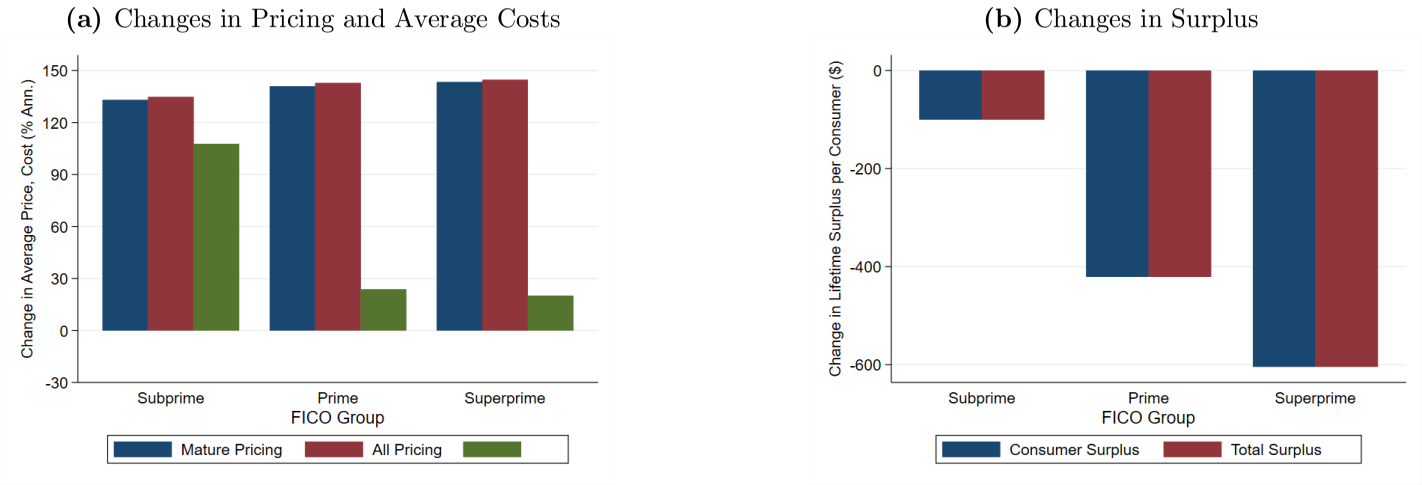
Appendix Figure 11 – Model-Simulated Pricing of Emergent Risk

Notes: The figure shows model counterparts of the FICO-score changes and pricing changes shown for actual pre- and post-CARD-Act data in Figure 2. The distribution of FICO score changes and price changes since origination are calculated from the stationary distribution of consumers across contracts and lenders in the pre- and post-CARD-Act equilibria in the model at the estimated model parameter values.

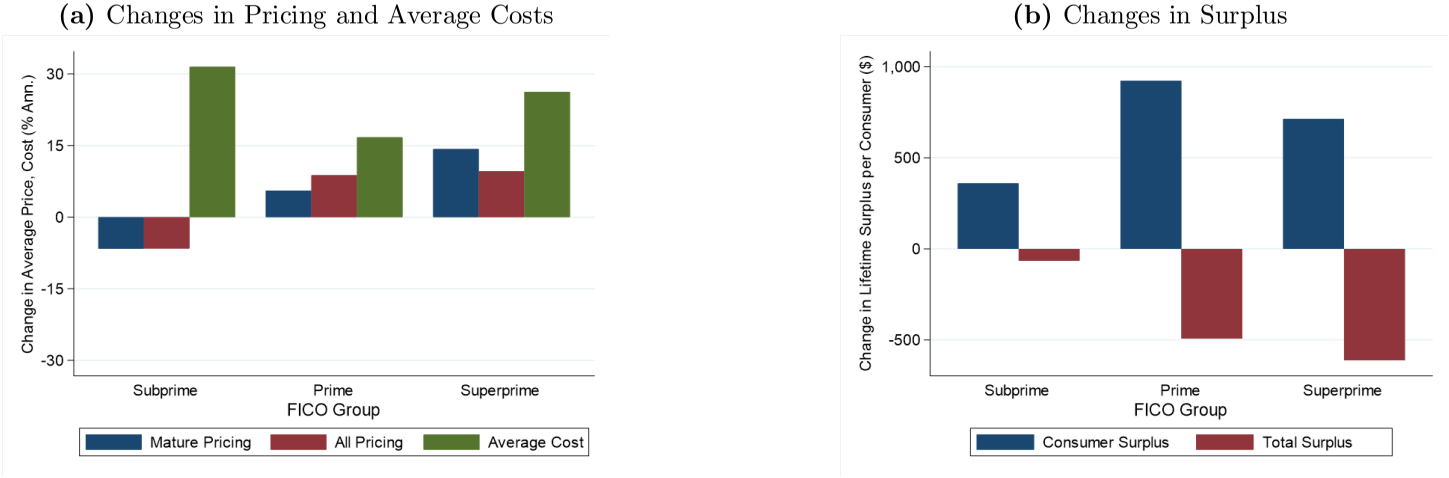


Appendix Figure 12 – Price Invariance of Default

Notes: The figure presents an analogous analysis to that in the right-side panel of Figure 5, here with loan default as the outcome. Specifically, the estimates in the right panel of the figure are the α_τ and $\alpha_{A,\tau}$ taken from the regression $\mathbf{1}_{\text{default}} = \alpha_{\theta l} + \sum_{\tau \neq 0} \alpha_\tau \times \mathbf{1}_{t==\tau} + \sum_{\tau \neq 0} \alpha_{A,\tau} \times \mathbf{1}_{t==\tau} + \epsilon_{j\theta t}$ This analysis is further discussed in Appendix Section A.7.

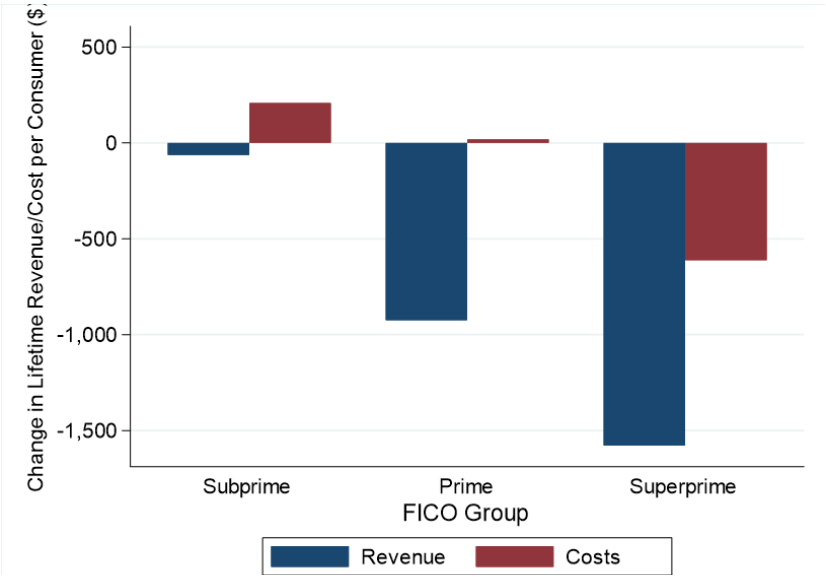


Appendix Figure 13 – Counterfactual with Zero Pre-CARD-Act Markups



Appendix Figure 14 – Counterfactual with Reduced Pre-CARD-Act Markups

Notes: The above two figures show, in the right panels, counterfactual versions of Figure 7a, and in the left panels, counterfactual versions of Appendix Figure 9. These counterfactual scenarios reflect two ways of decreasing ex-ante markups in the pre-CARD-Act equilibrium, as described in the text.



Appendix Figure 15 – Decomposition of Profit Changes

Notes: This figure decomposes the changes in profits plotted (as the difference between changes in consumer and total surplus) in Figure 7. The decomposition is into changes in revenue and changes in costs. The costs in this figure are distinct from the average costs plotted in prior figures, as these are a present value of expected costs over account lifetimes rather than an average of per-period costs.

Panel A: Changes in Interest Charges (% Ann.)					
FICO	P10	P25	Mean	P75	P90
580 - 599	2.46	-0.03	-2.52	-4.62	-2.83
600 - 619	2.16	0.89	-1.54	-4.32	-2.28
620 - 639	2.66	1.70	-0.75	-3.66	-1.91
640 - 659	3.03	2.49	0.12	-2.69	-2.11
660 - 679	3.01	2.95	0.88	-1.06	-2.15
680 - 699	2.67	3.15	1.38	0.05	-1.50
700 - 719	1.44	3.22	1.59	0.99	-0.49
720 - 739	0.44	3.18	1.56	1.33	0.44
740 - 759	-0.99	2.68	1.45	1.44	0.28
760 - 779	-2.55	1.91	1.07	1.44	-0.04
780 - 799	-2.54	-0.02	0.82	1.41	1.07

Panel B: Changes in Fee-Inclusive Charges (% Ann.)					
FICO	P10	P25	Mean	P75	P90
580 - 599	3.14	-0.06	-6.10	-7.39	-10.60
600 - 619	2.27	0.83	-3.43	-5.61	-6.31
620 - 639	2.76	1.64	-2.22	-4.87	-4.71
640 - 659	3.21	2.50	-0.90	-3.41	-3.49
660 - 679	3.14	3.04	0.20	-1.70	-2.86
680 - 699	2.78	3.25	0.90	-0.23	-2.37
700 - 719	1.50	3.23	1.25	0.36	-1.32
720 - 739	0.63	3.27	1.31	1.20	-0.35
740 - 759	-0.88	2.73	1.25	1.24	0.06
760 - 779	-2.35	1.97	0.88	1.30	-0.23
780 - 799	-2.74	0.10	0.68	1.42	0.76

Panel C: Changes in Borrowing and Credit Card Holding					
	Borrowing Share		Credit Card Holding Share		
FICO	Pre-	Post-	Pre-	Post-	% Chg.
580 - 599	0.93	0.91	0.36	0.26	-39.28
600 - 619	0.90	0.88	0.71	0.60	-17.55
620 - 639	0.89	0.87	0.81	0.74	-9.82
640 - 659	0.88	0.86	0.84	0.80	-5.25
660 - 679	0.86	0.84	0.85	0.83	-2.83
680 - 699	0.82	0.82	0.87	0.83	-4.80
700 - 719	0.78	0.78	0.87	0.85	-2.11
720 - 739	0.73	0.72	0.89	0.86	-3.04
740 - 759	0.67	0.65	0.89	0.87	-1.88
760 - 779	0.57	0.56	0.88	0.90	2.13
780 - 799	0.36	0.30	0.98	0.98	0.37

Appendix Table 1 – Observed Changes in Pricing and Borrowing Behavior

Notes: Panels (a) and (b) show percentage point changes in two price measures across the FICO score distribution from before the CARD Act to after (2008Q3 to 2009Q2 and 2011Q3 to 2014Q2 respectively). The first price measure, shown in Panel (a), is an account's annualized percentage interest charges, defined as annualized monthly interest charges divided by borrowed balances. The second price measure, shown in Panel (b), adds fee charges to the numerator of the first price measure. Panel (c) shows the share of credit card accounts that are used for borrowing in the same pre- and post-CARD-Act periods ("borrowing share"), and the share of consumers who hold a credit card at all in the same pre- and post-CARD-Act periods ("credit card holding share"). The final column of Panel (c) reports percent changes in the credit card holding share from pre- to post-CARD-Act data.

	(1) fee-inclusive price no annual fee	(2) fee-inclusive price with annual fee	(3) APR no annual fee	(4) APR with annual fee
10th Percentile	4.47	9.38	9.00	11.85
25th Percentile	10.14	14.55	11.99	14.15
50th Percentile	15.79	21.68	15.24	17.90
75th Percentile	24.66	32.25	20.99	22.90
90th Percentile	35.84	58.96	26.91	27.24

Appendix Table 2 – Testing for Two-part Tariff Pricing

Notes: This table shows the distributions of fee-inclusive prices and APRs for accounts that do and do not pay an annual fee. Annual fees are not used in the construction of either price; only fees directly related to consumer borrowing behavior are included in the fee-inclusive price.

FICO Group	Cum. Months of Borrowing	Share within FICO Group	Interest Charges (% Ann.) P25	Mean	P75	Fee-Inclusive Charges (% Ann.) P25	Mean	P75
620 - 639	0	1.81%	.	.	.	.	.	.
	1-2	2.13%	10.23	17.90	25.73	11.03	25.75	29.03
	3-5	4.10%	8.31	16.14	24.91	8.86	21.35	27.98
	6-11	20.79%	9.50	16.73	25.12	9.98	21.19	27.92
	12	71.16%	11.62	18.29	26.00	12.18	21.15	27.99
680 - 699	0	5.33%	.	.	.	.	.	.
	1-2	4.23%	4.78	12.89	19.34	4.94	16.14	21.21
	3-5	6.33%	2.87	11.28	17.79	2.96	13.34	19.21
	6-11	23.33%	4.33	12.02	18.13	4.61	13.58	19.34
	12	60.77%	8.35	14.36	19.46	8.57	15.36	20.38
740 - 759	0	15.86%	.	.	.	.	.	.
	1-2	8.01%	2.11	9.56	14.61	2.16	11.52	15.65
	3-5	9.27%	1.23	8.56	13.41	1.68	9.84	14.29
	6-11	24.03%	3.10	9.32	13.66	3.17	10.24	14.36
	12	42.83%	6.13	11.07	14.50	6.20	11.59	14.98
800 - 819	0	44.68%	.	.	.	.	.	.
	1-2	14.22%	0.00	7.59	12.71	0.00	9.82	13.41
	3-5	10.97%	0.27	8.26	12.86	0.47	9.66	13.40
	6-11	16.24%	3.79	8.82	12.72	3.90	9.69	13.15
	12	13.89%	5.46	9.71	12.72	5.51	10.15	13.01

Appendix Table 3 – Pre-CARD Act Price Distribution on Mature Accounts

Notes: The table shows price quartiles and means at selected FICO score groups and across accounts with different cumulative months of borrowing over the course of the year in the pre-CARD-Act period (2008Q3 to 2009Q2). This sample includes only mature accounts (observed at 18 or more months since origination). The two price measures shown are, first, an account's annualized percentage interest charges, defined as annualized monthly interest charges divided by borrowed balances, and second, a price measure that adds fees charged to the numerator of the first price. Borrowing is defined as not repaying a balance in full at the end of a given month.

Dependent Variable:	(1) Origination FICO	(2) Charge-off Rate	(3) Account Age (mo.)	(4) Balance ($)	(5) Utilization
Bank with Repricing Experiment	20.75***	-0.00526	-2.714	211.3	0.00498
	(4.268)	(0.00617)	(1.688)	(200.6)	(0.00744)
Controls:					
FEs for Consumer Types Θ	YES	YES	YES	YES	YES
Observations	4500491	7478485	7478485	7478485	7477859
R2	0.418	0.187	0.082	0.090	0.042

Appendix Table 4 – Repricing Campaign Borrower Observables

Notes: This table presents a series of regression tests for balance of borrower observables between the lender that conducted the repricing campaign shown in Figure 5 ("Bank A") and its competitor lenders. Consumer type θ fixed effects are included in all regressions. Utilization is defined as the ratio of balance to credit limit. Standard errors are clustered at the lender-consumer-type level.

FICO Group	Cum. Months of Borrowing	Share within FICO Group	Interest Charges (% Ann.) P25	Interest Charges (% Ann.) Mean	Interest Charges (% Ann.) P75	Fee-Inclusive Charges (% Ann.) P25	Fee-Inclusive Charges (% Ann.) Mean	Fee-Inclusive Charges (% Ann.) P75
620 - 639	0	2.03%	.	.	.	.	.	.
	1-2	2.49%	0.00	11.45	18.86	0.00	20.36	24.58
	3-5	4.90%	0.00	10.99	17.85	0.00	17.40	21.16
	6-11	38.15%	0.84	11.78	18.24	1.94	17.52	22.01
	12	52.43%	4.77	12.41	18.15	5.52	16.76	21.83
680 - 699	0	6.47%	.	.	.	.	.	.
	1-2	5.44%	0.00	6.90	12.62	0.00	10.17	14.56
	3-5	8.27%	0.00	6.58	12.35	0.00	8.87	13.88
	6-11	38.84%	0.00	6.81	12.44	0.00	8.64	13.62
	12	40.98%	0.00	8.16	12.88	0.00	9.57	13.91
740 - 759	0	15.00%	.	.	.	.	.	.
	1-2	8.83%	0.00	3.94	8.14	0.00	5.38	8.74
	3-5	11.36%	0.00	3.49	5.93	0.00	4.48	6.82
	6-11	36.24%	0.00	3.46	6.34	0.00	4.25	7.10
	12	28.58%	0.00	5.36	9.47	0.00	6.03	9.86
800 - 819	0	28.17%	.	.	.	.	.	.
	1-2	14.11%	0.00	3.37	5.08	0.00	4.97	6.48
	3-5	14.66%	0.00	2.74	0.61	0.00	3.67	2.12
	6-11	29.25%	0.00	2.38	1.54	0.00	2.89	2.87
	12	13.81%	0.00	3.62	7.17	0.00	4.12	7.56

Appendix Table 5 – Pre-CARD Act Price Distribution on New Accounts

Notes: The table shows price quartiles and means at selected FICO score groups and across accounts with different cumulative months of borrowing over the course of the year in the pre-CARD-Act period (2008Q3 to 2009Q2). By design, this sample includes only young accounts (observed at 12 or fewer months since origination). The two price measures shown are, first, an account's annualized percentage interest charges, defined as annualized monthly interest charges divided by borrowed balances, and second, a price measure that adds fees charged to the numerator of the first price measure. Borrowing is defined as not repaying a balance in full at the end of a given month.

FICO	Recent Borrowers		All Accounts	
Group	Transactor	Borrower	Transactor	Borrower
580	0.16	0.85	0.05	0.84
600	0.14	0.89	0.05	0.80
620	0.13	0.89	0.05	0.79
640	0.12	0.89	0.04	0.81
660	0.12	0.89	0.03	0.77
680	0.11	0.88	0.03	0.79
700	0.10	0.88	0.02	0.75
720	0.09	0.87	0.02	0.72
740	0.08	0.87	0.02	0.70
760	0.08	0.86	0.01	0.65
780	0.08	0.82	0.01	0.49

Appendix Table 6 – Persistence in Consumer Revolving Behavior

Notes: The table shows probabilities of next-quarter borrowing in the pre-CARD-Act period (2008Q3-2009Q2) for consumers who are either transactors (non-borrowers) or borrowers in the current period. The first two columns restrict the sample to consumers who have borrowed at least once in the past 6 months (recent borrowers), and the latter two columns extend these results to the full sample of active credit-card holders.

	(1)	(2)	(3)	(4)
Dependent Variable:	90 Days Past Due	90 Days Past Due	Charge-off	Charge-off
Estimator:	2SLS	2SLS	2SLS	2SLS
Borrowing Cost (annualized p.p.)	-0.00121	-0.000715	-0.00118	-0.00232
	(0.00219)	(0.00118)	(0.000894)	(0.00141)
Linear Time Trend	NO	YES	NO	YES
Observations	62748951	62748951	62102971	62102971
Dependent Variable Mean (p.p.)	0.029	0.029	0.010	0.010
10% C.I. Upper Bound on Default Response (p.p.)	0.002	0.001	0.0003	0.00001
5% C.I. Upper Bound on Default Response (p.p.)	0.003	0.002	0.001	0.0004

Appendix Table 7 – Price Invariance of Default

Notes: The table shows regression tests for price invariance of default, as described in Appendix Section A.7. The first two columns use delinquencies of 90 days or more past due as the outcome variable, and the final two columns use charge-offs as the outcome variable. The regression specifications are the same as in equations 4.18 and 4.19.