Liquidity Constraints and Credit Card Delinquency: Evidence from Raising Minimum Payments*

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Abstract

We use credit card data from a North American financial institution to estimate the impact of increasing minimum payments on consumer delinquency and on the distribution of payments and purchases. The institution we study increased the required minimum monthly payment from 3% to 5% of the revolving balance at a specific point in time, thereby tightening the liquidity constraint of affected borrowers. To separate the effect of minimum payments from time effects, our identification strategy exploits an unusual institutional feature: credit card borrowers can use their account to make purchases with both revolving loans (on which minimum payments increased) and term loans (on which there was no policy change). Borrowers differ in the proportion of their borrowing that is revolving, and consequently in the degree to which they are affected by the policy change. For current borrowers, quantile regression reveals that payments of 3% of the balance are largely replaced by payments of 5%, explaining why transitions into delinquency are unaffected. For delinquent borrowers, payments increase but the increase is insufficient to match the new requirement and thus results in lower cure rates (transitions from being delinquent to being current). On average, borrowers in the lower end of the payment distribution decrease the amount they charge on the credit card after the policy change.

JEL Classification: D12, D14, E21, G21.

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1 Introduction

Credit cards provide revolving lines of credit with low minimum monthly payment requirements. Each month, a typical issuer requires borrowers to pay the maximum between a small fraction of the end-of-the-month balance ranging from 1% to 5%, and a floor minimum amount ranging from $10 to $35 in order to keep the account in good standing. Borrowers who choose to repay such a small fraction of their revolving balance can take years to pay down their loan completely. Assuming the industry's average annual percentage rate (APR) of 15% (creditcards.com) and a minimum required payment of 2%, it takes approximately six and a half years to pay down a credit card balance by making only the minimum payment each month. Of the 68% of households holding at least one credit card, 55.1% revolve a balance (2010 U.S. Survey of Consumer Finances) and about 18% make the minimum required payment on the account (TransUnion). Borrowers who make only the minimum payment may face large debt burden and substantial interest payments.

In 2009, the United States Congress passed the Credit Card Accountability Responsibility and Disclosure (CARD) Act in an effort to increase transparency and to restrict the nature of fees charged in the consumer credit card market. One of its provisions intended to nudge borrowers into repaying their debt faster by forcing issuers to disclose on billing statements both the time needed to pay down the balance when making only the minimum payment and the monthly payment required to pay down the balance in 36 months. The effect of these new disclosure rules has generally been found to increase the payments made by borrowers paying small fractions of their balance each month (Agarwal, Chomsisengphet, Mahoney, and Stroebel, 2013; Jones, Loibl, and Tennyson, 2014; Keys and Wang, 2014).

In this paper, instead of analyzing the impact of a payment disclosure rule aimed at accelerating debt repayment, we examine the impact of an *actual* increase in the minimum payment required on consumer credit card accounts. We exploit proprietary data from a large North American financial institution that increased its minimum required payment on revolving balances from 3% to 5% but maintained its floor minimum payment of $10. The policy change results in a higher minimum payment for all balances over $200 and, unlike the CARD Act, has real economic consequences for borrowers who do not respond to the change. The increase was imposed on all borrowers at this financial institution and took effect at a specific date in recent years.[1] While this change does not directly affect borrowers who would otherwise pay well above (or below) the minimum, it increases the fraction of the balance that must be repaid to avoid delinquency for borrowers who were previously paying only the minimum.

Whether increasing the minimum required payment is good for borrowers depends on one's view about the optimality of carrying a credit card balance, and we do not take a stand on this question. Some consumers are rational in paying the minimum amount on their credit card, which suggests that their account provides the cheapest source of borrowing. Increasing the minimum payment reduces the welfare of these borrowers because they must either comply with the increased minimum and borrow from elsewhere, spend less than they otherwise would with the card, or enter delinquency. For consumers who are not rational in paying only the required minimum each month, their welfare could be improved by increasing the payment made on the account (e.g., by borrowing from some cheaper source) or by decreasing the spending made with the card.

We begin the analysis by looking at the differences in average outcomes before and after the policy change. However, such comparison between periods of low and high minimum payments makes it impossible to separate time effects from policy effects. To separate the effect of minimum payments from time effects, our main identification strategy exploits an unusual institutional feature: credit card borrowers can use their account to make purchases with both revolving loans (with no fixed term on which the minimum payments increased) and term loans (with a fixed interest rate and repayment schedule on which there was no policy change). Borrowers differ in the proportion of their borrowing that is revolving, and consequently in the degree to which they are affected by the policy change. We exploit this variation in an identification strategy akin to a difference-in-differences estimation which compares the difference in outcomes across different proportions of revolving balances before and after the minimum payment increase.

Our results show an important difference in the response to the policy change across current and delinquent accounts. On the one hand, conditional on an account being current, payments of 3% of the balance were largely replaced by payments of 5% of the balance. At the same time, current borrowers in the lower end of the payment distribution — who are most likely to be af-

[1] The date is not disclosed for data provider confidentiality. The policy change does not overlap with the period in which the CARD Act was rolled out.

fected by the minimum payment increase — reduced the purchases made with the card. For these borrowers, combining increased payments with reduced purchases successfully lead to decreasing their revolving balance. On the other hand, for delinquent borrowers, payments made around the minimum increased, but this increase was insufficient to match the new minimum payment requirement. Depending on the specification, we estimate that transitions out of delinquency decreased by 4.46 to 8.17 percentage points on a base cure rate of 52%. Delinquent borrowers also reduced the purchases made with the credit card in response to the policy, with the biggest effect found in the lower end of the payment distribution. In the two-year window around the policy change, our analysis suggests that the new minimum payment requirement increased the number of accounts going into default or bankruptcy by 4.33%.

We extend the main results in many ways. We instrument the proportion of the revolving balance on the accounts with its value lagged by six months and find quantitatively similar results. This addresses concerns that the minimum payment increase could itself affect the proportion of the revolving balance on the accounts. We present a falsification test for observations with revolving balances that were not affected by the policy change and show that no effect is detected. We exploit a kink in the minimum payment formula around the floor minimum payment which provides the effect of the policy on consumers with low revolving balances. Finally, we show that the effect of the policy was amplified for consumers with high revolving balances, high credit line utilization, worst credit scores, and a weaker banking relationship.

Our analysis relates to the literature on liquidity constraints, which are typically viewed as an inability to borrow funds against future wealth. Increasing the minimum payment effectively tightens the liquidity constraints of borrowers for who the minimum was previously binding. Theoretical results show that introducing liquidity constraints into a consumer's optimization problem has an impact on consumption similar to precautionary savings motives, in the sense that they tend to decrease current consumption in times when cash-on-hand is low (Carroll and Kimball, 1996, 2005; Carroll, 2001). Consistent with this, we find a reduction in purchases made with the credit card for borrowers at the bottom of the payment distribution, for who the policy change most likely resulted in tightened liquidity constraints. Researchers have often tested for the presence of liquidity constraints using data from credit cards since their widespread use, and the frequency at which their usage is reported makes them a natural place to look for such evidence.[2] Most research has focused on positive shocks to wealth or to buying power (e.g., tax rebates: Agarwal, Liu, and Souleles, 2007 and increased credit limit: Gross and Souleles, 2002), whereas our setting instead involves tightening the repayment schedule on a loan. In our context, the first order effect of liquidity constraints should be an increase in delinquency.

The paper closest to ours is a working paper by Keys and Wang (2014) which, in addition to their work on the CARD Act, exploit data from US banks that increased the *floor* minimum credit card payment, but not the minimum percentage of the balance that must be repaid. Their data includes banks that changed their floor minimum payment differently at different times and control banks that did not change their floor minimum payment. They find an increase in delinquency of one percentage point and a reduction in borrowers paying their account in full by 1%. In the period they study, floor minimum amounts increased at most to $35 (e.g. from $10 to $25).[3] Because floor minimum amounts are low both before and after their change, making these payments is a challenge only for the most constrained borrowers. Furthermore, varying these amounts only affects accounts with low revolving balances. In contrast, the policy change we study results in a substantial dollar amount increase for the average borrower, up from a much higher initial level. At the average revolving balance of $2,300 in our sample, the minimum payment increases from $69 to $115. Such increase provides a larger economic incentive for constrained borrowers to become delinquent on their loan and allows us to study the full distribution of payments and purchases made on the card. Our results complement the findings of Keys and Wang (2014) and show the effect of increasing minimum payments in regions where they are likely to bind for more borrowers.

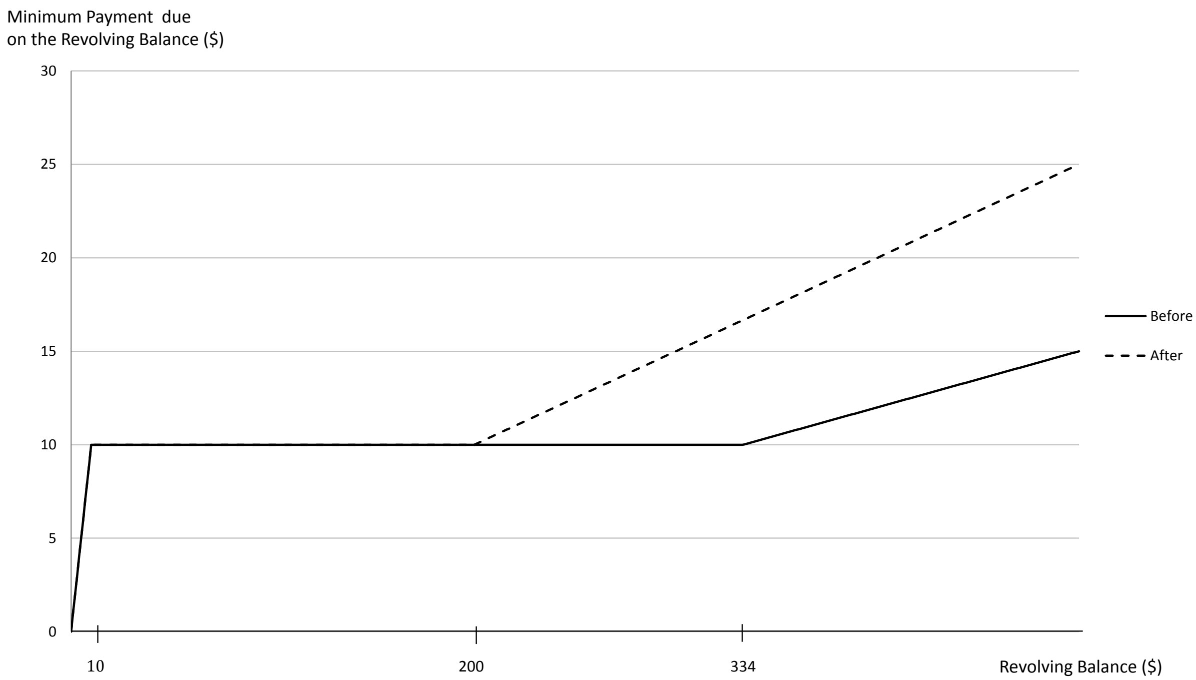
2 Institutional Setting and Identification

We use credit card data from a North American financial institution that recently changed its minimum payment policy by increasing the fraction of the current revolving credit card balance that

[2]Zeldes (1989) derived some of the first empirical tests of liquidity constraints by comparing consumption Euler equations for groups of consumers who are potentially constrained and unconstrained, with the assumption that liquidity-constrained borrowers are the ones who have low wealth and low assets. Alternatively, using data from the Survey of Consumer Finance, Jappelli, Pischke, and Souleles (1998) define constrained borrowers as those who were previously refused a loan, or who do not have access to a credit line. Closer to our interpretation of liquidity constraints, Gross and Souleles (2002) argue that households paying high interest rates on their revolving loans can also be thought of as liquidity constrained, due to the lack of a cheaper source of funding.

[3]As of June 2014, the highest floor minimum amount for a top 10 credit card issuer was $35 (creditcards.com).

Figure 1: Minimum Payment Due on the Revolving Balance - Before and After the Policy Change



Note: This figure shows the effect of the policy change on the monthly minimum payment due on the revolving balance. The solid and dashed lines, respectively, represent the minimum payment schedules on the revolving balance before and after the policy change. The minimum payment on the revolving balance must be added to the monthly installment on the term loan (if the borrower has one) to yield the total monthly minimum payment.

must be paid each month to avoid progressing in the delinquency cycle.[4] The minimum payment on the revolving balance was previously either \$10 or 3% of the revolving balance, whichever is greater, and was increased to either \$10 or 5%, whichever is greater. This change was imposed on all account holders at a specific date that we omit for data provider confidentiality.

Figure 1 plots the effect of the policy on the minimum monthly payment required on the revolving balance. The solid and dashed lines, respectively, represent the minimum payment schedules on the revolving balance before and after the policy change. For monthly balances under \$200, the policy had no effect on the minimum payment. For balances between \$200 and \$334, account holders were previously required to pay a fixed amount of \$10 and are now required to pay at least 5% of the balance. For balances over \$334, the new policy represents a 2% increase, as a fraction of the revolving balance.

This kinked structure suggests a regression kink design (RKD) to identify the effect of minimum payments while controlling non-parametrically for balance. We do this in Section 5.3. This

[4] All amounts are presented in local currency.

approach reveals the effect of very small increases of minimum payments, around the floor of $10 that must be repaid when the balance is under $334 before the policy change, or under $200 after the policy change. This kink-based approach mirrors the identification in Keys and Wang (2014), but in our context the floor minimum amount is even lower.[5]

Our main results identify the effect of larger changes in already non-negligible minimum payments by exploiting an important institutional feature that allows borrowers to use their credit card account to make purchases with both a revolving loan and a term loan. Crucial to our analysis, the change in the minimum payment policy only affected the revolving portion of a borrower's monthly balance and did not affect the term loan contracts. Both revolving and term loans are attached to the same account, and the total account balance consists of the sum of the term and revolving balances. Each month, the total minimum payment due on the account consists of the minimum payment on the revolving balance and the monthly installment on the term loan. It determines the minimum amount that must be paid in order to avoid progressing in the delinquency cycle. Concretely, this means that an account holder with an active term loan was subject to a total minimum payment increase exactly parallel to the one shown in Figure 1 but with the whole schedule shifted up by the amount of the monthly installment on the term loan.

The term loans can be contracted at select merchants as a way of financing consumer goods over monthly installments or at the bank, like any regular term loan. The term loans are repaid in fixed equal monthly installments, contrasting with the revolving balance which involves no fixed repayment schedule other than the minimum monthly payment. There is no distinction made between being delinquent on the revolving loan or on the term loan, the delinquency status is recorded at the account level. Delinquency standards are consistent with the Basel II regulatory framework, which states that an account that is six cycles delinquent is considered in default and must be written off by the institution.

Borrowers with a higher proportion of revolving balance compared to total account balance are relatively more affected by the policy change because a bigger portion of their balance is subject to the new minimum payment requirement. Conversely, borrowers who have a large portion of their

[5]The sample used by Keys and Wang (2014) has higher floor minimum payments but since changing the floor minimum payment only affects borrowers with low revolving balances, they document that for balances over $3,000 the average increase in minimum payment represents 0.3% as a fraction of the revolving balance. In contrast, the policy change that we exploit results in an increase in the minimum payment of 2% as a fraction of the balance for all accounts with a revolving balance higher than $334.

balance in the form of a term loan are relatively less affected by the policy because the term loan portion of their total balance was unaffected by the change. This provides the variation needed to identify the effect of the policy on revolving accounts while controlling for the proportion of the balance that is revolving.

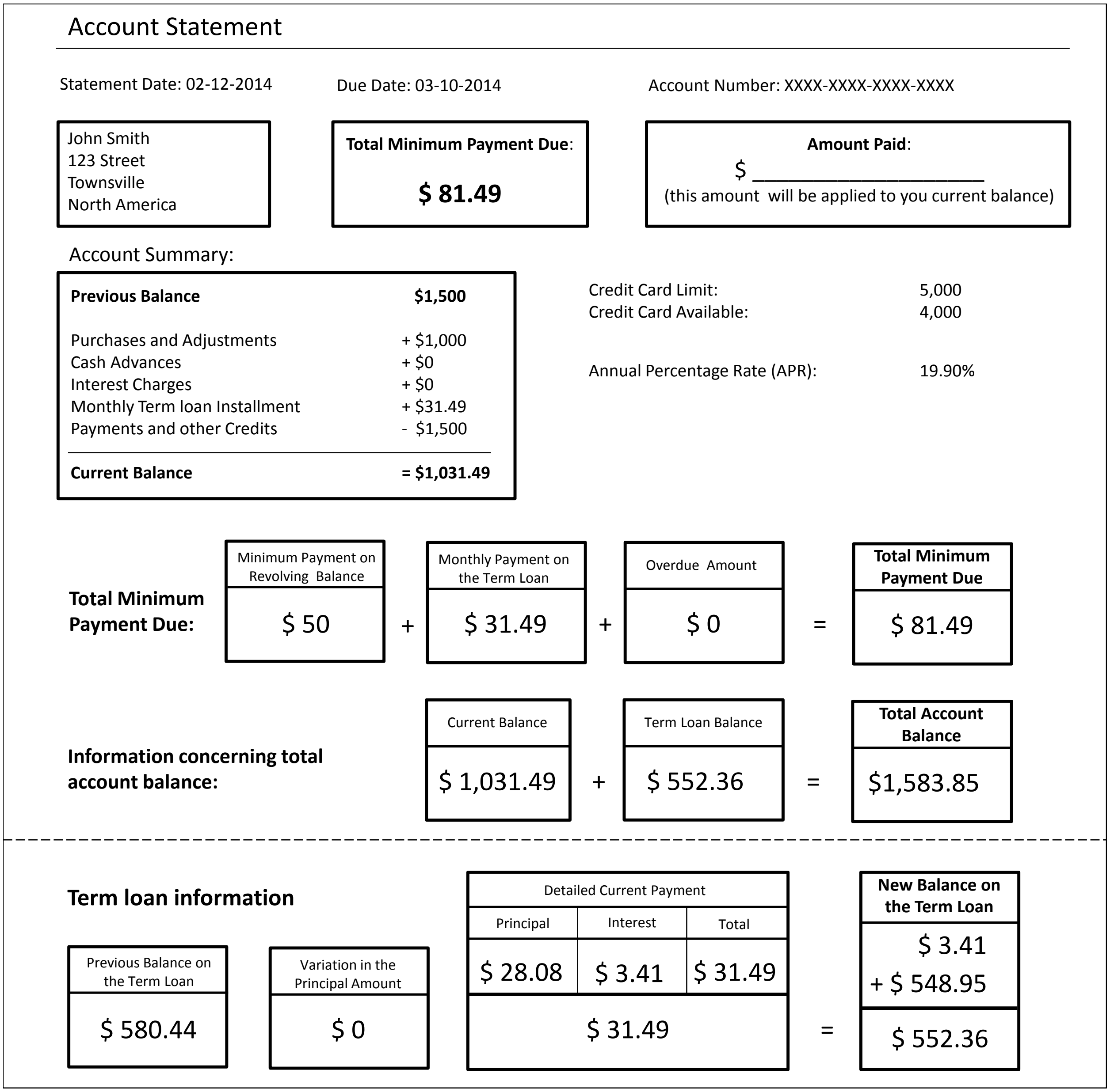
2.1 The Account Statement

Figure 2 shows a typical account statement for a borrower who is current on his payment obligations and who holds a term loan. The monthly statement presents information about the revolving and term loans on the account. The total minimum payment due is the amount needed for the account to be considered current at the beginning of the next billing cycle and consists of the minimum payment on the revolving balance, the monthly term loan payment and the overdue amount. It is \$81.49 in the example considered. The calculation of the minimum payment on the revolving balance excludes the monthly installment on the term loan from the current balance and is 3% for statements issued before the policy change and 5% for statements issued after the policy change. It is equal to \$50 in the example, which is $\$1,000 \times 0.05$. The overdue amount consists of the cumulative amount that arises from paying less than the total minimum payment due on previous statements and can include both minimum payments on past transactions and unpaid monthly installments on the term loan. It is \$0 in the example considered because the account is current. The monthly payment on the term loan consists of its installment amount and is \$31.49 in the example considered. The current term loan balance consists of the previous balance and any variation in the principal (new term loan or additional prepayment) from which the current capital repayment is deducted. In this example, out of the \$31.49 monthly installment, the borrower paid down \$28.08 of the loan's principal and paid \$3.41 in interest.

2.2 Identification Strategy

The identification of the effect of minimum payments comes from two features of the data. The policy change itself allows us to compare average outcomes before and after the minimum payment increase. This is first investigated in Section 3. However, comparing the pre- and post-policy change periods potentially involves confounding macroeconomic factors, which can lead to erroneous conclusions regarding the effect of the policy. To address this issue, we make use of the fact that the

Figure 2: Account Statement Example



Note: This figure shows a typical account statement for a borrower who is current on his obligations and who holds a term loan. The monthly statement presents information about the credit line and the term loan on the account. The total minimum payment due is the amount needed for the account to be considered current at the beginning of the next billing cycle and consists of the minimum payment on the credit card balance, the monthly term loan payment, and the overdue amount, which.is \$81.49 in the example considered. The calculation of the minimum payment on the credit card balance excludes the monthly installment on the term loan from the current balance. It is 3% for statements issued before the policy change and 5% for statements issued after the policy change. It is equal to \$50 in the example, which is $\$1,000 \times 0.05$. The monthly payment on the term loan consists of the installment due on the term loan in the current month and is \$31.49 in the example considered. The overdue amount consists of the cumulative amount that arises from paying less than the total minimum payment due on previous statements. The overdue amount may include both minimum payments on past transactions and unpaid monthly installments on the term loan. It is \$0 in the example considered because the account is current.

increase in minimum payment was imposed only on revolving balances and not on term loans. In this context, the treatment considered is the increased minimum payment on the revolving balance, and the control group arises from the possibility of holding a term loan on the account.

Define $\text{Prop}_{i,t} \in [0,1]$ as the the proportion of revolving balance to total balance on the account, such that

$$\text{Prop}_{i,t} = \frac{\text{Revolving Balance}_{i,t}}{\text{Revolving Balance}_{i,t} + \text{Term Loan Balance}_{i,t}}. \quad (1)$$

Accounts with higher proportions of revolving balance are more affected by the increase in minimum payment because they are relatively more exposed to the treatment. This variable can thus be seen as the intensity of the treatment.[6]

In Section 4, we use the proportion of the revolving balance on the account to measure the impact of the policy in a model akin to a difference-in-differences estimation. We provide support for this research design by showing two important things. First, before the policy change, accounts with low and high proportions of revolving balance, compared to the total balance, followed parallel delinquency trends. The identifying assumption is that accounts with different proportions of revolving balance would have continued their parallel trends absent of the policy change. Second, we show that the intensity of the treatment plays a crucial role in the delinquency patterns because it is precisely the accounts with a high proportion of revolving balance that were the most affected by the policy change.

Let $y_{i,t}$ be an outcome of interest — typically either payments or new purchases normalized by total account balance, or indicators for delinquency transitions (e.g., does a current borrower go delinquent). Our main regression model in the analysis can be expressed as

$$y_{i,t} = f\big(\delta_0 + \delta_1(\text{After}_t \times \text{Prop}_{i,t}) + \delta_2\text{Prop}_{i,t} + \boldsymbol{\delta}_3\mathbf{X}_{i,t} + \epsilon_{i,t}\big), \quad (2)$$

where, for example, $f(.)$ would invoke the normal density in the case of a probit model. $\text{Prop}_{i,t} \in [0,1]$ is the proportion of revolving balance to total balance on the account as defined by equation (1)

[6] To see this, consider a simplified example in which two identical individuals each have a monthly revolving balance of $500, but one has a monthly installment of $200 due on a term loan and the other does not. For both individuals, the minimum payment on the revolving balance increases from $15 to $25 with the new requirement. For the individual with no term loan, this represents a 66% increase, whereas for the individual with a term loan, it represents a $(225-215)/215 \approx 4.65\%$ increase in total minimum monthly payment. This is the variation captured by the variable $\text{Prop}_{i,t}$ which is calculated using the total account balance.

and After_t is an indicator variable that takes the value of one, if the observation is after the policy change, and zero, if it is before. The outcome of interest $y_{i,t}$ is measured at the end of the billing cycle and the explanatory variables are measured at the beginning of the billing cycle to avoid spurious relationships.

$\mathbf{X}_{i,t}$ is a vector of covariates that includes controls for demographic variables concerning the account holder such as sex, age, but also account-related controls such as internal and external measures of credit risk, age of the account, APR charged on the revolving balance, and a variable indicating whether the borrower pays to bear a reduced APR. To control for account utilization, we include monthly measures of revolving balance, total account balance (including term loan), monthly installment on the term loan, utilization rate of the credit line (defined as end-of-the-month revolving balance divided by the credit limit), and a dummy variable that indicates if the account has only a revolving balance (no term loan). We also control for the relationship between the account holder and the bank through a variable that indicates if the client has other accounts opened at the financial institution.[7] Using partial information about the billing address on the account, we are able to gather the average unemployment rates in the account holder's region. We include a set of dummy variable to control for the delinquency cycle of the account when necessary and dummy variables for the number of months an account has spent in the current state to control for the length of delinquency spells. Finally, we use a set of month dummies to control for month fixed effects. It is straightforward to interact some of the covariates used with time controls which we do in some of the specifications we estimate. In the results, we present different model specifications that increasingly control for the full set of covariates included in $\mathbf{X}_{i,t}$.

In this setting, our main focus is on the marginal effect of the treatment on the outcomes of interest which is given by the coefficient δ_1. Predictions and marginal effects are calculated at a proportion of revolving balance of 100% which allows us to interpret the marginal effect on the coefficient δ_1 as the difference between the pre- and post-policy periods for accounts that have only a revolving loan — the typical scenario for the majority of credit card accounts.

[7]There is literature focusing on the benefits of relationship banking in both corporate and consumer finance. In consumer retail markets, Puri, Rocholl, and Steffen (2013) find that consumers that have an account opened at the bank prior to undertaking a loan have a significantly lower default probability. For credit card accounts in particular, Agarwal, Chomsisengphet, Liu, and Souleles (2009) find that consumers that have a stronger relationship with the bank have lower default rates and higher rates of utilization. We find qualitatively similar relations in our sample.

3 Data Description and Preliminary Results

The data provided by the financial institution consist of all their credit card accounts and practically all non-sensitive variables that they record about the accounts each month. In order to measure the impact of an increase in the minimum payment, we retain all accounts that were open 12 months prior to the policy change and follow them for 24 months or until they default, go bankrupt or are closed in good standing. We drop all accounts that were inactive during this subsample as well as accounts for which months of observations are missing.

Over the 24 months studied, the sample covers $2,797,941$ accounts. On average, each account remains in the sample for 22.4 months. Accounts that never go delinquent provide little information on the effect of the policy on consumer behavior so we undersample them by randomly selecting 10% of them and assigning them a probability weight of 10. This yields $186,815$ overweighted accounts that never missed a payment in the period studied. All results presented are adjusted using an inverse probability weighting scheme.

The dataset is at the account-level and has a monthly frequency for which each observation corresponds to an account-month statement. We observe the month in which the statement was emitted although different accounts can have different statement dates. The important variables are recorded on the statement date and provide information about the account balance, the minimum payment and the delinquency cycle on the account. The main sample used in the analysis consists of all accounts with a revolving balance greater than $334. We choose to focus on these accounts because their minimum payment increased from 3% to 5% (see Figure 1).

3.1 Summary Statistics

In this section, we present summary statistics for the variables used in the analysis. Panel A of Table 1 presents account-level information. About 26% of the monthly observations have an active term loan. This variable is calculated on each statement date which allows a given account to be categorized as having a term loan or not in each month. The average monthly payment is $967.54 and includes any payments that were made between the previous bill and the current one and covers both the revolving and term loans on the account. Some credit card holders also do business with the bank for other accounts, for example, checking account, savings account or mortgage. Although

Table 1: Descriptive Statistics
(24-Month Window Around the Policy Change, All Accounts w/ Revolving Balance $\geq$ \$334)

	Mean	Std. Dev.	p5	p50	p95	Obs
A. Account-Level						
Has Term Loan	0.26	–	–	–	–	30,263,961
Monthly Payment	967.54	1,816.38	0.00	464.90	3,500.00	30,263,961
Has Other Accounts at this Bank	0.88	–	–	–	–	30,263,961
Account Age (Months)	124.39	96.31	19.30	96.90	320.50	30,263,961
APR (%)	17.04	3.90	9.90	19.40	19.40	30,263,961
Account Holder Age	44.72	15.53	22.00	44.00	72.00	30,259,481
Account Holder Sex	0.51	–	–	–	–	30,263,961
Delinquency Cycle	0.17	0.58	0.00	0.00	1.00	30,263,961
Internal Credit Score	3.32	2.21	1.00	3.00	8.00	30,263,961
External Credit Score	914.36	140.51	603.00	963.00	976.00	30,263,961
B. Revolving Loan						
Card Balance	2,302.94	2,806.22	396.67	1,296.47	7,655.57	30,263,961
Revolving Limit	6,277.65	136,893.83	500.00	5,000.00	18,800.00	30,263,961
Revolving Limit Used	0.53	0.50	0.06	0.49	1.03	30,263,827
C. Term Loan $\mid$ *Term Loan* > 0						
Term Loan Balance	3,944.01	5,307.81	149.75	2,027.43	14,511.15	7,896,848
Monthly Installment	167.07	152.25	26.92	120.90	449.96	7,896,848
Proportion of Revolving Loan	0.47	0.28	0.07	0.45	0.94	7,896,848

Note: The descriptive statistics are calculated on account-month observations that have a revolving balance greater than \$334 in a 24-month window around the policy change. Panel A presents account-level information, Panel B presents information concerning the revolving loan and Panel C presents information concerning the term loan attached to the account, if the borrower has one.

we do not have information on the card holder's other accounts, we observe an indicator variable showing that 88% of the account holders also do business with the bank for products other than their credit card. The average account age is about 124 months or slightly more than 10 years. Accounts differ in the APR charged on revolving balances and the average rate is 17.04%.

The delinquency cycle variable indicates how many months late is the account. Accounts can be current, or 1, 2, 3, 4 or 5 months late. Accounts that are six months late are considered to be in default and must be written-off by the institution. Note that the delinquency cycle does not indicate the number of calendar months that the account has been delinquent. An account could stay one month delinquent forever if the borrower always made the minimum payment without paying the overdue amount on the account. The average delinquency cycle is 0.17, and even at the 95th percentile its value is one, indicating that for at least 95% of the observations, the accounts are at most one month late on their obligations.

The credit scores on the account come from internal and external measures. The internal measure varies from 1 to 8 with lower numbers indicating higher credit quality. Its average value is 3.32. The external score is a bankruptcy prediction score and varies from 1 to $1,000$. Unlike FICO scores, which predict the probability of missing a payment on the loan, this type of measure predicts the probability of filing for Chapter 7 or Chapter 13 in the next two years and is typically higher than average FICO scores.

Panel B of Table 1 shows information that pertains specifically to the revolving loan on the account. The monthly credit card balance is $\$2,302.94$ on average, with a limit of $\$6,277.65$. A typical account holder uses 53% of his credit line limit in any given month. The credit card limit varies a lot, with higher percentiles of the data exhibiting very high limits.

Panel C of Table 1 presents information concerning the term loan, for accounts that have one. The term balance is on average $3,944.01$ with a monthly installment of \$167.07. The proportion of revolving balance to total account balance is 47% for accounts holding a term loan. It is obviously 100% for accounts with no term loan. At the 5th percentile, this variable is about 0.07 and increases up to 94% at the 95th percentile. This shows that there is substantial variation in the proportion of revolving and term balances on the accounts, which plays an important role in our identification strategy.

3.1.1 Account Transitions

Each month, an account can transition between three mutually exclusive states $\omega = \{C, L, W\}$ depending on its delinquency status. The account status is recorded at the beginning of the billing cycle and the states are defined as (C) if the account is current (no overdue amount), (L) if the account is at least one month late (i.e., delinquent) and (W) if the account is written off due to default or bankruptcy. The delinquent state is further refined into the exact number of months late on the account when needed.

The unconditional transition matrix for the two year sample is represented in Table 2. The estimators of the transition probabilities are equal to the sample transition frequencies (Gourieroux and Jasiak, 2007, Chapter 8). 93.7% of accounts that are current remain current in the next billing cycle each month. About 6.3% of accounts go delinquent each month. The proportion of current

Table 2: Aggregate Transition Probabilities
(24-Month Window Around the Policy Change, All Accounts w/ Revolving Balance $\geq$ \$334)

	C_t	L_t	W_t
C_{t+1}	0.937	0.523	0.000
L_{t+1}	0.063	0.460	0.000
W_{t+1}	0.000	0.017	1.000

Note: This table provides the average transition probabilities between states $\omega = \{C, L, W\}$ calculated on account-month observations that have a revolving balance greater than \$334 in a 24-month window around the policy change. The states are defined as (C) if the account is current, (L) if the account is at least one month late, (W) if the account is written off due to a default or due to bankruptcy.

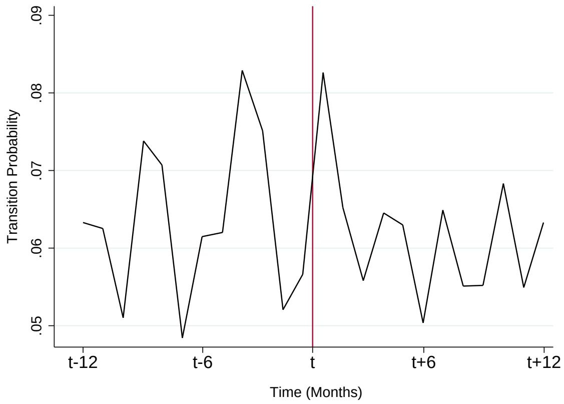
accounts that default or bankrupt is so small that it is zero when rounded to the third digit decimal place. This shows that current accounts transition, for the most part, between the current and delinquent states. For this reason, we omit the analysis of transitions from the current to the written-off state. Among all accounts that are late, 52.3% cure in the following billing cycle, 46.0% stay delinquent, and 1.7% end up in default or bankruptcy. Accounts that are written-off do not re-enter the sample and therefore remain in state W with a probability equal to one.

3.2 Before and After Comparison

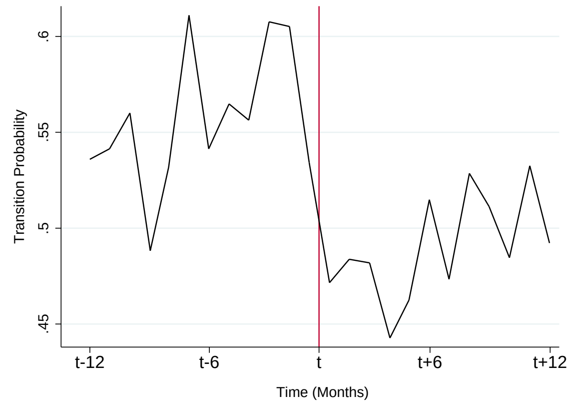
We begin by analyzing average outcomes before and after the minimum payment was increased. To get an idea of the time series variation in the delinquency probabilities over time, Figure 3 plots the aggregate transitions over the 24-month window covered in the sample. The horizontal line represents the month in which the minimum payment was increased. Panel (a) shows the probability of a current account entering delinquency. It is rather stable and there is no evidence of a break around the date of the policy change. Panels (b) and (c), respectively, plot the probabilities of a delinquent account transitioning into the current and delinquent states. There is clear evidence of a drop in the probability of curing the account as well as a symmetric increase in the probability of staying delinquent after the policy change. Finally, Panel (d) shows no evidence of a structural break in the probability of a delinquent account being written off. The variation in the probability of transitioning from the current to the current state, $\mathbb{P}(C_{t+1}|C_t)$, is omitted because it is perfectly symmetrical to Panel (a).

Figure 3 shows that most current account holders successfully complied with the new policy.

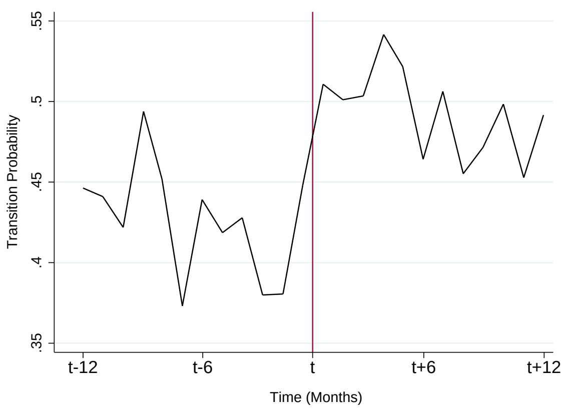
Figure 3: Transition Probabilities
(24-Month Window Around the Policy Change, All Accounts w/ Revolving Balance $\geq$ \$334)



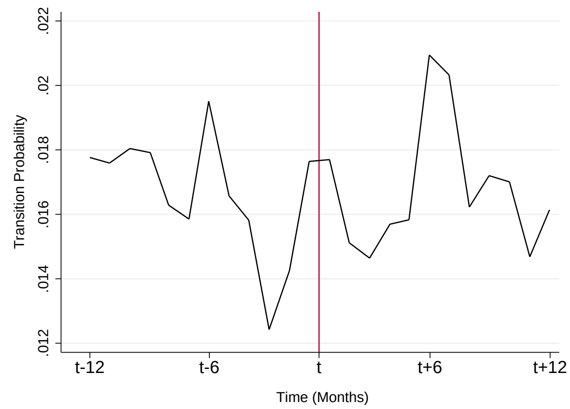
(a) $\mathbb{P}(L_{t+1}|C_t)$



(b) $\mathbb{P}(C_{t+1}|L_t)$



(c) $\mathbb{P}(L_{t+1}|L_t)$



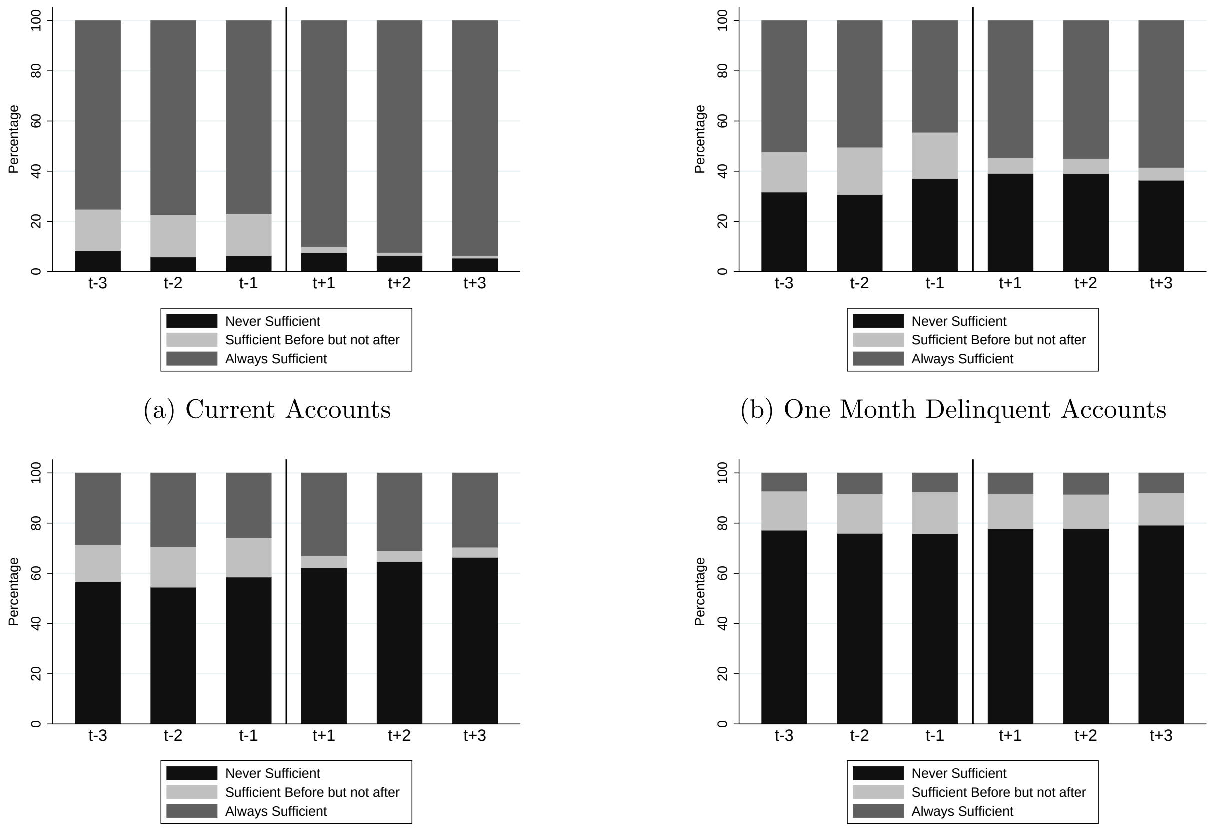
(d) $\mathbb{P}(W_{t+1}|L_t)$

Note: This figure plots the aggregate transition probabilities between states $\omega = \{C, L, W\}$ calculated on account-month observations that have a revolving balance greater than \$334 in a 24-month window around the policy change. The states are defined as (C) if the account is current, (L) if the account is at least one month late, (W) if the account is written-off, due to a default or due to bankruptcy. The transition $\mathbb{P}(C_{t+1}|C_t)$ is omitted because it is perfectly symmetrical to Panel (a).

However, for accounts that are evolving in the delinquent state, the lower rate at which accounts cure shows that some borrowers were not able to adjust to the higher required payments. If we think of delinquency as the realized outcome of binding liquidity constraints around the minimum payment, this provides evidence that the policy had the most severe effect among liquidity-constrained borrowers.

We quantify the effect of the policy on transitions in a regression model identifying off of a dummy variable respectively equal to 0 and 1 before and after the policy change. The model estimated is otherwise similar to that of equation (2) except that we do not exploit the variations

Figure 4: Proportion of Borrowers Making Payments Needed to Cure the Account
(6-Month Window Around the Policy Change, All Accounts w/ Revolving Balance $\geq$ \$334)



(a) Current Accounts

(b) One Month Delinquent Accounts

(c) Two Months Delinquent Accounts

(d) Three+ Months Delinquent Accounts

Note: This figure shows the proportion of account-month payments made relative to the minimum payment for observations that have a revolving balance greater than \$334 in a six-month window around the policy change. The categories classify borrowers according to their payments being never sufficient to cure the account, sufficient to cure the account before but not after the policy change, and always sufficient to cure the account. The counterfactual minimum payments used are based on the monthly revolving balance. The horizontal line represents the date of the policy change.

in proportions of revolving balance but only the change in minimum payment policy. The results are presented in the Appendix in Table A1 and we differ the details of the different specifications estimated to Section 4.1. For now, it is sufficient to note that, across periods of high and low minimum payments, there is a significant decrease in the rate of exiting delinquency varying from 9.01 to 14.34 percentage points, depending on the specification estimated.

The delinquency transitions can also be mapped to the proportion of borrowers making the minimum payment, or not, on the account. To further analyze the repayment behavior of account holders around the minimum amounts required to cure an account, we construct counterfactual payments that would be required under the 3% and 5% rules. Each month, we classify accounts into three categories depending on the payment posted on the account. First, a payment that is less than what was required under the old regime is classified as being never sufficient to cure the account. Those are payments that are less than 3% of the revolving balance, plus any overdue amount on the account and the monthly installment on the term. Second, a payment that is greater than what was necessary under the old regime but less than what is required in the new regime is categorized as being sufficient to cure the account before but not after the change. Those payments are between 3% and 5% of the revolving balance, plus the overdue amount and the term installment. Finally, a payment that is higher than what is required under the new regime is classified as being always sufficient to cure the account. Payments that fall in this category are greater than 5% of the monthly revolving balance, plus the overdue amount and the term installment.[8]

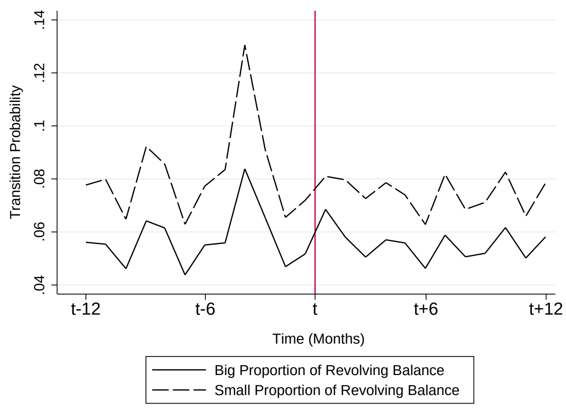
The classification is shown in Figure 4 and is segmented by delinquency cycle. In general, we see a shift away from the old requirement, as we would expect. For current accounts, the shift is almost perfect with only a marginal increase in accounts paying less the minimum payment after the policy change. Across delinquent accounts, the increase in the proportion of borrowers making less than the minimum payment required is substantial, which explains the increase in delinquency. It is worth noting that no clear repayment pattern is apparent once an account reaches three or more months late. In this severe delinquency state, it might be optimal for borrowers to pay whatever cash-on-hand they have available, even if it does not fully cure the account, as long as it can prevent them from defaulting.

4 Main Results

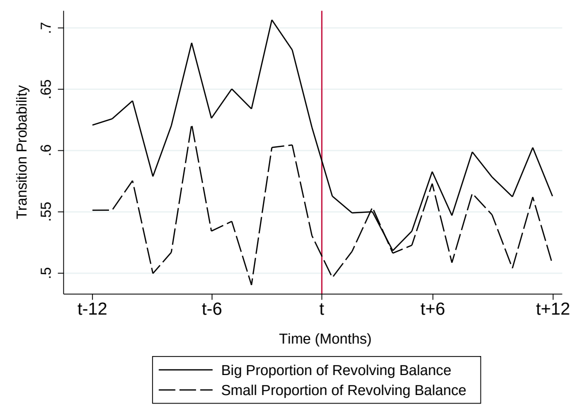
Before turning to the multivariate analysis of the minimum payment increase, we provide graphical evidence supporting our identification strategy through the proportion of revolving balance to total account balance. To do so, Figure 5 plots the transition probabilities for accounts that have high (greater than 95%) and low (smaller than 5%) proportions of revolving balance. Two important conclusions should be drawn from this analysis. First, by examining the time period before the policy change, we can verify that both groups follow parallel trends with respect to delinquency transitions. This is true for all the transition probabilities pictured, and most evident

[8] We allow payments to fall within a 5% range of the calculated categories to make sure we capture small idiosyncratic variations in the effective amount paid.

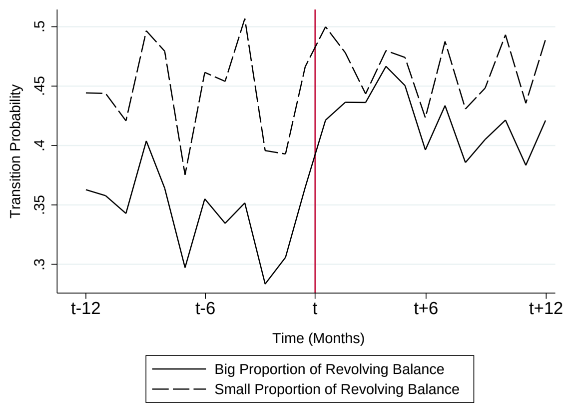
Figure 5: Transition Probabilities
(24-Month Window Around the Policy Change,
Accounts w/ High and Low Proportions of Revolving Balance)



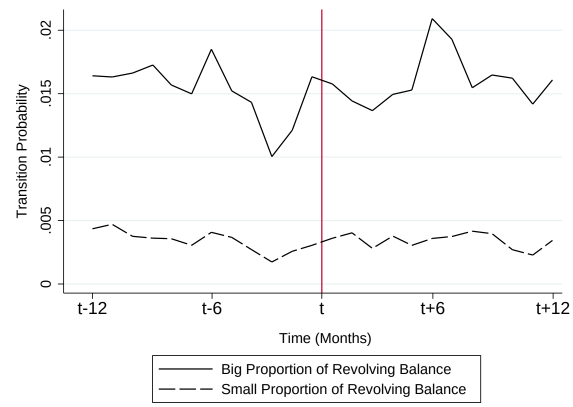
(a) $\mathbb{P}(L_{t+1}|C_t)$



(b) $\mathbb{P}(C_{t+1}|L_t)$



(c) $\mathbb{P}(L_{t+1}|L_t)$



(d) $\mathbb{P}(W_{t+1}|L_t)$

Note: This figure plots the aggregate transition probabilities between states $\omega = \{C, L, W\}$ for accounts that have a big (greater than 95%) and a small (smaller than 5%) proportion of revolving balance to total balance in a 24-month window around the policy change. The states are defined as (C) if the account is current, (L) if the account is at least one month late, (W) if the account is written-off due to a default or due to bankruptcy. The transition $\mathbb{P}(C_{t+1}|C_t)$ is omitted because it is perfectly symmetric to Panel (a).

for current accounts which were virtually unaffected by the policy change. This provides support for the parallel trend assumption used in this kind of difference-in-differences analysis. Second, for delinquent accounts, the policy change only affected borrowers with a high proportion of revolving balance. This is clear in Panels (b) and (c) of Figure 5. In both cases, the delinquency patterns of accounts with small proportions of revolving balance are stable across the period studied, but the situation of accounts with high proportions of revolving balances severely worsens. Taken together, these two facts justify our identification strategy.

4.1 Delinquency Transitions

We first analyze delinquency transitions by estimating probit regressions for the probability that an account will transition across states. For an account that is current, in period t, we analyze its potential transition in the current and delinquent states in the next period, and, similarly, for an account that is delinquent, we analyze its potential transition in the current, delinquent, and written-off states. For each case, we run four specifications, increasingly controlling for observable variables.

The first specification runs the model on the policy dummy, the proportion of revolving balance and their interaction. In the second specification, we add controls for month fixed effects, a dummy variable indicating if the account has only revolving balance, and its interaction with a linear trend. The third specification adds the interaction of the proportion of revolving balance with a linear trend, and, for delinquent accounts, delinquency cycle dummies, and the interaction of linear delinquency cycles with a linear trend. The full set of covariates that control for the risk of the account are added in the fourth specification along with dummies for the length of the spell.[9] Standard errors are corrected for within account heteroscedasticity in all the specifications presented.

Table 3 shows the marginal effects calculated from probit regressions on the probabilities of entering delinquency, of exiting delinquency, and of the account being written-off due to default or bankruptcy. The symmetric results for the probability of current accounts remaining current and late accounts remaining late are relegated to the Appendix in Table A2 because they present nearly identical results but with opposite effects.

The first set of results estimates the probability of entering delinquency. The interaction between the policy dummy and the proportion of revolving loan is positive throughout all specifications, indicating that the marginal effect of the treatment is to increase delinquency rates. However, this result is small and implies that, all else constant, the passage of the policy lead to an increase

[9] The set of control variables, which we group under "Account Risk" in Table 3, are age and sex of the account holder, internal and external measures of credit score, an indicator variable equal to one if the borrower has other accounts at this institution, an indicator variable equal to one if the borrower pays for a reduced APR, APR charged on the revolving balance, average unemployment rate in the borrower's region, account age (in months), revolving credit limit, revolving balance, utilization of the revolving balance (defined as revolving balance/revolving limit), total account balance, and monthly installment on the term loan. All controls are taken at the beginning of the billing cycle to avoid spurious relationships with the independent variable.

Table 3: Effect of the Policy on Delinquency Transitions (Probit Marginal Effects)
(24-Month Window Around the Policy Change, All Accounts with Revolving Balance $\geq$ \$334)

	$\mathbb{P}(L_{t+1}\|C_t)$				$\mathbb{P}(C_{t+1}\|L_t)$				$\mathbb{P}(W_{t+1}\|L_t)$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
After Change × Prop. Revolv.	0.0062***	0.0084***	0.0018***	0.0020***	-0.0527***	-0.0446***	-0.0817***	-0.0610***	0.0015***	0.0014**	0.0005	-0.0004
	(0.0005)	(0.0007)	(0.0007)	(0.0006)	(0.0021)	(0.0029)	(0.0031)	(0.0028)	(0.0004)	(0.0006)	(0.0006)	(0.0006)
After the change?	-0.0064***				-0.0334***				-0.0004			
$1 = yes$, $0 = no$	(0.0004)				(0.0018)				(0.0003)			
Prop. Revolving Loan	-0.0141***	-0.0210***	-0.0293***	0.0106***	0.2529***	0.1305***	0.0717***	0.0432***	-0.0068***	-0.0024***	-0.0064***	-0.0031***
	(0.0005)	(0.0008)	(0.0011)	(0.0009)	(0.0016)	(0.0028)	(0.0037)	(0.0033)	(0.0003)	(0.0005)	(0.0008)	(0.0007)
Month F.E.	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Only Revolv.	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Only Revolv. × Trend	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Prop. Revolv. × Trend	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES
Delinquency Dummies	-	-	-	-	NO	NO	YES	YES	NO	NO	YES	YES
Delinquency × Trend	-	-	-	-	NO	NO	YES	YES	NO	NO	YES	YES
Spell Dummies	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
Account Risk	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
$Pseudo-R^2$	0.000	0.004	0.004	0.201	0.020	0.024	0.115	0.251	0.002	0.003	0.503	0.715
Log Likelihood	-6,240,833	-6,221,255	-6,221,134	-4,619,195	-2,398,483	-2,387,985	-2,166,008	-1,729,872	-295,321	-294,855	-147,146	-79,696
Observations	26,628,063	26,628,063	26,628,063	24,215,110	3,535,545	3,535,545	3,535,545	3,338,118	3,535,545	3,535,545	3,535,545	3,337,806

Note: This table shows the marginal effect of the policy on delinquency transitions estimated from a probit regression model using monthly credit card accounts with revolving balances greater than \$334 in a 24-month window around the policy change. The set of control variables grouped under "Account Risk" are age and sex of the account holder, internal and external measures of credit score, an indicator variable equal to one if the borrower has other accounts at this institution, an indicator variable equal to one if the borrower pays for a reduced APR, APR charged on the revolving balance, average unemployment rate in the borrower's region, account age (in months), revolving credit limit, revolving balance, utilization of the revolving balance (defined as revolving balance/revolving limit), total account balance, and monthly installment on the term loan. All controls are taken at the beginning of the billing cycle to avoid spurious relationships with the independent variable. Standard errors are corrected for within account heteroscedasticity.

of 0.18 to 0.84 percentage points in the probability of entering delinquency for accounts with 100% revolving balance. The second set of results shows that the policy had a big effect on the probability that an account cures. The coefficient on the interaction between the policy dummy and the proportion of revolving balance is significantly negative and stable across specifications. The estimation suggests that the passage of the new minimum payment requirement decreased the probability that an account cures by 4.46 to 8.17 percentage points, on a base rate of 52.3%. These numbers are in line with the graphical representation of Figure 5 but are lower than what is implied by the simple comparison of the periods before and after the policy change (see Table A1). Finally, the third set of results shows a mostly insignificant change in the probability that an account will be written off due to the policy. However, because accounts are spending more time in the delinquent state after the new policy passed, even a stable probability of being written-off actually translates to more accounts being written-off each month. Using the changes in transition probabilities over the 24-month period we study, we estimate that the number of accounts that were written-off due to the policy change increased by 4.33%.

4.1.1 Within Delinquency Cycle Transitions

The results presented thus far show the transition between the current and delinquent states, but we can analyze the delinquency behavior further by looking at the probability of progressing or improving within the delinquency cycle. For a late account, paying the total minimum payment due ensures that the account is classified as current by the financial institution at the beginning of the next billing cycle. By paying down only part of the overdue amount, the borrower reduces the delinquency cycle according to past minimum payment amounts without necessarily curing the loan. A late account can therefore migrate through different delinquency cycles depending on the amount paid by the borrower. This information is managed by the institution, and we rely on their characterization of an account's delinquency cycle.

We split the delinquency transitions into three categories depending on whether an account improves its delinquency cycle, stays in the same cycle or progresses further in delinquency. For example, an account that improves has a delinquency cycle in period $t+1$ that is strictly smaller than that of period t. We estimate a multinomial logit model on the probability of these three outcomes using the full specification of our econometric model (specification (4) in Table 3). We

Table 4: Within Delinquency Cycle Transitions (Multinomial Logit Probabilities)
(24-Month Window Around the Policy Change, All Accounts w/ Revolving Balance ≥ $334,
Effect Implied at a Proportion of Revolving Balance of 100%)

	Current		1 Month Late		2 Months Late		3+ Months Late	
	Before	After	Before	After	Before	After	Before	After
Improve/Cure	-	-	0.673	0.613	0.650	0.598	0.295	0.276
			(0.001)	(0.002)	(0.003)	(0.005)	(0.003)	(0.006)
Stay	0.931	0.928	0.121	0.200	0.100	0.148	0.157	0.154
	(0.000)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)
Progress	0.069	0.072	0.206	0.187	0.250	0.254	0.548	0.570
	(0.000)	(0.001)	(0.001)	(0.002)	(0.002)	(0.005)	(0.004)	(0.007)
$Pseudo-R^2$	0.174		0.171		0.139		0.035	
Log Likelihood	-4,776,790		-1,818,184		-477,082		-386,628	
Observations	24,215,110		2,372,421		580,27		387,830	

Note: This table shows the predicted effect of the policy on within delinquency cycle transitions estimated at a proportion of revolving balance of 100%. The predictions are based on a multinomial logit regression model, estimated using monthly credit card accounts with revolving balances greater than $334 in a 24-month window around the policy change. The full set of controls used for specification (4) of Table 3 are included. Standard errors are corrected for within account heteroscedasticity.

then compute the probability of being in each category before and after the policy change, for a proportion of the revolving balance of 100%.

Table 4 shows the results. For current accounts, the probability of remaining current after the policy change is virtually unchanged, mirroring previous results from Table 3. For accounts that are late, an interesting pattern emerges. After the policy change, we see a decrease in the probability that an account will improve or cure, similar to the main delinquency transition result we already presented. However, we see an important increase in the probability of staying in the same delinquency cycle, but only a small increase in the probability of progressing in delinquency. This provides evidence that although delinquent accounts were not able to sustain the increase in the minimum payment, most consumers continued to pay amounts that at least allowed them to stay in the same delinquency cycle.

4.2 Payment Distributions

In this section, we model the full payment distribution conditional on the delinquency cycle of the account, in a six-month window around the policy change. We show evidence that the policy change mostly affected account holders at the lower end of the payment distribution, where the change in minimum payment requirement is binding. In the next section, we model the purchases made with the account conditional on the payment distribution and show that the response in purchases is most significant in regions of the payment distribution directly affected by the policy change.

To study the whole payment distribution on the revolving accounts, we analyze the conditional quantiles of the percentage of the account balance paid by borrowers (defined as the payments made on the account between two monthly statements divided by the total account balance). We top code the percentage of the balance paid at 100%[10] representing borrowers that repaid their balances fully. The least a borrower can repay is 0% of the monthly balance, so the fraction of the balance repaid lies on the $[0,1]$ interval. For this reason, we use logistic quantile regressions (Bottai, Cai, and McKeown, 2009) and model conditional quantiles as

$$\begin{aligned} Q_\tau(\text{logit}(pmt_{i,t})|\mathbf{X}_i) = \beta_0 + &\beta_1(\text{After}_t \times \text{Prop}_{i,t}) + \beta_2\text{Prop}_{i,t} + \boldsymbol{\beta}_3\text{Only Revol}_{i,t} \\ &+ \boldsymbol{\beta}_4(\text{Only Revol}_{i,t} \times \text{Trend}_t) + \boldsymbol{\beta}_5\mathbf{Month\ F.E.}_t + \epsilon_{i,t}, \qquad (3) \end{aligned}$$

where $Q_\tau(\text{logit}(pmt_{i,t}))$ represents the τth quantile of the $pmt_{i,t}$ distribution using the logistic transformation.[11] All results are presented after transforming the $pmt_{i,t}$ variable back to its level, using the inverse logit transformation. The fraction of the balance that is repaid is defined as

$$pmt_{i,t} = \frac{\text{Payments Posted on the Account for Statement of Date } t}{\text{Total Account Balance for Statement of Date } t}. \qquad (4)$$

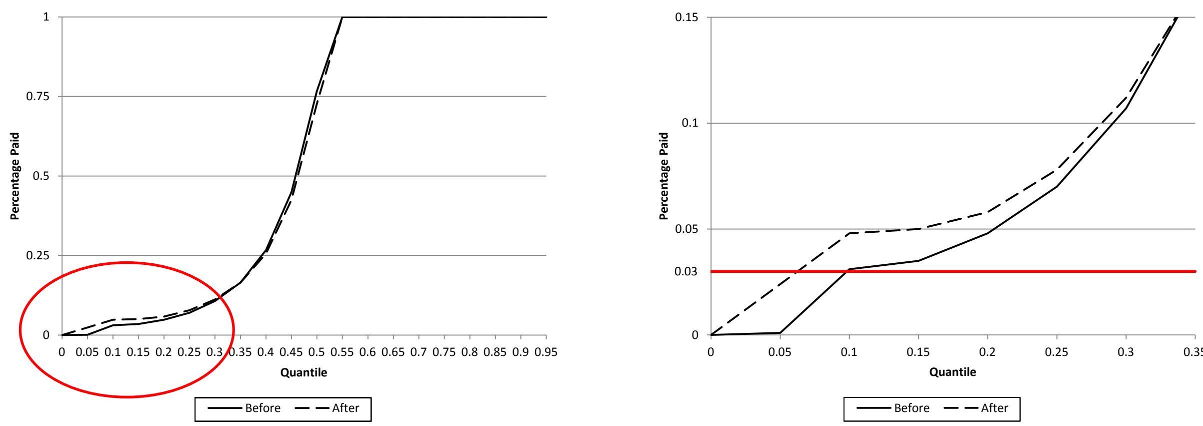
As in the previous specifications, After_t is an indicator variable that takes value of one if the observation is after the policy change and zero if it is before, $\text{Prop}_{i,t}$ is the proportion of revolving balance on the account as defined in equation (1), $\text{Only Revol}_{i,t}$ is a dummy variable indicating that the account has only a revolving balance, Trend_t is a linear trend and $\mathbf{Month\ F.E.}_t$ is vector that includes a full set of month dummies.

The quantile regressions are estimated by minimizing what is sometimes called a check function

[10] Some account holders repay more than 100% of their balance each month because they make purchases and repay them online before they are included in the end-of-the-month balance. This implies higher payments than we observe as monthly balances, but it does not change the fact that these individuals paid off the totality of their balance.

[11] The logistic transformation is given by $logit(y) = \frac{y - y_{min}}{y_{max} - y}$ and insures that predictions of the dependent variable will not exceed its lower and upper bound limits. We follow Bottai, Cai, and McKeown (2009) and add $\epsilon = 0.001$ to ensure that the model can treat values of y on the boundaries. Importantly, our results are quantitatively unchanged if we analyze the fraction of the balance repaid without the logit transformation, except that some of our predictions lie outside the $[0,1]$ interval.

Figure 6: Payment Distribution - Current Accounts
(6-Month Window Around the Policy Change, Current Accounts w/ Revolving Balance $\geq$ \$334, Effect Implied at a Proportion of Revolving Balance of 100%)



(a) Current Accounts   (b) Current Accounts (ZOOM)

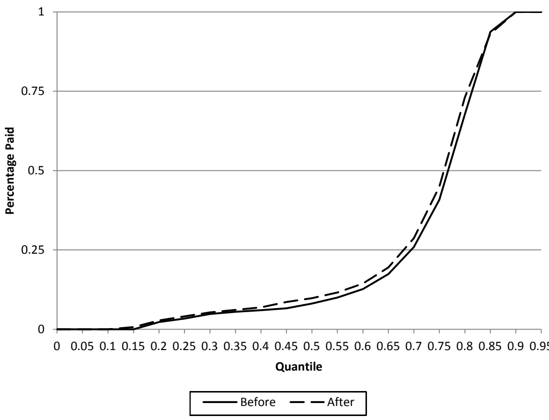
Note: This figure plots the conditional payment quantiles for current accounts before and after the policy change as predicted by the results of Table A3, evaluated at a proportion of the revolving balance of 100%.

using linear programming methods (see Koenker and Hallock, 2001 for an introduction to these techniques). We estimate all quantiles independently, starting at the fifth one and increasing in steps of 5%.[12] The estimation results for some of the most common quantiles are presented in Table A3. The estimation is segmented according to accounts being current, 1, 2 or 3+ months late. We also estimate the OLS regression for the same model, which provides the estimation results at the mean and allows to contrast the effect of the policy on average, and along different quantiles.

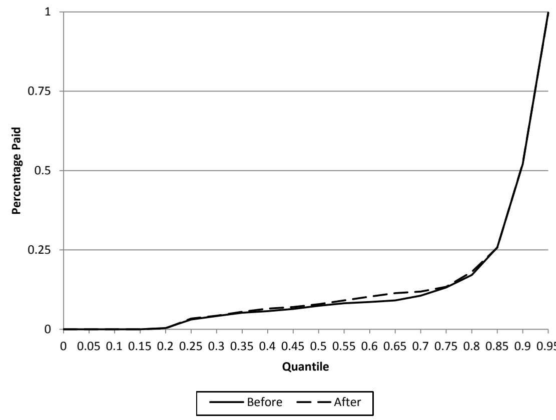
Looking at the OLS results in Table A3, we see that, on average, current accounts did not change the fraction of the payments made on the account after the policy change. This is what we would expect from a policy that affects only borrowers that were repaying around 3% of their balances before the policy change. Consistent with the finding that current accounts did not significantly increase their probability of entering delinquency, Table A3 shows that around the tenth percentile of the payment distribution of current accounts, the effect of the policy is an increase in the percentage of the balance repaid by close to the 2% mandatory increase. This is the region in which borrowers were previously paying about 3% of their balance and increased to the new minimum of 5%. The effect is even clearer when we construct the full conditional quantile

[12]Because the dependent variable does not vary much in the tails of the distribution, some of the quantiles estimated do not converge. For this reason, in the graphics presented, we use the nearest converging quantile to replace ones that did not converge. This only affects some very small quantiles of the payment distribution in regions where the repayment is in any case 0%.

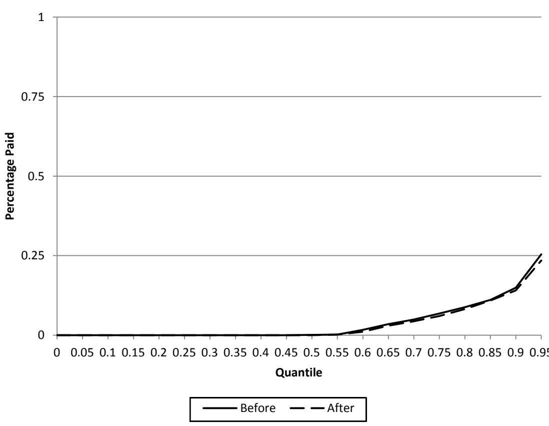
Figure 7: Payment Distributions - Delinquent Accounts
(6-Month Window Around Policy Change, Delinquent Accounts w/ Revolving Balance $\geq$ \$334, Effect Implied at a Proportion of Revolving Balance of 100%)



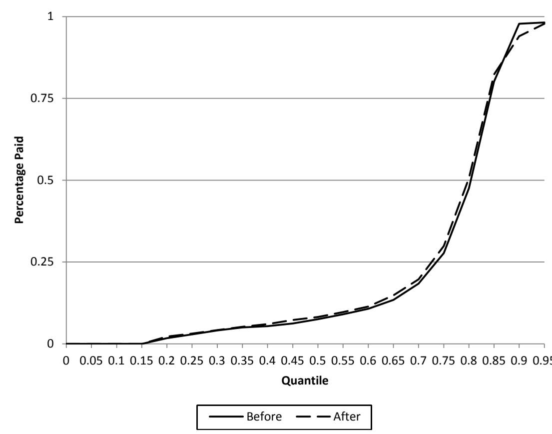
(a) One Month Delinquent Accounts



(b) Two Month Delinquent Accounts



(c) Three+ Months Delinquent Accounts



(d) All Delinquent Accounts

Note: This figure plots the conditional payment quantiles for delinquent accounts before and after the policy change as predicted by the results of Table A3, evaluated at a proportion of revolving balance of 100%.

distributions for the pre- and post-policy change periods, as shown in Figure 6. Such conditional quantiles are constructed from the estimates presented in Table A3 and predicted at a proportion of revolving balance equal to 100%. We can see that on average the distribution of payments did not change after the policy, except around the vicinity of the 3% to 5% payments of the balance. This part of the distribution is shown in Figure 6b and makes clear that the payments increased to perfectly offset the policy starting from the tenth quantile.

Similarly, Table A3 shows that for late accounts, there is no significant increase in the overall percentage of the balance paid off each month, except for accounts that are one cycle delinquent, which increased their payments by about 1.1 percentage point. The conditional distributions of the percentage paid of the balance are also constructed for delinquent accounts and are shown in Figure 7. In general, the effect of the policy is rather weak for delinquent accounts. We see that borrowers in their first delinquency cycle significantly increased the percentage of their account balance paid each month, but the increase was not sufficient to counter the minimum payment policy change for all borrowers, as evidenced by our previous delinquency analysis. For delinquent accounts, the region where we would expect the policy to bind is less clear because the payment required to cure an account depends on what previous payments were posted on the accounts and therefore what the overdue amount is on the account.

4.3 Purchases on the Account

Next, to study the impact of the minimum payment increase on the charging behavior with the credit card, we estimate new monthly purchases conditional on quantiles of the payment distribution, as estimated in the previous section. Specifically, we construct predicted quantiles for the percentage of the account balance paid using the estimation results of Table A3 and compare them to the true observed percentage paid. We then predict the level of purchases for the pre- and post-policy change periods conditional on the true payment posted on the account lying between predicted payment quantiles. Formally, we estimate

$$\mathbb{E}[\text{New Purchases}_{i,t}|\mathbf{X}_{i,t}, \widehat{Q}_{\tau_1}(pmt_{i,t}) < pmt_{i,t} \leq \widehat{Q}_{\tau_2}(pmt_{i,t})], \tag{5}$$

where τ_1 and τ_2 represent the lower and upper quantiles of the payment distribution on which we condition our estimation. $\mathbf{X}_{i,t}$ represents the vector of covariates used in equation (3) and new purchases are constructed as a fraction of the account balance, that is,

$$\text{New Purchases}_{i,t} = \frac{\text{New Purchases as of Statement of Date } t}{\text{Total Account Balance on Statement of Date } t}. \tag{6}$$

The same type of expected value is calculated for the variable $pmt_{i,t}$ and results are presented in Table 5. Alongside these two calculated measures, we also show average monthly new purchases, revolving balance and payments at their levels. Because this policy most directly affects account holders who were previously paying close to the minimum requirements each month, we expect the impact on purchases to be most salient in the range of the payment distribution affected by the increased minimum payment.

The estimation is conducted independently for current and delinquent accounts and is segmented by the predicted payment distribution regions. For current accounts, we classify each account-month observations in three categories, depending on the actual payment posted on the account being (1) lower than its prediction at the 25th percentile, (2) between its 25th and 50th predicted percentile, and (3) greater than its 50th predicted percentile. We choose these regions of the payment distribution because, as shown in Figure 6a, above the 50th percentile most account holders are predicted to repay their balances in full, and the biggest increase in the percentage of the balance paid is under the 25th percentile. For delinquent accounts, we segment the higher region of the distribution further into the region where the actual payment is between its 50th and 75th predicted percentile and the region where it is higher than its 75th percentile.

In Panel A of Table 5, the results show that, over the full payment distribution, there is no significant changes in purchases and payments for current accounts. The most significant change in purchases happens in the lower end of the payment distribution where the estimated purchases were reduced by half as a proportion of the total account balance. This is precisely the region of the distribution that increased the payments on the account to comply with the new policy. However, in this region the purchases made with the account already represent a small fraction of the total account balance. Although the purchases dropped by almost 50%, in this region of the distribution it only represents a movement from 8.6% to 4.3% of the total account balance. Furthermore, the average monthly charge is around $198.69.

In Panel B of Table 5 a similar pattern arises for delinquent accounts. The biggest reduction in purchases is in the lowest region of the payment distribution and corresponds to a reduction of about 44% in purchases. Importantly, the results for delinquent accounts show that, on average, once an account is in the delinquent state the purchases made with the account are already very low. On average the new purchases made with a delinquent account are $182.86, which is around 8% of the total account balance. A reduction of purchases of the order of 44% is therefore big in percentage terms but it is relatively small in dollar amounts.

From this analysis, we also estimate an average reduction in revolving balance of $50 for current borrowers. The hazard model for delinquency transition, estimated in Section 4, suggests that

Table 5: Purchases and Payments as a Fraction of Total Balance
(6-Month Window Around the Policy Change, All Accounts w/ Revolving Balance $\geq$ \$334)

	New Purchases/Total Balance				Payments/Total Balance				Average Levels		
	Before	After	Difference	% Change	Before	After	Difference	% Change	New Purchases	Revolving Balance	Payments
A. Current Accounts											
All Observations	0.597	0.595	-0.002	-0.003	0.520	0.521	0.001	0.002	\$912	\$2,328	\$1,043
	(0.003)	(0.002)	(0.004)	(0.007)	(0.001)	(0.001)	(0.002)	(0.003)	(\$1,927)	(\$2,856)	(\$1,872)
$pmt_{i,t} \leq \widehat{Q}_{25}(pmt_{i,t})$	0.086	0.043	-0.043***	-0.499***	0.031	0.042	0.011***	0.345***	\$199	\$3,458	\$165
	(0.005)	(0.003)	(0.008)	(0.062)	(0.000)	(0.000)	(0.000)	(0.007)	(\$1,597)	(\$3,555)	(\$204)
$\widehat{Q}_{25}(pmt_{i,t}) < pmt_{i,t} \leq \widehat{Q}_{50}(pmt_{i,t})$	0.270	0.259	-0.011***	-0.042***	0.241	0.237	-0.004***	-0.016***	\$502	\$2,442	\$528
	(0.002)	(0.001)	(0.003)	(0.012)	(0.001)	(0.001)	(0.001)	(0.006)	(\$957)	(\$2,900)	(\$794)
$\widehat{Q}_{50}(pmt_{i,t}) < pmt_{i,t}$	1.008	1.056	0.048***	0.047***	0.906	0.915	0.009***	0.010***	\$1,473	\$1,707	\$1,739
	(0.004)	(0.003)	(0.006)	(0.006)	(0.000)	(0.000)	(0.001)	(0.001)	(\$2,244)	(\$2,181)	(\$2,381)
B. Late Accounts											
All Observations	0.089	0.083	-0.006**	-0.068**	0.201	0.214	0.013***	0.065***	\$183	\$2,447	\$538
	(0.002)	(0.001)	(0.003)	(0.028)	(0.002)	(0.001)	(0.003)	(0.015)	(\$707)	(\$2,813)	(\$1,411)
$pmt_{i,t} \leq \widehat{Q}_{25}(pmt_{i,t})$	0.022	0.013	-0.010**	-0.442***	0.006	0.007	0.001***	0.105***	\$34	\$2,535	\$34
	(0.003)	(0.002)	(0.005)	(0.150)	(0.000)	(0.000)	(0.000)	(0.037)	(\$637)	(\$2,911)	(\$88)
$\widehat{Q}_{25}(pmt_{i,t}) < pmt_{i,t} \leq \widehat{Q}_{50}(pmt_{i,t})$	0.031	0.029	-0.002	-0.073	0.053	0.059	0.006***	0.112***	\$92	\$3,084	\$225
	(0.001)	(0.001)	(0.002)	(0.049)	(0.000)	(0.000)	(0.000)	(0.008)	(\$292)	(\$3,142)	(\$240)
$\widehat{Q}_{50}(pmt_{i,t}) < pmt_{i,t} \leq \widehat{Q}_{75}(pmt_{i,t})$	0.045	0.046	0.002	0.034	0.110	0.120	0.010***	0.094***	\$120	\$2,231	\$351
	(0.001)	(0.001)	(0.002)	(0.050)	(0.000)	(0.000)	(0.001)	(0.007)	(\$382)	(\$2,530)	(\$394)
$\widehat{Q}_{75}(pmt_{i,t}) < pmt_{i,t}$	0.241	0.223	-0.018***	-0.075***	0.580	0.596	0.016***	0.028***	\$485	\$1,937	\$1,540
	(0.003)	(0.003)	(0.006)	(0.024)	(0.002)	(0.002)	(0.004)	(0.007)	(\$1,111)	(\$2,484)	(\$2,518)

Note: This table shows the predicted effect of the policy change on new purchases (as defined by equation (6)) and payments (as defined by equation (4)) conditional on payment quantiles predicted using the results in Table A3. Also reported, are the average new purchases, revolving balance, and payments at their levels. Controls used in the regressions include the proportion of revolving balance, its interaction with the policy dummy, month fixed effects, a dummy variable indicating if the account has only a revolving balance, and its interaction with a linear trend. For delinquent accounts, dummies for the delinquency cycle and their interaction with a linear trend are included. Predictions are made at a proportion of revolving balance equal to 100%. All amounts are presented in local currency.

reducing the revolving balance reduces the probability of delinquency. Using this variation in revolving balance, we find that higher payments and reduced purchases resulted in a decrease of 0.0011% of the accounts that entered delinquency in the 24-month period we study. This shows that the policy was at least effective for current borrowers.

5 Extensions

In this section we present extensions that provide further evidence of the effect of the minimum payment increase.

5.1 Instrumenting for Proportion of Revolving Balance

We alleviate concerns that the policy change itself might have affected the proportion of the revolving and term balances of borrowers by instrumenting the measure of treatment intensity by its value lagged by six months. The policy change could affect the proportion of revolving balances in two ways. First, borrowers might switch to term loans as a response to the minimum payment increase on the revolving balances. Figure A1a shows that the rate at which term loans are contracted is stable before and after the policy change so that there seems to be no switching effect. However, as a loss mitigation strategy, the bank also offers the possibility for severely delinquent borrowers to consolidate their revolving balance into a term loan. If borrowers who cannot sustain the increase in minimum payment convert their revolving balance into a term loan through consolidation, it will limit our ability to find an effect from the policy. Figure A1b shows that there is evidence of an increase in conversion of revolving loans to term loans as a result of the policy change although the rate of conversion is still smaller than 0.025% even at its peak.

Second, the increase in minimum payment could also have the perverse effect of increasing the revolving balance of consumers that cannot afford the increase. Such a feedback effect from the policy to the proportion of revolving balance could confound our results. Figure A1c shows the average proportion of revolving balance in the 24-month window around the policy for current and delinquent accounts. There is a general increasing trend in the proportion of revolving balance, but there seems to be no change in trend before and after the policy change.

As a robustness check, we therefore run two-stage least squares regressions on the probability of delinquency transitions. The proportion of revolving balance is instrumented by its value lagged by six months, while its interaction with the policy dummy is instrumented using the policy dummy interacted with the six-month lagged proportion of revolving balance. Tables A4 and A5 show that the first stages strongly predict the potentially endogenous variable. The second stage regressions show that our results do not change much once we instrument the treatment intensity variable. We still find that the probability of entering delinquency only marginally increased following the minimum payment increase and that the probability of exiting delinquency decreased by about 6.5 percentage points. This shows that the possibility that the policy affected the proportions of revolving and term balances should not be a concern in the interpretation of our results.

5.2 Falsification Test

Up to now, our main results have been restricted to accounts with balances over $334. Those are the accounts with a balance sufficiently high to be directly affected by the minimum payment increase (see Figure 1). Accounts with revolving balances under $200 are not affected by the policy change at all because their minimum repayment is equal to the floor amount ($10) both before and after the change. We thus perform a falsification test by retaining only accounts with balances under $200 but above $10 and perform the delinquency analysis again. The results are presented in Table A6 and show that the policy change did not affect the delinquency outcome with any economic significance. This provides reassurance that the effect we find is not artificial.

5.3 Regression Kink Design

Next, to estimate the effect of the policy change for borrowers with low monthly revolving balances, we exploit the piece-wise linear feature of the minimum payment schedule in regions where the minimum payment binds to its floor amount of $10 (see Figure 1). We keep observations that have only a revolving balance over a time window of six months around the policy change and identify off the two kinks implied by the policy change, around revolving balances of $200 and $334. This is analogous to the changes in floor payment studied by Keys and Wang (2014), although our kinks are at lower balances than theirs. In our sample, the effect of the minimum payment increase is therefore less binding for borrowers in this region.

Figure A2 shows average transition probabilities as well as purchases made with the account and payments before and after the minimum payment increase, for accounts with revolving balances around the kinks implied by the minimum payment schedule. Only the probability of curing the account seems to be affected by the kinks. Following the typical strategy in regression kink designs (Card, Lee, Pei, and Weber, 2012), we quantify the effect implied around the kinks through the equation

$$y_{i,t} = \beta_0 + \beta_1 \text{After} \times \frac{(\text{Revolving Balance}_{i,t} - k)}{100} + \beta_2 \frac{(\text{Revolving Balance}_{i,t} - k)}{100} + \boldsymbol{\beta}_3 \boldsymbol{X}_{i,t} + \epsilon_{i,t}, \quad (7)$$

where After_t is an indicator variable that takes the value of one if the observation is after the policy change and zero if it is before, and $\boldsymbol{X}_{i,t,}$ includes month fixed effects and a set of dummy variables for revolving balance in \$5 bins. Everything is centered around the kink, by subtracting its value from the running variable and normalizing by 100. The coefficient of interest is β_1 which measures the the impact of increasing the revolving balance by \$100 in the region around the kinks.

Table A7 presents the results with Panel A showing the impact around the first kink and Panel B around the second kink. The first column shows that the identification strategy works in identifying the increase in minimum payment. The next columns show the transition probabilities and present results similar to our main analysis. There is a negligible increase in the probability of entering delinquency and a decrease in the probability of exiting delinquency, although it is only statistically significant for the \$334 kink. In this range of revolving balances, the probability of exiting delinquency is close to 75%, so a decrease of 3.85 percentage points in the probability of an account curing represents a drop of about 5%. This is smaller than the effect we find in the main analysis for accounts with higher balances. The last two columns shows that the average purchases and payments made on the card were not significantly affected by the policy change in this region of revolving balances.

5.4 Heterogeneous Effects

Finally, we investigate the effect of the minimum payment increase through the moderating effects of account characteristics such as the revolving balance (measured both in dollars and as a proportion of the limit), the external credit score, and whether the account holder is also a client at the institution for other accounts. We re-estimate the probit models presented in Table 3 under specification (4) and interact the policy dummy with the proportion of revolving balance and these characteristics.

Panels A and B of Table A8 show that the effect of the policy was more severe for accounts with a higher revolving balance, both in dollar amounts and as a proportion of the credit limit. Accounts with higher balances are more likely to become delinquent and less likely to cure as a result of the policy change, although the latter effect is not statistically significant. There is some evidence that a higher revolving balance also leads to a higher probability of the account being written-off. This is in line with such policy change that affects higher balances more severely in dollar terms and shows that it is important to consider the effect of minimum payment changes in this range of balances.

Panel C shows that borrowers with better external scores were less affected by the policy change as one would imagine. Finally, Panel D shows that account holders who do business with the institution for other accounts seem to have been less affected by the policy change, in line with the literature on relationship banking.

6 Conclusion

We document the effects of minimum credit card payments by studying a policy change that increased the minimum monthly required payment from 3% to 5% of the revolving balance. This change contrasts with the disclosure rules imposed by the 2009 CARD Act, which only nudged borrowers in repaying their balance faster without imposing higher minimum payments. We document an overall increase in the time spent in delinquency as well as a reduction in spending made with the credit card for borrowers in the lower end of the payment distribution.

Current borrowers who would have paid 3% of their balance, absent of the policy change, increase their payments almost one-for-one with the new minimum requirement, so that the rate of transition into delinquency is unaffected. At the same time, current borrowers in the lower end of the payment distribution — who are most likely to be affected by the minimum payment increase — reduce the purchases made with the card. For these borrowers, combining increased payments with reduced purchases successfully leads to decreasing their revolving balance. However, we estimate that such a small change only decreased the number of accounts that entered delinquency by 0.0011% in the 24-month window around the policy change. This suggests that increasing minimum payments on current borrowers is likely to be an effective strategy to accelerate debt repayment without increasing delinquency. Whether such a change is good for borrowers depends on one's view about the optimality of carrying a credit card balance.

Delinquent borrowers respond to the policy change by increasing the payments on the account, but the increase is not sufficient to keep up with the new minimum payment requirement, leading to lower transitions out of delinquency. Delinquent borrowers who would otherwise have paid the minimum find it difficult to increase payments sufficiently and consequently fail to cure the account. This is estimated to have increased the number of accounts that were written-off by the institution by 4.33%. This suggests that liquidity constraints bind more tightly for delinquent borrowers than current ones. Our analysis implies that lower minimums for delinquent than current borrowers might encourage faster debt repayment without inducing substantial increases in delinquency.

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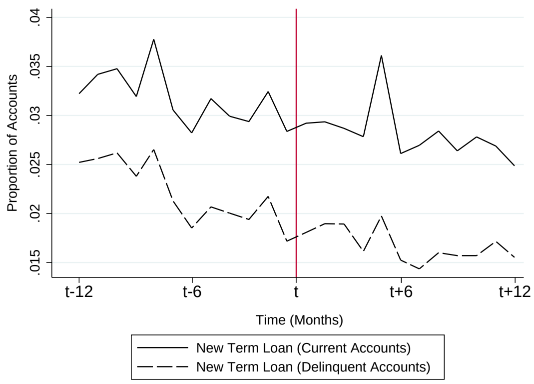
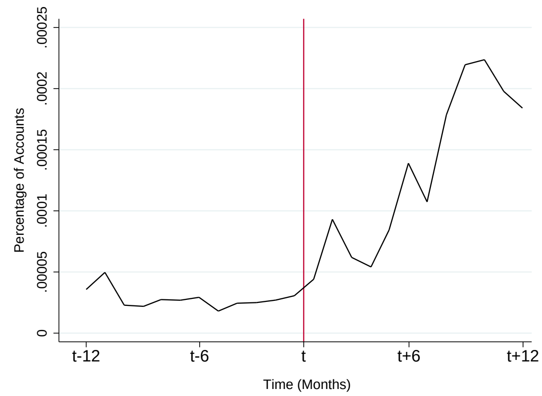
7 Appendix

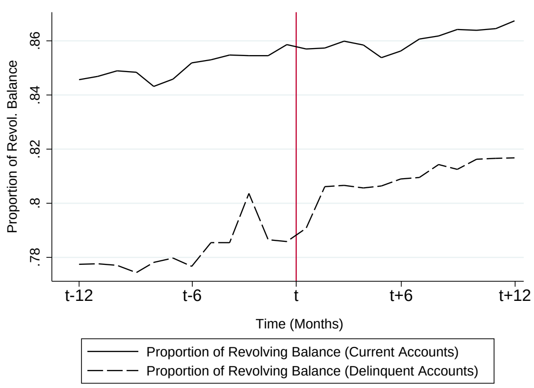
Figure A1: Term and Revolving Loans



(a) New Term Loans



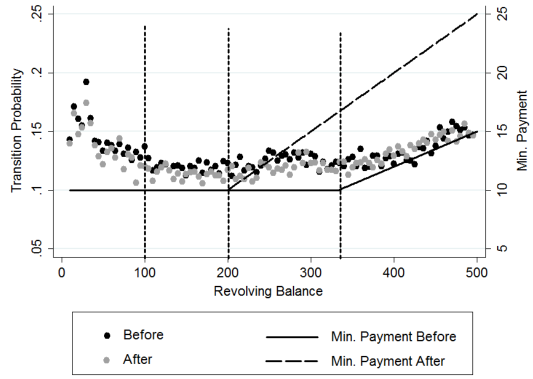
(b) New Conversions into Term Loans



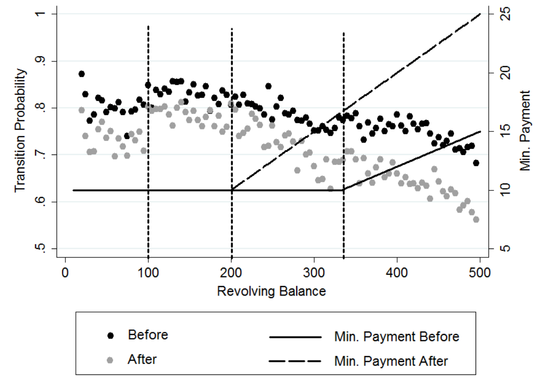
(c) Proportion of Revolving Balance

Note: This figure shows term and revolving borrowing in the 24-month period around the policy change. Panel (a) shows the rate of new term loans being opened each month. Panel (b) shows the rate of conversions from revolving to term loans each month. Panel (c) shows the average proportion of revolving balance to total account balance for current and delinquent accounts.

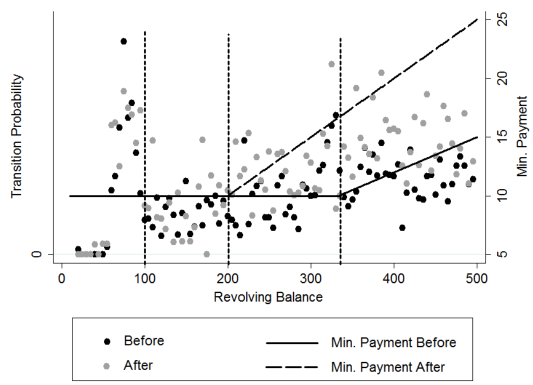
Figure A2: Average Outcomes Around the Minimum Payment Kinks



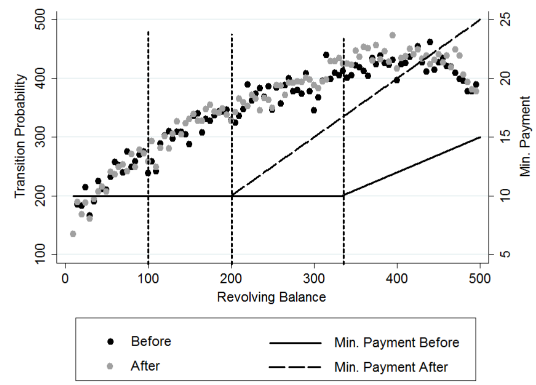
(a) $\mathbb{P}(L_{t+1}|C_t)$



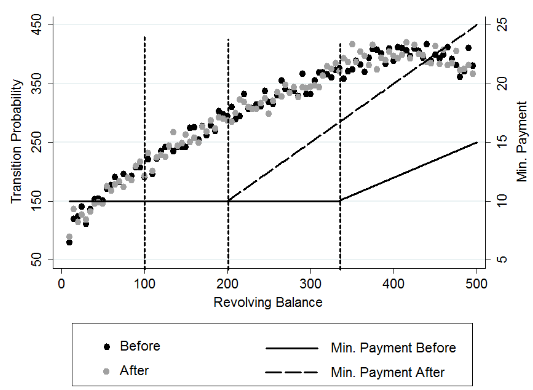
(b) $\mathbb{P}(C_{t+1}|L_t)$



(c) $\mathbb{P}(W_{t+1}|L_t)$



(d) Purchases



(e) Payments

Note: This figure plots average outcomes before and after the minimum payment change for accounts with a revolving balance between \$0 and \$500 in a six-month window around the policy change.

Table A1: Effect of the Policy on Delinquency Transitions (Probit Marginal Effects)
(24-Month Window Around the Policy Change, Accounts with only Revolving Balance $\geq$ \$334)

	$\mathbb{P}(L_{t+1}\|C_t)$			$\mathbb{P}(C_{t+1}\|L_t)$				$\mathbb{P}(W_{t+1}\|L_t)$			
	(1)	(2)	(3)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
After the change?	-0.0007***	0.0034***	-0.0002	-0.0901***	-0.1434***	-0.1259***	-0.1035***	0.0011***	0.0018***	0.0006***	-0.0003
$1 = yes$, $0 = no$	(0.0001)	(0.0002)	(0.0003)	(0.0008)	(0.0013)	(0.0012)	(0.0011)	(0.0002)	(0.0003)	(0.0002)	(0.0002)
Quadratic Trend	NO	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Delinquency Dummies	-	-	-	NO	NO	YES	YES	NO	NO	YES	YES
Delinquency $\times$ Trend	-	-	-	NO	NO	YES	YES	NO	NO	YES	YES
Spell Dummies	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
Account Risk	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
$Pseudo - R^2$	0.000	0.000	0.213	0.006	0.007	0.094	0.253	0.000	0.000	0.549	0.748
Observations	19,381,958	19,381,958	17,463,475	2,257,923	2,257,923	2,257,923	2,108,357	2,257,923	2,257,923	2,257,923	2,107,918

Note: This table shows the marginal effect of the policy on delinquency transitions estimated from a probit regression model using monthly credit card accounts with revolving balances greater than \$334 in a 24-month window around the policy change. The effect of the policy change is calculated only from the variation between periods of low and high minimum payments. The set of control variables grouped under "Account Risk" are age and sex of the account holder, internal and external measures of credit score, an indicator variable equal to one if the borrower has other accounts at the same institution, an indicator variable equal to one if the borrower pays for a reduced APR, APR charged on the revolving balance, average unemployment rate in the borrower's region, account age (in months), revolving credit limit, revolving balance, utilization of the revolving balance (defined as revolving balance/revolving limit), total account balance, and monthly installment on the term loan. All controls are taken at the beginning of the billing cycle to avoid spurious relationships with the independent variable. Standard errors are corrected for within account heteroscedasticity.

Table A2: Effect of the Policy on Delinquency Transitions (Probit Marginal Effects)
(24-Month Window, All Accounts with Revolving Balance $\geq$ \$334)

	$\mathbb{P}(C_{t+1}\|C_t)$				$\mathbb{P}(L_{t+1}\|L_t)$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
After Change × Prop. Revolv.	-0.0062***	-0.0084***	-0.0017**	-0.0020***	0.0527***	0.0447***	0.0838***	0.0624***
	(0.0005)	(0.0007)	(0.0007)	(0.0006)	(0.0020)	(0.0028)	(0.0031)	(0.0028)
After the change?	0.0063***				0.0328***			
$1 = yes$, $0 = no$	(0.0004)				(0.0017)			
Prop. Revolving Loan	0.0142***	0.0210***	0.0294***	-0.0108***	-0.2459***	-0.1277***	-0.0632***	-0.0388***
	(0.0005)	(0.0008)	(0.0011)	(0.0009)	(0.0016)	(0.0028)	(0.0038)	(0.0034)
Month F.E.	NO	YES	YES	YES	NO	YES	YES	YES
Only Revolv.	NO	YES	YES	YES	NO	YES	YES	YES
Only Revolv. × Trend	NO	YES	YES	YES	NO	YES	YES	YES
Prop. Revolv. × Trend	NO	NO	YES	YES	NO	NO	YES	YES
Delinquency Dummies	-	-	-	-	NO	NO	YES	YES
Delinquency × Trend	-	-	-	-	NO	NO	YES	YES
Spell Dummies	NO	NO	NO	YES	NO	NO	NO	YES
Account Risk	NO	NO	NO	YES	NO	NO	NO	YES
$Pseudo - R^2$	0.000	0.004	0.004	0.201	0.019	0.023	0.094	0.225
Log Likelihood	-6,246,011	-6,226,469	-6,226,347	-4,619,785	-2,392,984	-2,382,901	-2,210,513	-1,785,079
Observations	26,628,063	26,628,063	26,628,063	24,215,110	3,535,545	3,535,545	3,535,545	3,338,118

Note: This table shows the marginal effect of the policy on delinquency transitions estimated from a probit regression model using monthly credit card accounts with revolving balances greater than \$334 in a 24-month window around the policy change. The set of control variables included in "Account Risk" are age and sex of the account holder, internal and external measures of credit score, an indicator variable equal to one if the borrower has other accounts at the same institution, an indicator variable equal to one if the borrower pays for a reduced APR, the APR charged on the revolving balance, the average unemployment rate in the borrower's region, the account age (in months), the revolving credit limit, the revolving balance, the utilization of the revolving account (defined as revolving balance/revolving limit), the total account balance, and the monthly installment on the term loan. Standard errors are corrected for within account heteroscedasticity.

Table A3: Payments - Quantile Regressions
(6-Month Window Around the Policy, All Accounts w/ Revolving Balance ≥ $334)

	Quantile Regressions					Least Squares
	0.10	0.25	0.50	0.75	0.90	OLS
A. Current Accounts						
After Change × Prop. Revolving Bal.	0.016***	0.006***	-0.030***	0.014***	0.004***	0.001
	(0.000)	(0.001)	(0.003)	(0.000)	(0.000)	(0.002)
Prop. of Revolving Bal	0.025***	0.040***	0.153***	0.210***	0.242***	0.293***
	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.001)
Constant	0.019***	0.029***	0.050***	0.084***	0.112***	0.061***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Observations	6,757,276	6,757,276	6,757,276	6,757,276	6,757,276	6,757,276
B. 1 Month Late						
After Change × Prop. Revolving Bal.	-	0.006***	0.015***	0.033***	-0.021***	0.011***
		(0.001)	(0.001)	(0.007)	(0.000)	(0.002)
Prop. of Revolving Bal	-	0.033***	0.066***	0.246***	0.272***	0.181***
		(0.001)	(0.001)	(0.006)	(0.000)	(0.002)
Constant	-	0.022***	0.051***	0.106***	0.107***	0.069***
		(0.000)	(0.000)	(0.002)	(0.000)	(0.001)
Observations		693,012	693,012	693,012	693,012	693,012
C. 2 Months Late						
After Change × Prop. Revolving Bal.	-	0.003	0.004**	0.001	0.002	0.002
		(0.002)	(0.002)	(0.004)	(0.023)	(0.004)
Prop. of Revolving Bal	-	0.030***	0.069***	0.145***	0.514***	0.148***
		(0.002)	(0.002)	(0.003)	(0.018)	(0.004)
Constant	-	0.009***	0.040***	0.084***	0.132***	0.047***
		(0.000)	(0.001)	(0.001)	(0.007)	(0.002)
Observations		155,738	155,738	155,738	155,738	155,738
D. 3+ Months Late						
After Change × Prop. Revolving Bal.	-	-	-0.003***	-0.008*	-0.008	-0.002
			(0.000)	(0.004)	(0.009)	(0.004)
Prop. of Revolving Bal	-	-	0.009***	0.076***	0.188***	0.080***
			(0.000)	(0.003)	(0.008)	(0.004)
Constant	-	-	0.003***	0.105***	0.116***	0.056***
			(0.000)	(0.005)	(0.006)	(0.003)
Observations			89,884	89,884	89,884	89,884
E. All Late Accounts						
After Change × Prop. Revolving Bal.	-	0.005***	0.008***	0.025***	-0.015***	0.011***
		(0.001)	(0.001)	(0.004)	(0.000)	(0.002)
Prop. of Revolving Bal	-	0.023***	0.063***	0.207***	0.245***	0.158***
		(0.001)	(0.001)	(0.003)	(0.000)	(0.002)
Constant	-	0.074***	0.090***	0.178***	0.314***	0.139***
		(0.001)	(0.001)	(0.002)	(0.000)	(0.001)
Observations		938,634	938,634	938,634	938,634	938,634

Note: This table shows the estimation of quantile regressions for which the independent variable is the ratio of payments to total account balance, as defined by equation (4). The sample used consists of observations that have a revolving balance greater than $334 in a six-month window around the policy change. Additional unreported controls are month fixed effects, a dummy variable indicating if the account has only a revolving balance and its interaction with a linear trend. For delinquent accounts, dummies for the delinquency cycle and their interaction with a linear trend are included. Some quantiles in the lower end of the payment distribution did not converge due to insufficient variation in the dependent variable and are therefore omitted.

Table A4: 2SLS Delinquency Transitions - Current Accounts
(24-Month Window Around the Policy Change, Current Accounts with Revolving Balance $\geq$ \$334)

	First Stages		Instrumented 2nd Stage		First Stages		Instrumented 2nd Stage	
	Prop. Revol	After Change ×Prop. Revol	$\mathbb{P}(C_{t+1}\|C_t)$	$\mathbb{P}(L_{t+1}\|C_t)$	Prop. Revol	After Change × Prop. Revol	$\mathbb{P}(C_{t+1}\|C_t)$	$\mathbb{P}(L_{t+1}\|C_t)$
After Change × Prop. Revolv.			-0.0035***	0.0035***			-0.0128***	0.0128***
			(0.0004)	(0.0004)			(0.0012)	(0.0012)
Prop. Revolving Loan			0.0144***	-0.0143***			-0.1522***	0.1513***
			(0.0007)	(0.0007)			(0.0024)	(0.0024)
After Change × Prop. Revolv.$_{t-6}$	0.0037***	0.8780***			-0.0081***	0.5316***		
	(0.0008)	(0.0007)			(0.0015)	(0.0017)		
Prop. Revolv.$_{t-6}$	0.7746***	-0.0468***			0.2162***	-0.1551***		
	(0.0010)	(0.0003)			(0.0017)	(0.0009)		
Month F.E.	YES	YES	YES	YES	YES	YES	YES	YES
Only Revolv.	NO	NO	NO	NO	YES	YES	YES	YES
Only Revolv. × Trend	NO	NO	NO	NO	YES	YES	YES	YES
Delinquency Dummies	-	-	-	-	-	-	-	-
Delinquency × Trend	-	-	-	-	-	-	-	-
Spell Dummies	NO	NO	NO	NO	YES	YES	YES	YES
Account Risk	NO	NO	NO	NO	YES	YES	YES	YES
R^2	0.619	0.936	0.002	0.002	0.851	0.963	0.128	0.127
Log Likelihood	7,683,705	15,258,797			15,785,221	19,126,856		
Observations	21,431,841	21,431,841	21,364,441	21,364,441	19,385,054	19,385,054	19,324,415	19,324,415

Note: This table shows the results of Two-Stage Least Squares estimates of the delinquency transitions. The proportion of revolving balance is instrumented by its value lagged of six months while its interaction with the policy dummy is instrumented using the policy dummy interacted with the six-month lagged proportion of revolving balance.The set of control variables grouped under "Account Risk" are age and sex of the account holder, internal and external measures of credit score, an indicator variable equal to one if the borrower has other accounts at the same institution, an indicator variable equal to one if the borrower pays for a reduced APR, APR charged on the revolving balance, average unemployment rate in the borrower's region, account age (in months), revolving credit limit, revolving balance, utilization of the revolving balance (defined as revolving balance/revolving limit), total account balance, and monthly installment on the term loan. All controls are taken at the beginning of the billing cycle to avoid spurious relationships with the independent variable. Standard errors are corrected for within account heteroscedasticity.

Table A5: 2SLS Delinquency Transitions - Delinquent Accounts
(24-Month Window Around the Policy Change, Delinquent Accounts with Revolving Balance $\geq$ \$334)

	First Stages		Instrumented 2nd Stage			First Stages		Instrumented 2nd Stage		
	Prop. Revol	After Change ×Prop. Revol	$\mathbb{P}(C_{t+1}\|L_t)$	$\mathbb{P}(L_{t+1}\|L_t)$	$\mathbb{P}(W_{t+1}\|L_t)$	Prop. Revol	After Change × Prop. Revol	$\mathbb{P}(C_{t+1}\|L_t)$	$\mathbb{P}(L_{t+1}\|L_t)$	$\mathbb{P}(W_{t+1}\|L_t)$
After Change × Prop. Revolv.			-0.0671***	0.0676***	-0.0005			-0.0606***	0.0617***	-0.0011
			(0.0019)	(0.0019)	(0.0004)			(0.0033)	(0.0033)	(0.0009)
Prop. Revolving Loan			0.2908***	-0.2867***	-0.0042***			0.0144***	-0.0235***	0.0091***
			(0.0020)	(0.0020)	(0.0003)			(0.0047)	(0.0047)	(0.0013)
After Change × Prop. Revolv.$_{t-6}$	-0.0002	0.8844***				-0.0052***	0.6783***			
	(0.0006)	(0.0005)				(0.0013)	(0.0013)			
Prop. Revolv.$_{t-6}$	0.8171***	-0.0321***				0.3832***	-0.1455***			
	(0.0006)	(0.0002)				(0.0016)	(0.0008)			
Month F.E.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Only Revolv.	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
Only Revolv. × Trend	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
Delinquency Dummies	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
Delinquency × Trend	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
Spell Dummies	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
Account Risk	NO	NO	NO	NO	NO	YES	YES	YES	YES	YES
R^2	0.782	0.954	0.024	0.025	0.000	0.878	0.967	0.271	0.245	0.346
Log Likelihood	1,635,907	2,664,001				2,335,144	2,993,185			
Observations	2,993,195	2,993,195	2,978,689	2,978,689	2,978,689	2,820,668	2,820,668	2,807,181	2,807,181	2,807,181

Note: This table shows the results of two-stage least squares estimates of the delinquency transitions. The proportion of revolving balance is instrumented by its value lagged of six months while its interaction with the policy dummy is instrumented using the policy dummy interacted with the six-month lagged proportion of revolving balance. The set of control variables grouped under "Account Risk" are age and sex of the account holder, internal and external measures of credit score, an indicator variable equal to one if the borrower has other accounts at the same institution, an indicator variable equal to one if the borrower pays for a reduced APR, APR charged on the revolving balance, average unemployment rate in the borrower's region, account age (in months), revolving credit limit, revolving balance, utilization of the revolving balance (defined as revolving balance/revolving limit), total account balance, and monthly installment on the term loan. All controls are taken at the beginning of the billing cycle to avoid spurious relationships with the independent variable. Standard errors are corrected for within account heteroscedasticity.

Table A6: Falsification Test (Probit Marginal Effects)
(24-Month Window Around the Policy Change, Accounts with \$10 < Revolving Balance < \$200)

	$\mathbb{P}(L_{t+1}\|C_t)$				$\mathbb{P}(C_{t+1}\|L_t)$				$\mathbb{P}(W_{t+1}\|L_t)$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
After Change × Prop. Revolv.	0.0047***	-0.0030***	-0.0042***	-0.0049***	-0.0073**	0.0130***	0.0031	0.0073*	0.0007*	0.0004	0.0002	0.0017***
	(0.0006)	(0.0010)	(0.0010)	(0.0010)	(0.0030)	(0.0047)	(0.0046)	(0.0044)	(0.0004)	(0.0007)	(0.0005)	(0.0005)
After the change?												
$1 = yes$, $0 = no$	-0.0081***				-0.0102***				0.0004			
	(0.0006)				(0.0015)				(0.0003)			
Prop. Revolving Loan	-0.0162***	0.0135***	0.0059**	0.0182***	0.1771***	-0.0413***	0.0731***	0.0500***	0.0165***	0.0203***	-0.0065***	-0.0153***
	(0.0005)	(0.0016)	(0.0029)	(0.0025)	(0.0021)	(0.0050)	(0.0085)	(0.0081)	(0.0003)	(0.0007)	(0.0013)	(0.0009)
Month F.E.	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Only Revolv.	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Only Revolv. × Trend	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Prop. Revolv. × Trend	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES
Delinquency Dummies	-	-	-	-	NO	NO	YES	YES	NO	NO	YES	YES
Delinquency × Trend	-	-	-	-	NO	NO	YES	YES	NO	NO	YES	YES
Spell Dummies	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
Account Risk	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
$Pseudo-R^2$	0.002	0.006	0.006	0.179	0.016	0.022	0.069	0.162	0.062	0.065	0.659	0.846
Log Likelihood	-1,586,609	-1,579,023	-1,579,015	-1,243,458	-672,775	-668,476	-636,792	-556,620	-49,441	-49,299	-17,976	-7,786
Observations	7,667,733	7,667,733	7,667,733	7,197,342	1,012,117	1,012,117	1,012,117	983,642	1,012,117	1,012,117	1,012,117	980,833

Note: This table mimics the regressions presented in Table 3 but for observations that have a monthly revolving balance between \$10 and \$200. The policy change did not affect these accounts so we would expect to find no significant effect. The set of control variables grouped under "Account Risk" are age and sex of the account holder, internal and external measures of credit score, an indicator variable equal to one if the borrower has other accounts at the same institution, an indicator variable equal to one if the borrower pays for a reduced APR, APR charged on the revolving balance, average unemployment rate in the borrower's region, account age (in months), revolving credit limit, revolving balance, utilization of the revolving balance (defined as revolving balance/revolving limit), total account balance, and monthly installment on the term loan. All controls are taken at the beginning of the billing cycle to avoid spurious relationships with the independent variable. Standard errors are corrected for within account heteroscedasticity.

Table A7: Kink Regression Design
(6-Month Window, Accounts with Only Revolving Balances)

	Min. Payment	$\mathbb{P}(L_{t+1}\|C_t)$	$\mathbb{P}(C_{t+1}\|L_t)$	$\mathbb{P}(W_{t+1}\|L_t)$	Purchases	Payments
A. First Kink (\$100 < *Revolving Balance* < \$334)						
$After \times (CardBalance - 200)/100$	3.1560***	0.0028**	-0.0113	-0.0020	-14.8554*	-6.4223
	(0.005)	(0.001)	(0.010)	(0.002)	(8.277)	(6.311)
$(CardBalance - 200)/100$	-1.2392***	0.0150**	0.0354	-0.0110	199.4779***	108.2610***
	(0.019)	(0.007)	(0.052)	(0.012)	(48.293)	(37.771)
Month F.E.	YES	YES	YES	YES	YES	YES
Revol. Bal. Dummies (\$5 bins)	YES	YES	YES	YES	YES	YES
Revol. Bal. Dummies × Trend)	YES	YES	YES	YES	YES	YES
R^2	0.985	0.001	0.019	0.002	0.007	0.012
Observations	1,392,264	1,318,166	70,633	70,633	1,392,264	1,392,264
B. Second Kink (\$200 < *Revolving Balance* < \$500)						
$After \times (CardBalance - 334)/100$	3.2652***	0.0084***	-0.0385***	0.0004	11.5744	4.4177
	(0.003)	(0.001)	(0.008)	(0.002)	(7.938)	(5.829)
$(CardBalance - 334)/100$	-0.4367***	0.0157**	0.0344	0.0052	86.1159*	66.9560*
	(0.022)	(0.008)	(0.051)	(0.012)	(49.559)	(39.770)
Month F.E.	YES	YES	YES	YES	YES	YES
Revol. Bal. Dummies (\$5 bins)	YES	YES	YES	YES	YES	YES
Revol. Bal. Dummies × Trend)	YES	YES	YES	YES	YES	YES
R^2	0.995	0.001	0.020	0.002	0.005	0.007
Observations	1,316,835	1,230,181	84,441	84,441	1,316,835	1,316,835

Note: This table presents the results of OLS regressions of equation (7) for values of k equal to 200 and 334, using monthly credit card accounts with revolving balances around each kinks in a six-month window around the policy change.

Table A8: Heterogeneous Effects of the Policy Change (Probit Marginal Effects)
(24-Month Window, All Accounts with Revolving Balance ≥ $334)

	$\mathbb{P}(L_{t+1}\|C_t)$	$\mathbb{P}(C_{t+1}\|L_t)$	$\mathbb{P}(W_{t+1}\|L_t)$
A. Revolving Balance/1000			
After Change × Prop. Revol. × Revol. Balance	0.0011***	-0.0024	0.0001
	(0.0004)	(0.0017)	(0.0003)
After Change × Prop. Revolv.	-0.0032***	-0.0626***	0.0003
	(0.0008)	(0.0035)	(0.0007)
After Change × Revol. Balance	0.0007**	0.0009	-0.0001
	(0.0003)	(0.0016)	(0.0003)
Prop. Revol. × Revol. Balance	-0.0023***	-0.0100***	-0.0000
	(0.0003)	(0.0012)	(0.0002)
B. Revolving Balance/Revolving Credit Limit			
After Change × Prop. Revol. × Line Utilization	0.0024	-0.0117*	0.0010*
	(0.0029)	(0.0064)	(0.0006)
After Change × Prop. Revolv.	0.0028	-0.0549***	-0.0020**
	(0.0018)	(0.0060)	(0.0009)
After Change × Line Utilization	0.0200***	0.0116*	-0.0016***
	(0.0023)	(0.0060)	(0.0004)
Prop. Revol. × Line Utilization	0.0159***	0.0230***	-0.0009***
	(0.0011)	(0.0050)	(0.0002)
C. External Score/1000			
After Change × Prop. Revol. × Ext. Credit Score	-0.0074**	0.0175	-0.0052***
	(0.0036)	(0.0109)	(0.0018)
After Change × Prop. Revolv.	0.0090***	-0.0737***	0.0029***
	(0.0032)	(0.0091)	(0.0011)
After Change × Ext. Credit Score	-0.0132***	-0.0214**	0.0033**
	(0.0032)	(0.0092)	(0.0015)
Prop. Revol. × Ext. Credit Score	0.0122***	0.0525***	-0.0032***
	(0.0010)	(0.0036)	(0.0008)
D. Client at Institution? (1=yes, 0=no)			
After Change × Prop. Revol. × Client	-0.0018	0.0147**	-0.0023**
	(0.0017)	(0.0059)	(0.0012)
After Change × Prop. Revolv.	0.0032**	-0.0705***	0.0020**
	(0.0015)	(0.0050)	(0.0008)
After Change × Client	0.0016	-0.0161***	0.0006
	(0.0015)	(0.0050)	(0.0009)
Prop. Revol. × Client	0.0133***	0.0692***	-0.0009
	(0.0009)	(0.0030)	(0.0006)

Note: This table shows the heterogeneous effects of the policy on delinquency transitions estimated from separate probit regressions using monthly credit card accounts with revolving balances greater than $334 in a 24-month window around the policy change. The specification follows model (4) in Table 3 with added interaction terms. Standard errors are corrected for within account heteroscedasticity.