Liquidity Constraints and Credit Card Delinquency:

Evidence from Raising Minimum Payments

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INTERNET APPENDIX

Figure IA-1: **Account Statement Example**

Account Statement

Statement Date: 02-12-2014 　　　Due Date: 03-10-2014 　　　　Account Number: XXXX-XXXX-XXXX-XXXX

John Smith 123 Street Townsville North America	**Total Minimum Payment Due:** **$ 81.49**	**Amount Paid:** $ _____ (this amount will be applied to you current balance)

Account Summary:

Previous Balance	**$1,500**	Credit Card Limit:	5,000
		Credit Card Available:	4,000
Purchases and Adjustments	+ $1,000		
Cash Advances	+ $0	Annual Percentage Rate (APR):	19.90%
Interest Charges	+ $0		
Monthly Term loan Installment	+ $31.49		
Payments and other Credits	- $1,500		
Current Balance	**= $1,031.49**		

Total Minimum Payment Due:

Minimum Payment on Revolving Balance		Monthly Payment on the Term Loan		Overdue Amount		Total Minimum Payment Due
$ 50	+	$ 31.49	+	$ 0	=	$ 81.49

Information concerning total account balance:

Current Balance		Term Loan Balance		Total Account Balance
$ 1,031.49	+	$ 552.36	=	$1,583.85

Term loan information

		Detailed Current Payment			New Balance on the Term Loan
		Principal	Interest	Total	$ 3.41
Previous Balance on the Term Loan	Variation in the Principal Amount	$ 28.08	$ 3.41	$ 31.49	+ $ 548.95
$ 580.44	$ 0		$ 31.49		= $ 552.36

Figure IA-1 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. 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. 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. The monthly payment on the term loan consists of its installment amount and 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.

Figure IA-2: **Term and Revolving Loans**

(a) New Term Loans

(b) Proportion of Revolving Balance

(c) New Conversions into Term Loans
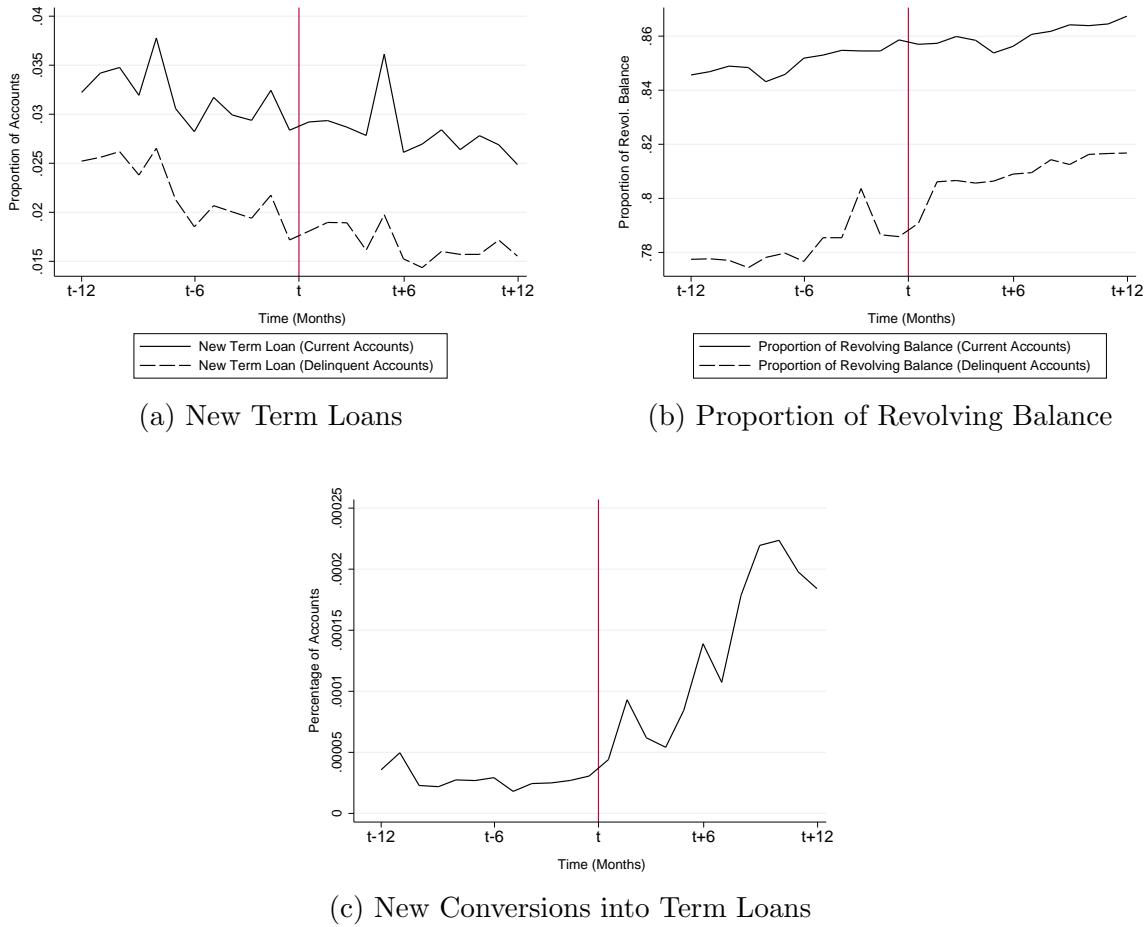
Figure IA-2 shows term and revolving borrowing in the 24-month period around the policy change. Panel (a) shows the rate of new term loans being opened each month. Panel (b) shows the rate of conversions from revolving to term loans each month. Panel (c) shows the average proportion of revolving balance to total account balance for current and delinquent accounts.

Figure IA-3: **Minimum Revolving Payment - Before and After the Policy Change**
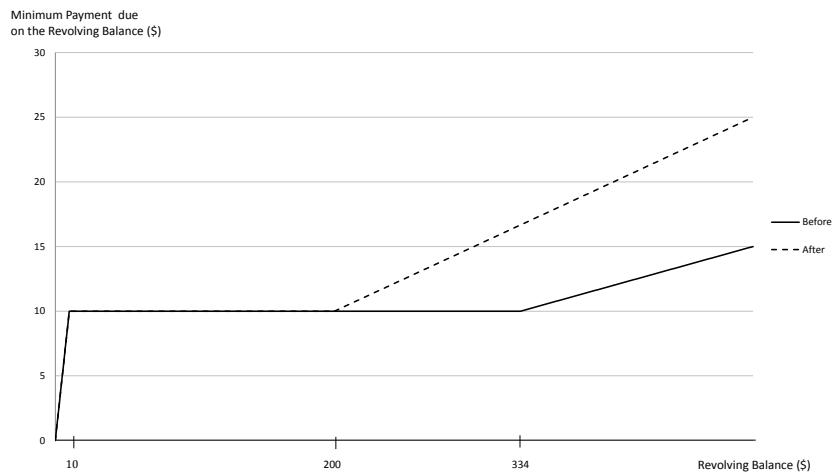
Figure IA-3 shows the effect of the policy change on the monthly minimum payment due on the revolving balance. The solid and dashed lines, respectively, represent the minimum payment schedules on the revolving balance before and after the policy change. The minimum payment on the revolving balance must be added to the monthly installment on the term loan (if the borrower has one) to yield the total monthly minimum payment.

Figure IA-4: **Transition Probabilities**

(24-Month Window Around the Policy Change, Accounts w/ Revolving Balance $> \$333$

Split According to Average Fraction of Revolving Balance Repaid in Months $t-7$ to $t-12$)

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

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

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

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

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

(f) $\mathbb{P}(W_{t+1}|L_t)$
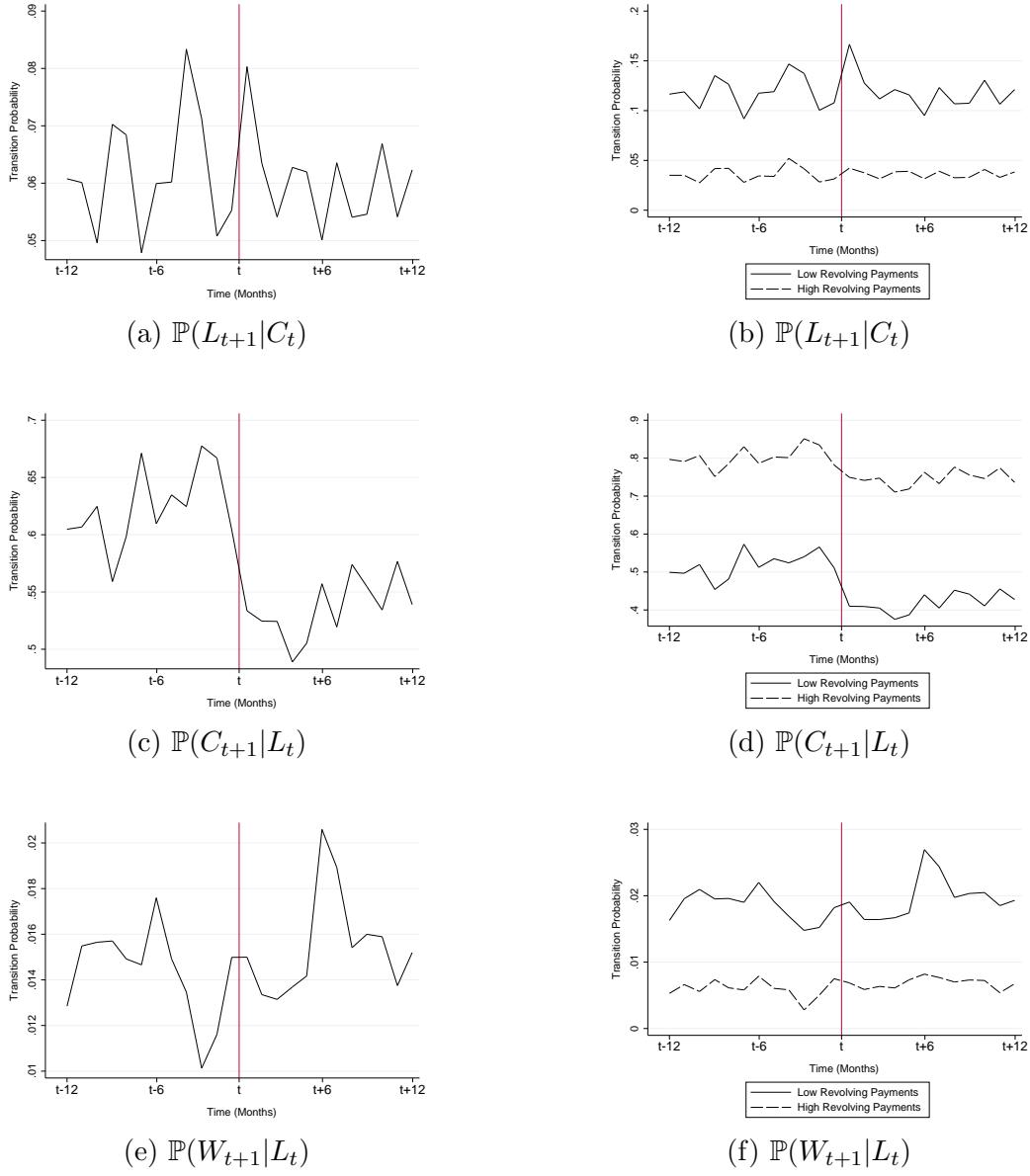
Figure IA-4 plots the aggregate transition probabilities between delinquency states for accounts with no term loans that have a revolving balance greater than \$333 in a 24-month window around the policy change. Accounts are *ex ante* identified as repaying a big (greater than 20%) and a small (smaller than 20%) proportion of the revolving balance according to equation (2) which is first averaged over 6 months and then lagged by 6 months.

Figure IA-5: **Write-Offs and Exposure at Default**

(24-Month Window Around the Policy Change, Accounts w/ Revolving Balance $> \$333$

Split According to Average Fraction of Revolving Balance Repaid in Months $t - 7$ to $t - 12$)
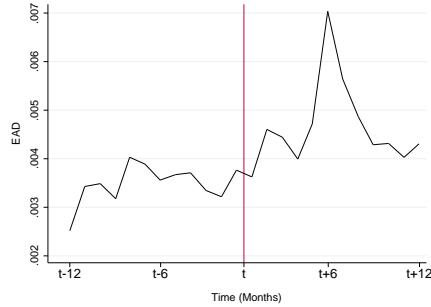
(a) $\overline{EAD}_{t+1}|L_t$ or C_t
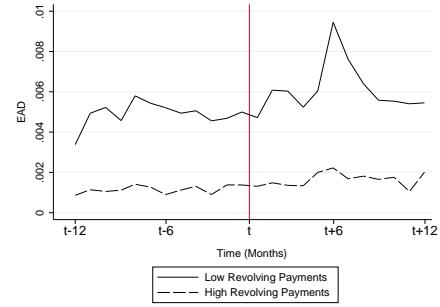
(b) $\overline{EAD}_{t+1}|L_t$ or C_t
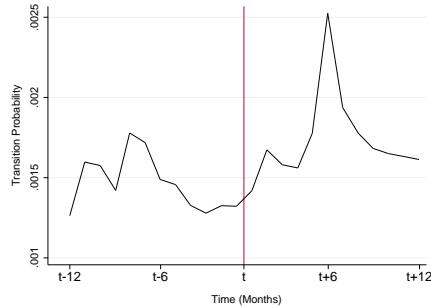
(c) $\mathbb{P}(W_{t+1}|C_t$ or $L_t)$
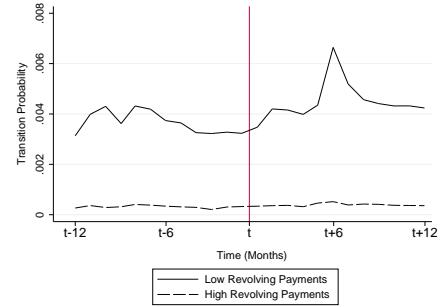
(d) $\mathbb{P}(W_{t+1}|C_t$ or $L_t)$
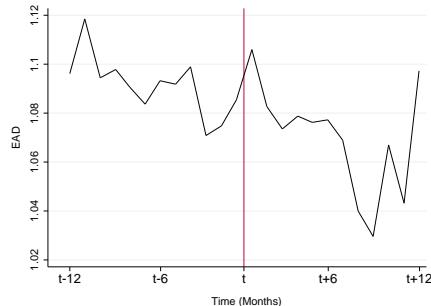
(e) $\overline{EAD}_{t+1}|L_t$ or $C_t,$ and $W_{t+1} = 1$
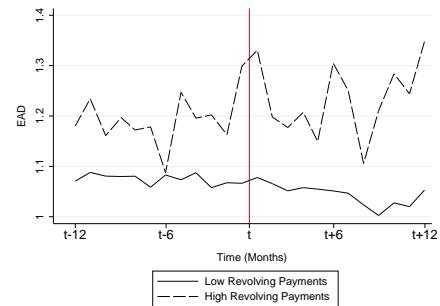
(f) $\overline{EAD}_{t+1}|L_t$ or $C_t,$ and $W_{t+1} = 1$

Figure IA-5 plots the EAD (unconditional and conditional on default) and the unconditional write-off probability for accounts with no term loans that have a revolving balance greater than $333 in a 24-month window around the policy change. Accounts are *ex ante* identified as repaying a big (greater than 20%) and a small (smaller than 20%) proportion of the revolving balance according to equation (2) which is first averaged over 6 months and then lagged by 6 months. The EADs are weighted by the last current balance on the account.

Table IA-1: Payments - Quantile Regressions
(6-Month Window Around the Policy, All Accounts w/ Revolving Balance > $333)

	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: Table IA-1 reports the estimation of quantile regressions for which the independent variable is the ratio of payments to total account balance, as defined by equation (5). The sample used consists of observations that have a revolving balance greater than $333 in a 6-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. 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%. * and ** indicate significance at the 5% and 1% levels, respectively.

Table IA-2: 2SLS Delinquency Transitions
(12-Month Window Around the Policy Change, Accounts with Revolving Balance > \$333)

	First Stages $\mid C_t$		Instrumented 2nd Stage	First Stages $\mid L_t$		Instrumented 2nd Stages	
	Prop. Revol	After Change ×Prop. Revol	$\mathbb{P}(L_{t+1}\mid C_t)$	Prop. Revol	After Change × Prop. Revol	$\mathbb{P}(C_{t+1}\mid L_t)$	$\mathbb{P}(W_{t+1}\mid L_t)$
After Change × Prop. Revolv.			0.0139**			-0.0880**	-0.0018
			(0.0016)			(0.0047)	(0.0011)
Prop. Revolving Loan			0.0377**			-0.0127**	0.0085**
			(0.0089)			(0.0046)	(0.0011)
After Change × Prop. Revolv.$_{t-6}$	-0.0018	0.5329**		0.0040*	0.6814**		
	(0.0021)	(0.0022)		(0.0018)	(0.0016)		
Prop. Revolv.$_{t-6}$	0.3697**	-0.0789**		0.5429**	-0.0681**		
	(0.0032)	(0.0012)		(0.0021)	(0.0008)		
Month F.E.	YES	YES	YES	YES	YES	YES	YES
Only Revolv.	YES	YES	YES	YES	YES	YES	YES
Only Revolv. × Trend	YES	YES	YES	YES	YES	YES	YES
Prop. Revolv. × Trend	NO	NO	NO	NO	NO	NO	NO
Bal. Dummies × Min. Pay	YES	YES	YES	YES	YES	YES	YES
Delinquency Dummies	-	-	-	YES	YES	YES	YES
Delinquency × Trend	-	-	-	YES	YES	YES	YES
Spell Dummies	YES	YES	YES	YES	YES	YES	YES
Account Characteristics	YES	YES	YES	YES	YES	YES	YES
R^2	0.792	0.958	0.076	0.856	0.964	0.206	0.366
Observations	9,810,168	9,810,168	9,810,168	1,449,003	1,449,003	1,449,003	1,449,003

Note: Table IA-2 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 6 months while its interaction with the policy dummy is instrumented using the policy dummy interacted with the 6-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 1 if the borrower has other accounts at the same institution, an indicator variable equal to 1 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. * and ** indicate significance at the 5% and 1% levels, respectively.

IA-8

(24-Month Window Around the Policy Change, All Accounts with Revolving Balance > \$333)

	$\mathbb{P}(L_{t+1}\|C_t)$		$\mathbb{P}(C_{t+1}\|L_t)$		$\mathbb{P}(W_{t+1}\|L_t)$	
	(1)	(2)	(3)	(4)	(5)	(6)
After Change × $\overline{\text{Prop. Revol.}}$	0.0013**	0.0079**	-0.0948**	-0.0511**	0.0010*	-0.0014*
	(0.0004)	(0.0006)	(0.0021)	(0.0022)	(0.0004)	(0.0006)
After?	-0.0028**		0.0003		-0.0007	
	(0.0004)		(0.0018)		(0.0004)	
$\overline{\text{Prop. Revol.}}$	-0.0167**	0.0018	0.2516**	-0.0274**	-0.0064**	0.0029**
	(0.0006)	(0.0013)	(0.0018)	(0.0022)	(0.0003)	(0.0005)
Month F.E.	NO	YES	NO	YES	NO	YES
Only Revolv.	NO	YES	NO	YES	NO	YES
Only Revolv. × Trend	NO	YES	NO	YES	NO	YES
Prop. Revolv. × Trend	NO	NO	NO	NO	NO	NO
Bal. Dummies × Min. Pay	NO	YES	NO	YES	NO	YES
Delinquency Dummies	-	-	NO	YES	NO	YES
Delinquency × Trend	-	-	NO	YES	NO	YES
Spell Dummies	NO	YES	NO	YES	NO	YES
Account Characteristics	NO	YES	NO	YES	NO	YES
R^2	0.000	0.086	0.025	0.226	0.000	0.347
Observations	24,406,551	21,993,773	3,159,000	2,964,165	3,159,000	2,964,165

Note: Table IA-3 reports the main regressions when the proportion of revolving balance on the account is measured as the average over the 6 months period before the start of the orginal sample. Standard errors are corrected for within account heteroscedasticity. * and ** indicate significance at the 5% and 1% levels, respectively.

Table IA-4: **Heterogeneous Effects of the Policy Change (Probit Marginal Effects)**
(24-Month Window, Accounts with Revolving Balance > \$333)

	$\mathbb{P}(L_{t+1}|C_t)$	$\mathbb{P}(C_{t+1}|L_t)$	$\mathbb{P}(W_{t+1}|L_t)$
A. Revolving Balance/1000			
After Change × Prop. Revol. × Revol. Balance	0.0038**	-0.0064**	-0.0002
	(0.0005)	(0.0019)	(0.0005)
After Change × Prop. Revolv.	-0.0112**	-0.0516**	0.0032**
	(0.0012)	(0.0040)	(0.0010)
After Change × Revol. Balance	-0.0028**	0.0039*	0.0001
	(0.0005)	(0.0017)	(0.0005)
Prop. Revol. × Revol. Balance	0.0005	0.0063**	0.0009**
	(0.0005)	(0.0004)	(0.0001)
R^2	0.074	0.189	0.358
Observations	23,979,721	3,310,085	3,310,085
B. Revolving Balance/Revolving Credit Limit			
After Change × Prop. Revol. × Line Utilization	-0.0001	0.0133	0.0073
	(0.0035)	(0.0360)	(0.0058)
After Change × Prop. Revolv.	0.0089**	-0.1076**	-0.0069
	(0.0020)	(0.0320)	(0.0052)
After Change × Line Utilization	0.0228**	0.0019	-0.0074
	(0.0032)	(0.0327)	(0.0053)
Prop. Revol. × Line Utilization	0.0185**	-0.0910**	-0.0050**
	(0.0021)	(0.0092)	(0.0012)
R^2	0.081	0.195	0.359
Observations	23,979,721	3,310,085	3,310,085
C. External Score/1000			
After Change × Prop. Revol. × Ext. Credit Score	-0.0411**	0.0325**	-0.0241**
	(0.0086)	(0.0111)	(0.0049)
After Change × Prop. Revolv.	0.0217**	-0.0651**	0.0153**
	(0.0080)	(0.0092)	(0.0044)
After Change × Ext. Credit Score	0.0910**	-0.1177**	0.0268**
	(0.0074)	(0.0088)	(0.0041)
Prop. Revol. × Ext. Credit Score	-0.0345**	0.1332**	-0.0270**
	(0.0036)	(0.0031)	(0.0009)
R^2	0.075	0.191	0.359
Observations	23,979,721	3,310,085	3,310,085
F. Client at Institution? (1=yes, 0=no)			
After Change × Prop. Revol. × Client	0.0009	0.0015	-0.0047*
	(0.0038)	(0.0067)	(0.0019)
After Change × Prop. Revolv.	0.0001	-0.0707**	0.0053**
	(0.0038)	(0.0057)	(0.0018)
After Change × Client	-0.0093**	0.0085	0.0008
	(0.0034)	(0.0057)	(0.0018)
Prop. Revol. × Client	0.0271**	0.0237**	-0.0018*
	(0.0031)	(0.0036)	(0.0008)
R^2	0.075	0.189	0.358
Observations	23,979,721	3,310,085	3,310,085
Month F.E.	YES	YES	YES
Only Revolv.	YES	YES	YES
Only Revolv. × Trend	YES	YES	YES
Prop. Revolv. × Trend	YES	YES	YES
Delinquency Dummies	-	YES	YES
Delinquency × Trend	-	YES	YES
Spell Dummies	YES	YES	YES
Total Bal. Dummies × Min. Pay Dummies	YES	YES	YES
Account Characteristics	YES	YES	YES

Note: Table IA-4 reports the heterogeneous effects of the policy on delinquency transitions estimated from separate probit regressions using monthly credit card accounts with revolving balances greater than \$333 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. * and ** indicate significance at the 5% and 1% levels, respectively.

Table IA-5: 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. Revol.	0.0048**	-0.0033**	-0.0032**	-0.0029**	-0.0079**	-0.0037	0.0107*	0.0190**	0.0008	0.0012	0.0001	-0.0000
	(0.0006)	(0.0010)	(0.0010)	(0.0011)	(0.0030)	(0.0052)	(0.0045)	(0.0046)	(0.0004)	(0.0009)	(0.0005)	(0.0005)
After Change? 1 = yes, 0 = no	-0.0081**				-0.0101**				0.0004			
	(0.0006)				(0.0015)				(0.0003)			
Prop. Revol.	-0.0161**	0.0107**	0.0029	0.0083**	0.1780**	-0.0926**	0.0658**	-0.0792**	0.0164**	0.0223**	-0.0067**	-0.0075**
	(0.0005)	(0.0029)	(0.0027)	(0.0029)	(0.0021)	(0.0090)	(0.0081)	(0.0089)	(0.0003)	(0.0012)	(0.0012)	(0.0014)
Month F.E.	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Only Revol.	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Only Revol. × Trend	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Prop. Revol. × Trend	NO	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	YES
Delinquency Dummies	-	-	-	-	NO	YES	YES	YES	NO	NO	YES	YES
Delinquency × Trend	-	-	-	-	NO	YES	YES	YES	NO	NO	YES	YES
Spell Dummies	NO	NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES
Total Bal. Dummies × Min. Pmt Dummies	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
Account Characteristics	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
R^2	0.002	0.006	0.050	0.098	0.016	0.023	0.094	0.118	0.062	0.065	0.663	0.668
Observations	7,683,542	7,683,542	7,683,542	7,024,429	1,011,586	1,011,586	1,011,586	956,818	1,011,586	1,011,586	1,011,571	956,804

Note: Table IA-5 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 1 if the borrower has other accounts at the same institution, an indicator variable equal to 1 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. * and ** indicate significance at the 5% and 1% levels, respectively.