

Credit Lines

Xavier Mateos-Planas José-Víctor Ríos-Rull

University of Southampton, Minnesota, FRB Mpls, CAERP

Preliminary

IFS, Monday 23rd March, 2009 04:43

Introduction - Objective

General aim:

- To investigate the macroeconomic and distributional implications of unsecured consumer credit (e.g., credit cards).

Specific objectives:

- 1 To extend the theory of unsecured credit to long term contracts under the restrictions imposed by the *actual* legal environment.
- 2 Assess how it accounts for U.S. allocations and contracts.
- 3 The implications of the recent tightening of bank regulation (Regulation AA, to be enforced by mid 2010).

The U.S. Legal Environment and transaction costs

- 1 The Bankruptcy Laws: People can unilaterally ask for debt to be condoned. They cannot save when they file for bankruptcy. Filing for bankruptcy is part of the public record for 10 years.
- 2 Under the current interpretation of the “Consumer Credit Protection Act” and Regulation Z (the Fed’s rules that implement it) banks are free to change the terms of an existing credit line
 - ▶ Banks can increase or reduce a line of credit but not below the existing loan size.
 - ▶ Banks can change the interest rate even in existing balances.
- 3 It is costly for households to create or to switch credit lines.
- 4 It is costly for banks to setup credit lines.

Policy Comp: Alternative details of allowable contracts

- 1 Current policy. The bank can change the interest rate and the credit limit but the bank cannot impose a reduction of the debt.
- 2 Regulation AA: The Banks cannot increase interest rates on existing debt. We are interpreting it as they cannot increase interest rate on all debt nor impose its reduction.

A literal interpretation of Reg AA has considerable problems for a variety of reasons (repeated borrowing, state variables)

There are many other possible policies, regarding limits, existing debt and state contingent (based on observables).

I. Introduction - The policy debate

- Fed statement of purpose (May 2008):
"prohibit unfair practices regarding credit cards and overdraft services that would, among other provisions, protect consumers from unexpected increases in the rate charged on pre-existing credit card balances."
- The Republican White House (and the bankers):
"The Administration opposes H.R. 5244 (...) because it would broadly constrain the ability of financial institutions to price risk, likely resulting in less access to credit and in higher interest rates for consumers. For the credit market to operate efficiently, creditors must have the flexibility to react to changes in customer risk and market conditions."

I. Introduction - Why a new theory?

- We are talking changes in conditions on an existing credit relationship. This is NOT a case of price regulation (e.g., interest ceiling). Hence:
 - ▶ Need long term revolving credit contracts.
 - ▶ Need to consider different degrees of bank commitment.
- More generally, realism in quantitative theory perhaps interesting in its own right when dealing with actual arrangements.

Some basic observations for the theory

- ① Credit limits increase with income.
- ② The size of loans increases in income.
- ③ More frequent borrowers face tighter limits.
- ④ More frequent borrowers bear higher interest rates.

Source: SCF 95-98-01 data via Bertaut and Haliassos (2006).

A Commercial

- We take the position that the actual forms of contracts are data.

Elements of the theory

We explicitly incorporate US Bankruptcy Law, banks contracting capabilities and contracting costs on both sides. Specifically

- 1 Borrowers cannot commit to pay back (they can file for bankruptcy) nor can they commit not to switch to another bank.
- 2 Banks are not committed to the interest rate of the loan.
- 3 Banks are not committed to credit limits except for existing debt.

Consequently, the contracts have to be time consistent. Banks make adjustments to the terms to remove the bad, to keep the good, to exploit the lock-in.

- 4 Contracts are costly to sign for both borrowers and lenders. (Otherwise no long term contracts).
- 5 Households can have either one or zero credit lines. (This is a thorny issue.)

- We extend Eaton and Gersovitz (1981), Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007), Livshits, MacGee, and Tertilt (2007), Mateos-Planas (2007) to multiperiod contracts.
- Big literature on endogenous constraints: Kehoe and Levine (1993), Wang (1995), Kocherlakota (1996), Cole and Kocherlakota (2001), Hopenhayn and Werning (2008). This a different strand.
- A somewhat related (and excellent) paper is Drozd and Nosal (2007): search frictions and full commitment on the part of banks.

Model - Households (state)

Many; infinitely-lived; with standard utility over consumption.

Initial state $z = \{e, y, \varepsilon, \chi, \omega, h\}$:

- Public information

- ▶ Social class e is Markov with transition $\Gamma_{e,e'}$
- ▶ Asset position $y \in \mathcal{Y} = \mathcal{Y}^- \cup 0 \cup \mathcal{Y}^+$.
- ▶ One contract $\omega \in \Omega$ with a bank if any (no contract $0 \in \Omega$)
- ▶ A credit history $h \in \{0, 1\}$: δ probability to turn good

- Private Information

- ▶ Endowment/income ε : class-dependent probability $F(\varepsilon|e)$
- ▶ lid utility costs shocks, $\chi = \{\chi_d, \chi_s\}$ to defaulting and contracting. Purely technical. We write $F(\varepsilon, \chi, e)$.

Model - Households (contracts)

Credit contracts: ω are associated with observables when signing:

- Initial loan $y'^{\omega} \leq 0$
- Initial (inverse of gross) interest rate $(q^{\omega})^{-1}$.
- Initial class e^{ω} and

And continuation plans based on observables for:

- Credit limits $b^{\omega}(e, y)$ so $y' \geq b^{\omega}(e, y) \leq y$.
- (Inverse of gross) interest rates $q^{\omega}(e, y)$

Model - Households (choices & constraints)

Decisions: default $d \in \{0, 1\}$, switch line $s \in \{0, 1\}$, and save/borrow y' .

- Good record ($h = 0$)
 - If no default ($d = 0$), keep good record $h' = 0$ and repay debts
 - ▶ If no switch $s = 0$: same line $\omega' = \omega$ and $y' \geq b^\omega(e, y)$.
 - ▶ If switch $s = 1$: $\omega' \in \Omega$ s.t. $e^{\omega'} = e$ and $y' = y'^{\omega'}$, disutility χ_s .
 - If default ($d = 1$), gets bad record $h' = 1$ and debts discharged
 - ▶ disutility χ_d , zero line $\omega' = 0$, zero assets $y' = 0$.
- Bad record ($h = 1$)
 - With prob. $1 - \delta$, keeps bad record $h' = h$ and $\omega' = 0$
 - With prob. δ , gets good record $h' = 0$ and can switch to $\omega' \in \Omega$.

Household Problems

- We write the main problem in stages.
 - 3 Saving decision $y'(z)$ conditional on new history h' and contract $\omega'(z)$.
 - 2 Switching decision $s(z)$ conditional on new history h' .
 - 1 Default decision $d(z)$ conditional on state.
- We also solve for $\{\tilde{d}(z, q, b), \tilde{s}(z, q, b), \tilde{y}'(z, q, b)\}$, for what to do for arbitrary one period deviations in credit terms.
- We also solve for $\{y'(z, \hat{\omega}, q, b), \hat{\omega}'^s(z, \hat{\omega}, q, b), \hat{d}(z, \hat{\omega}, q, b), \hat{s}(z, \hat{\omega}, q, b)\}$, and $\{\hat{\hat{d}}(z, \hat{\omega}, q, b), \hat{\hat{s}}(z, \hat{\omega}, q, b)\}$, alternative contract deviation decision rules.

Some properties of decision rules

Switching $\tilde{s}(z, q, b)$:

- Switching first increases (large loans, high interest) and then decreases with wealth; it may then increase and fall again (small loans, better conditions).
- Switching increases with higher interest rate and tighter limit.

Default $\tilde{d}(z, q, b)$:

- Default declines with wealth, but may increase at some point.
- Default increases with higher interest rate and tighter limit.

Model - Intermediaries (possible contracts)

- A bank issues a contract ω from the potential set Ω^P at fixed cost π .
 - A new contract ω specifies initial loan y^{ω} and interest q^{ω} for type e^{ω} .
 - If it survives, the bank sets limit and prices based on observables as $b^{\omega}(e, y)$, $q^{\omega}(e, y)$. (It does not matter if it specifies it)
- The space of all possible contracts. Let $\mathcal{C}_b = b : E \times \mathcal{Y}^- \rightarrow \mathcal{Y}^-$ and $\mathcal{C}_q = q : E \times \mathcal{Y}^- \rightarrow \mathcal{Y}^-$. Then

$$\Omega^P = \{E \times \mathcal{Y}^- \times [0, 1] \times \mathcal{C} - b \times \mathcal{C}_q\}$$

- The potential set Ω^P is very large. Active contracts are a subset.

Intermediaries- Value of a contract (under commitment)

- Let $g(z) = [1 - d(z)] [1 - s(z)]$. Then the value of $\{e, y, \omega\}$ is

$$\begin{aligned}\Psi(e, y, \omega) = & -y \mathbf{1}_{y < 0} \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) [1 - d(z(\varepsilon, \chi))] + \\ & \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) g(z(\varepsilon, \chi)) q^\omega(e, y) y'^n(z(\varepsilon)) \mathbf{1}_{y'^n(z(\varepsilon)) < 0} \\ & + q^* \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) g(z(\varepsilon, \chi)) \sum_{e'} \Gamma_{e, e'} \Psi(e', y'^n(z(\varepsilon)), \omega)\end{aligned}$$

And when issuing ω

$$\Psi_0(\omega) = q_0^\omega y_0'^\omega + q^* \sum_{e'} \Gamma_{e^\omega, e'} \Psi(e', y_0'^\omega, \omega)$$

Intermediaries- Value of a contract (without commitment)

A bank is free to change terms.

$$\begin{aligned}\tilde{\Psi}(e, y, \omega, q, b) = & -y 1_{y < 0} \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) [1 - \tilde{d}(z, q, b)] + \\ & \sum_{\varepsilon} F_e(\varepsilon, \chi) \tilde{g}(z, q, b) q \tilde{y}'^n(z, q, b) 1_{\tilde{y}'^n(z, q, b) < 0} \\ & + q^* \sum_{\varepsilon} F_e(\varepsilon, \chi) \tilde{g}(z, q, b) \sum_{e'} \Gamma_{e, e'} \Psi(e', \tilde{y}'^n(z, q, b), \omega)\end{aligned}$$

Five key terms:

- Current default rate \tilde{d} .
- Current switching rate \tilde{s} , hence survival \tilde{g} .
- The new borrowing level \tilde{y}' .
 - ▶ Next-period default rate d' .
 - ▶ Next-period switching rate s' .

Banks: Time-consistency and commitment

Time consistency requires contract policies to solve:

$$\max \tilde{\Psi}(e, y, \theta, q, b).$$

We consider two specific models:

- Pre-reform (no commitment): Can drop initial θ so

$$\max_{q, b \geq y} \tilde{\Psi}(e, y, \cdot, q, b).$$

- Post-reform (price commitment): Can drop q and keep θ so

$$\max_{b \geq y} \tilde{\Psi}(e, y, \theta, \cdot, b).$$

EQUILIBRIUM

An equilibrium is a set of contracts $\Omega^E \subset \Omega^P$ an allocations and ... s.t.

(A) Agents maximize (standard).

(B) Zero profit or free entry in each existing contract.

$$\Psi(y'^{\omega}, e^{\omega}, \omega) - \pi = 0, \quad \forall \omega \in \Omega^E.$$

(C) Time consistency

$$q^{\omega}(y, e), b^{\omega}(y, e) = \arg \max_b \tilde{\Psi}(y, e, \omega, q, b), \quad \forall \omega \in \Omega^E.$$

(D) Unprofitable opening of other contracts. $\nexists \omega \in \Omega, \omega \notin \Omega^E$ that satisfies

- (i) Profits are non negative;
- (ii) $q^{\omega}(y, e)$ and $b^{\omega}(\cdot, \cdot, q)$ are time consistent;
- (iii) Some households choose it.

Actual size of Contract Space, Existence and uniqueness

Using condition (D) we look for a small set of contracts:

- Let $\Omega = \{E \times \mathcal{Y}\}$. This is the set of possible holds demands/types. It is useful to index the minimal set of contracts.
- For each $\omega \in \Omega$ we solve for q^ω and $b^\omega(e, y)$ and $q^\omega(e, y)$ that yield zero profits and are time consistent.
- Important Questions.
 - ① Do such objects exist for all $\omega \in \Omega$?
 - ② Given any q^ω will there be a unique pair $q^\omega(e, y)$, $b^\omega(e, y)$?
 - ③ Can more than one set of q^ω and b^ω , q^ω for initial e, y coexist?

What do we know so far?

- 1 We have always found such pair of q^ω and subsequent $b(\cdot, \cdot, q^\omega)$, $q(\cdot, \cdot, q^\omega)$ with zero profits and time consistent (although often such offers are not taken by households). Once we dealt with continuity problems that plague this environment.
- 2 It seems that along any equilibrium there is a unique pair of fns $b^\omega()$, $q^\omega()$ that are time consistent (but this only deals with individual deviations). We have not found any of this (silly?) coordination multiplicities. If we did, we could change the timing so that default occurs after the setting of the credit limit.
- 3 We check whether alternative q^ω and implied time consistent choice of $q^\omega()$, $b^\omega()$ may simultaneously yield non-negative profits and some households taking them and we have found none.

This yields a strategy to find equilibrium

- Discretize (recall the nonconvexity).
- Guess that there is one contract per pair $(e^\omega, y^{l\omega})$.
- Find initial prices q^ω and continuation prices and limit rules $q^\omega(z), b^\omega(z)$ s.t. zero-profit + time-consistency. This is obviously, a nasty fixed point problem and required convexification of profit function via the utility costs shocks.
- Check for profitable one-shot deviation $\hat{\omega}$ and update Ω^E if needed.
- Calculate the stationary distribution over $e, \varepsilon, y, \omega, h$. This is standard. We implicitly use a small open economy. Not really relevant Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007).

Other Policy Environments

- Extensions to alternative policy environments is easy theoretically expect for a too literal implementation of the policy change as it may imply multiple interest rates on existing debt.
- Other environments such as our interpretation of the policy change (commitment to the interest rate but not to the credit limit) are almost immediate and we bear you the details.

The Benchmark model economy

We calibrate our model economy to include just the 75% poorest.

We adjust it as in Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007) to reduce both creditors and debt to that implied by voluntary debt.

- Two social classes that are quite persistent. Introduces specific implications unlikely to be robust.
- Risk aversion is 2.
- Interest rate is 3%, while patience is .9: wealth to income ratio is 1.4* .
- The maximum possible level of borrowing is 75% of average income. The actual maximum loan is about 30%.
- The borrowing limits move in 3.8% intervals of average income.
- Time cost of defaulting is 10 years.
- The consumption-equivalent utility cost of switching is 0.4% and of defaulting is 11% (the latter does not matter really).
- Cost of issuing a contract for the bank is $\pi = 0.2\%$ of average cons.

Main Aggregate Statistics

Variable	Target	Value in Model
Wealth to Income ratio	1.4	1.33
Population Filing	0.29%	0.27%
Population in Debt	3.60%	0.64%
Stdv of Log Earnings	0.92	0.93
Autocorr of Log Earnings	0.60	0.56

- As it is standard, we do not have enough debt/default (Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007)). It should be .21% and .51%.
- Luckily, Costas is not here.

- Checking the data (Terms Of Credit)

	average	low type	high type	ratio
All contracts				
credit limit	0.169	0.133	0.432	3.24
loan size	0.163	0.133	0.382	2.87
price	0.490	0.436	0.887	2.03
Continuing contracts				
credit limit	0.198	0.142	0.533	3.75
loan size	0.171	0.142	0.343	2.41
price	0.457	0.398	0.809	2.03

- Low income class has higher interest rates.
- Interest rates go up over the life of the contract.
- Credit limits vary differently.

Frequency Of Full Repayment

Repay with prob. $> 50\%$	limit	0.241
	price	0.709
Repay with prob. $< 50\%$	limit	0.216
	price	0.466

Further implications

Table 5 - Default and switching

	average	low type	high type
Default			
Def. rate among debtors	0.426	0.489	0.024
Def. rate among constrained	0.622	0.672	0.065
Write-off rate	0.400	0.551	0.037
Switching			
Switch rate	0.0051	0.0044	0.0007
Switch rate from no-card	0.0048	0.0043	0.0005
Switch rate from another card	0.0002	0.0001	0.0001

Table 6 - Changes when switching from current card

	if no switch	if switch
debt limit/loan size	0.272	0.233
price	0.513	0.621

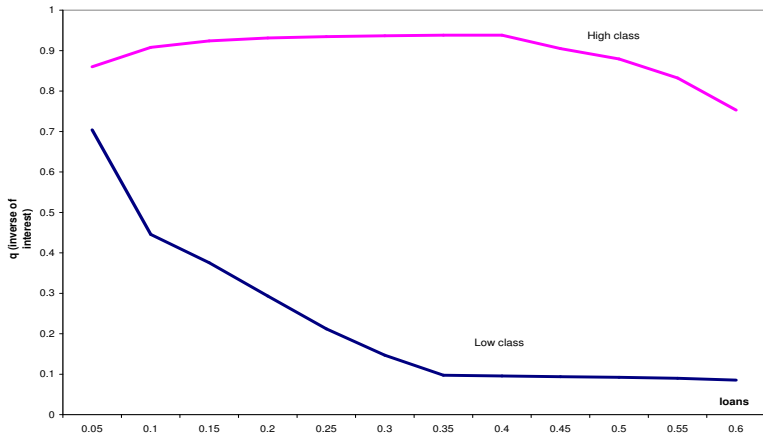
On average, switchers borrow less than previous limit at a lower interest.
Refinancing.

Findings: Properties of Contracts. Sizing up with data (Tentative)

- We still have to evaluate this issue.
 - ① Credit limits increase with income class. Yes.
 - ② The sizes of loans increase with income class.
 - ③ Credit Limits are tighter for households that are very often in debt.
 - ④ More frequent users bear higher interest rates.

Properties of Contracts: INITIAL TERMS:

- Very high interest rates for low class.



Initial contracts with positive entry

e	$y^{\prime\omega}$	q^{ω}	$E[d']$	$E[s']$	% inflow
1	-0.20	0.293	0.653	0.00042	0.1036
1	-0.15	0.375	0.556	0.00037	0.5658
1	-0.05	0.704	0.148	0.00027	0.2174
2	-0.55	0.832	0.131	0.00000	0.0215
2	-0.50	0.879	0.082	0.00000	0.0046
2	-0.40	0.938	0.019	0.00924	0.0344
2	-0.35	0.938	0.017	0.03001	0.0297
2	-0.30	0.936	0.016	0.02675	0.0157
2	-0.25	0.934	0.015	0.02353	0.0067

- Low class borrows very little.
- High class borrows a lot and in different ways.

Set of contracts

Continuing contracts, low type e

y	b	q	def	switch	surv.	av loan	max loan
-0.2000	-0.2000	0.9468	0.6667	0.0000	0.3333	-	0.200
-0.1500	-0.2000	0.7306	0.5677	0.0000	0.4323	-	0.200
-0.1000	-0.1500	0.6585	0.4696	0.0000	0.5304	-	0.150
-0.0500	-0.1500	0.3942	0.1516	0.0000	0.8484	0.150	0.150
0.0000	-0.1500	0.3701	0.0000	0.0455	0.9545	0.150	0.150
0.0500	-0.1500	0.3701	0.0000	0.0115	0.9885	0.150	0.150
0.1000	-0.1500	0.3701	0.0000	0.0077	0.9923	0.150	0.150
0.1500	-0.0500	0.6825	0.0000	0.0000	1.0000	0.050	0.050
0.2000	-0.0500	0.8748	0.0000	0.0000	1.0000	-	0.000
0.2500	-0.0500	0.9709	0.0000	0.0000	1.0000	-	0.000
0.3000	-0.1000	0.9709	0.0000	0.0000	1.0000	-	0.000
0.3500	-0.2500	0.9709	0.0000	0.0000	1.0000	-	0.000
0.4000	-0.4000	0.9709	0.0000	0.0000	1.0000	-	0.000
0.4500	-0.6000	0.8748	0.0000	0.0000	1.0000	-	0.000
0.5000	-0.6000	0.9228	0.0000	0.0000	1.0000	-	0.000

Continuing contracts, high type e

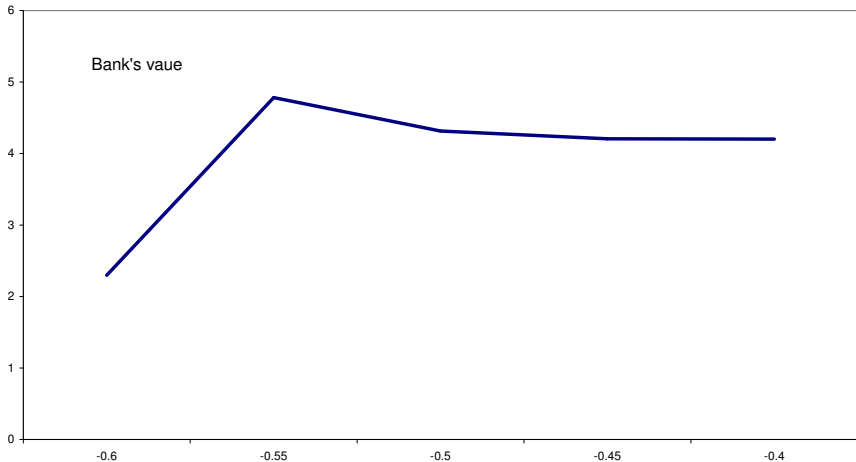
y	b	q	def	switch	surv.	av loan	max loan
-0.5500	-0.6000	0.8748	0.1161	0.0000	0.8839	0.150	0.600
-0.5000	-0.5000	0.9468	0.0654	0.0000	0.9346	0.150	0.500
-0.4500	-0.5500	0.8267	0.0371	0.0115	0.9513	-	0.550
-0.4000	-0.5500	0.8267	0.0019	0.0094	0.9887	0.550	0.550
-0.3500	-0.5500	0.8027	0.0000	0.0306	0.9694	0.550	0.550
-0.3000	-0.5500	0.8027	0.0000	0.0273	0.9727	0.550	0.550
-0.2500	-0.5500	0.8027	0.0000	0.0240	0.9760	0.550	0.550
-0.2000	-0.5500	0.8027	0.0000	0.0210	0.9790	0.550	0.550
-0.1500	-0.5500	0.8027	0.0000	0.0183	0.9817	0.550	0.550
-0.1000	-0.5500	0.8027	0.0000	0.0158	0.9842	-	0.550
-0.0500	-0.5500	0.8027	0.0000	0.0137	0.9863	0.550	0.550
0.0000	-0.5500	0.8027	0.0000	0.0122	0.9878	0.539	0.550
0.0500	-0.5500	0.8027	0.0000	0.0112	0.9888	0.527	0.550
0.1000	-0.5500	0.7786	0.0000	0.0223	0.9777	0.501	0.550
0.1500	-0.5500	0.7786	0.0000	0.0202	0.9798	0.480	0.550
0.2000	-0.5000	0.8267	0.0000	0.0142	0.9858	0.423	0.500
0.2500	-0.5000	0.8027	0.0000	0.0199	0.9801	0.390	0.500
0.3000	-0.5000	0.8027	0.0000	0.0171	0.9829	0.372	0.500
0.3500	-0.5000	0.8027	0.0000	0.0147	0.9853	0.349	0.500
0.4000	-0.5000	0.8027	0.0000	0.0128	0.9872	0.343	0.500
0.4500	-0.5000	0.8027	0.0000	0.0113	0.9887	0.335	0.500
0.5000	-0.5000	0.8027	0.0000	0.0100	0.9900	0.325	0.500

- The borrowing limit is endogenous.

Bank's trade-offs (1)

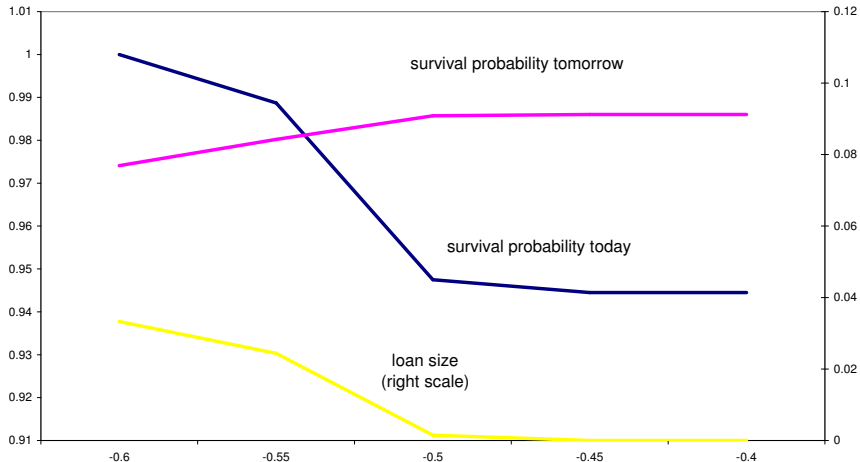
[[Example is: $e = 2$, $y = -0.40$ with optimal $b = -0.55$ and $q = 0.8267$.]]

CHANGING THE DEBT LIMIT



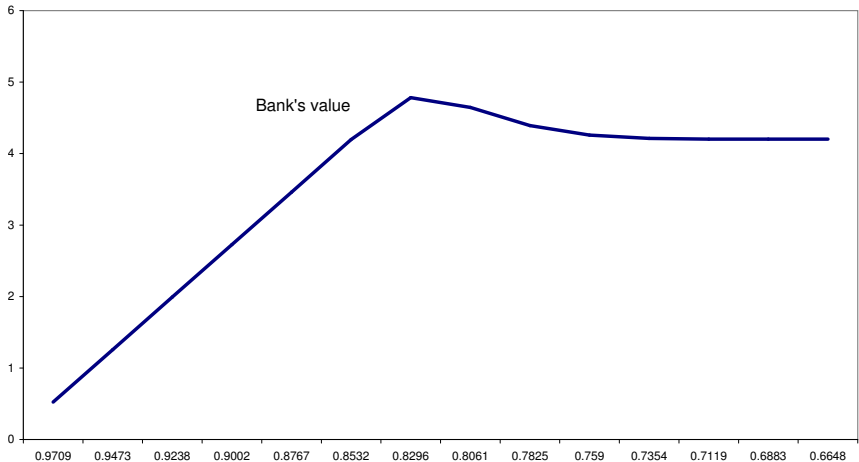
Bank's trade-offs (2)

CHANGING THE DEBT LIMIT



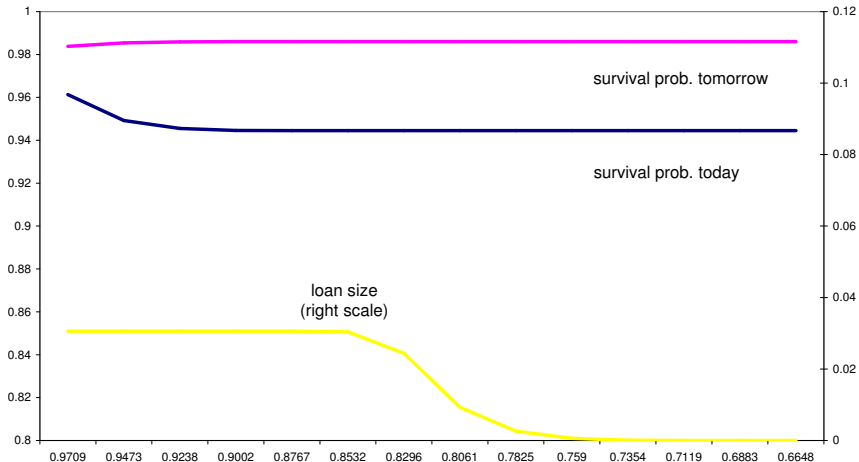
Bank's trade-offs (3)

CHANGING THE PRICE



Bank's trade-offs (4)

CHANGING THE PRICE

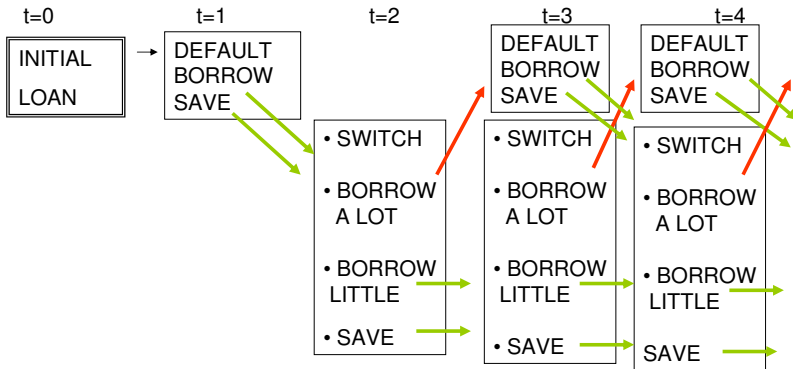


- Contract dynamics

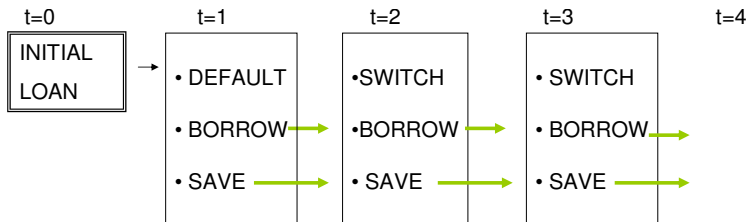
HIGH-CLASS Hholds shift recurrently between a regime where default may occur and one where it cannot.

LOW-CLASS contracts: hhold may only default in the beginning and settles on a never-default regime thereafter

Contract dynamics (2)



Contract dynamics (3)



Policy reform: Aggregate long-run effects

- 1 Generally, banks tighten debt limits but charge lower interest rates.
- 2 Borrowing increases (calibration specific)
- 3 Wealth increases.
- 4 The number of defaulters and the volume defaulted on decreases.
- 5 The frequency of contract switching increases. (calibration specific)
- 6 Average consumption rises slightly because of the wealth increase.

Aggregate long-run effects (2)

	Pre-reform (no commitment)	Post-reform (price commitment)
Mass in debt	0.0064	0.0165
Mass of defaulters	0.0027	0.0012
Mass switchers	0.0051	0.0059
Write-off rate	0.400	0.117
Wealth	1.860	1.877
Debt	0.00104	0.00143
Loan size (initial)	0.1613	0.0861
Loan price (initial)	0.4996	0.7809
Loan size (continuing)	0.1708	0.0862
Loan price (continuing)	0.4572	0.8136
Debt limit (continuing)	0.1980	0.0945
Aver. Consumption	1.3980	1.4018

- Both wealth and debt increase. And also switching goes up.

(Reverse) policy reform - Welfare

- Reform involves some non-trivial transitional dynamics.
- So consider the simpler reverse reform: from interest-rate commitment to no-commitment.
- Findings. When removing commitment on ongoing contracts:
 - ▶ All consumers lose out: looser limits but higher interest.
 - ▶ Average lost in equiv. cons.: 0.20% (and quite uniform)
 - ▶ Low class loose more: 0.26%
 - ▶ Low-debt households (1.4% of pop.) loose the most: 1% - 1.5%
- But we have to still compute the higher profits from the operation.

Conclusions

- We wanted and we obtained a theory of Credit lines that delivers
 - ① Limits become looser as education/income increases.
 - ② Among those in debt, the level of debt increases in income.
 - ③ Credit Limits are tighter for households that are very often in debt.
- Contracts arise under U.S. like specific institutional conditions
 - It demonstrates that time-consistent contracts can be analysed.
 - Elicits novel features relating to dynamics of contracts
 - We use it to analyze a much debated policy change. We find that the devil is in the details.
 - An approach that can be easily extended for other applications.

Table 5 - Default and switching

	average	low type	high type
Default			
Def. rate among debtors	0.119	0.133	0.089
Def. rate among constrained	0.629	0.634	0.376
Write-off rate	0.270	0.328	0.180
Switching			
Switch rate	0.0243	0.0188	0.0054
Switch rate from no-card	0.0190	0.0142	0.0044
Switch rate from another card	0.0055	0.0046	0.0010

Table 6 - Changes when switching from current card

	if no switch	if switch
debt limit/loan size	0.230	0.349
price	0.789	0.626

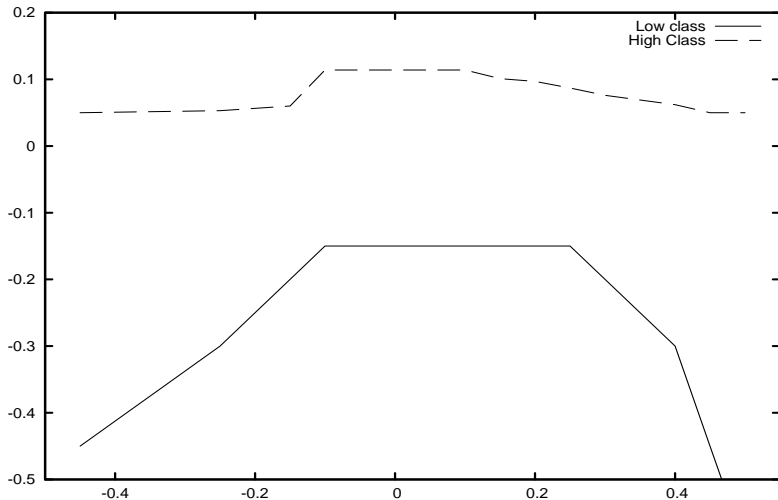


Figure: Credit Limits

References

- BERTAUT, C., AND M. HALIASSOS (2006): *The Economics of Consumer Credit* chap. Credit Cards: Facts and Theories, pp. 181–238. MIT Press, Edited by G. Bertola, R. Disney and C. Grant.
- CHATTERJEE, S., D. CORBAE, M. NAKAJIMA, AND J.-V. RÍOS-RULL (2007): “A Quantitative Theory of Unsecured Consumer Credit with Risk of Default,” *Econometrica*, 75(6), 1525–1589.
- COLE, H. L., AND N. R. KOCHERLAKOTA (2001): “Efficient Allocations With Hidden Income and Hidden Storage,” *Review of Economic Studies*, 68(523-542).
- DROZD, L. A., AND J. B. NOSAL (2007): “Competing for Customers: A Search Model of the Market for Unsecured Credit,” Mimeo, Nosal’s job market paper.
- EATON, J., AND M. GERSOVITZ (1981): “Debt with Potential Repudiation: Theoretical and Empirical Analysis,” *res*, 48(2), 289–309.
- HOPENHAYN, H., AND I. WERNING (2008): “Equilibrium Default,” Manuscript, MIT.
- KEHOE, T., AND D. LEVINE (1993): “Debt Constrained Asset Markets,” *Review of Economic Studies*, 60, 865–888.
- KOCHERLAKOTA, N. R. (1996): “The Equity Premium: It’s Still a Puzzle,” *Journal of Economic Literature*, 34(1), 42–71.
- LIVSHITS, I., J. MACGEE, AND M. TERTILT (2007): “Consumer Bankruptcy: A Fresh Start,” *American Economic Review*, 97(1), 402–418.
- MATEOS-PLANAS, X. (2007): “A model of credit limits and bankruptcy with applications to welfare and indebtedness,” Mimeo, University of Southampton.
- WANG, C. (1995): “Dynamic Insurance with Private Information and Balanced Budgets,” *res*, 62(577-595).

OTHER BENCHMARK FEATURES

These are some curiosities ...

- Large majority of households do not hold a card (around 90%). (It means that only those who need to borrow acquire a card. They go into default and reemerge without a card at a rate that approximately matches the rate at which households borrow.)
- Switchers are looking for higher loans but at a higher interest.

2007 Wealth and Income data

Sample Age	Poor Defined by Income				Poor Defined by Wealth		
	Full All	All	Poor 75% < 65	< 60	All	Poor 75% < 65	< 60
Mean Earnings	53,777	29,013	35,909	37,541	39,045	46,296	48,125
Median Earnings	31,879	24,681	32,908	34,964	29,823	37,021	39,078
Coeff Var Earnings	18,184	8,244	6,440	6,074	9,142	7,628	7,356
Mean Income	84,144	41,114	43,704	43,939	49,566	54,201	54,960
Median Income	47,305	37,021	41,135	41,135	38,050	44,219	45,248
Coeff Var Income	31,354	5,135	4,824	4,801	7,040	6,579	6,530
Mean Net Worth	555,443	205,665	164,937	145,000	115,093	106,197	102,424
Median Net Worth	120,430	69,400	47,305	38,800	64,680	52,700	47,580
Coeff Var NW	43,637	27,734	30,631	31,444	9,807	10,309	10,506
Mean Debt	97,070	60,457	71,644	73,214	77,534	84,742	86,862
Median Debt	27,700	15,000	25,300	27,000	21,100	33,750	36,300
Coeff Var Debt	14,222	14,670	13,141	12,723	13,583	12,253	12,008
Mean TCL	25,854	14,749	14,942	13,934	14,423	14,743	14,097
Median TCL	9,000	4,200	3,000	2,500	4,500	4,000	3,600
Coeff Var TCL	84,754	64,476	70,718	79,140	14,280	14,126	13,924
Wealth/Income	6.60	5.00	3.77	3.30	2.32	1.96	1.86

Distributional Statistics of the Total Population and the 75% poorer under 60 (2007 SCF)

Findings: Properties of Contracts. Sizing up with data

- 1 Credit limits increase with income class. Yes. Table Terms Of Credit.
- 2 The sizes of loans increase with income class. Yes. Table Terms Of Credit.
- 3 Credit Limits are tighter for households that are very often in debt. Yes. Table Frequency of Full Repayment. Interpreted as credit limits are tighter for hholds with high probability of keeping a balance.
- 4 More frequent users bear higher interest rates. Mixed findings. See Table Frequency of Full Repayment.

Table - Terms Of Credit

	average	low type	high type	ratio
All contracts				
credit limit	0.225	0.195	0.332	1.70
loan size	0.204	0.177	0.300	1.69
price	0.817	0.830	0.796	0.96*
Continuing contracts				
credit limit	0.222	0.170	0.419	2.46
loan size	0.143	0.102	0.296	2.90
price	0.854	0.897	0.694	.77

Table - Frequency Of Full Repayment

		low type	high type
Repay with prob. $> 50\%$	limit	0.246	0.514
	price	0.860	0.689
Repay with prob. $< 50\%$	limit	0.159	0.500
	price	0.893	0.598

Characterization of Contracts: Initial Terms

- For both types initial contracts, loans are either very large or small.
- Non monotonic price schedule because of fixed costs. Banks recover 30% of the initiation cost in the first period.
- Monotonic expected default.
- Non Monotonic expected switch.
- High Class gets better initial terms.

Initial Contract Interest Rates and Loan Sizes

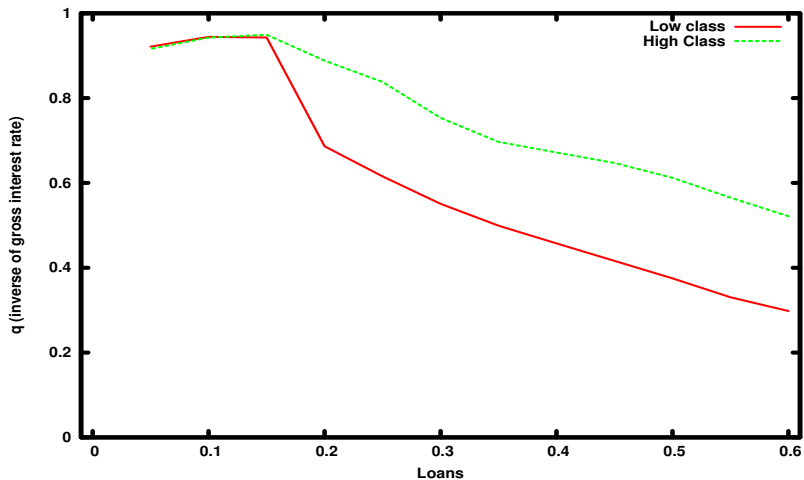


Figure: Credit Limits

Initial Contracts

Initial contracts with positive entry

e	y'^{ω}	q^{ω}	$E[d']$	$E[s']$	% inflow
1	-0.45	0.42	0.56	0.00	0.20
1	-0.15	0.94	0.00	0.29	0.29
1	-0.10	0.94	0.00	0.12	0.21
1	-0.05	0.92	0.00	0.10	0.07
2	-0.60	0.52	0.45	0.01	0.05
2	-0.55	0.57	0.41	0.00	0.02
2	-0.50	0.61	0.36	0.00	0.07
2	-0.25	0.84	0.12	0.08	0.02
2	-0.15	0.95	0.00	0.13	0.08
2	-0.10	0.94	0.00	0.08	0.03
2	-0.05	0.92	0.00	0.07	0.00 ⁺

Continuing Terms

- The credit limits tend to expand initially. They track debt.
- For the low types the loan price is not monotonic as result of the the conflicting interests of keeping, pruning and extracting rents.
- When type improves credit limit becomes looser but interest rates go up except in extreme circumstances (artifact of the distribution).
- For the high type there is a U shape of loan prices.
- Survival is decreasing in debt.
- Limits are inverted U shape.
- New loans are inverted U shape.

Table 8(a) - Continuing contracts, low type e

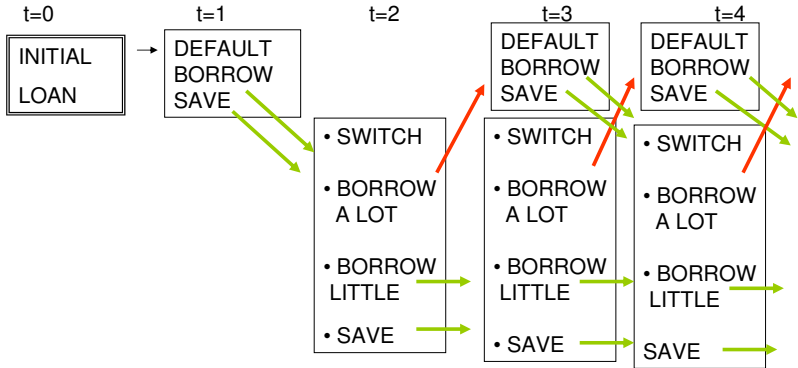
y	b	q	def	switch	surv.	av loan	max loan
-0.45	-0.45	0.97	0.63	0.00	0.37	0.05	0.05
-0.25	-0.30	0.81	0.42	0.00	0.58	0.05	0.05
-0.15	-0.20	0.76	0.00	0.34	0.66	0.06	0.10
-0.10	-0.15	0.92	0.00	0.14	0.86	0.11	0.15
-0.05	-0.15	0.92	0.00	0.11	0.89	0.11	0.15
0.00	-0.15	0.92	0.00	0.08	0.92	0.11	0.15
0.05	-0.15	0.92	0.00	0.05	0.95	0.11	0.15
0.10	-0.15	0.92	0.00	0.02	0.98	0.11	0.15
0.15	-0.15	0.90	0.00	0.03	0.97	0.10	0.15
0.20	-0.15	0.90	0.00	0.02	0.98	0.10	0.15
0.25	-0.15	0.88	0.00	0.02	0.98	0.09	0.15
0.30	-0.20	0.85	0.00	0.02	0.98	0.08	0.10
0.35	-0.25	0.81	0.00	0.03	0.97	0.07	0.10
0.40	-0.30	0.81	0.00	0.01	1.00 ⁻	0.06	0.10
0.45	-0.45	0.81	0.00	0.00	1.00 ⁻	0.05	0.05
0.50	-0.60	0.81	0.00	0.00	1.00	0.05	0.05

Table 8(b) - Continuing contracts, high type e

y	b	q	def	switch	surv.	av loan	max loan
-0.55	-0.60	0.88	0.33	0.00	0.67	0.05	0.05
-0.50	-0.55	0.88	0.28	0.00	0.72	0.05	0.05
-0.45	-0.50	0.88	0.24	0.00	0.76	0.05	0.05
-0.25	-0.50	0.59	0.05	0.08	0.87	0.44	0.50
-0.15	-0.50	0.59	0.00	0.08	0.92	0.45	0.50
-0.10	-0.50	0.59	0.00	0.07	0.93	0.45	0.50
-0.05	-0.50	0.59	0.00	0.06	0.94	0.45	0.50
0.00	-0.50	0.59	0.00	0.05	0.95	0.45	0.50
0.05	-0.50	0.59	0.00	0.04	0.96	0.45	0.50
0.10	-0.50	0.59	0.00	0.04	0.96	0.44	0.50
0.15	-0.50	0.59	0.00	0.04	0.96	0.44	0.50
0.20	-0.25	0.81	0.00	0.04	0.96	0.15	0.25
0.25	-0.25	0.81	0.00	0.03	0.97	0.15	0.25
0.30	-0.25	0.81	0.00	0.02	0.98	0.15	0.25
0.35	-0.25	0.81	0.00	0.01	0.99	0.14	0.25
0.40	-0.20	0.81	0.00	0.01	0.99	0.11	0.20
0.45	-0.15	0.81	0.00	0.01	0.99	0.09	0.15
0.50	-0.30	0.81	0.00	0.01	0.99	0.08	0.15
0.55	-0.45	0.78	0.00	0.00 ⁻	1.00 ⁻	0.07	0.10
0.60	-0.60	0.78	0.00	0.00 ⁻	1.00 ⁻	0.06	0.10
0.65	-0.60	0.88	0.00	0.00	1.00	0.07	0.10
0.70	-0.60	0.78	0.00	0.00	1.00	0.05	0.05
0.75	-0.60	0.88	0.00	0.00	1.00	0.05	0.05

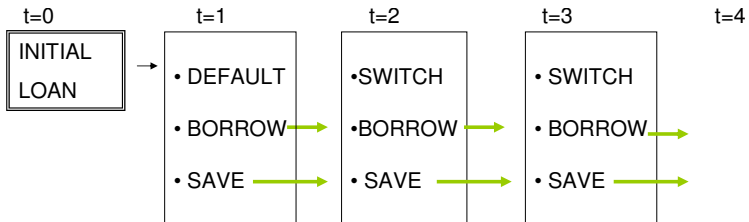
Contracts - Time-consistent dynamics

HIGH-TYPE Hholds shift recurrently between a regime where default may occur and one where it cannot.



Contracts - Time-consistent dynamics (2)

LOW-TYPE contracts: hhold may only default in the beginning and settles on a never-default regime thereafter



Properties of equilibrium consumer decision rules

Switching $\tilde{s}(z, q, b)$: Seems to happen more often to increase borrowing limit (occasionally can happen even to get a better interest rate).

- Those more indebted are more likely to switch (they want to borrow at better rates).
- Higher cash in hand borrowers are more likely to switch as they want better terms.

Default $\tilde{d}(z, q, b)$:

- Higher assets implies less default always.
- Higher earnings almost always implies less default. It may happen that one can be too poor to default.

Bank decision rules: Properties limits and prices

Credit limits $q^\omega(y, e)$, $b^\omega(y, e)$ for a given contract ω . Recall

$$\begin{aligned}\tilde{\Psi}(e, y, \omega, q, b) = & -y \mathbf{1}_{y < 0} \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) [1 - \tilde{d}(z, q, b)] + \\ & \sum_{\varepsilon} F_e(\varepsilon, \chi) \tilde{g}(z, q, b) q \tilde{y}'^n(z, q, b) \mathbf{1}_{\tilde{y}'^n(z, q, b) < 0} \\ & + q^* \sum_{\varepsilon} F_e(\varepsilon, \chi) \tilde{g}(z, q, b) \sum_{e'} \Gamma_{e, e'} \Psi(e', \tilde{y}'^n(z, q, b), \omega)\end{aligned}$$

Four key terms:

- The current default rate d .
- The endowment composition of non-defaulting customers, F 's
- The current switch (or retention) rate, s
- The value of future loans Ψ : risk and size

Bank decision rules - limits (2)

- THE CONFLICTING EFFECTS OF LOWERING THE DEBT LIMIT:

Key channels:

- Fewer defaulters tomorrow.
 - Higher switching today, which lowers retention
-
- consequently
 - Limits may increase: to increase retention of low risk customers
 - Limits may decrease: drive away high risk customers

Policy reform - Preliminaries

- The Fed's new rules (Regulation AA) will prevent increases in interest rates within an ongoing credit line. So something has to give.
- Note this is NOT a cap on prices, but a rule on commitment.
- Remarks on modeling:
 - Banks can still alter the limit within a contract in time-consistent manner.
 - Commitment to price means: as many types of potential ongoing contracts as prices in initial agreements; have to take care of possibly different contracts for same initial loan.

Policy reform - Aggregate effects of commitment

- 1 Generally, banks tighten debt limits but charge lower interest rates. These changes are most visible for high-type households.
- 2 Borrowing decreases.
- 3 Wealth increases.
- 4 The number of defaulters and the volume defaulted on decreases.
- 5 The frequency of contract switching declines.
- 6 Average consumption rises slightly because of the wealth increase.
- 7 We are not reporting welfare. The increase in wealth is a bad omen but we do not know yet.

Policy reform - Comparison of Aggregates

	Pre-reform (no commitment)	Post-reform (price commitment)
Mass in debt	0.03221	0.03080
Mass of defaulters	0.00383	0.00315
Mass switchers	0.02433	0.02095
Write-off rate	0.26980	0.23279
Wealth	1.1852	1.2105
Debt	0.00658	0.00582
Loan size (initial)	0.2262	0.2199
Loan price (initial)	0.8031	0.7935
Debt limit (initial)	0.2262	0.2199
Loan size (continuing)	0.1430	0.1298
Loan price (continuing)	0.8543	0.9000
Debt limit (continuing)	0.2224	0.1790
Aver. Consumption	1.37246	1.37736

Policy reform - Initial contracts

e	y	q	$E[d']$	$E[s']$	% inflow
1	-0.4500	0.40305	0.56264	0.19154	0.13906
1	-0.1500	0.89665	0.00000	0.01906	0.29564
1	-0.1000	0.91359	0.00000	0.11454	0.22940
1	-0.0500	0.89768	0.00000	0.09435	0.07123
2	-0.6000	0.51082	0.45740	0.10470	0.00559
2	-0.5500	0.55292	0.41286	0.07226	0.02076
2	-0.5000	0.59879	0.36438	0.03400	0.10637
2	-0.1500	0.91651	0.00000	0.07464	0.10597
2	-0.1000	0.91215	0.00000	0.09824	0.02598

- Active contracts (almost) same loan sizes as in benchmark
- Higher initial interest rate for given contract size
- There is one contract per loan size (in spite of free-entry)