CREDIT LINES

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(old yet preliminary)

I. MOTIVATION

General aim: Investigating macroeconomic and distributional implications of unsecured consumer credit (e.g., credit cards).

- Why?
  - Much household unsecured lending is in the form of revolving credit-card contracts: no specified repayment period.

Consumer credit, June '09
(excludes home-secured, billions of $)

Total	2502.7
Revolving (unsecured)	917.0
Non-revolving	1585.7

  - recent regulatory reform: Regulation AA
- The question is:
  - Do we know how these contracts work?
  - And does it matter?

I. OBJECTIVE

- THEORY - Study the significance of revolving credit contracts under the constraints imposed by the actual institutional environment:
  - Why these contracts emerge at all.
  - How they compare with non-revolving credit.
  - How credit terms – limits and interest – are determined.

- POLICY: The implications of the recent tightening of regulation in the credit card market (Regulation AA, 2010)

- EMPIRICS: Assess how it accounts for U.S. allocations and terms of contracts (i.e., credit limits and interest rates)

I. U.S. INSTITUTIONS

- The Bankruptcy Code: borrowers can declare bankruptcy.
- The "Consumer Credit Protection Act" and Regulation Z:
  - So far, banks have been free to change the terms – interest rate and credit limit – of an existing credit line (even on existing balances).
  - Regulation AA of"Unfair or Deceptive Acts or Practices" bans interest rate hikes on existing balances.

Our ultimate question: is such regulation of bank commitment desirable?

I. INTRODUCTION - WHY A NEW THEORY?

We are talking changes in conditions on an existing credit relationship. This is NOT a case of straight price regulation (e.g., interest ceiling). Hence:

- Need long term revolving credit contracts.
- Need to consider different degrees of bank commitment.

I. ELEMENTS OF THE THEORY

Incorporate bankruptcy code, banks' legal capabilities, and contracting costs:

1. Borrowers cannot commit to repay nor can they commit to stick with current bank.

2. Banks do NOT commit to the initial approved interest rate (although, post-reform, will have to commit not to raise it)

3. Banks do NOT commit to credit limits (yet must allow to roll over existing debt).

4. Contracts are costly to sign for both borrowers and lenders.

I. LITERATURE

- Extend Chatterjee, Corbae, Nakajima, Ríos-Rull 2007, Livshits, MacGee and Tertilt 2007, Mateos-Planas 2007, to multiperiod contracts.
- Athreya, Young et al. : imperfect info; LIvshits - transaction costs
- A somewhat related paper is Drozd and Nosal 2007: search frictions and full commitment on the part of banks.
- Big literature on endogenous constraints. Kehoe and Levine 1993, Wang 1995, Kocherlakota 1996, Cole and Kocherlakota 2001, Hopenhayn and Werning 2008.

I. PREVIEW OF FINDINGS

(based on simple parameterizations of the model)

- Contract configuration and dynamics:
  - There are short and long term contracts.
  - Interest rates may differ markedly from initial agreement (e.g., the "interest hikes")
  - Limits are often increased, even after bad news.
- Revolving contracts matter
  - affect prices and credit
  - dominate one-period loans

Policy reform and welfare:

- Tighter limits and higher offered rates
- Prevents interest-rate hikes

II. MODEL - OUTLINE

1. Households
2. Banks
3. Equilibrium
4. Remarks on finding it

II. MODEL - HOSEHOLDS (state)

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

State $z = \{e, y, \theta, \varepsilon, \chi, h\}$:

- Public information
  - Observed income type e, Markov or iid
  - Asset position y, positive or negative
  - One contract $\theta \in \Theta$ with a bank, if any
  - A credit history $h \in \{0, 1\}$
- Private Information
  - Endowment/income ε, with type-dependent prob. distribution
  - i.i.d. utility costs shocks χ to defaulting and contracting (Purely technical.) We write $F(\varepsilon, \chi, e)$.

II. MODEL - TIMING

1. State gets realized.
2. Bank chooses interest rates and credit limits for new and existing contracts.
3. Households choose whether to default or switch.
4. Households consume and save/borrow.

II. MODEL - HOUSEHOLDS (contracts)

Credit contracts: θ are associated with observables when signing:

- Initial loan $y'^{\theta} \leq 0$
- Initial interest rate $(q^{\theta})^{-1}$
- Initial income type e^{θ}

And continuation plans based on observables for

- Credit limits, $b^{\theta}(e, y)$ so that $y' \geq b^{\theta}(e, y)$
- (Inverse of gross) Interest rates, $q^{\theta}(e, y)$

II. MODEL - HOUSEHOLDS (choices and endog. states)

Decisions:

- default $d \in \{0, 1\}$
- switch line $s \in \{0, 1\}$ and which line θ'
- save/borrow y'

The credit status h' evolves depending on the current status, the default decision, and nature.

The credit line θ' is governed by the new credit status and the switching decision.

II. MODEL - HOUSEHOLDS (decision rules)

- For the given set of traded contracts Θ:
  1. Default decision $d(z)$ conditional on state.
  2. Switching decision $s(z)$ and contract $\theta'(z)$.
  3. Saving decision $y'(z)$.
- What to do for arbitrary one-period deviations in credit terms?
  1. Default decision $\widetilde{d}(z, q, b)$
  2. Switching decision $s(z, q, b)$
  3. Saving decision $y'(z, q, b)$
- For alternative contracts not in Θ, further deviation decision rules. (Only relevant under commitment)
  - for the prospective contract $\widehat{\theta} \notin \Theta$, $\{y'(z, \widehat{\theta}, q, b), \widehat{\theta}'^{s}(z, \widehat{\theta}, q, b), \widehat{d}(z, \widehat{\theta}, q, b), \widehat{s}(z, \widehat{\theta}, q, b)\}$,
  - and for existing contracts, $\{\widehat{\widehat{d}}(z, \widehat{\theta}, q, b), \widehat{\widehat{s}}(z, \widehat{\theta}, q, b)\}$.

II. MODEL - HOUSEHOLDS (some properties of decision rules)

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

- Default on outstanding balances increases with a higher interest rate and a tighter limit.

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

- Switching increases with higher interest rate and tighter limit.

II. MODEL - BANKS (possible contracts)

- A bank takes deposits at the safe discount price q^*.
- A bank issues a contract θ at fixed cost π
- Active contracts Θ are a subset of a large potential set Θ^P

II. MODEL - BANKS (Value with deviations)

A bank is free to change terms b and q:

$$\widetilde{\Psi}(e, y, \theta, q, b) = -y\ 1_{y<0} \sum_{\varepsilon,\chi} F_e(\varepsilon, \chi)[1 - \widetilde{d}(z, q, b)]$$
$$+ \sum_{\varepsilon} F_e(\varepsilon, \chi)\ \widetilde{g}(z, q, b)\ q\ \widetilde{y}'(z, q, b)\ 1_{\widetilde{y}'(z,q,b)<0}$$
$$+ q^* \sum_{\varepsilon} F_e(\varepsilon, \chi)\ \widetilde{g}(z, q, b) \sum_{e'} \Gamma_{e,e'}\ \Psi(e', \widetilde{y}'(z, q, b), \theta)$$

II. MODEL - BANKS (trade-offs)

The value to an existing line:

$$\begin{aligned}\widetilde{\Psi}(e, y, \theta, q, b) \;=\; & \underbrace{-yE[1-d]}_{debt\ repaid} \\ & + E[\underbrace{(1-d)(1-s)}_{survival}\ \underbrace{(-y')}_{new\ debt}\ \underbrace{(q^*(1-d')-q)}_{profit\ margin}] \\ & + [Continuation\ \ value]\end{aligned}$$

where d, s, y' (and so d') depend on bank's choices q and b.

Bank's trade-offs

- Limit: too loose, and bad debts; too tight, and high default.
- Interest: too low, and low return; too high, and much default or much switching or little lending.

II. MODEL - BANKS (time-consistency and commitment)

Time consistency requires contract policies to solve:

$$\max_{q,b} \widetilde{\Psi}(e, y, \theta, q, b).$$

subject to institutional constraints on q and b.

We consider two specific models:

- Pre-reform:
  - q - freely chosen
  - $b \leq y$ - allow revolving existing debt
- Post-reform (price commitment): q cannot fall below initial agreement's (or constant).

II. MODEL - EQUILIBRIUM

An equilibrium is a set of contracts $\Theta \subset \Theta^P$ and allocations s.t.:

(A) Agents maximize (standard).

(B) Zero profit or free entry in new contracts.

(C) Time consistency

(D) Unprofitable alternative contracts (When commitment only)

II. MODEL - existence, uniqueness ...

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

- Let $\Theta = \{E \times \mathcal{Y}\}$, the set of possible hholds' demands/types.
- For each $\theta \in \Theta$, solve for q^θ and $b^\theta(e, y)$ and $q^\theta(e, y)$.
- Important questions.
  1. Do such objects exist for all $\theta \in \Theta$?
     We always found one.
  2. Given any q^θ, will there be a unique pair $q^\theta(e, y)$, $b^\theta(e, y)$?
     It seems so.
  3. Can more than one set of q^θ and b^θ, q^θ for initial e, y' coexist?
     It does not seem so.

II. MODEL - SOLUTION APPROACH

- Discretize (recall the non-convexity).
- Guess that there is one contract per pair $(e^{\theta}, y'^{\theta})$.
- Fixed point problem requires convexification of profit function via the utility costs shocks.
- Check for profitable one-shot deviation $\hat{\theta}$ and update Θ if needed.
- Calculate the stationary distribution over $e, \varepsilon, y, \theta, h$.

III. "THEORETICAL" SETTINGS

Simple settings:

- Two-state income process: employment/unemployment
- Income for the unemployed is 10% of that of the employed.
- Parameters: 3% risk-free rate; 0.85 discount; truncated-normal utility costs; 8 years bankruptcy penalty.

Variants in income process:

- Benchmark: iid + public information; no commitment
- Private information
- Persistence

III. Parameters

Table - Common parameters

Description	Parameter	value
Model		
Risk aversion	σ	2.00
Discount	β	0.85
Prob. clear history	δ	0.10
Bank's cost	π	0.01
Risk-free interest	$1/q_0 - 1$	0.03
Grids		
Lower bound for y		-0.75
Lower bound for q		0.20
Upper bound for q		1.30

Grid for assets has 100 points (15 negative). Utility costs truncated normal distribution.

III. Parameters income process

Income process: IID + public info

Description	Parameter	value
	Income process	
Number of types	N_e	2
Transition types	$\Gamma_{e,e'}$	.05 .95
		.05 .95
Number of endowments	N_ε	2
Value of endowments	ε	0.10 1.10
Density endowments	$F(\varepsilon, e)$	1 if $\varepsilon = 0.10$ and $e = 1$
		1 if $\varepsilon = 1.10$ and $e = 2$
		0 otherwise

IV. PROPERTIES - OUTLINE

1. New contracts
2. Continuing contracts
3. Household
4. Dynamics of switching
5. Comparison with one-period contracts
6. Private information
7. Markov income

IV. Properties - New Contracts

- Interest and initial default rising in size of debt (although price could be non-monotonic due to bank fixed cost).
  (see Fig 1)
- Two types of contracts emerge in terms of the average expected future profitability: Small loans, make negative initial profit and expect future profits. Larger contracts make initial profits and expect future losses.
  (see Fig 2)
- What are the active contracts?
  - Not all are active. Only for initial debt that is not too high.
  - Mainly acquired by the unemployed.
  - Most will make profits in the future so further lending will occur. (But the few contracts involving high debt will make future losses.)

  (see Fig 3)
- Unemployed start with higher interest because they borrow more. (see Fig 4 and Fig 5)

New Contracts: Interest rate and default

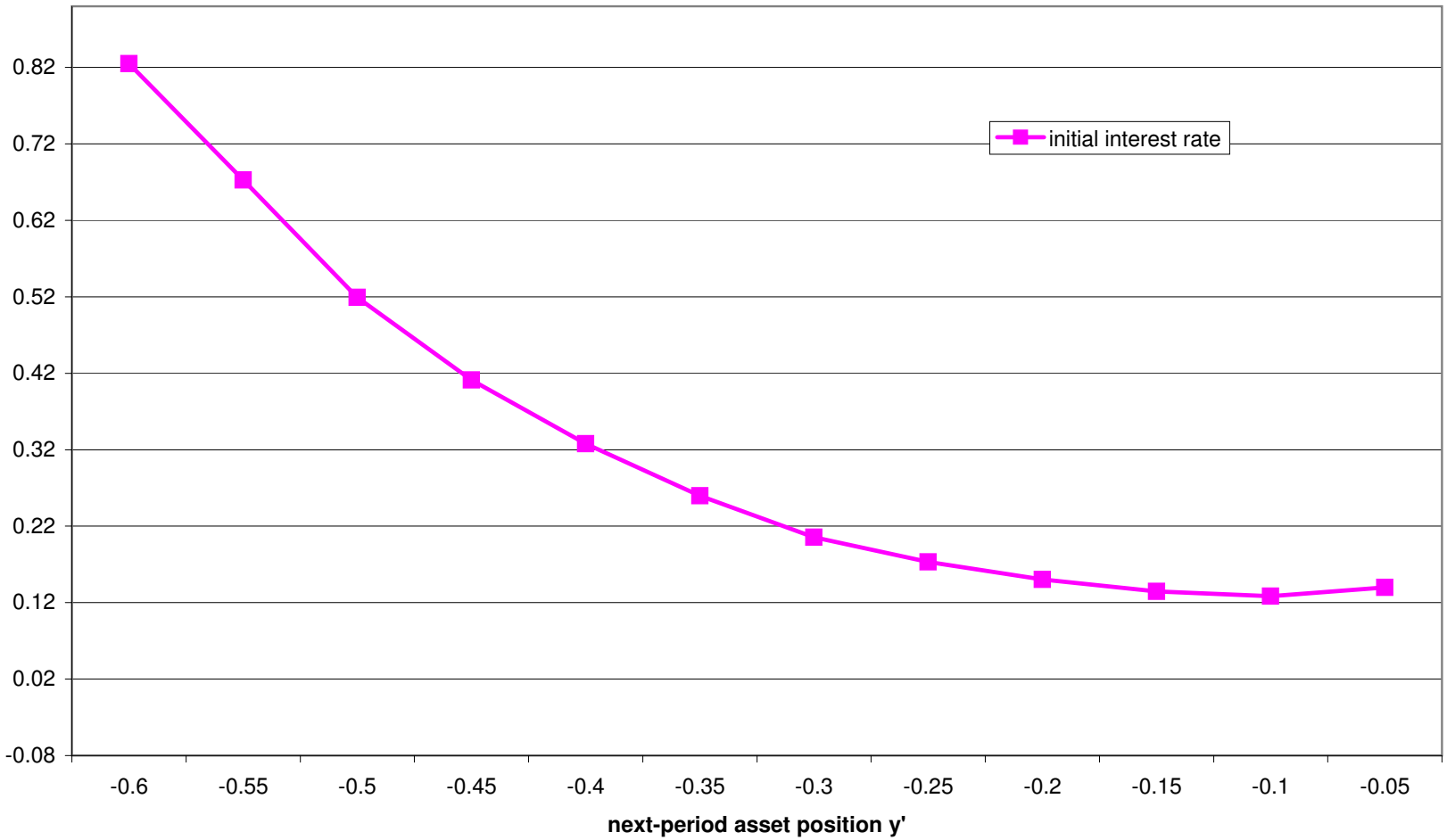


Figure 1: Interest and default on initial loans

New Contracts: Expected profits in first period

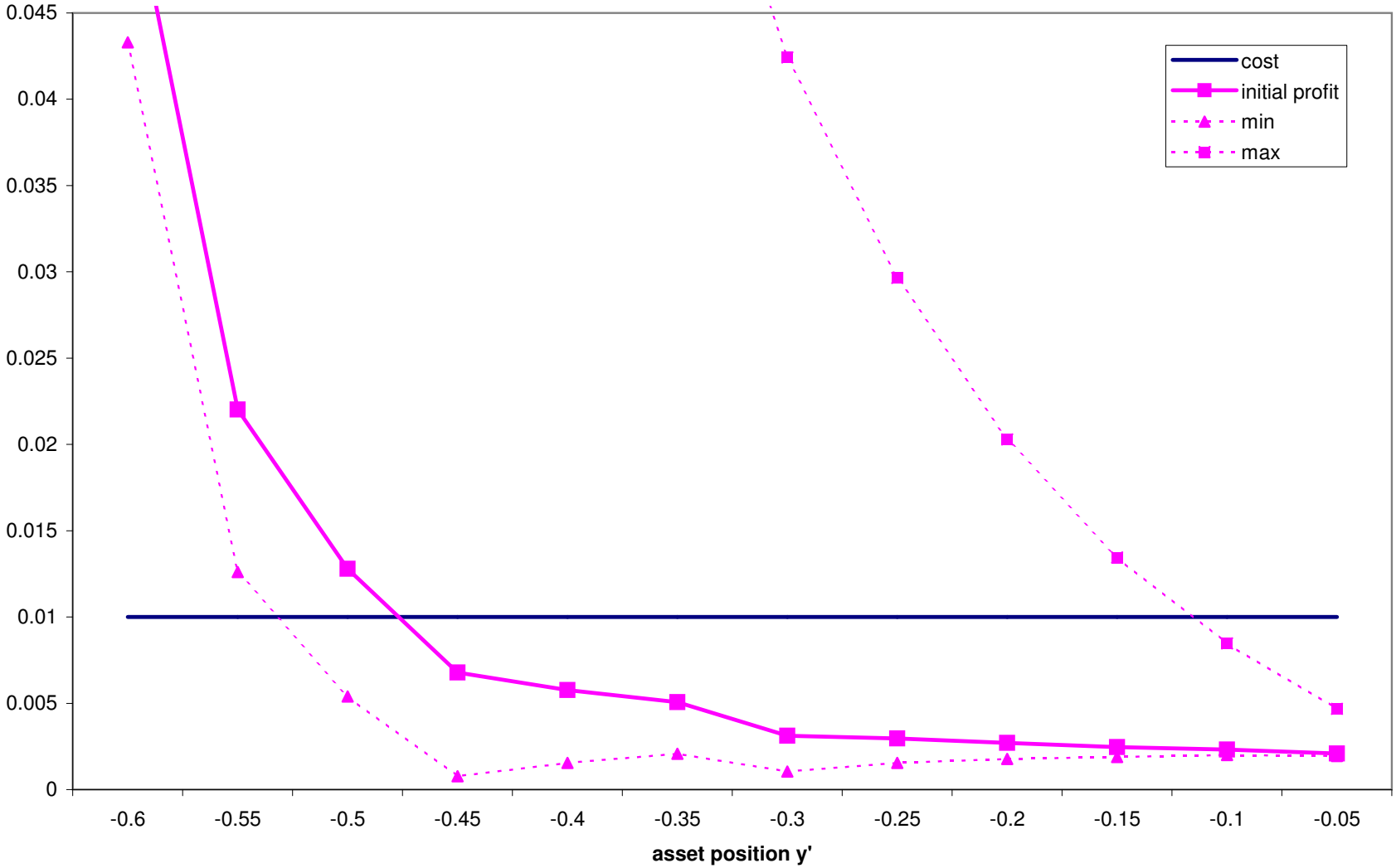


Figure 2: Initial profits

New Contracts: Initial outcomes on active contracts

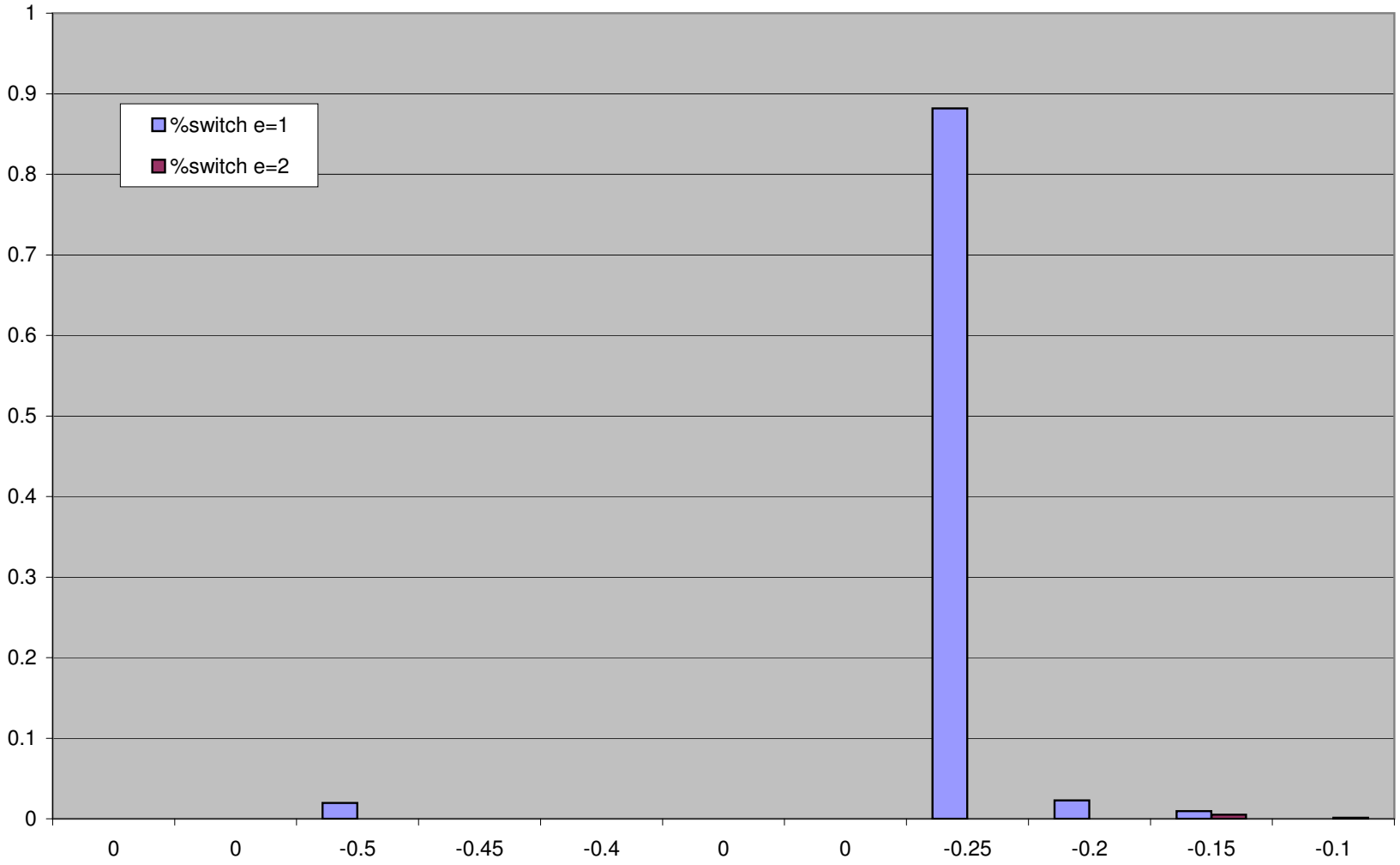


Figure 3: The proportion of switchers over chosen debt levels

New Contracts: Initial saving/borrowing

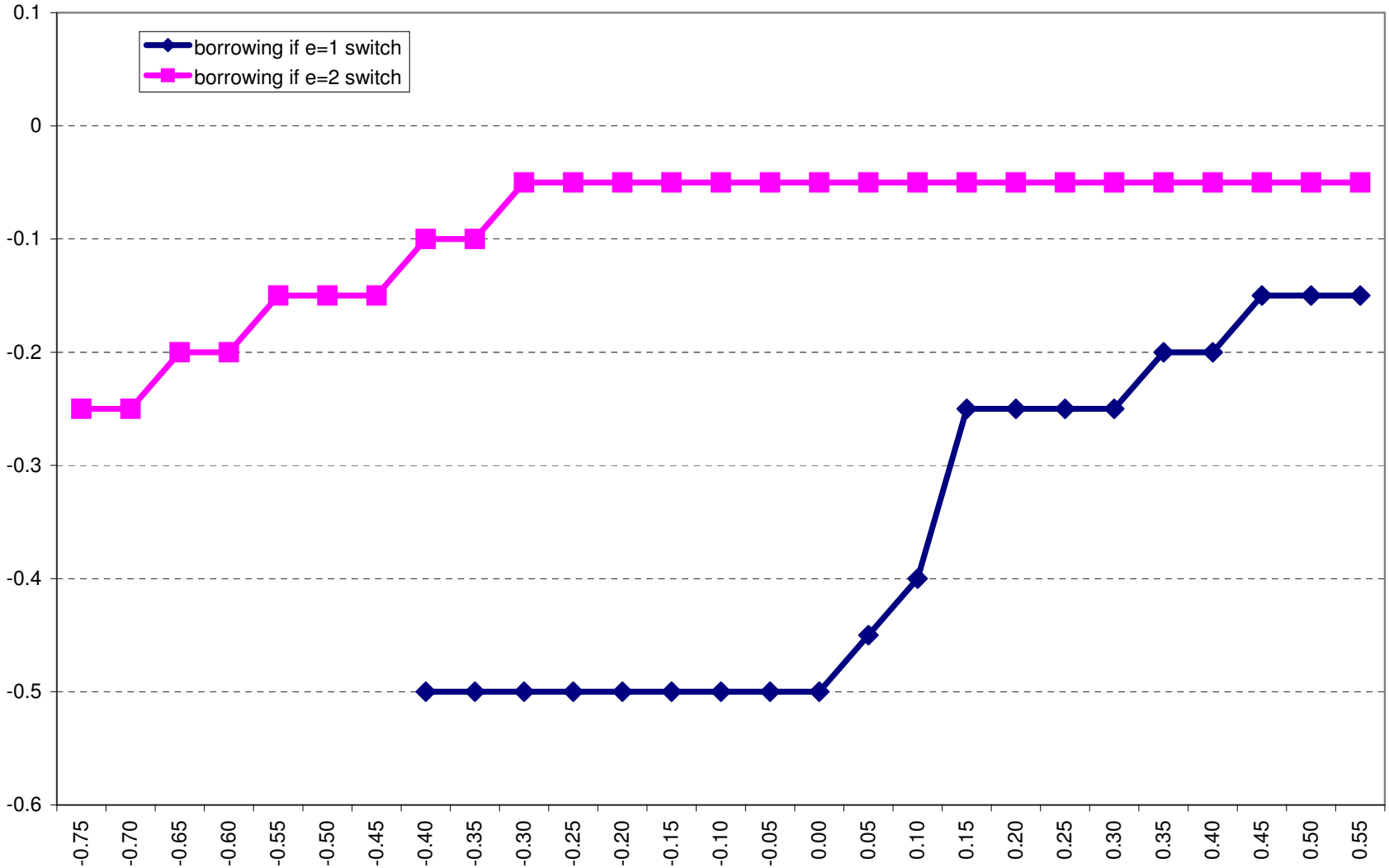


Figure 4: Initial borrowing for switchers

New Contracts: Initial interest

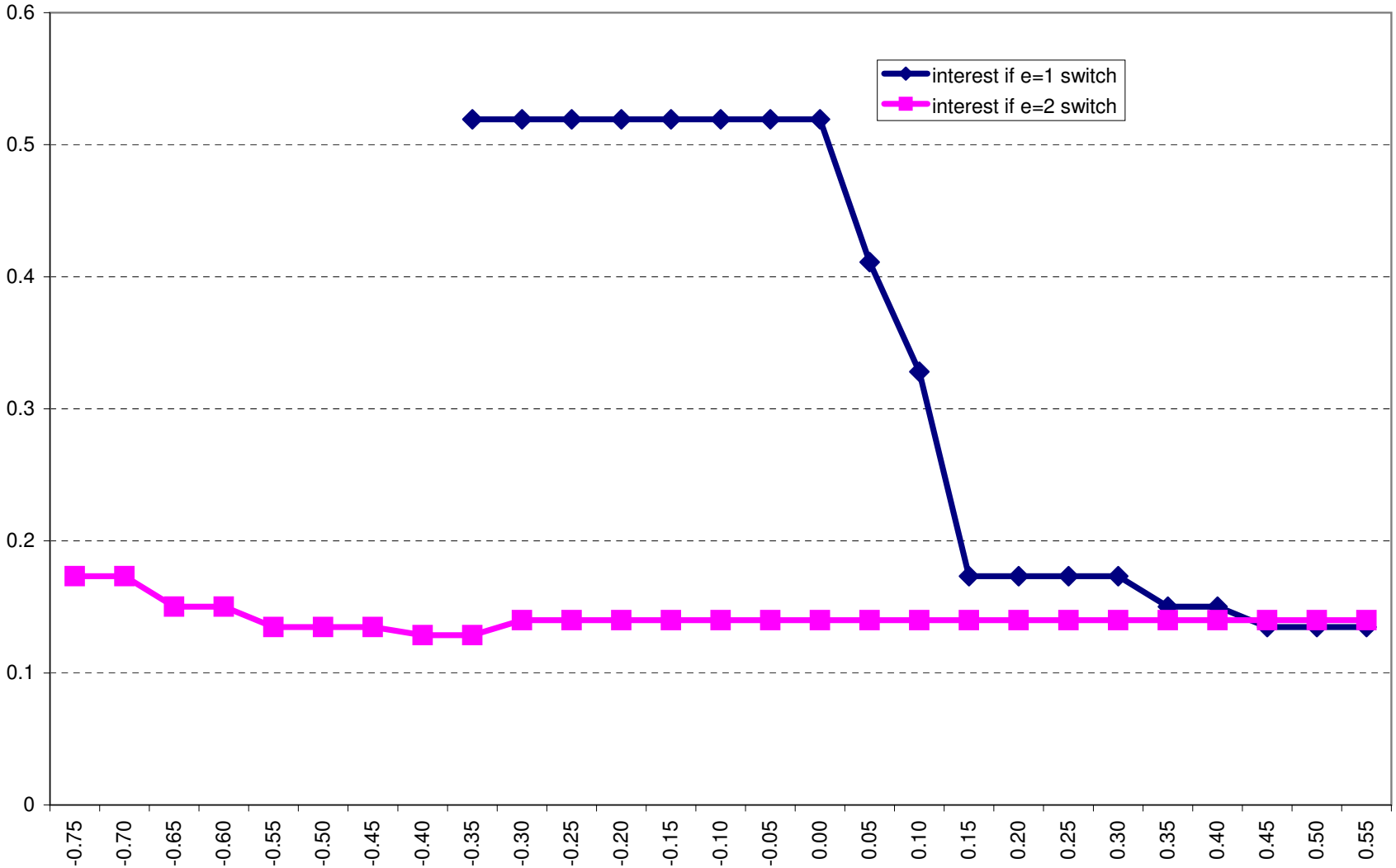


Figure 5: Initial interest rate for switchers

IV. Properties - Continuing Contracts (1)

Debt limit $b(e, y)$ and hhold borrowing y':

- For high-debt unemployed hhold, the limit is as tight as possible; at lower debt, the limit exceeds current debt.
- At high-debt, the unemployed hhold borrows to the limit.
- The bank sets a tighter limit for households holding lower debt/higher assets: the current risk of defaults becomes less of a concern.
- For an employed hhold the bank's limit is never binding and the household pays off debts fast.

(see Fig 6 and 7)

Credit limit and borrowing choice for the unemployed

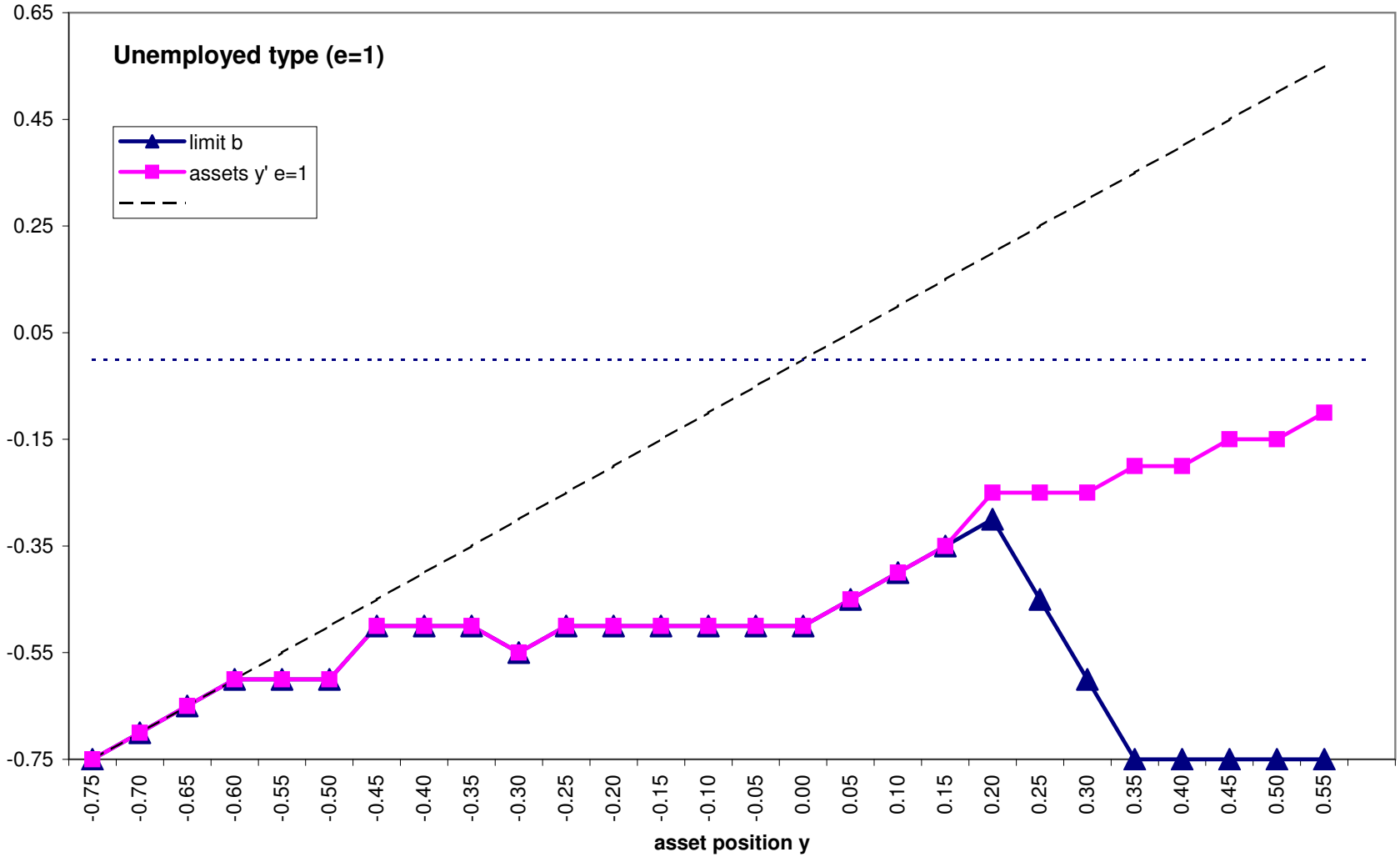


Figure 6: Continuation limits and loans - low income

Credit limit and borrowing choice for the employed

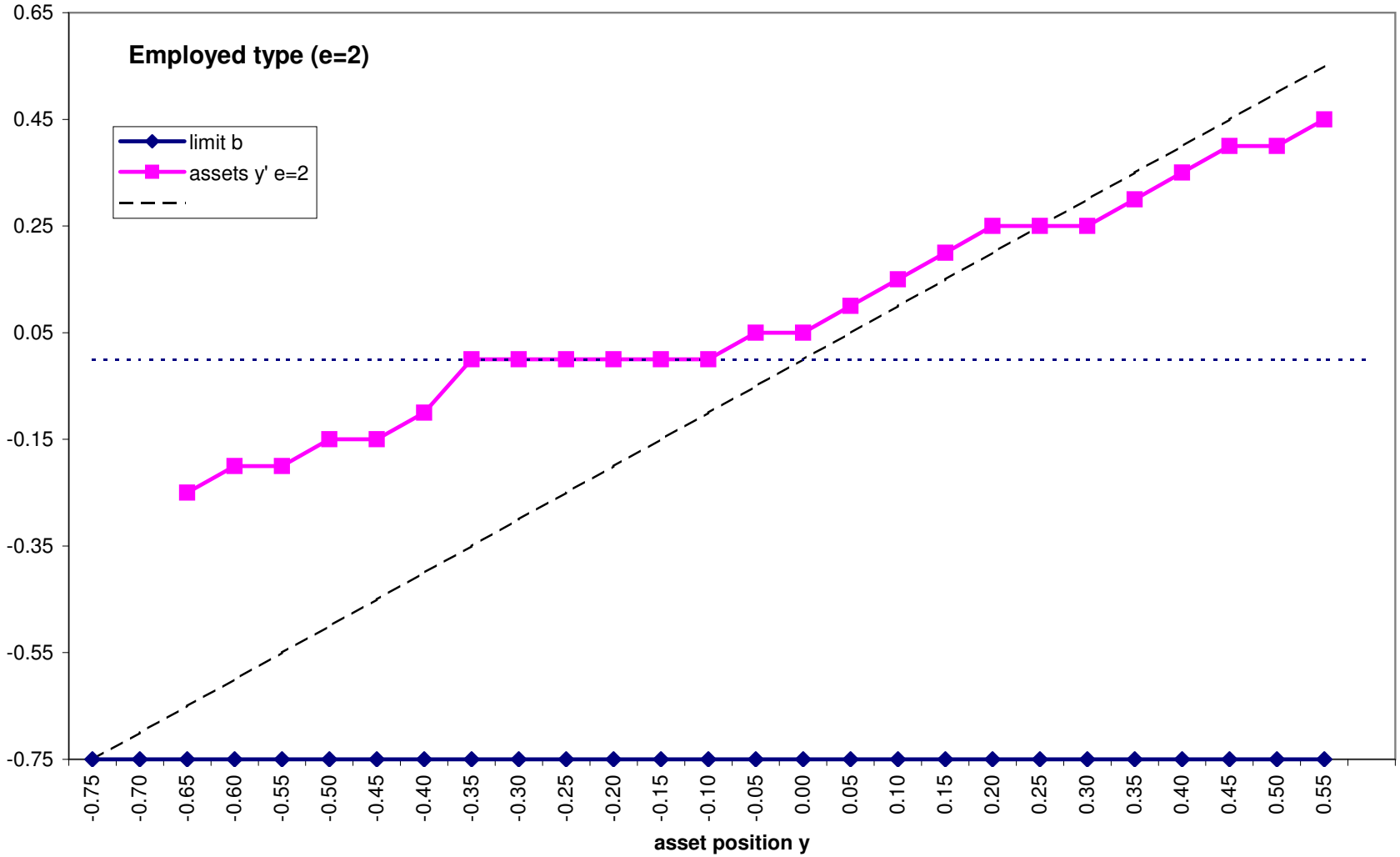


Figure 7: Continuation limits and loans - high income

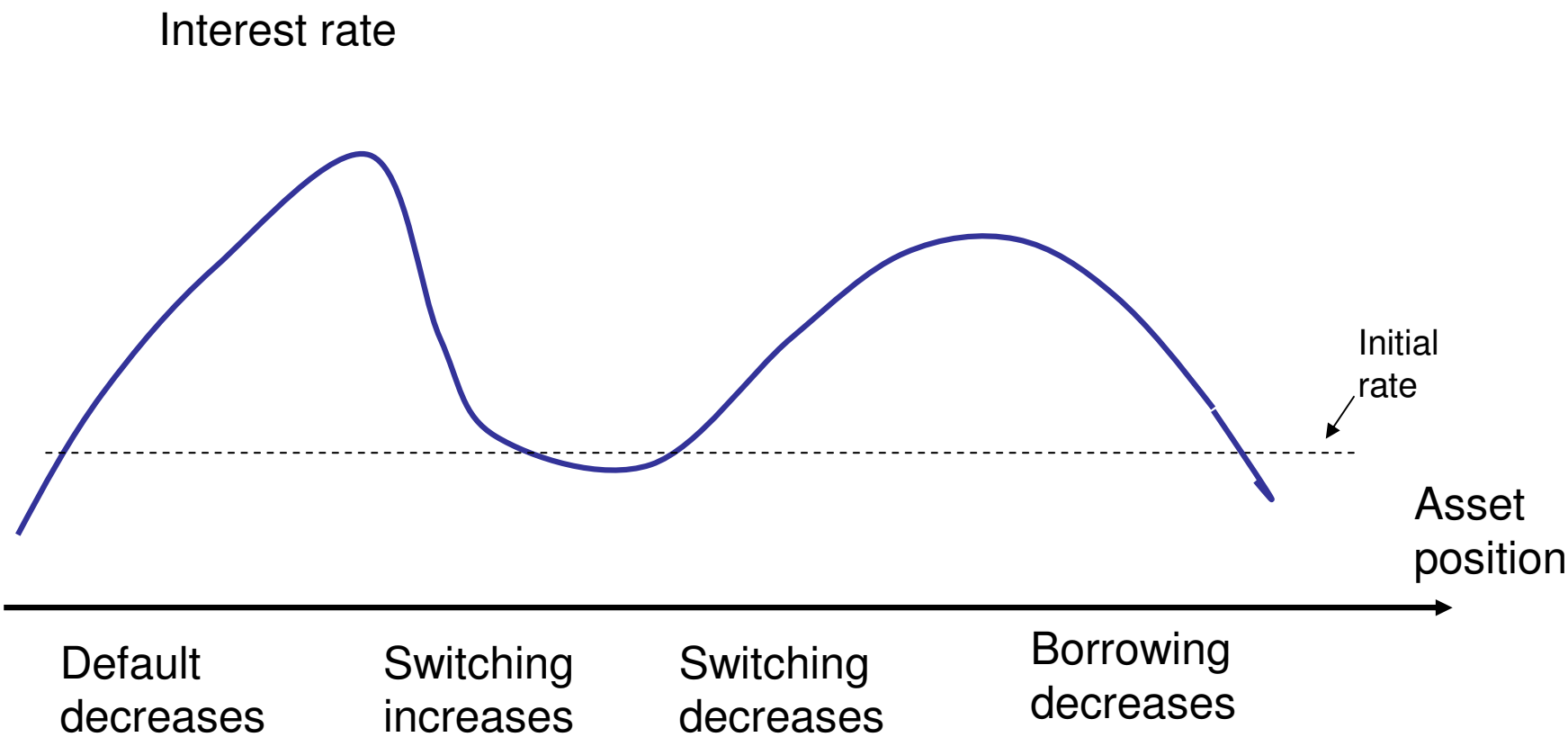
IV. Properties - Continuing Contracts (2)

Price $q(e, y)$: (see Fig 8)

- The interest rate first increases as then decreases with current debt: first, the default risk from raising the interest rate becomes less severe; then, the risk of switching begins to rise.
- The interest rate may increase and decrease again

Profits:

- After the first period, banks will make losses on households with low income type and high debts. In the rest of cases, banks will continue to make profits.
  (see Fig 9)



(dominant factors as asset position increases)

Interest rates for credit lines for both types

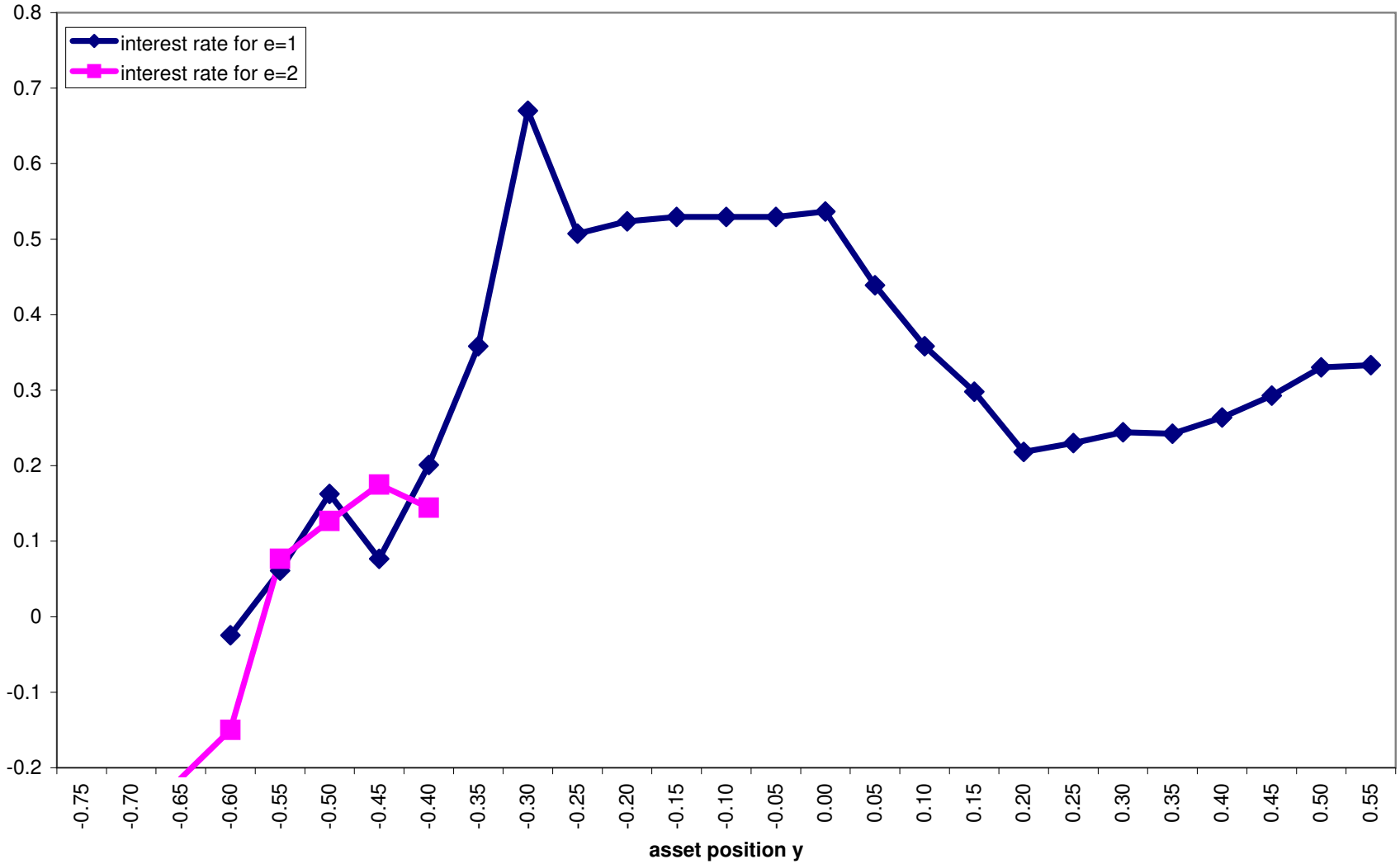


Figure 8: Continuation interest rates

Residual expected profits for both types

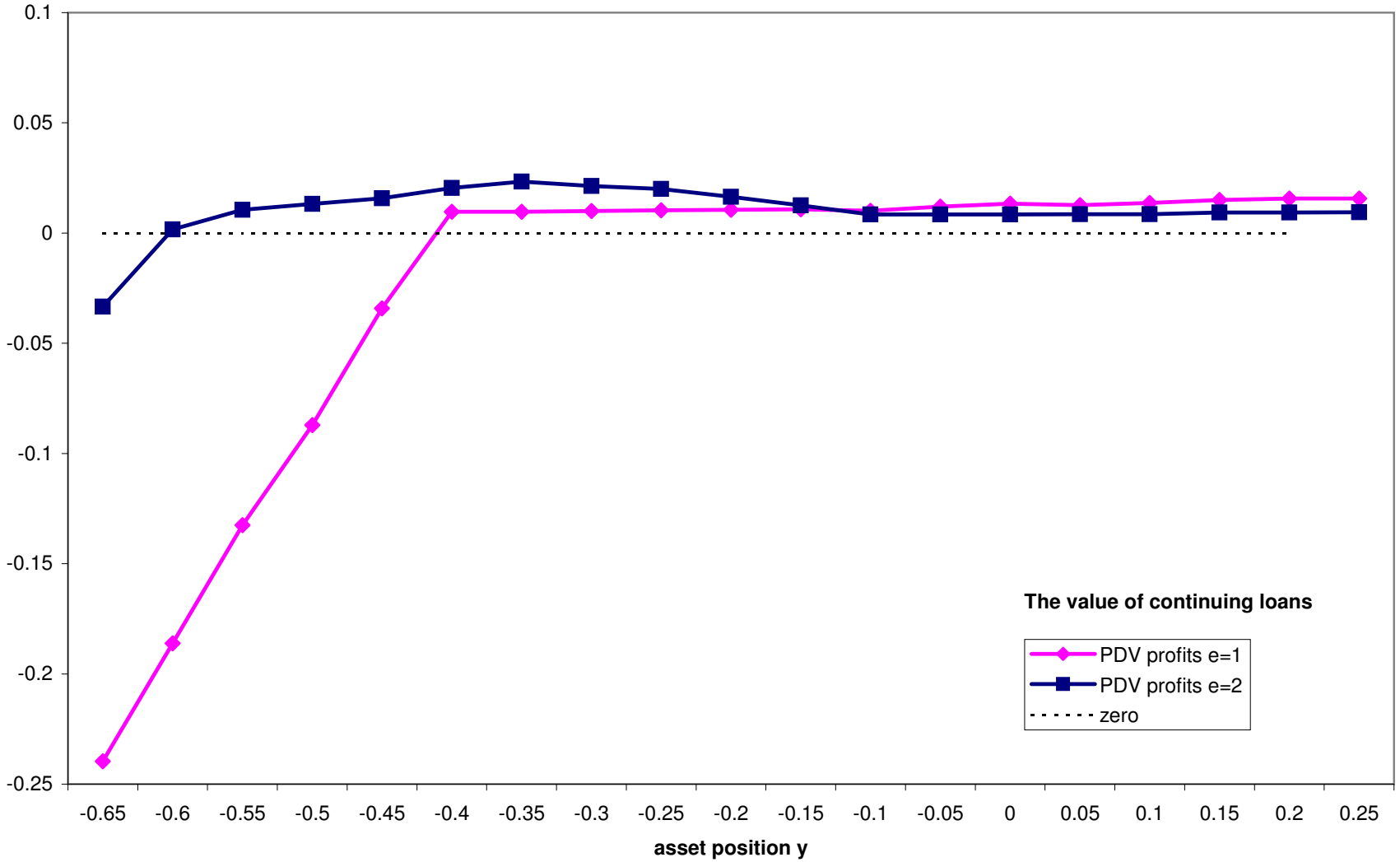


Figure 9: The continuation value of the bank

IV. Properties - Household and actions distribution

Clean households who hold a contract: (see Fig 10 and 11)

- Debt is highly concentrated
- Low-income hholds switch from a certain wealth and never default
- High-income hholds default when in debt

Clean households who do not hold a contract: (see Fig 12)

- Low-income hholds switch to a new contract
- High-income hholds save a stay without contract

Bankrupt households who do not hold a contract: (see Fig 13)

- Low-income hholds switch if they have the chance
- High-income hholds save a stay without contract

Distribution low income: $\omega = 1$, $h = 0$

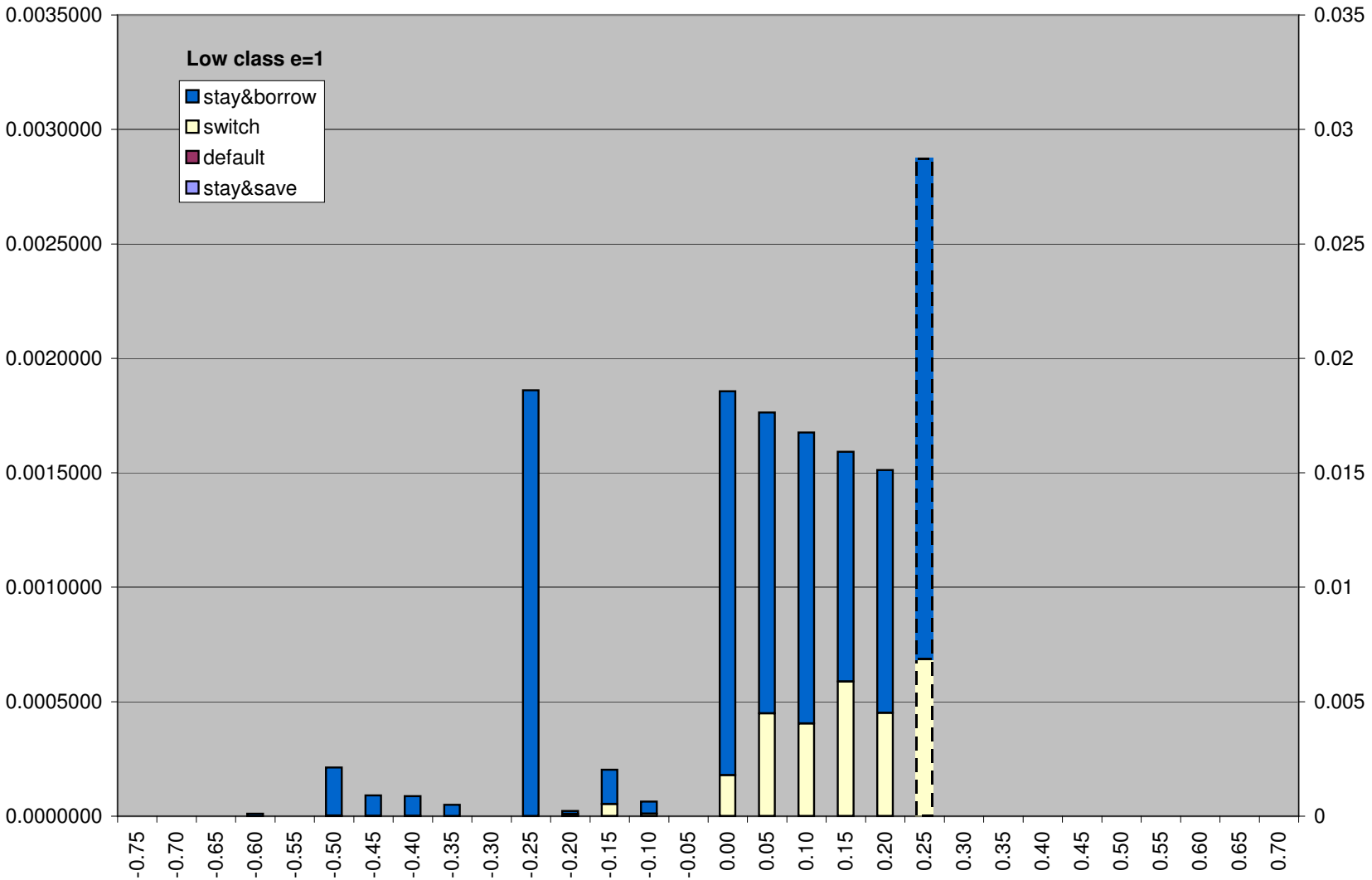


Figure 10: The distribution with defaulters and switchers ($h = 0$, $\omega = 1$)

Distribution high income: $\omega = 1$, $h = 0$

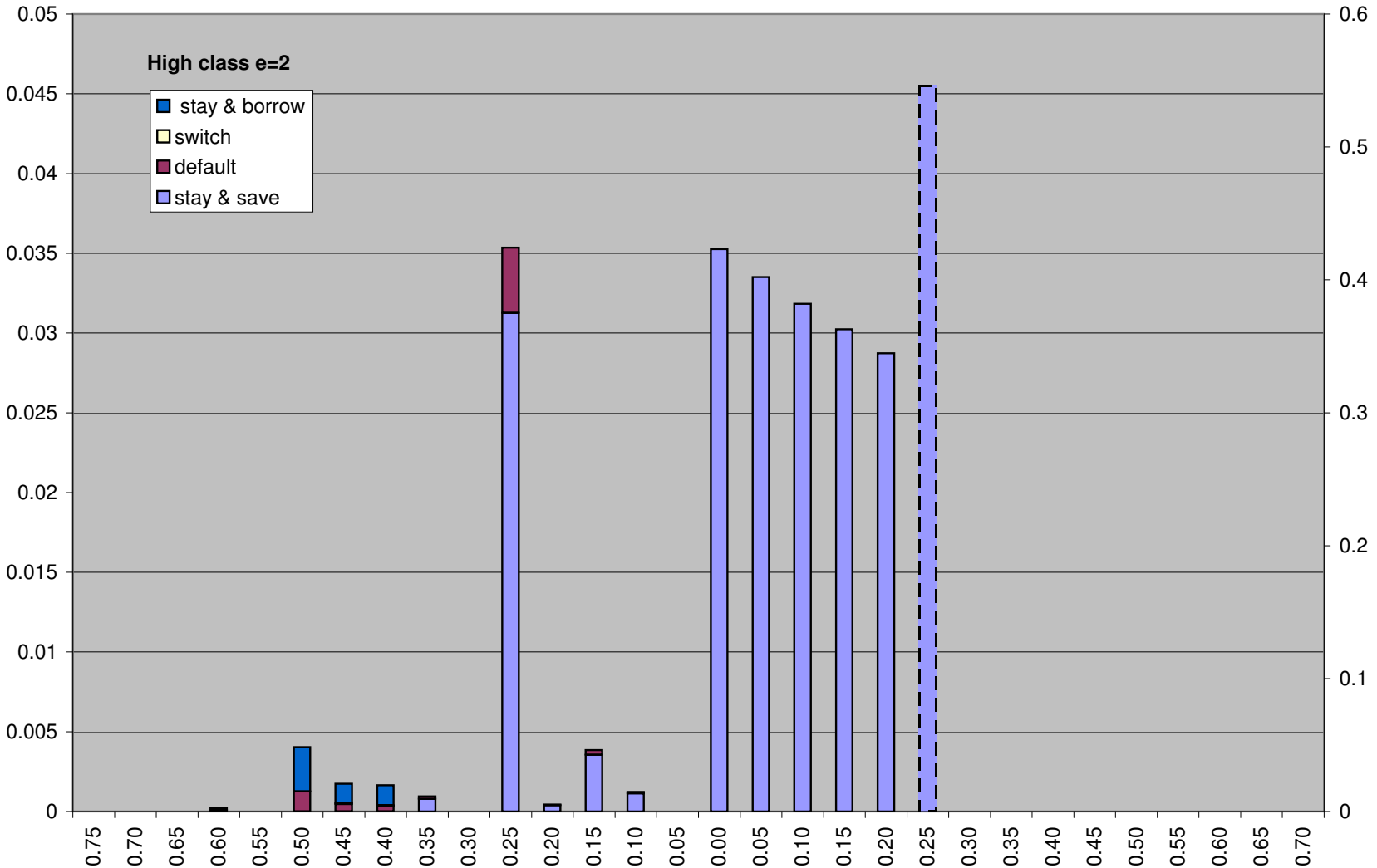


Figure 11: The distribution with defaulters and switchers ($h = 0$, $\omega = 1$)

Distribution: $\omega = 0,\ h = 0$

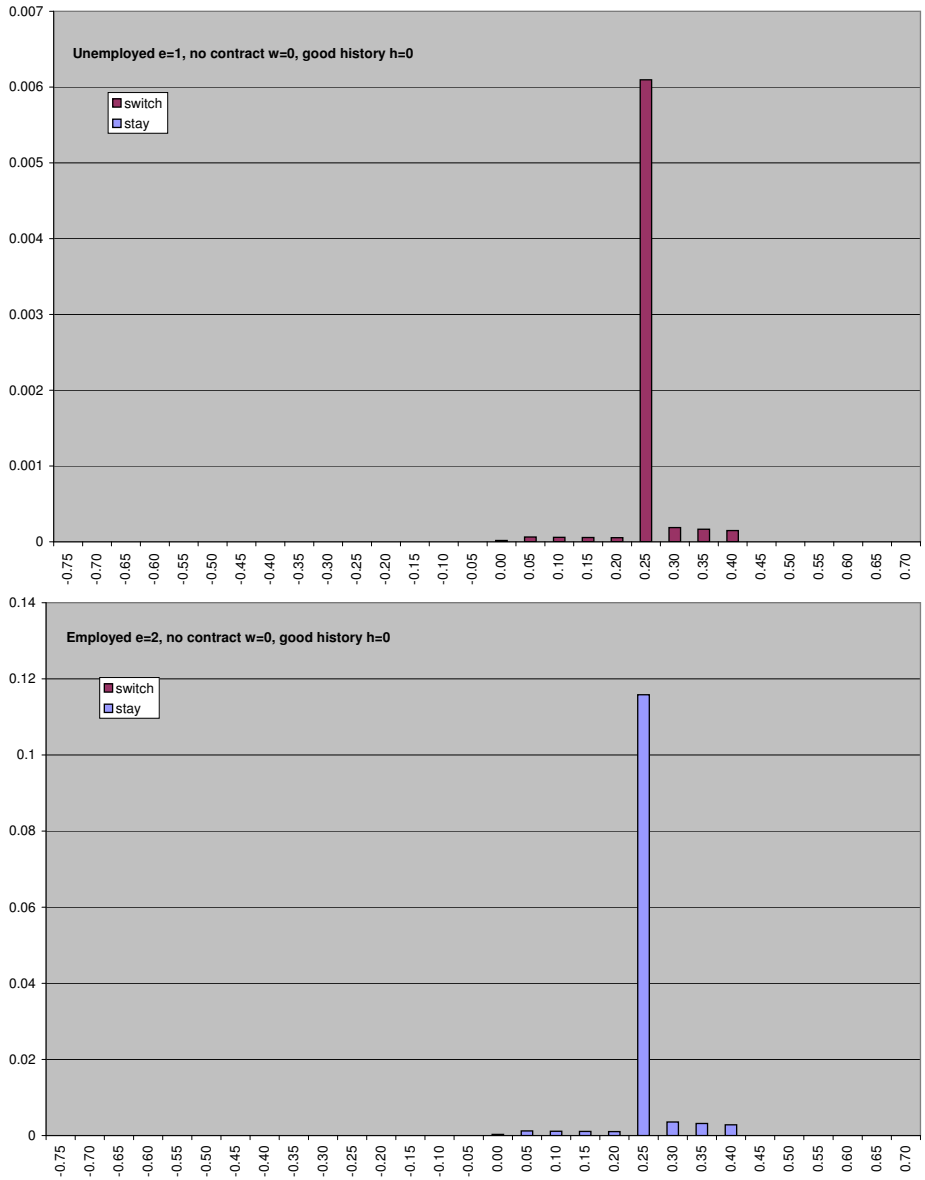


Figure 12: The distribution with defaulters and switchers ($h = 0$, $\omega = 0$)

Distribution: $\omega = 0,\ h = 1$

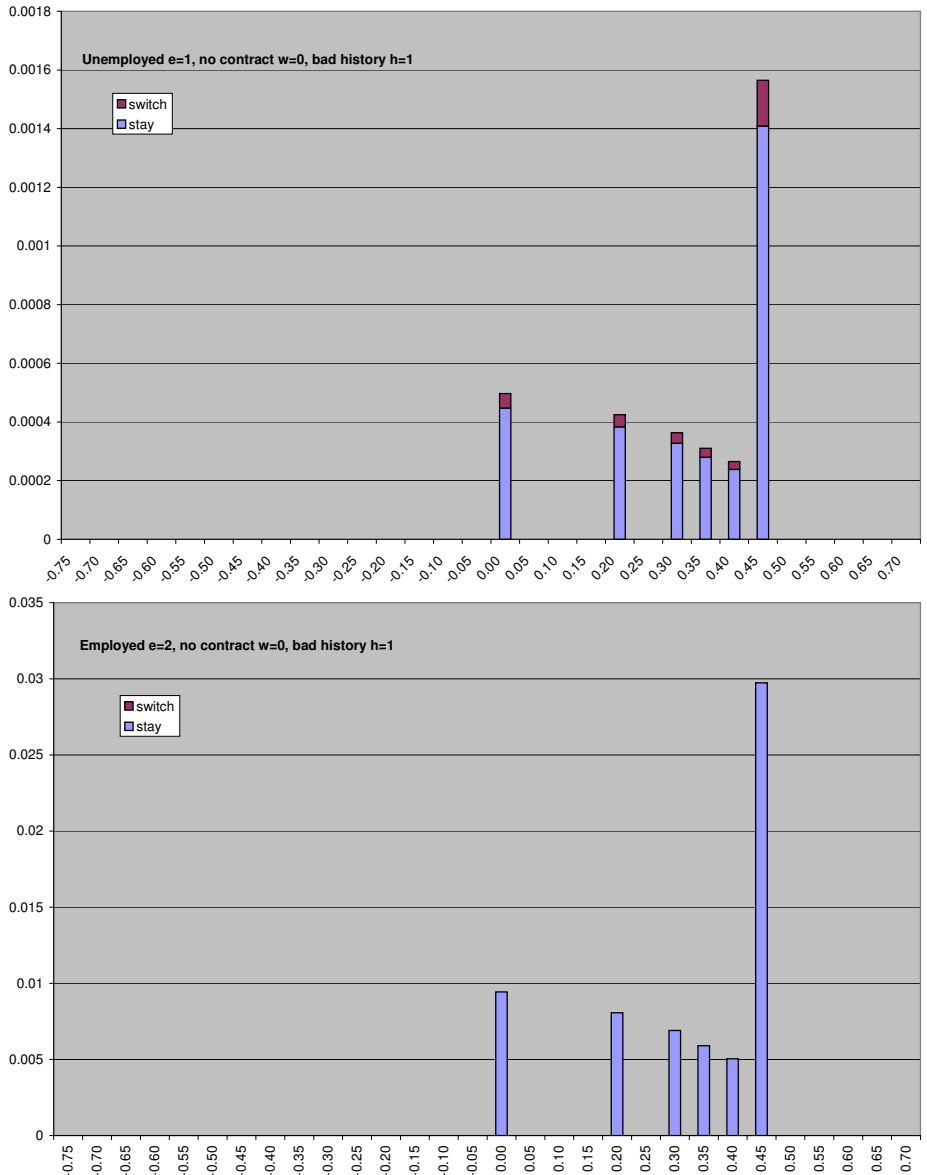


Figure 13: The distribution with defaulters and switchers ($h = 1$,$\omega = 0$)

IV. Properties - Household dynamics

- Debt stories:
  - Start with moderate debt when unemployed.
  - Stay in debt (or default) if employment not found soon.
  - Debt builds up as long as limit keeps loosening up.
  - Interest first increases (as switching risk falls) and then decreases (as default risk increases). At high debt, the bank subsidizes with negative interest.

- Example: typical unemployed with no contract:
  - Asset position: -0.25, -0.50, -0.60, -0.60, ...
  - Price: 0.8523, 0.6634, 0.8600, 1.025, 1.025, ...

- Terms on a new and an existing contract differ markedly. Sometimes tougher, sometimes softer.
  - The hold-up problem cuts both ways:
  - So interest rate changes with asset position non-monotonically.
  - Distinct possibility of "interest hikes" (i.e., interest up for same debt or loan).

IV. Properties - Comparison of terms with one-period loans

- More competitive terms than a zero-profit one-period contract of the same debt.
  (see Fig **??**)

- Households borrow more and carry larger balances than with one-period contracts.
  (see Fig 1)

Comparison of terms with one period loans

Comparison of terms with one period loans

IV. Properties - private information

IV. Properties - Markov income - Initial terms

V. POLICY REFORM

- 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.

- Now let's imagine an implementation of Regulation AA. Banks have to commit not to raise the interest rate (but can temporarily lower it).

- 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

V. Aggregate long-run effects

1. Generally, banks tighten debt limits but charge lower interest rates. (esp. for high-type households)
2. But charge higher initial rates.
3. Borrowing decreases slightly
4. The number of defaulters and the volume defaulted on decreases.
5. The frequency of contract switching declines
6. Average consumption rises.

Steady States

	No commitment	Commitment
Mass with a contract	0.794	0.808
Mass no contract but clean h=0	0.137	0.127
Mass in debt	0.052	0.051
Mass of defaulters	0.69%	0.64%
Mass switchers	1.6%	1.2%
Write-off rate	0.152	0.143
Wealth/output	0.191	0.196
Debt/output	0.014	0.013
Loan size (all)	0.274	0.269
Loan price (all)	0.813	0.824
Loan size (initial)	0.263	0.329
Loan price (initial)	0.842	0.786
Loan size (continuing)	0.279	0.250
Loan price (continuing)	0.800	0.837
Debt limit (continuing)	0.327	0.283
Average Consumption	0.9074	0.9179

Main changes in policies

- A comparison of the policies.
  - Initial interest rates rotate the right way. The reform induces more expensive smaller loans (see Fig14).
  - Banks have to make more profits on initial loan (see Fig15).
  - The typical first-time unemployed faces a much tighter limit. Hence they switch more often in order to borrow more at a high interest.

Initial Loan Prices

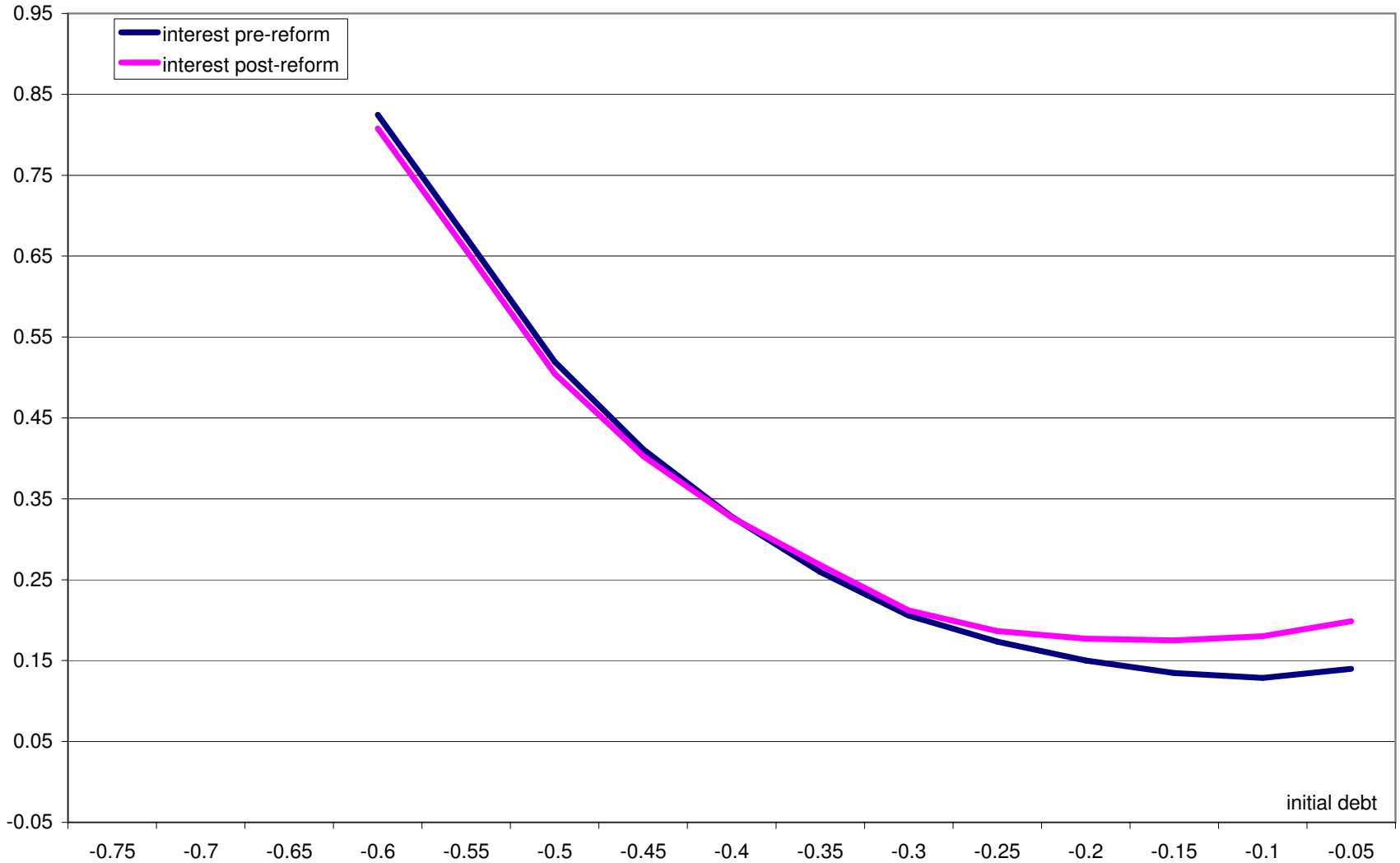


Figure 14: The distribution with defaulters and switchers ($h = 0$, $\omega = 1$)

Initial Loan Prices

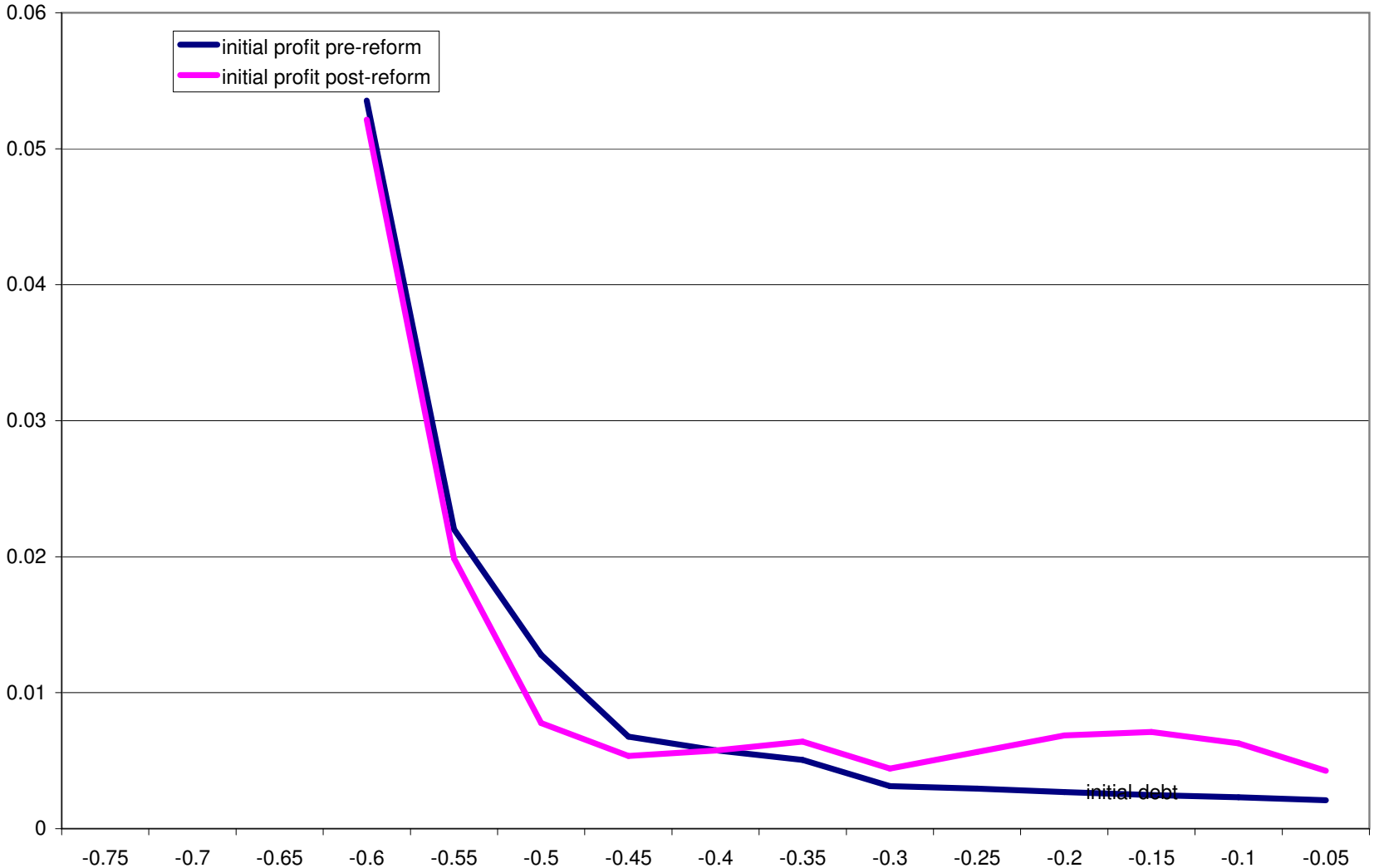


Figure 15: The distribution with defaulters and switchers ($h = 0$, $\omega = 1$)

V. Welfare

Findings. When introducing commitment on ongoing contracts:

- Most consumers gain, but small 0.08% on average: heavy borrowers ($y = -0.15$) now have to switch but get somewhat better interest; moderate borrowers ($y = 0.25$) staying when banks cannot raise interest.
- Most unemployed debtors, with intermediate debt ($y = -0.25$), loose -0.32% (0.19% of pop.): banks tighten limit; will charge higher interest when re-gaining employment.
- Some unemployed debtors, with high debts ($y = -0.40$), gain a large 1.5%-5% (0.013% of pop.): the bank will charge sharply lower interest, esp. if regaining employment.

Welfare effects of reform

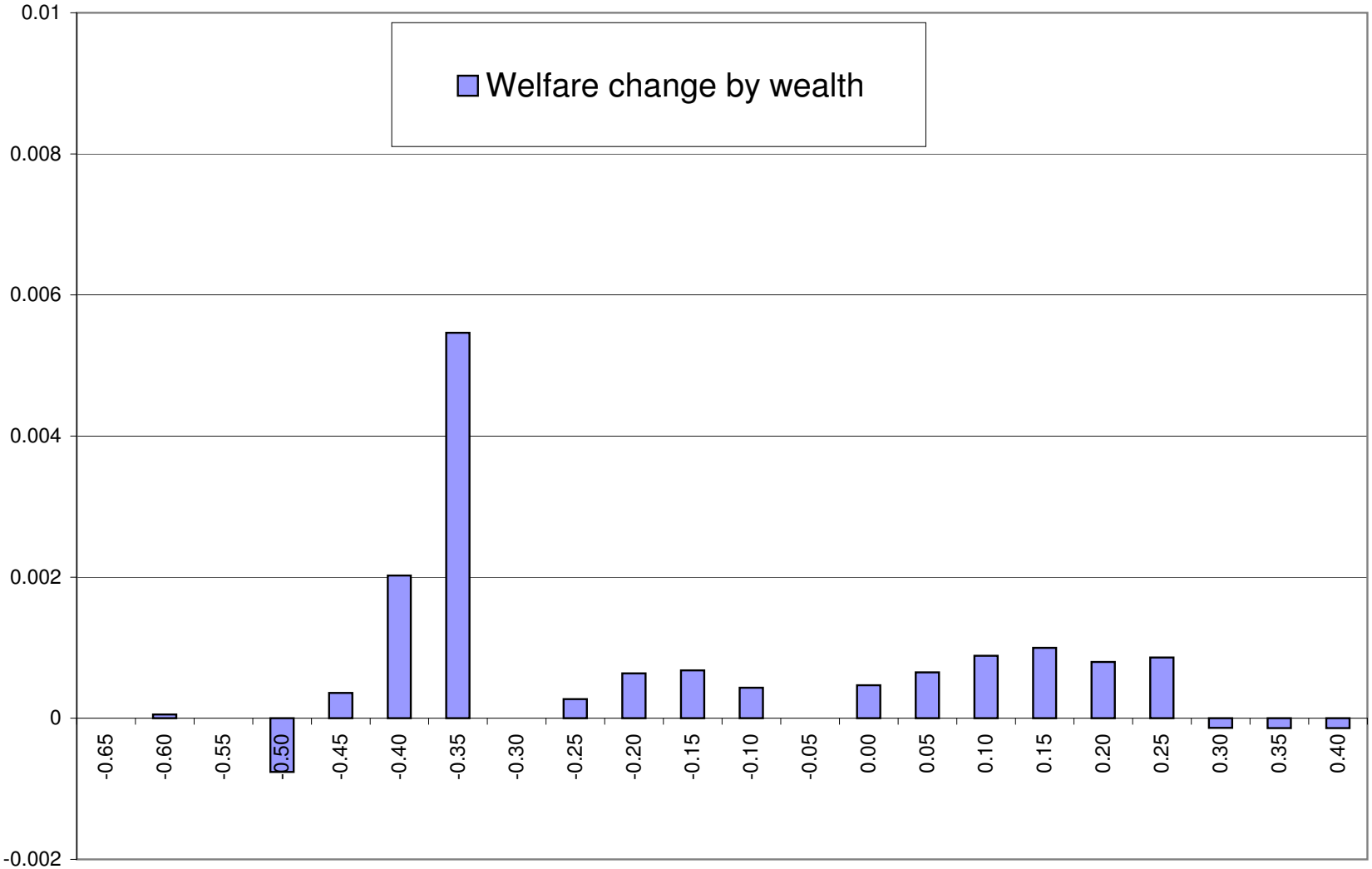


Figure 16: The distribution of welfare changes

Welfare effects of reform

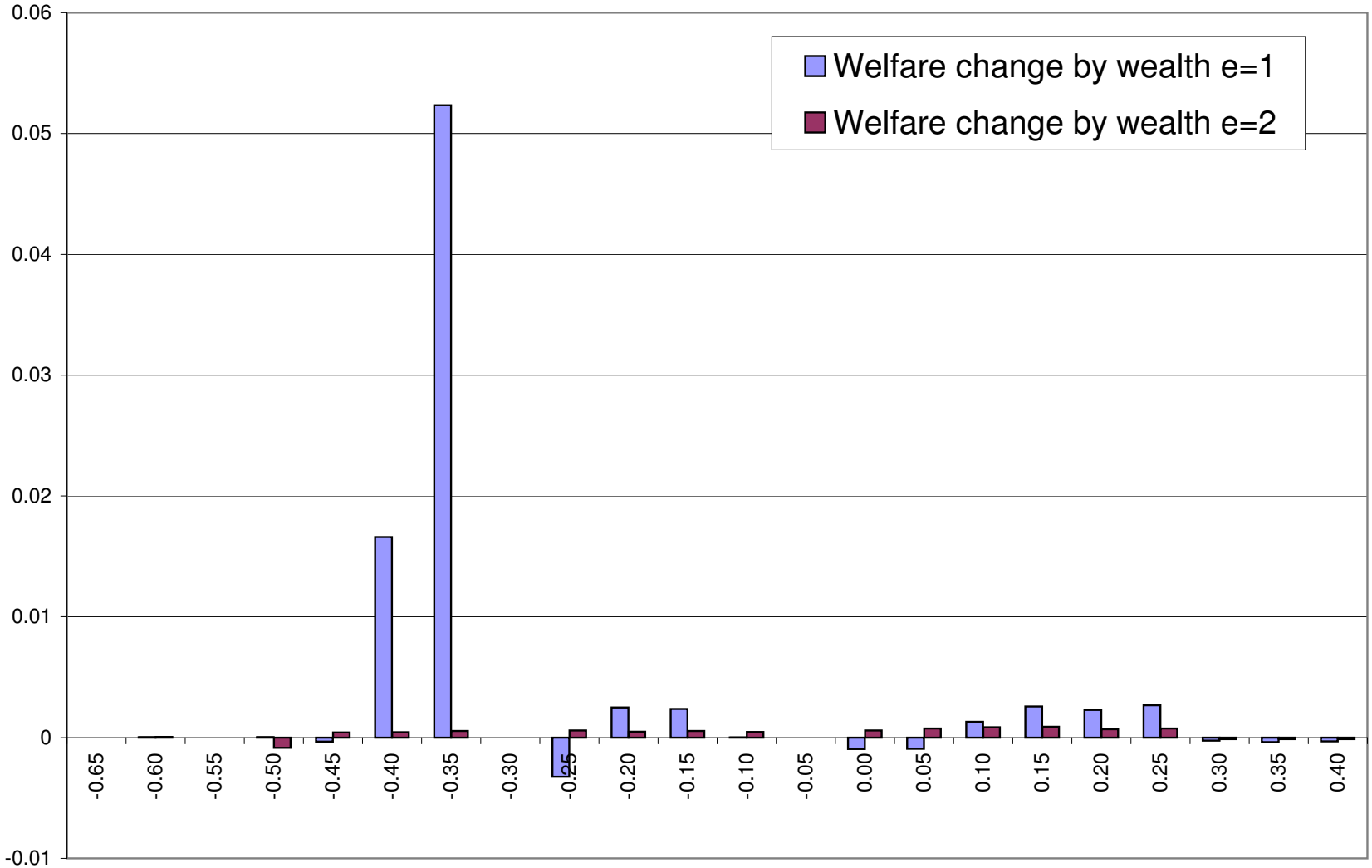


Figure 17: The distribution of welfare changes

CONCLUSIONS

- A theory of credit lines with:
  - Long-term credit card contracts under competition.
  - Different degrees of banks' commitment.
  - It demonstrates that time-consistent contracts can be handled.
  - We can analyse a much debated policy change.

- To-do list:
  - Study robustness: private information; persistent income.
  - More systematic exploration of simple settings. Any "theorems"?
  - Calibration/estimation for meaningful policy analysis.