Building Credit Histories

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Introduction

- Basic theme: **Access to credit**
- Credit access hinges on credit histories, but how does a new borrower acquire a credit history?
- Traditional view: credit histories are histories of repayment
- For new borrowers, such histories are short
  $\Rightarrow$ lenders may rely on other information when lending to them
- We explore how borrowers build credit histories by taking on loans
  - distinct from (and complementary to) credit-history building through repayment behavior
  - and not the same as a improving a credit score

What We Do

- Document key facts about new (emerging) borrowers and the evolution of their access to credit
  - Incumbent lenders increase credit card limits in response to emerging borrowers' opening a new card
    - this effect is substantially less pronounced for established borrowers
  - ☞ Our interpretation: borrowing from one lender may improve assessment of the borrower's credit worthiness by other lenders
    - we refer to this mechanism as "credit-history building"
- Develop a new theory consistent with this story
  - ☞ to better understand tradeoffs and welfare implications associated with credit-history building and derive testable implications
- Show that the testable implications are borne out in the data

Data and Empirical Facts

Data from a Credit Reporting Agency

- Custom created, novel dataset from TransUnion
  - Panel of credit records
  - One million individuals
  - Snapshots on September 30th of 2014, 2015, 2016, 2017
- Two groups:
  - Study – *emerging* borrowers:
    - 500k drawn at random whose oldest trade in 2014 is $\leq$ 6 months old
  - Control – *established* borrowers:
    - 500k drawn at random from the universe of credit records to reproduce the U.S. Vantage distribution in 2014, excluding emerging borrowers
- Key aspect of data: panel at the level of a trade-line
  - Individual cards' credit limits, balances, etc
  - Important: we can match cards over time

Credit Growth and New Cards

Table 1: Growth Rate of Aggregate Credit Card Limit, 2014-15, %

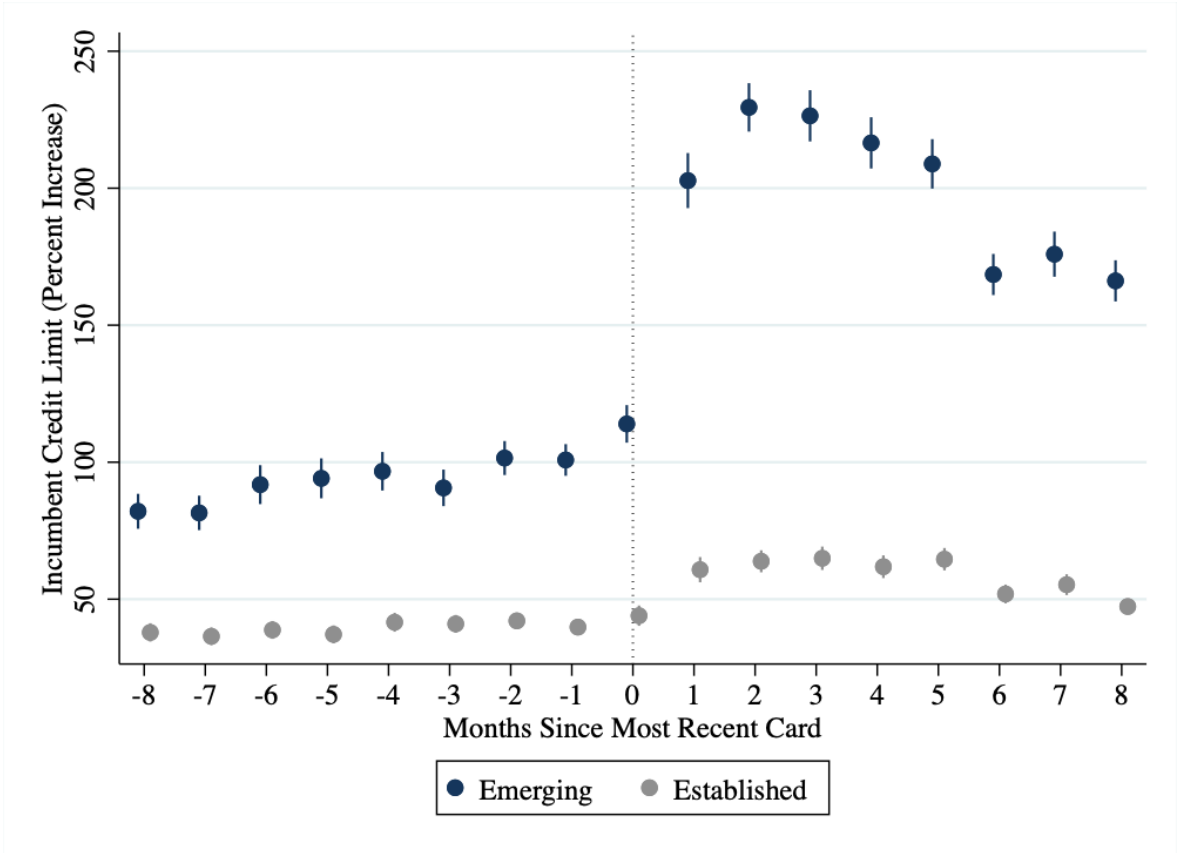
	Emerging	Established
Total	58.69	2.83
Conditional on opening new card	226.38	31.32
Conditional on no new card	22.58	−2.55
Incumbent cards, cond. new card	137.17	5.05

- Borrowers with a new credit card saw a larger increase in credit access
- For emerging borrowers, 60% of that growth (= 137.17/226.38) came from incumbent lenders
  - for established borrowers, the number is 16% (= 5.05/31.32)
- The same pattern holds for unused credit Unused credit

Credit products | Credit lines and balances | Credit card limit growth | Regressions | Levels

Lenders React Positively to Borrower Opening New Card

Figure 1: Avg % Increase in Incumbent Credit Limit



- Comparing borrowers who just got a new card to those who are about to get one
- Stark jump after new card for emerging borrowers, less so for established
- The timing of the jump indicates that the increase is associated with opening a new card, not repayment

Summary and Interpretation

- Summarizing the data facts:
  - Incumbent lenders increase credit limits in response to emerging borrowers' opening a new card
  - This effect is substantially less pronounced for established borrowers
- Our interpretation of these data facts:
  - Incumbent lenders interpret a new credit card as a signal of positive information that the new lender has about the borrower

  What else could it be?
- Next: develop a novel framework that captures this idea in a parsimonious way

Model

Model

Two periods

- Period I: Lending period
  - Two stages, 1 and 2
- Period II: Repayment/Default period

Borrower

- Per-period utility $u(\cdot)$, $u' > 0$, $u'' \leq 0$;
  Discounting: none b/w stages of period 1, $\beta \geq 0$ for period II
  - To simplify further, set $\beta = 0$ and u linear
- State $s \in \{g, b\}$—borrower is either "good" or "bad"
  - Unknown to everyone
  - Borrower's state is g with probability α
- Endowment in period I: none
- Endowment in period II: uncertain
  - Support: $\{e_\ell, e_m, e_h\}$
  - Endowment distribution of g-borrowers first-order stochastically dominates that of b-borrowers
  - Cost of defaulting on loans is fraction φ of the endowment

Lenders

- Many (≥ 4), partitioned into two classes
- Risk neutral, discount period-II payoff with $\bar{q} = 1/(1+\bar{r})$
- In stage 1, each lender observes a signal about the borrower's state
  - $\sigma \in \{A, B\}$
  - $\Pr(\sigma = A | s = g) = \Pr(\sigma = B | s = b) = (1+\rho)/2$, where $\rho \in (0, 1]$
  - Within each class, lenders observe the same signal
  - Signals across the classes are conditionally independent
  - A lender's signal is his *private information*
- Lenders' information in stage 2 of period I
  - Signal from stage 1 + borrower's credit history from stage 1

Actions and Timing

- In each stage of period I
  - Lenders offer contracts: (loan size, price)=(x, q)
  - Borrower accepts one or none of the offered contracts in each stage
  - The terms of the accepted contract are publicly observed
    - as long as the loan size is no smaller than a minimal threshold $\underline{x} > 0$
  - Credit history in stage 1: $\emptyset$
  - Credit history in stage 2: (x, q, j), where (x, q) is the contract accepted in stage 1, and j is the identity (or class) of the lender who offered it
- In period II
  - After observing endowment e, borrower chooses to repay or default
  - If the borrower defaults, she consumes $(1 - \varphi)e$
    - φe is the dead-weight loss of bankruptcy

Payoffs

- Suppose borrow x_1 at q_1 in stage 1 and x_2 at q_2 in stage 2.
  The borrower's expected payoff is

$$\pi^B = u(q_1 x_1 + q_2 x_2) + \beta E u\left(\max\left\{e - x_1 - x_2, (1-\varphi)e\right\}\right)$$

  - the borrower repays iff $x_1 + x_2 \leq \varphi e$

- Payoff to a lender, whose contract (x_i, q_i) was accepted in stage i

$$\pi^L = -q_i x_i + \bar{q} x_i E \mathbb{1}_{[\varphi e \geq x_1 + x_2]}$$

Loan Sizes

- Since $\beta = 0$, in equilibrium total loan sizes $\in \{\varphi e_\ell, \varphi e_m, \varphi e_h\}$ — call them small, medium, large loans
  - Default probabilities and hence prices are constant for total loan sizes in each of the intervals $(0, \varphi e_\ell]$, $(\varphi e_\ell, \varphi e_m]$, $(\varphi e_m, \varphi e_h]$
  - Since $\beta = 0$, the borrower will pick the corner
  - Notice that the loan φe_ℓ is riskless as everyone repays it
- Assume that the size of the smallest visible loan $\underline{x}$ equals φe_ℓ

Notation

- A-lender—a lender who observes a signal realization A
- B-lender— a lender who observes a signal realization B
- AA-borrower—a borrower for whom both classes of lenders observe a A signal realization
- BB-borrower—a borrower for whom both classes of lenders observe a B signal realization
- AB-borrower—a borrower for whom the pair of signal realizations for the two lender classes are A and B

Equilibrium Concept

- Perfect Bayesian Equilibria
  - Signaling/screening game means tons of equilibria
- Select the favorite equilibrium of the best (AA-) borrowers
  - Captures the spirit of Cho-Kreps intuitive criterion
    - the environment is too rich for Cho-Kreps to apply
  - Generically, this selects unique equilibrium outcome

Credit-History Building

Here's how credit-history building works in the model:

- Only lenders with positive (A) signals make offers in stage 1
- Borrowers who see offers from lenders stage 1 conclude that these lenders have positive information about them
- By accepting an offer, borrower transmits this positive info to other lenders
- Lenders who see that a borrower accepted an offer conclude that this offer came from a lender with a positive signal
- They update their belief about the borrower's creditworthiness upwards, and offer better contract terms in stage 2

Example Equilibrium

- In stage 1,
  - A-lenders offer a small loan (φe_ℓ)
  - All borrowers with such offers (AAs and ABs) accept one
- In stage 2,
  - A-lenders whose class' offer was not accepted, top up AAs to a large loan
  - Either A- or B-lenders top up ABs to a medium loan
  - BB-borrowers receive a small loan
- Loan price = expected probability of repayment $\times\ \bar{q}$

$q_h^{AA} = \Pr(\text{repaying large loan}|AA)\bar{q} = \Pr(e = e_h|AA)\bar{q} \leftarrow$ stage-2 price for AAs

$q_m^{AB} = \Pr(\text{repaying medium loan}|AB)\bar{q} = \Pr(e \in \{e_m, e_h\}|AB)\bar{q} \leftarrow$ stage-2 price for ABs

$q^A = \Pr(AA|A)q_h^{AA} + \Pr(AB|A)q_m^{AB} \leftarrow$ stage-1 price Details

- Condition for cross-subsidization: ABs accept stage-1 offer if

$$\boxed{q_h^{AA} > q_m^{AB}}$$

AA-Borrowers Build Credit History

- We refer to taking a stage-1 loan with the purpose of facilitating information aggregation as *credit-history building*
- *AA*-borrowers build credit history
  - *A*-lenders whose class' offer was not accepted update their beliefs upwards and offer better terms in stage 2
- *AB*-borrowers do not
  - They have no need to let a *B*-lender know there is an *A*-lender
    - borrowing from a *B*-lender who knows the other signal is *A* is the same as borrowing from an *A*-lender who knows the other signal is *B*
  - *AB*s accept the stage-1 loan only to free-ride on a better, cross-subsidized price

Do AA's Always Choose to Build Credit History?

- Potential cost of credit-history building (to *AA*-borrowers): excessive borrowing
  - when *AA*-borrowers end up with a large loan, while under symmetric info they would get a medium loan Formal conditions
  - reason: they cannot commit to borrowing specific amounts in stage 2
- When this cost is particularly severe (which happens on a small set of parameter values when computed numerically), the selected equilibrium features no credit-history building
  - where no loans are made in stage 1, and *AA*s and *AB*s get the same loan in stage 2 Details

Welfare Implications

- Does the availability of credit records necessarily improve ex-ante (before-the-signal-realizations) welfare?
  - No. Ex-ante welfare may be higher without credit-history building even when AA-borrowers prefer credit-history building
  - Tradeoff associated with credit-history building:

    Pros: tailor loans based on more precise (aggregated) information
    Cons: potential excessive borrowing by AA-borrowers
- Does increase in the info quality necessarily increase welfare?
  - No. Ex-ante welfare may be non-monotone in the signal precision
  - As signal precision $\uparrow$, AA-borrowers get better terms on any given-size loan in stage 2

    $\Rightarrow$ may choose to over-borrow $\Rightarrow$ ex-ante utility $\downarrow$

Comparative Statics Welfare Figure

Testable Implications

New Insight into Debt Dilution

- Stage-1 lender is diluted by the stage-2 lender
- Surprising result: When early lender is uncertain about the extent of dilution, more dilution is associated with lower default risk
  - conventional wisdom: more dilution increases default risk
- Two effects:
  - Dilution effect: For a *given* borrower, larger loan raises default risk
  - Selection effect: *More creditworthy* borrowers take out *larger* loans
- Selection effect dominates dilution effect in the model Details
- This model prediction is borne out in the data

Testing "More Dilution, Lower Default Risk"

Table 2: New Card and Future Delinquency: Probit

	Emerging		Established	
	(1)	(2)	(3)	(4)
New card limit '14-'15 (share '14 lim)	-0.0007***	-0.0008***	0.0029***	-0.0004
	(0.0001)	(0.0001)	(0.0002)	(0.0003)
Opened new card '14-'15 (0/1)	0.0395***	0.0327***	0.0117***	0.0093***
	(0.0010)	(0.0010)	(0.0010)	(0.0009)
Vantage score '14		-0.0006***		-0.0008***
		(0.0000)		(0.0000)
N	206,951	206,951	285,529	285,529
Sample avg. delinquency rate	0.052	0.052	0.060	0.060
Psuedo R^2	0.0165	0.1104	0.0024	0.2280

Notes: The table displays marginal effects from a probit regression of a dummy for any card trade more than 90 days past due in 2016 onto the indicated row variables.

- For emerging borrowers, a greater expansion of credit is associated with lower delinquency rates; this relationship is absent for established borrowers
- For all borrowers, opening a new card is associated with higher delinquency rates

Credit-History Building vs. Improving a Credit Score

- It is important to distinguish credit-history building from improving a credit score
- Credit scores are meant to be a summary statistic for borrowers' probability of default
- Building credit history in our model may actually lower the borrower's credit score
- Borrowers who take on early loans successfully communicate that they have a lower default probability for a given loan size
- But they may also end up with a higher default probability in equilibrium due to taking on a larger loan

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Conclusion

- Document evolution of credit access for emerging borrowers
  - Points to importance of borrowing from multiple lenders
- Develop a model of credit-history building by taking on loans
  - Credit-history building as a way of aggregating information
- Cost of credit-history building: excessive borrowing
- Novel insights into debt dilution and role of credit records

Thank You!

Additional Slides

Matching Algorithm

- For each individual and each date, we observe card-level data (balances and credit limits) for up to 5 credit cards
  - these cards are ordered (card 1, card 2, ...) by the size of the balance
  - and so card 1 in 2014 may not correspond to card 1 in 2015
- To link cards over time, we came up with the following algorithm:
  - Use an account status indicator which reflects each existing card's status over each of the past 24 months
    - in each month, a card may have a transactor ("T"), revolver ("R"), or an inactive ("I") status
    - yields a string of 1 to 24 digits for each card-year observation
  - Seek matches in a card's months 13-24 history in one year to the months 1-12 histories for the same borrower's cards in the prior year
  - Matching criteria:
    - the two sequences exactly match and
    - none of the borrower's other cards in the prior year are an exact match

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Table 1: Percent of Baseline Sample With Open Credit Types

Percent of sample with...	Emerging	Emerging with credit card	Control	Control with credit card
Auto	13.5	2.9	24.5	33.5
Credit card	52.6	100.0	62.6	100.0
Mortgage	0.4	0.1	25.1	36.4
Retail	14.8	4.1	47.7	66.3
Student	13.3	1.9	11.9	14.4
Mean no. open trades	1.179	1.173	5.071	6.668
Mean no. total trades	1.196	1.185	11.313	15.654
Mean age oldest trade (mo)	2.7	2.7	195.7	239.8
N	500,000	263,103	500,000	312,886

Notes: Table displays the percent of each sample with the indicated types of open credit trades, measuring at the baseline observation (2014). Credit types are not mutually exclusive.

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Table 2: Baseline Credit Lines and Balances

	Emerging	Emerging with credit card	Control	Control with credit card
Credit Line				
All (no mortgage)	4,671 [495k]	3,531 [263k]	45,339 [358k]	49,891 [307k]
Auto	14,353 [67k]	15,162 [8k]	25,937 [123k]	26,834 [105k]
Credit card	2,922 [263k]	2,922 [263k]	27,301 [301k]	27,301 [301k]
Mortgage	229,923 [2k]	-	218,163 [126k]	225,835 [114k]
Retail	1,392 [74k]	896 [11k]	7,103 [217k]	7,571 [194k]
Student	4,070 [66k]	4,358 [5k]	32,691 [59k]	35,589 [45k]
Balance				
All (no mortgage)	3,964 [399k]	1,696 [191k]	19,541 [329k]	19,944 [286k]
Auto	13,953 [67k]	14,685 [8k]	17,396 [123k]	17,824 [105k]
Credit card	946 [186k]	946 [186k]	5,641 [268k]	5,641 [268k]
Mortgage	226,089 [2k]	-	190,502 [126k]	197,775 [114k]
Retail	712 [48k]	489 [7k]	1,556 [125k]	1,592 [112k]
Student	3,980 [66k]	4,260 [5k]	30,371 [59k]	32,376 [45k]

Notes: Table reports mean amount of credit or balance in USD, measuring at the baseline observation (2014). Number of observations in brackets. Cells representing less than 0.1% of the sample (less than 500 observations) excluded. Means conditional on having credit type. Credit limits and balances taken from trades verified in the preceding 12 months.

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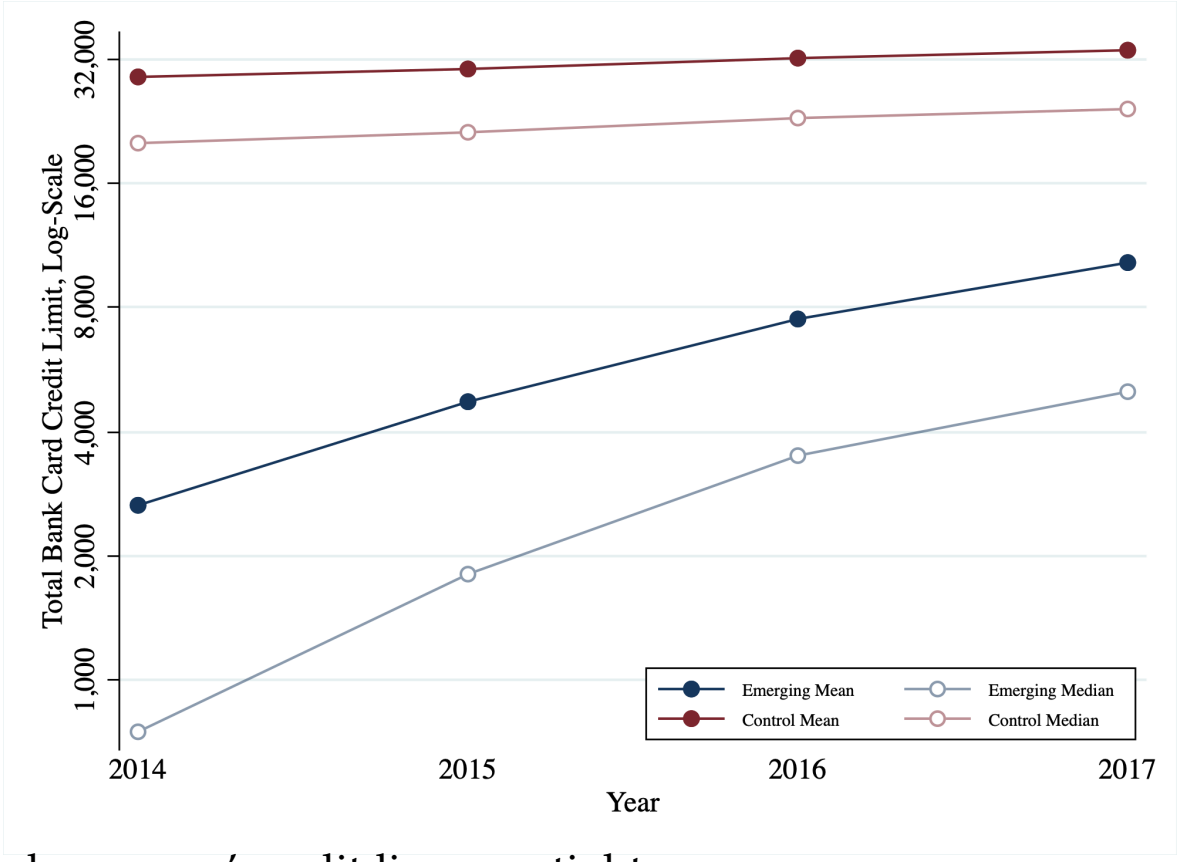
Credit Card Growth, Emerging vs. Established

Figure 1: Credit Growth



- Emerging borrowers' credit lines are tight...
  - mean credit line in 2014 was $2,946 for emerging and $27,215 for established borrowers
- ...but they expand quickly
  - growth of that mean 2014-15 was 69.9% for emerging and 4.3% for established borrowers

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Table 4: Growth Rate of Aggregate Available Credit Card Limit, 2014-15, %

	Emerging	Established
Cond. new card	221.62	32.54
Cond. no new card	13.99	−3.16
Incumbent cards, cond. new card	137.29	5.80

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Table 10: Aggregate Credit Limit Evidence

	Growth rate	2014 Average	2015 Average	No. obs
Emerging				
All	58.69	2,812	4,463	217,240
Cond. new card	226.38	1,938	6,325	55,860
Cond. no new card	22.58	3,115	3,819	161,380
Incumbent cards, cond. new card	137.17	1,938	4,596	55,860
Established				
All	2.83	22,641	23,282	256,197
Cond. new card	31.32	20,302	26,661	45,437
Cond. no new card	−2.55	23,145	22,554	210,760
Incumbent Cards, cond. new card	5.05	20,302	21,326	45,437

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What Else Could it Be?

Alternative explanations (that don't seem to explain all our empirical results):

- reacting to **repayment**
  - the timing of the jump in the event study suggests reaction not to observing the record of repayment, but to opening a new card

- **demand shocks**: individuals with liquidity needs both seek new cards and approach incumbent lenders for credit-line increases
  - would expect the shock to act simultaneously on incumbent and new lenders, and thus occasionally the incumbent lender would move first, creating a pre-trend on Figure 1; we don't observe it
  - would expect such individuals to have little available, or unused credit; however, the same pattern as in Table 1 is true for unused credit Unused credit

- the desire of the incumbent to be the **"top-of-the-wallet"**
  - would expect to see a stronger effect for established rather than emerging borrowers

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Table 5: Impact of New Card on % Increase of Incumbent Card Credit Limit

	(1)	(2)	(3)	(4)	(5)	(6)
Emerging (0/1)	0.333***	0.640***	0.631***	0.467***	0.737***	0.036
	(0.006)	(0.018)	(0.018)	(0.022)	(0.021)	(0.041)
Opened new card (0/1)	0.201***	0.113***	0.106***	0.106***	0.426***	0.135***
	(0.006)	(0.009)	(0.009)	(0.009)	(0.025)	(0.049)
Emerging x New card	**0.932*** **	**0.669*** **	**0.657*** **	**0.648*** **	**0.355*** **	**0.649*** **
	(0.019)	(0.026)	(0.027)	(0.026)	(0.035)	(0.055)
No. bank inquiries past 12 months			0.027***	0.007		
			(0.005)	(0.005)		
Utilization (pp)			0.000	-0.001***		
			(0.000)	(0.000)		
Constant	0.323***	0.423***	0.409***	2.037***	0.326***	1.026***
	(0.002)	(0.006)	(0.007)	(0.089)	(0.013)	(0.037)
Sample						
Full	X					
Opened card +/- 8 months		X	X	X	X	X
Only 1 card					X	
Card less than 18 mo.						X
Only 1 card					X	
Additional controls				X		
N	546,044	191,718	191,718	191,718	53,278	47,694
R^2	0.036	0.051	0.052	0.067	0.058	0.023

Notes: Each column displays coefficients from a regression of card level credit limit growth onto row variables. Growth measured as percent growth (where a value of 1 = 100% growth) between 2014 and 2015. Controls all measured in 2014, except inquiries, which are measured between 2014 and 2015. New card variable defined as dummy that new card was opened after Sep. 2014 and on or before Sep. 2015. Additional controls in column (4) are total credit line, any mortgage, any auto trade, any student loans, fin score, card with largest balance (0/1), and card balance. Clustered standard errors in parenthesis.

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More Dilution, Lower Default Risk

- Heterogeneity in dilution means cross-subsidization from better- to worse-quality borrowers
- Recall the example equilibrium:
  - AAs dilute to a large loan
  - ABs dilute to a medium loan
  - Condition for cross-subsidization: $q_h^{AA} > q_m^{AB}$, or

$$\boxed{\Pr(\text{repaying large loan}|AA) > \Pr(\text{repaying medium loan}|AB)}$$

- Higher quality borrowers take larger additional loans, but default with a lower probability

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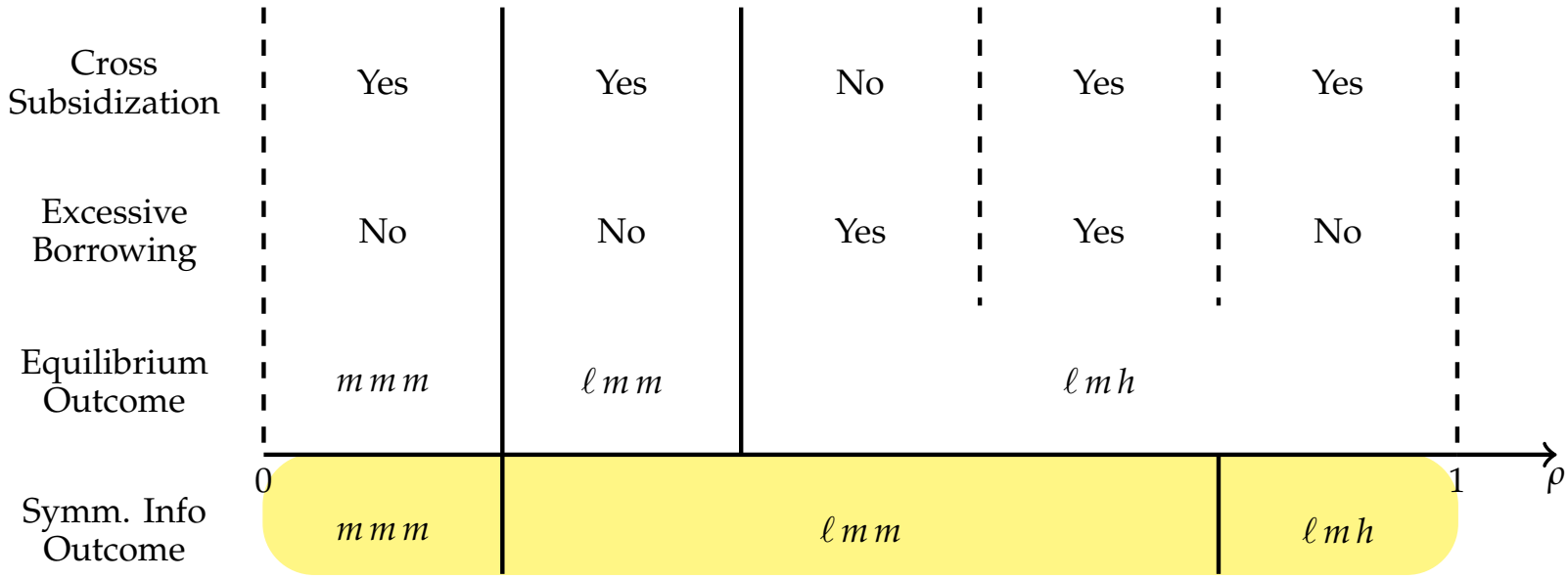
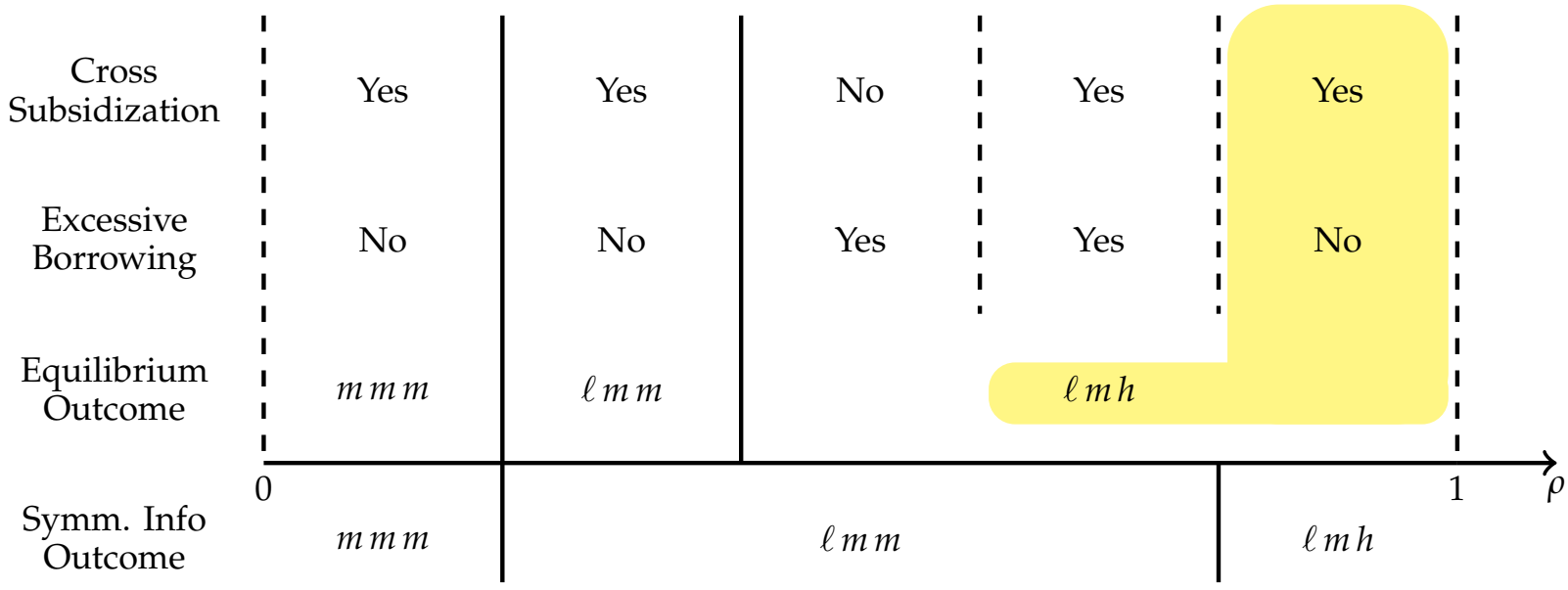
Equilibrium Outcomes (Comparative Statics)



Notation: ℓmh means φe_ℓ to BB, φe_m to AB, φe_h to AA

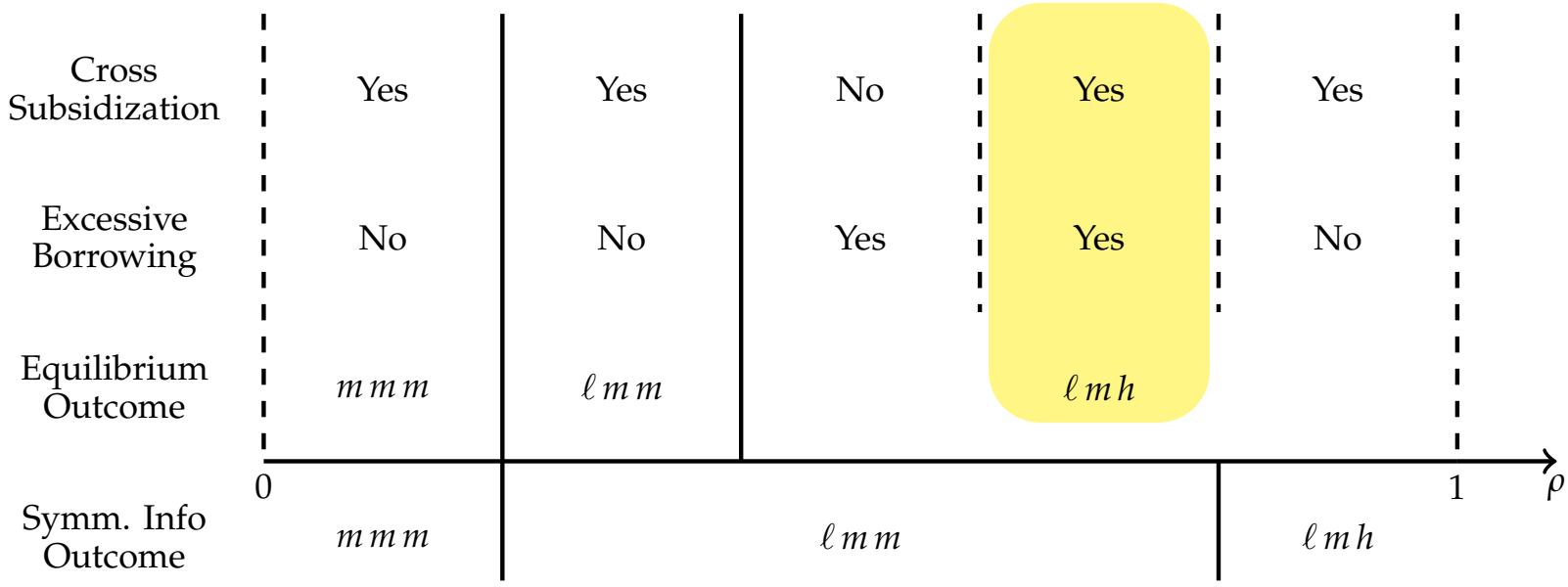
- Symmetric Information Benchmark
  - As ρ declines, AAs become less optimistic about their endowment process and choose to borrow less
  - Because signals are symmetric, the belief about ABs' endowment process does not change with ρ

Cross-Subsidization



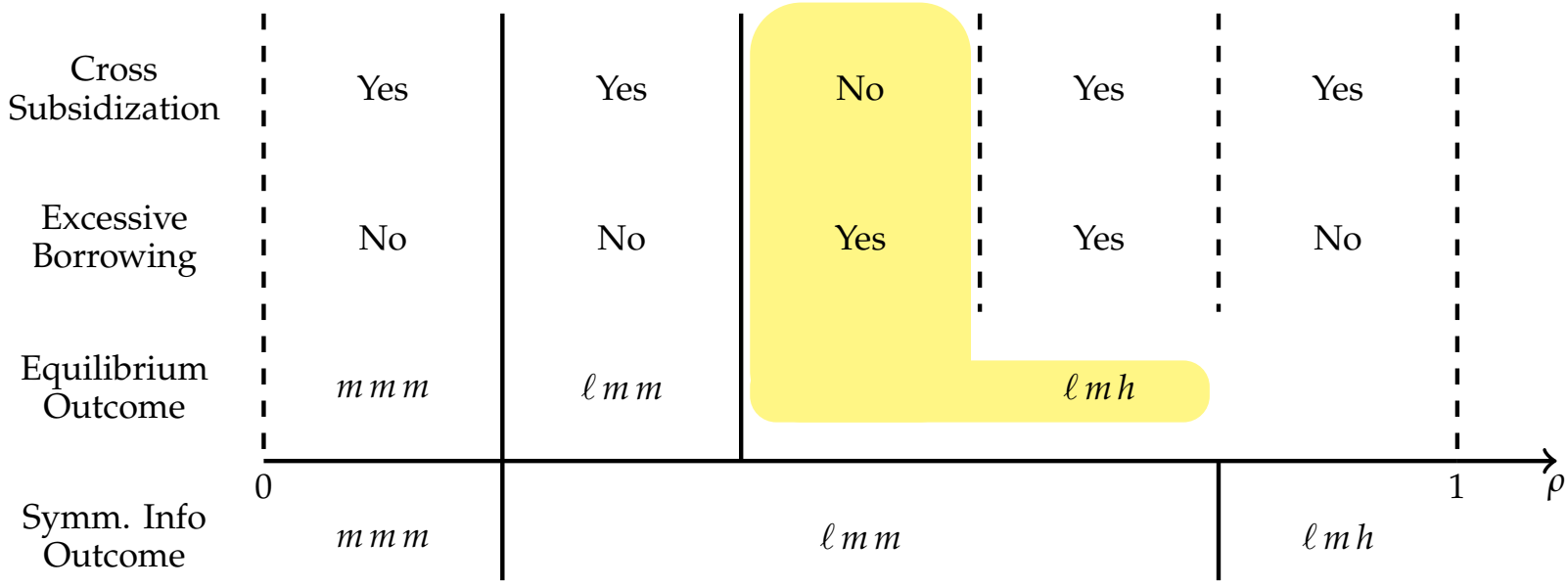
- Cross-subsidization in equilibrium for high signal precision
  - *AA*s take on early loan to aggregate information
  - *AB*s do so to free-ride on cheap stage-1 financing
- Intuitive equil. implies stage-1 loan size is $\bar{x}$ — smallest visible
  - *AA*s want to cross-subsidize as little as possible

Excessive Borrowing



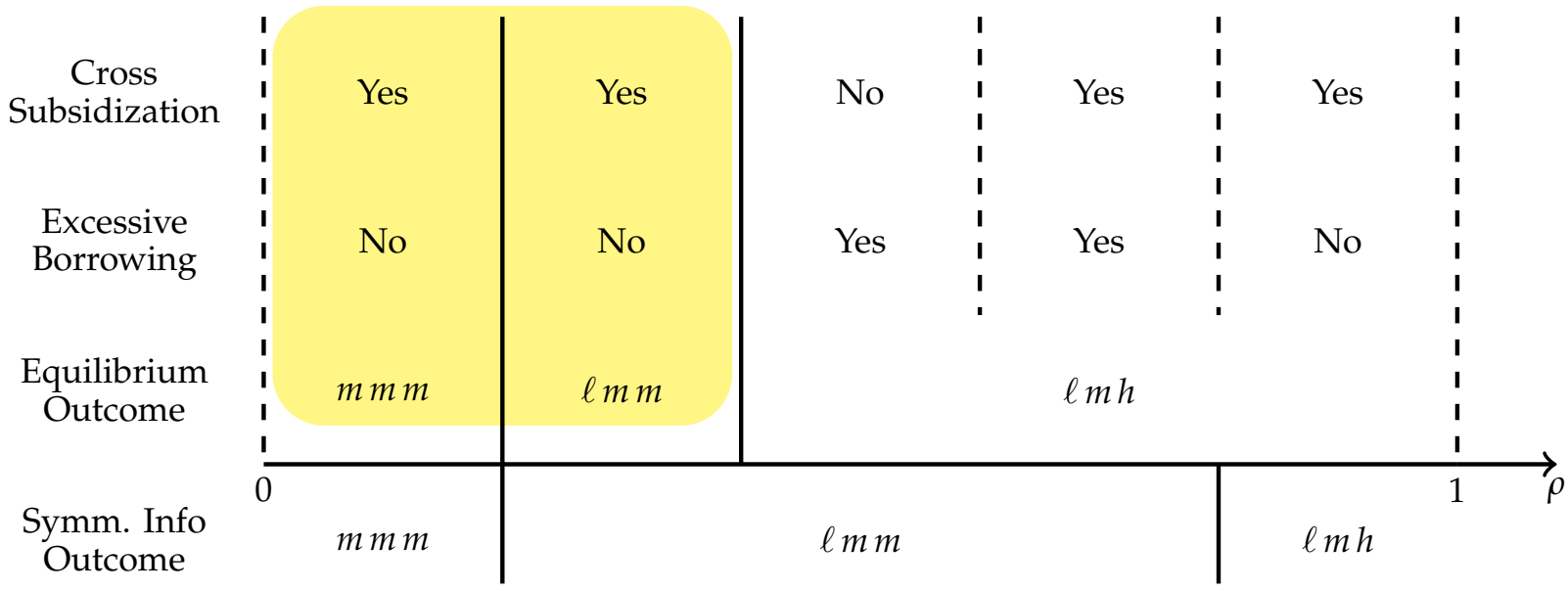
- Excessive Borrowing for lower signal precision
  - Equilibrium same as above, benchmark different
- Why do *AA*s overborrow (get h instead of m)?
  - Cross-subsidization implies under-borrowing in first stage ($q_1 x_1$ too low)
  - Lack of self-control

No More Cross-Subsidization



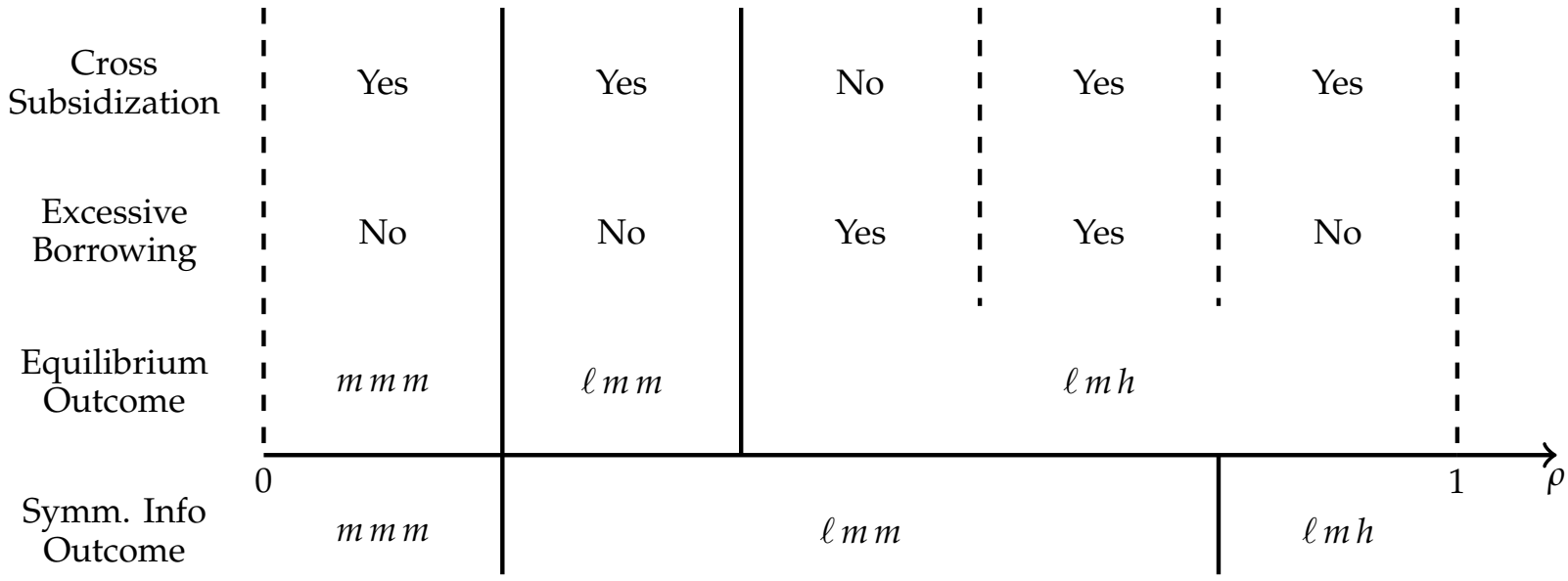
- As ρ falls further, *AA*s (with large loans) become riskier than *AB*'s (with medium loans)
- Why do *AA*s overborrow (get h instead of m)?
  - To prevent cross-subsidization
  - Lack of self-control

Low Signal Precision



- For low ρ, information aggregation affects prices not loan sizes
- Cross subsidization inevitably reemerges, as AAs price of medium loan is better than that of ABs

Comparative Statics: Summary



- Cross subsidization takes place for large enough and small enough values of the signal precision
- Excessive borrowing occurs for intermediate values of signal precision
- Excessive borrowing occurs either due to lack of self-control or because of the (threat of) cross-subsidization

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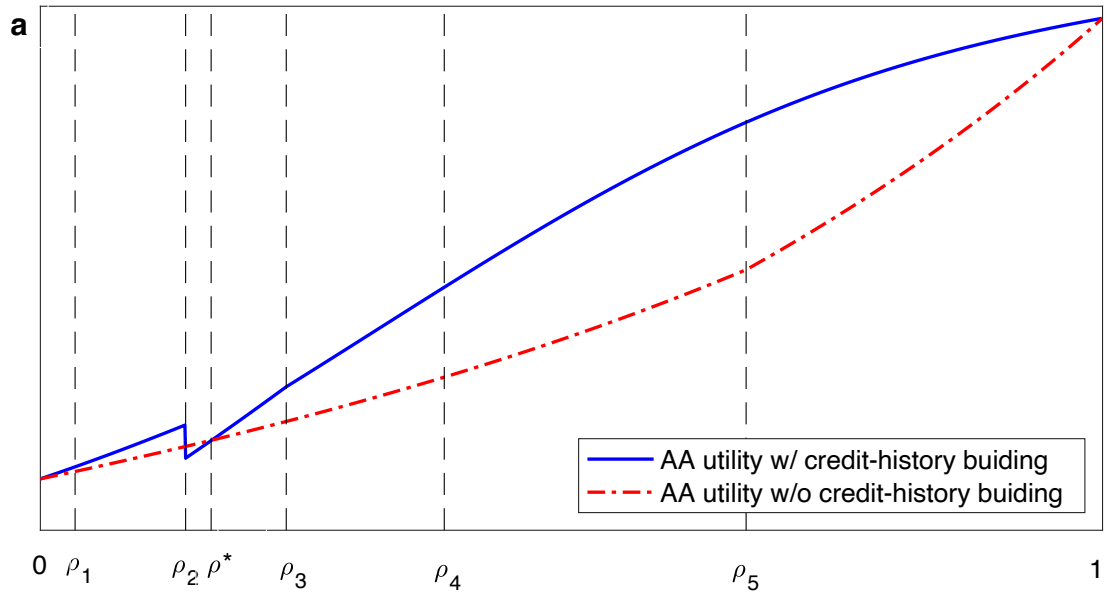
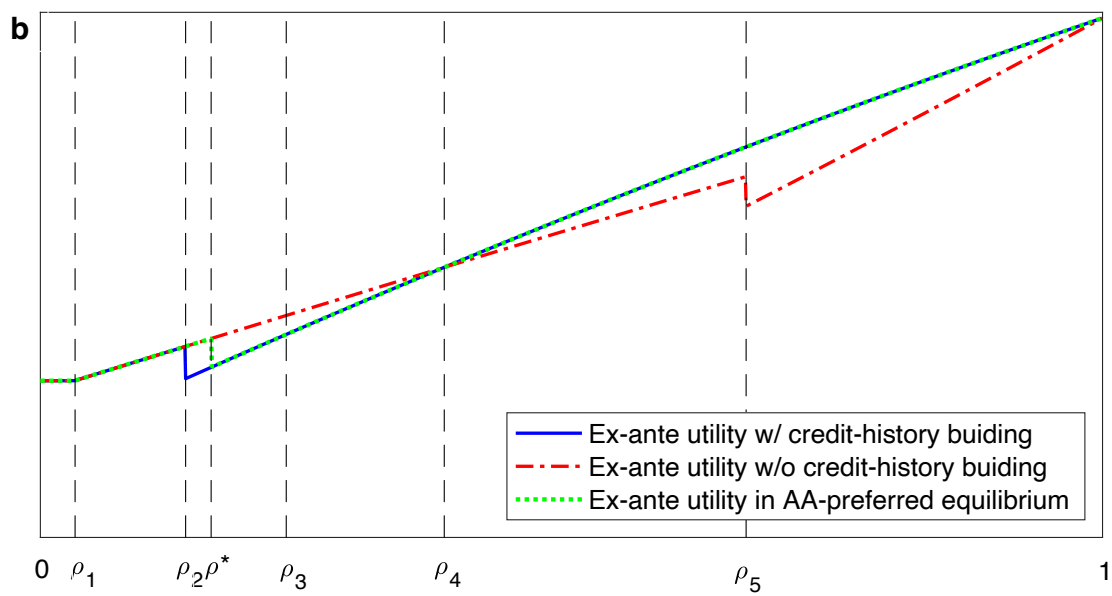
Comparative Statics: Welfare as a Function of ρ





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Example Equilibrium with Cross-Subsidization

- When equilibrium features cross-subsidization
  - i.e., when $q_h^{AA} > q_m^{AB}$

  the pure strategy equilibrium is asymmetric (in stage 1)
  - One class of lenders make a more generous offer whenever they get A-signal

$$q^A = \Pr(AA|A) q_h^{AA} + \Pr(AB|A) q_m^{AB}$$

  - while the other class make a more conservative offer

$$q^A = q_m^{AB}$$

  - with only the former price reflecting the cross-subsidization

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Excessive Borrowing

Conditions for excessive borrowing:

$$q_h^{AA} e_h < q_m^{AA} e_m,$$
$$q_h^{AA} (e_h - e_\ell) > q_m^{AA} (e_m - e_\ell),$$

where

$$q_h^{AA} = \Pr(\text{repaying large loan}|AA)\bar{q} = \Pr(e = e_h|AA)\bar{q},$$
$$q_m^{AA} = \Pr(\text{repaying medium loan}|AA)\bar{q} = \Pr(e \in \{e_m, e_h\}|AA)\bar{q}.$$

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Equilibrium with No Information Aggregation

- No offers made at stage 1
  - Intuitive beliefs assigned to off-equilibrium stage-1 loans
  - Beliefs about the stage-1 lender's signal depend on price
- In stage 2,
  - AA- and AB-borrowers get the same size loan
  - Pure strategy equilibrium necessitates asymmetry again
  - One class of A-lenders makes a pooling offer

$$q^A = \Pr(AA|A)q^{AA} + \Pr(AB|A)q^{AB}$$

  while the other class of A-lenders offers $q^A = q^{AB}$
- Cross-subsidization is larger than with credit-history building
  - as pooling is now on the entire loan, not just $\underline{x}$
- But there is no excessive borrowing

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