Payments and privacy in the digital economy[a]

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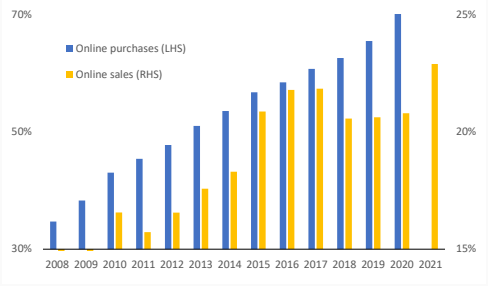
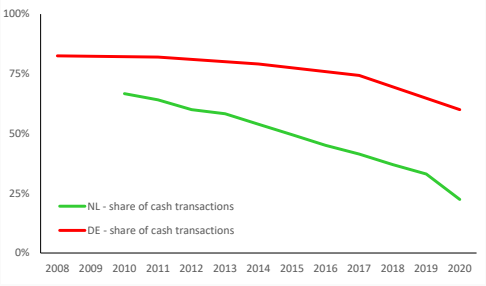
[a]The views expressed are our own and not necessarily those of the European Central Bank or the Eurosystem. The authors are not part of the digital euro project.

Motivation

- A digital economy requires digital payments
  - As online sales grow, the use of cash is declining

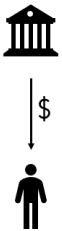




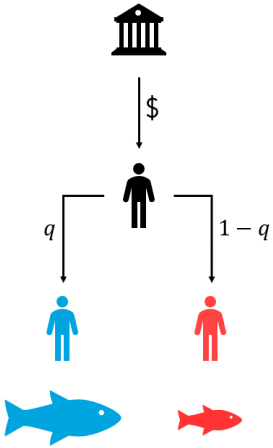
Motivation

- Electronic payments generate lots of data (unlike cash)
  - gives rise to privacy concerns
  - the business model of large tech firms is to monetise (payments) data
- What are the economic trade-offs associated with payments and privacy?
  - so far: focus on consumers (e.g. Garratt / van Oordt 2021 JPE)
  - here: merchants / sellers in the lending market
- What are the implications for policy (regulation, CBDC issuance)?

A simple model of lending



A simple model of lending



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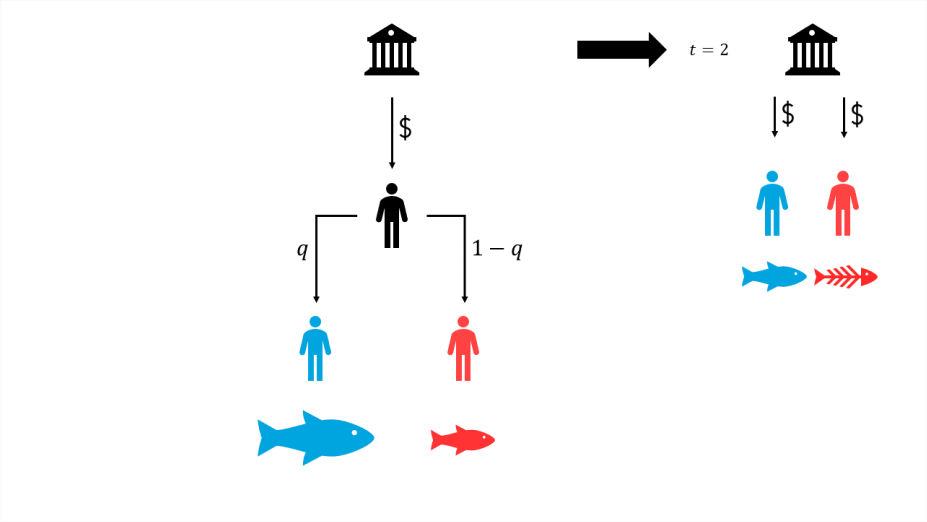

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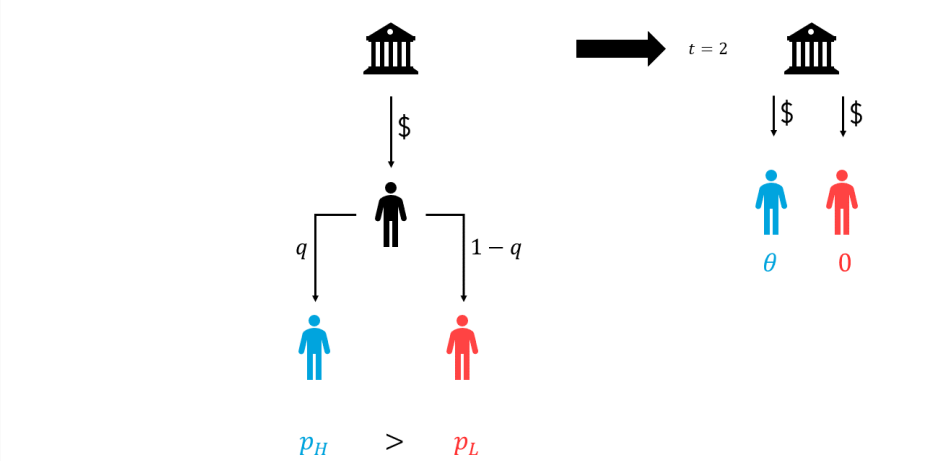
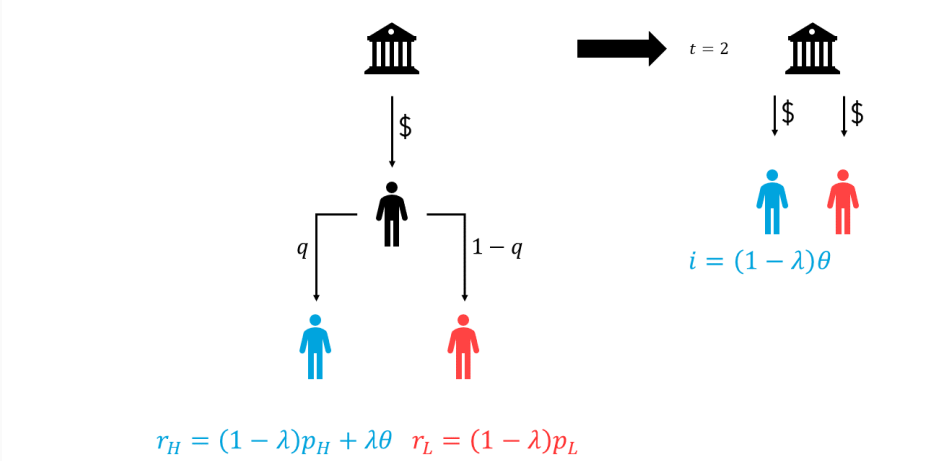


- Information on sales is useful for the lender for
  1. avoiding adverse selection on continuation loan (q is low)
  2. rent extraction (lender sets a menu of repayments)

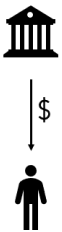
A simple model of lending



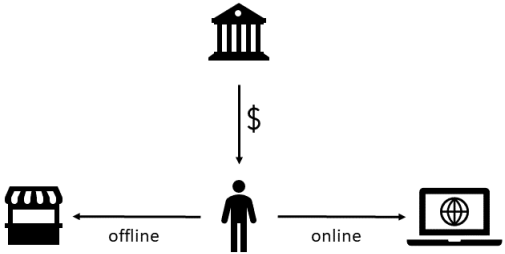
- the seller can abscond with a share λ of the loan / production
- a fully informed lender extracts the entire surplus adding more text for another line

The digital economy

Venue choice: merchants can distribute online or offline



Merchants can distribute online or offline



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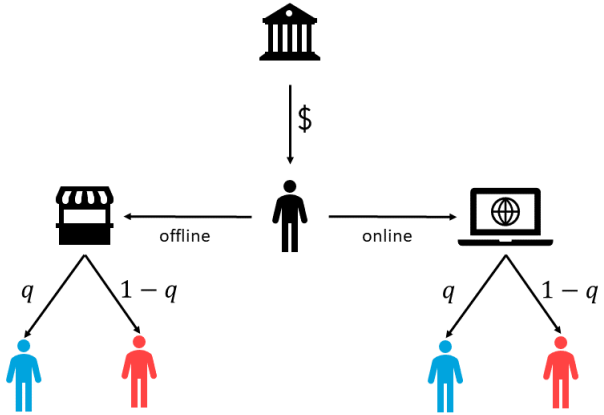
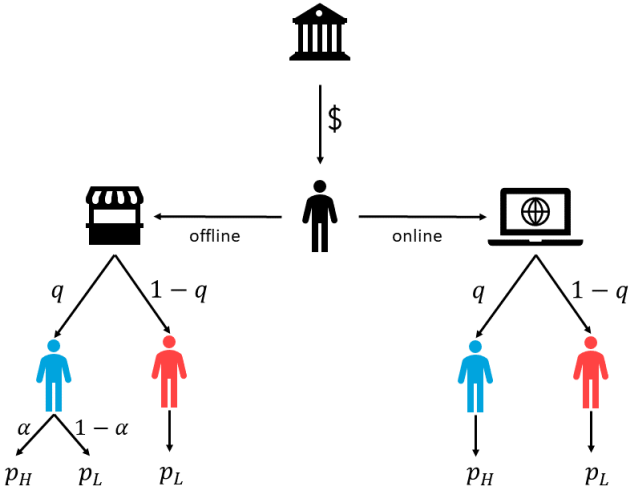


Online distribution is more efficient...



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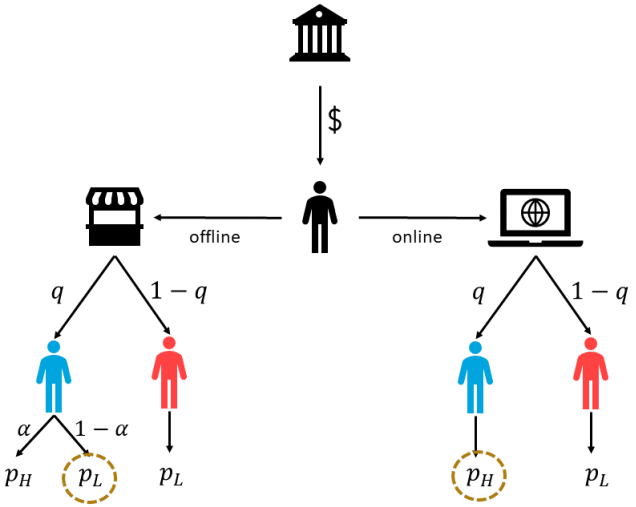
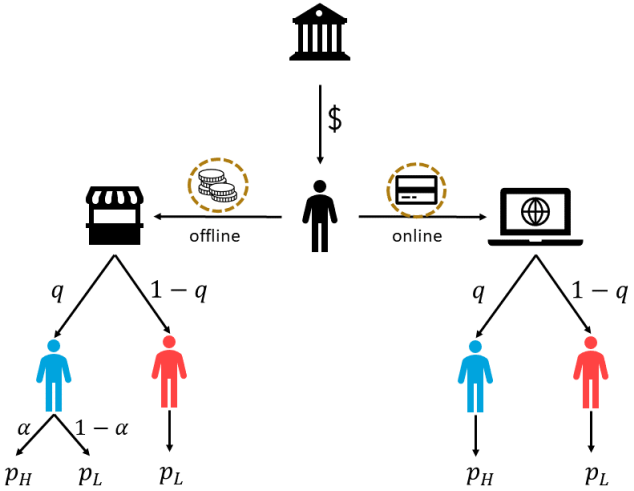


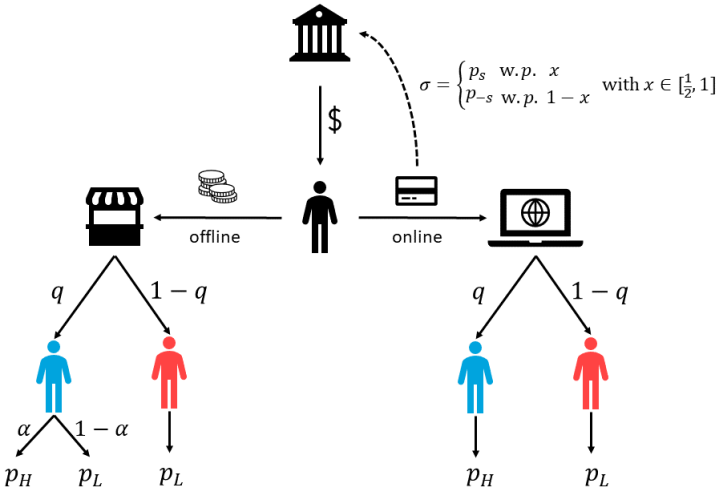
- Online distribution generates higher (expected) sales

Payments and privacy

...but requires digital payments...



...which provide information to the lender



- Focus on a fully-informative digital means of payment ($x = 1$)

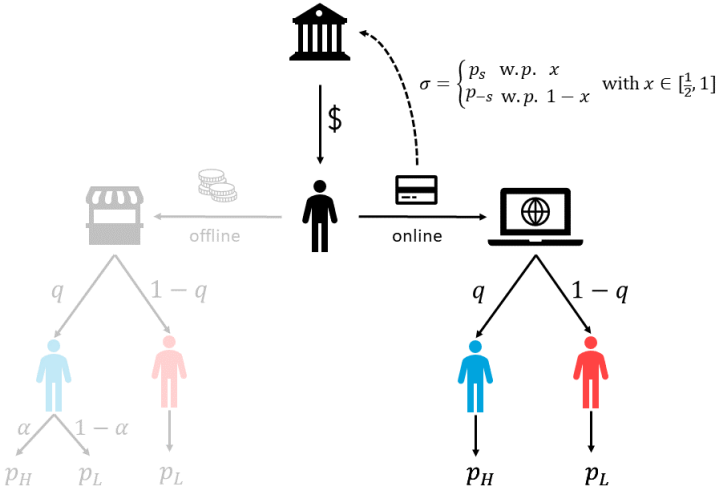
Three sources of inefficiency

- Offline sales are inefficient (in expectation): $p_L < p_H$
- Continuation lending should be offered to all H-sellers (and only to them): $1 < \theta$
- Absconding destroys resources: $\lambda < 1$

1st-round lending contract

Online

Suppose sellers distribute online...

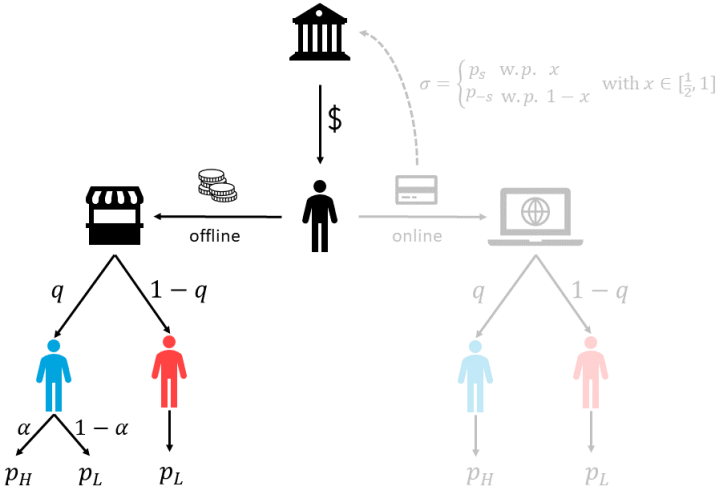


Optimal arrangement with online distribution

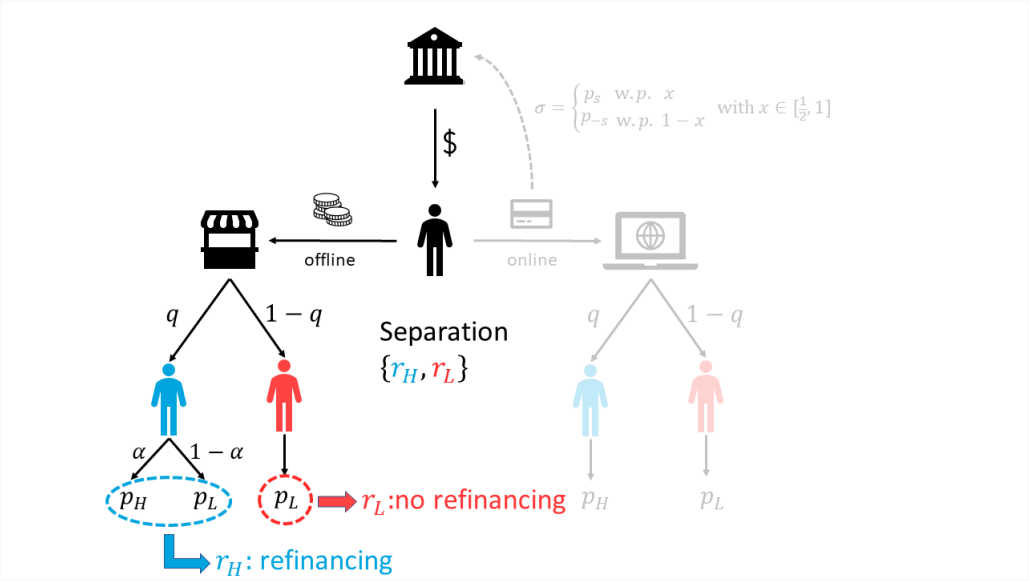
- Higher surplus for online distribution (with D-money, for bank deposits)
- Lender observes the seller's type and extracts the maximum possible
  - participation constraints of seller bind
  - all H-sellers receive a continuation loan
- **Lemma.** The lender sets repayments $r_L^{\mathcal{D}} = (1-\lambda)p_L$ and $r_H^{\mathcal{D}} = (1-\lambda)p_H + \lambda\theta$.
- Intuition: information from payment flows allow the lender to condition the contract terms on the signal
- Sellers only receive the outside option

Offline

Now suppose sellers distribute offline



Different arrangements are possible



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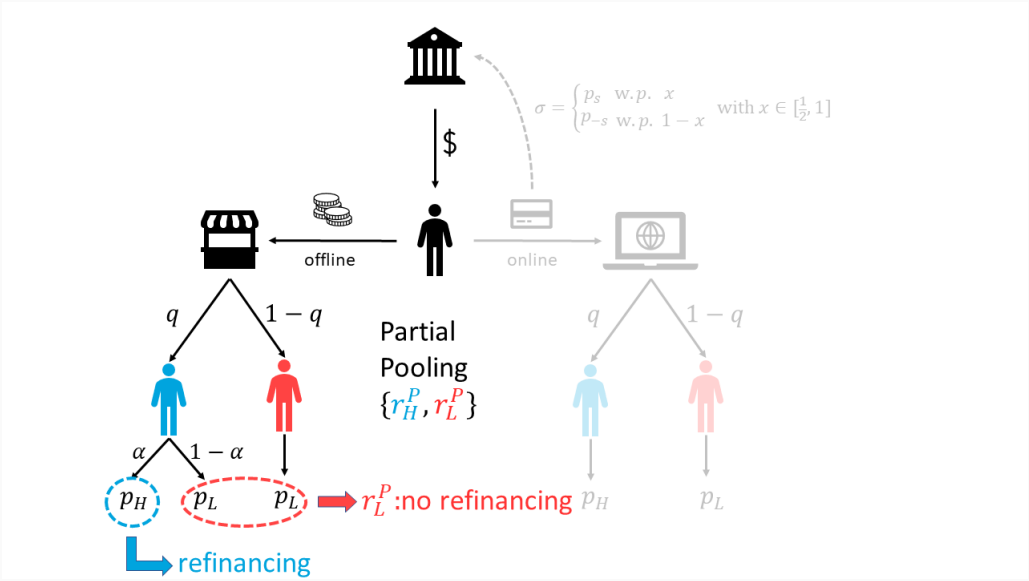


Optimal lending contract with offline distribution

- Lender receives no signal, so obtains information via menu of contracts
  - Lender wishes to learn about type and sales
- Complication: H-sellers sometimes realize low sales p_L
- **Lemma.** The lender offers a separating contract (S) whenever

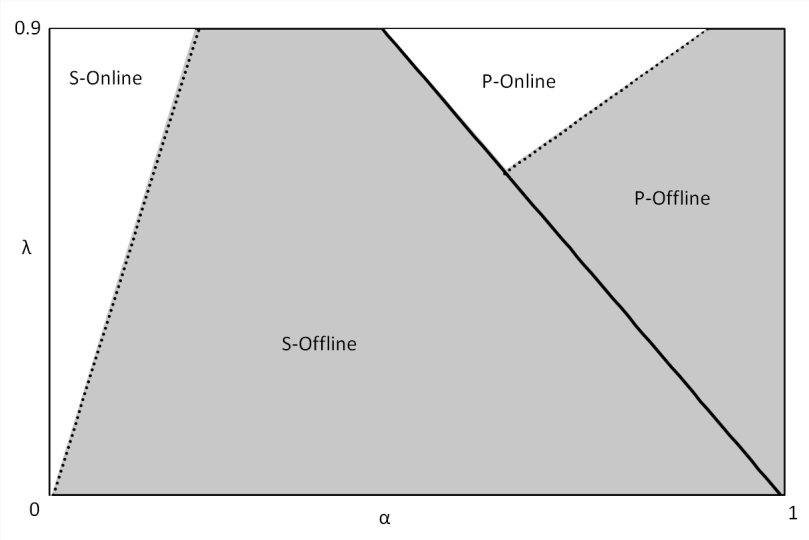
$$q(1-\alpha)(\theta-1) \geq q\lambda(\theta-p_L),$$

  and a partial pooling contract (P) otherwise. The repayments are $r_L^S = (1-\lambda)p_L$, $r_H^S = p_L$, and $r_L^P = (1-\lambda)p_L$, $r_H^P = (1-\lambda)p_L + \lambda\theta$.
  - benefit of separation: HL-sellers also receive continuation loan
  - benefit of pooling: higher repayment (cede fewer information rents to seller)
- Full pooling contract and partial participation contract not optimal

Sellers' decision

- Take the lender's choice of contracts (S or P) as given, depending on parameters
- Choose a venue (offline or online)
- A trade-off
  - online distribution creates a larger pie, but sellers earn a smaller piece
- It can be optimal to stay offline (and use cash)
  - socially inefficient

Equilibrium: seller's choice of venue



P-money

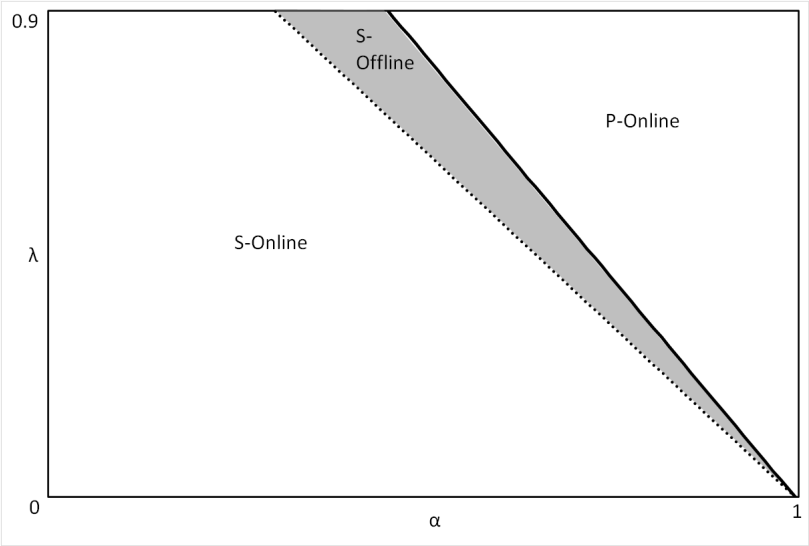
New means of payments

- So far: digital means of payment reveals a lot of information
  - D-money, bank deposits ($x = 1$)
- Now: Privacy-preserving digital payments
  - P-money
  - new players (non-bank PSP), new technologies (CBDC, blockchain)
  - lender does not extract information from payment flows ($x = \frac{1}{2}$)

Lender adjusts contractual arrangements

- Suppose seller distributes online, settled in P-money
- Lender always offers a separating contract
  - similar problem to offline sales settled in cash
  - but online sales generate higher sales and fewer states
  - inference problem is simpler for the lender
- More information rents for the seller
  - best of both worlds (online and information rents)
- P-money replaces D-money

P-money: seller's choice of venue



Two gains in welfare

1. More online distribution, so higher sales
2. Since lender opts for (full) separation when sellers choose to distribute online, all H-sellers are refinanced

- (Still some inefficiencies related to settling some offline distribution in cash)

C-money

Control over payments data

- C is for control (over payments data)
  - motivated by open banking, India Stack (control over data), some CBDC designs
  - Seller chooses whether lender receives a signal, and whether it is revealed before or after repayment

  Privacy is not the opposite of sharing, it is control over sharing. (Acquisiti et al., 2016)

- Sellers choose to reveal after repayment
- A separating contract is no longer feasible, so the lender offers a pooling contract

Proposition

Sellers always distribute online, and all online sales are settled in C-money. The equilibrium is efficient.

Extensions

- Imperfect signal ($\frac{1}{2} < x < 1$)
  - some additional channels, results (in paper)
- Endogenous sales
  - Nash bargaining (in paper)

Ongoing revision

- Uncertain propensity to abscond $\lambda \sim F(\cdot)$
  - publicly observed before the initial loan may be granted
  - (but after the planner designs the means of payment)
  - e.g. competition in the lending market
- Affects the participation of the lender
  - sometimes not profitable to grant the initial loan
  - especially acute for C-money (pooling contract)
- Generates a trade-off between P-money and C-money
  - C-money is more efficient than P-money *when both monies are feasible*
  - fewer initial loans granted with C-money

Conclusions

- A tractable framework for the interconnections between payments and privacy in the digital economy
  - trade-off in the baseline model: digital payments allow for efficient online distribution but at costly loss of privacy
  - endogenous benefits of privacy
  - privacy choice can be inefficient
- Privacy-preserving digital means of payment raise welfare
  - remain anonymous when it matters, reveal their type when needed, while reaping the benefits of online distribution
- Best of both worlds
- Implications for the regulation of payment systems and the design of CBDC