From Cash to Buy-Now-Pay-Later

Impacts of platform-provided credit on market efficiency

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Motivation

- The dual role of e-commerce platforms
    - Brokerage: match buyers and sellers
    - Credit: delayed settlement, record-keeping, enforcing repayment
        ▶ For instance, **buy-now-pay-later** on Amazon, Alipay, JD.com.
        ▶ The surge of BNPL is closely related to inflation and rise of e-commerce (Cornelli et al. 2023).

- Regulatory frameworks treat brokerage and credit provision separately
    EU: Revised European Consumer Credit Directive (Oct 23)
    US: Proposal by Consumer Financial Protection Bureau (Nov 23)
    UK: Treasury's Legislative Proposal (Feb 23)
    ...
    - These frameworks overlook that some of the major credit providers are also platforms.

0 **Intro**
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- The separated regulation approach can be problematic because:

    - merchants: lack the incentive to adopt credit technology because it is costly and part of the benefits are given to platform in the form of fees
    - platform: can subsidize credit usage (or even provide *for free*), then charge a high transaction fee to extract surplus
    - regulator: given that credit is highly subsidized, challenge to regulate directly

- Questions:
    1. Why do some sellers adopt credit while others do not?
    2. To whom would the platform find it profitable to provide credit?
    3. What are the potential distortions? How to regulate?

- We examine the equilibrium, distortions, and regulations of a monopolist dual-role (brokerage + credit) platform.

Preview of results

Microfoundation of payment

- Means of payment: money v.s. credit.
    - Money: money-holding costs, e.g., inflation (passed on to sellers)
    - Credit: lump-sum cost paid by sellers

- Some sellers have higher matching capacity
    - e.g., better inventory / advertising capacities, goods of higher quality etc.

- Directed search environment
    - prices, matching capacities, accepted means of payment all observable

- In equilibrium, sellers with higher matching capacity attract more buyers
  and charge higher prices $\Rightarrow$ sellers incur higher money-holding costs $\Rightarrow$
  greater incentive to adopt credit

A monopolist platform operates the market

- platform obtains higher profits by combining matching and credit services

- coexistence of monetary and credit payment on platform

- credit usage are subsidized (even for free)

Distrotions in credit provision

- if equil. has hybrid payment, credit provision is too low compared to social planner's solution
  - platform exercises market power (not subsidize sellers sufficiently)

- if equil. has pure credit payment, credit provision can be too high
  - platform provides credit for free, and imposes high transaction fees to extract surplus
  - despite using credit is dominated by using money

Literature

Coexistence of credit and money

- Dong and Huangfu (2021), Wang, Wright and Liu (2020), Andolfatto, Berentsen and Martin (2019), Lotz and Zhang (2016), Gu, Mattesini and Wright (2016), Ferraris and Watanabe (2012), Nosal and Rocheteau (2011), Sanches and Williamson (2010), Telyukova and Wright (2008), Berentsen, Camera and Waller (2007)

Hybrid or dual-mode of platforms

- Tirole and Bisceglia (2023), Madsen and Vellodi (2023), Gautier, Hu and Watanabe (2023), Etro (2023), Shopova (2023), Hagiu, Teh and Wright (2022), Anderson and Bedre-Defolie (2022), Kang and Muir (2022), Padilla, Perkins and Piccolo (2022), Zennyo (2022), Chiu and Wong (2022)

This talk

- 1. Micro-foundation of Payment

- 2. Platform Economy

- 3. Distortions

- 4. Regulations

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I. The Microfoundation of Payment

Set-ups: A variant of Lagos and Wright (2005)

discount between periods
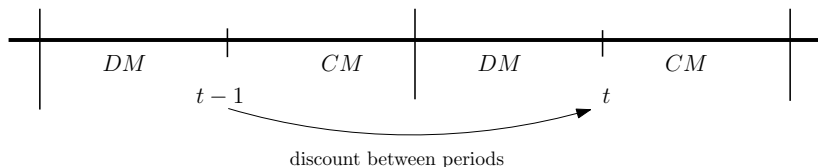
- Each period: DM then CM; agents discount between periods
- CM: Walrasian / buyers work and prepare money / sellers produce the good for DM & set up means of payment
- DM: trade an *indivisible* good
  - Buyers: unit demand (value u), free entry (entry cost k)
  - Sellers: selling capacity 1 unit, measure one

Means of Payment in DM

- Sellers can adopt credit tech at cost ϕ

- w credit tech, the matched buyer can pay by credit*

  *pay in next CM and no credit limit

- w/o credit tech, buyers need to pay fiat money

Search Frictions in DM

- Directed search
  - prices and other infor. observable on platform
- Matching prob, for sellers: $\xi\alpha(x)$, for buyers: $\xi\alpha(x)/x$
  - $\alpha' > 0, \alpha'' < 0, \alpha(0) = 0, \alpha(\infty) = 1$.
  - x: buyer-seller ratio (or queue length)
- Each seller has a matching capacity $\xi \in [\underline{\xi}, \bar{\xi}]$
  - ξ follows a continuous dist. with cdf. $G(\xi)$ and pdf. $g(\xi)$

Timing

1. In CM, **sellers** draw ξ, decide to join DM or not. If join, he
   - produces one unit DM good at cost κ;
   - announces price and accepted payment methods in DM.

2. Observing prices, means of payment and ξ's, **buyers** simultaneously decide which submarket of sellers to visit, prepare money if needed.

3. Trade occurs in DM.

If a seller opts for credit payment ...

- The seller's problem:

$$\max_{x,p} \ \xi\alpha(x)p, \quad \text{s.t.} \ \frac{\xi\alpha(x)}{x}\,(u-p) = k,$$

$$\text{f.o.c}: \ \xi\alpha'(x_c)u = k.$$

  where k is the buyer's market value (entry cost).

- $x_c(\xi)$ increases in ξ, more efficient sellers attract more buyers

- The optimized profits:

$$\pi_c(\xi) = \xi\alpha(x_c)u - x_c k.$$

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If a seller opts for monetary payment ...

- The seller's problem:

$$\max_x \xi\alpha(x)p, \quad \text{s.t.} \quad \frac{\xi\alpha(x)}{x} \ (u - p) - ip = k.$$

$$\text{f.o.c}: \ x_m = x_m(\underset{-}{i}, \underset{+}{\xi}).$$

- The optimized profits:

$$\pi_m(\xi, i) = \xi\alpha(x_m)u - x_m k - ix_m p_m$$

- Money-holding costs are passed to the seller.

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Adopting credit tech or not...

- A seller's maximized profit

$$\text{credit: } \pi_c(\xi) = \xi\alpha(x_c)u - x_c k,$$
$$\text{money: } \pi_m(\xi, i) = \xi\alpha(x_m)u - x_m k - ix_m p_m.$$

- A seller opts for credit payment if

$$\phi < \Delta\pi(\xi, i) \equiv \pi_c(\xi) - \pi_m(\xi, i)$$
$$= \left\{ [\xi\alpha(x_c) - \xi\alpha(x_m)]u - (x_c - x_m)k \right\} + x_m i p_m.$$

- $\Delta\pi(\xi, i)$ increases in i and ξ

$$\frac{\partial\Delta\pi(\xi, i)}{\partial\xi} = \underbrace{(\alpha(x_c) - \alpha(x_m))(u - c)}_{\text{volume effect}} + \underbrace{x_m i[\partial p_m/\partial\xi]}_{\text{price effect}},$$

Equilibrium

- Equilibrium conditions

$$\text{Participate: } \max\{\pi_c(\xi) - \phi, \pi_m(\xi, i)\} \geq \kappa,$$

$$\text{Adopt credit: } \phi \leq \Delta\pi(\xi, i).$$

- Notations

$$\xi_l : \text{ the lowest } \xi \text{ of participating sellers,}$$

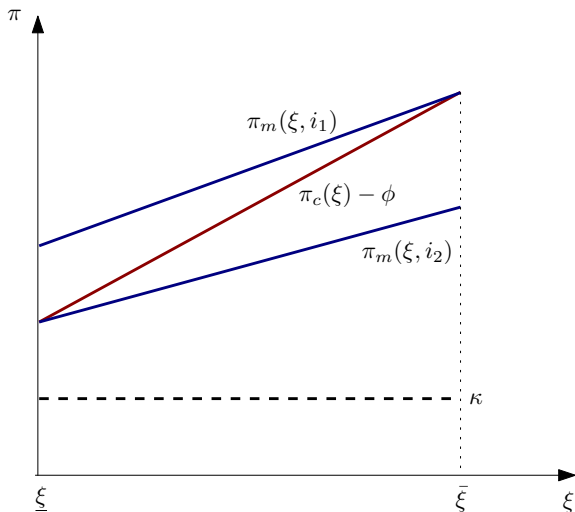$$\hat{\xi} : \text{ the threshold to adopt credit.}$$

- Assumption: production cost is low:

$$\kappa < \pi_c(\underline{\xi}) - \phi,$$

so all sellers participate in the DM.

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Props. The threshold of adopting credit $\hat{\xi}$ satisfies $\Delta\pi(\hat{\xi}, i) = \phi$ if $i \in (i_1, i_2)$;
$\hat{\xi} = \bar{\xi}$ ($\underline{\xi}$) if $i \le i_1$ ($i \ge i_2$).

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II. The Platform Economy

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A monopolist platform

- Suppose the DM outlined above is operated by a platform.
- Sellers and buyers can not match and trade outside the platform.
- Match-Making
  - the platform has a directed search environment
  - the platform charges a *proportional transaction fee* $t \in [0, 1]$
- Means of Payment
  - sellers can always accept cash
  - sellers can accept credit by paying *lump sum fee* $f \geq 0$ to the platform
  - cost of credit tech for the platform: $\phi > 0$

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Timing

0. **In CM, the platform publicly announces** $(t, f) \in \mathbb{T} \equiv [0,1] \times \mathbb{R}_+$.

1. Sellers draw ξ, decide to join DM or not. If join, he
   - produces one unit DM good at cost κ;
   - announces prices and accepted payment methods in DM.

2. Observing prices, means of payment, and ξ's, buyers simultaneously decide which seller to visit, and prepare money if needed.

3. Trade occurs in DM.

Equilibrium

Sellers' best responses:

- join platform iff $\max\{(1-t)\pi_m(\xi, i), (1-t)\pi_c(\xi) - f\} \geq \kappa$
- opt for credit iff $(1-t)\Delta\pi(\xi, i) \geq f$

For the analysis, we divide platform's strategy space as follows:

- **Credit Entry**: ξ_l-seller opt for credit payment
- **Money Entry**: ξ_l-seller opt for monetary payment
- Note that under **money entry**, a hybrid payment system is possible

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Credit Entry

- The platform's problem:

$$\Pi_c = \max_{(t,f)\in\mathbb{T}} \int_{\xi_l}^{\bar{\xi}} \left(t\pi_c(\xi) + f - \phi \right) dG(\xi),$$

$$s.t. \quad (1-t)\pi_c(\xi_l) - f = \kappa,$$

$$(1-t)\pi_m(\xi_l, i) < \kappa.$$

lemma Profit maximization implies $f = 0$, $t = 1 - \frac{\kappa}{\pi_c(\xi_l)}$.

- Inserting f and t, platform faces a standard monopoly quantity trade-off:

$$\Pi_c = \max_{\xi_l\in[\underline{\xi},\bar{\xi}]} \int_{\xi_l}^{\bar{\xi}} \left(\left(1 - \frac{\kappa}{\pi_c(\xi_l)} \right) \pi_c(\xi) - \phi \right) dG(\xi).$$

Money Entry

- The platform's problem:

$$\Pi_m(i) = \max_{(t,f)\in\mathbb{T}} \Big\{ \int_{\xi_l}^{\hat{\xi}} t\pi_m(\xi, i) dG(\xi) + \int_{\hat{\xi}}^{\bar{\xi}} \big(t\pi_c(\xi) + f - \phi \big) dG(\xi) \Big\}$$

$$s.t. \quad (1-t)\pi_m(\xi_l, i) = \kappa,$$

$$(1-t)\pi_c(\hat{\xi}) - f = (1-t)\pi_m(\hat{\xi}, i).$$

lemma Under money-entry, platform profits are maximized by $\hat{\xi} = \bar{\xi}$ iff $i \le i_1$.
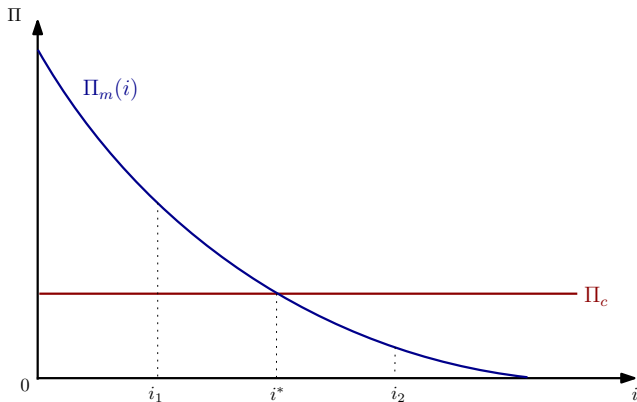
- $\hat{\xi} = \bar{\xi}$: pure monetary payment
- $i \le i_1$: monetary payment gives higher surplus than credit payment for all ξ

lemma $\Pi_m(i)$ decreases in i with

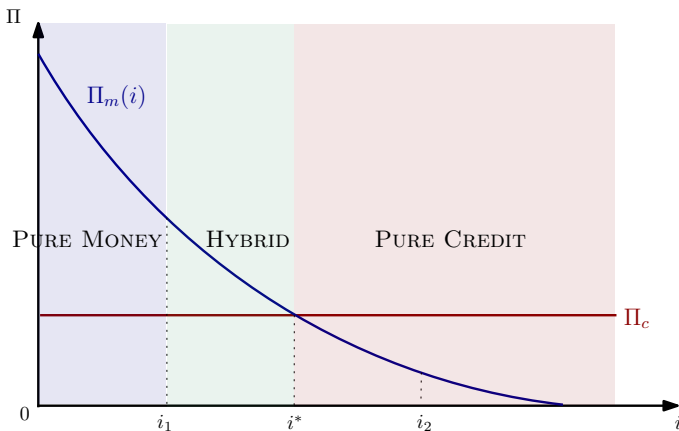$$\lim_{i\to 0} \Pi_m(i) > \Pi_c, \text{ and } \Pi_m(i) < \Pi_c \text{ for } i > i_2.$$

Platform profit-maximization

Propos. $\exists! i^* \in (0, i_2]$, $\Pi_m(i^*) = \Pi_c$.

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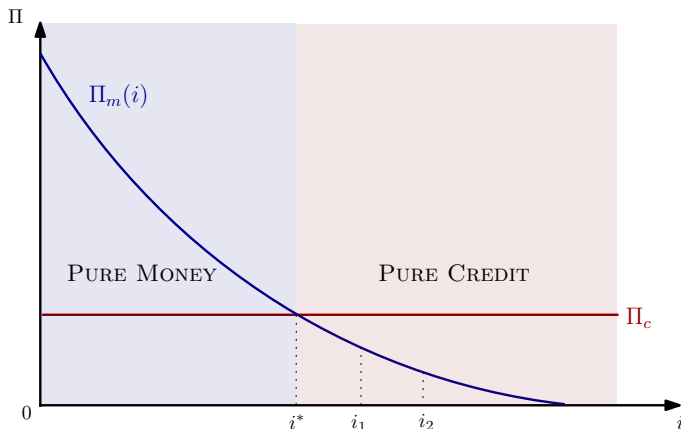
Platform payment mode

Propos. $\exists! i^* \in (0, i_2]$, $\Pi_m(i^*) = \Pi_c$.

A case that credit-entry is profitable but suboptimal

Cor. $\exists \bar{\phi} > 0$. If $\phi < \bar{\phi}$, then $i^* < i_1$.

Remark: Despite $\pi_m(\xi, i) > \pi_c(\xi) - \phi$ for all ξ, platform still chooses credit-entry.

Credit-entry: profitable but suboptimal

- Even if $\pi_m(\xi, i) > \pi_c(\xi) - \phi$ for all ξ, platform may choose credit-entry.

- At $i = i_1$, suppose the platform uses money-entry with t_m, the profit is

$$\Pi_m = \int_{\xi_l}^{\bar{\xi}} t_m \pi_m(\xi, i) dG(\xi) \text{ with } (1 - t_m)\pi_m(\xi_l, i) = \kappa.$$

- Keeping ξ_l, and switching to credit entry allows the platform to charge a higher fee $t_c > t_m$:

$$\Pi_c = \int_{\xi_l}^{\bar{\xi}} (t_c \pi_c(\xi) - \phi) dG(\xi) \text{ with } (1 - t_c)\pi_c(\xi_l) = \kappa.$$

Platform extracts a higher share of surplus at the expense of credit provision cost ϕ.

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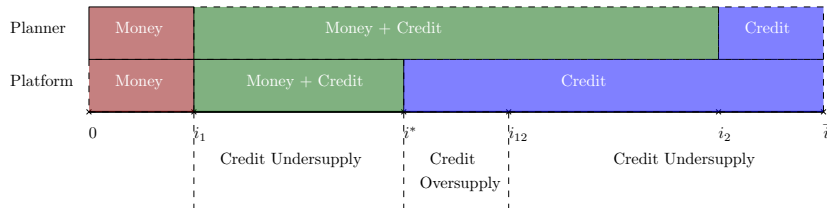
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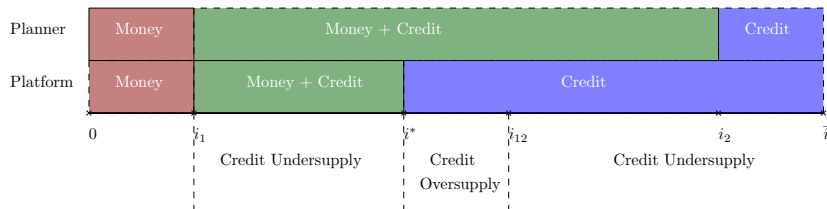00000

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III. Distortions

Distortions on two margins

1. Entry margin: efficiency requires $\xi_I = \underline{\xi}$.

2. Credit adoption margin: efficiency requires $\phi = \Delta\pi(\hat{\xi}, i)$.

- Under Pure Money, only the entry margin.

- Under Hybrid Payment, two margins are separate.

- Under Pure Credit, entry margin $=$ adoption margin.

Pure Monetary Payment

- standard monopoly quantity distortion

- possibly insufficient entry of sellers

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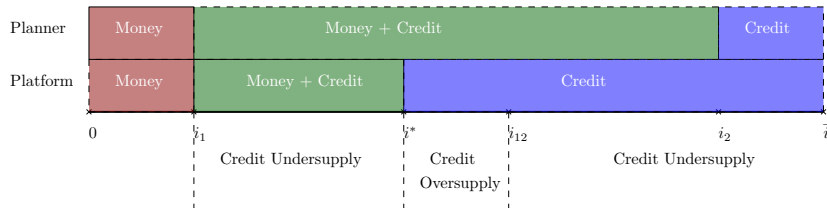
Hybrid Payment (Money + Credit)

Propos. Credit provision is always too low compared to the efficient level.

proof. Fix ξ_l, platform's profits:

$$\int_{\xi_l}^{\bar{\xi}} t\pi_m(\xi, i)dG(\xi) + \int_{\hat{\xi}}^{\bar{\xi}} \left(t\Delta\pi(\xi, i) + \underbrace{(1-t)\Delta\pi(\hat{\xi}, i)}_{f} -\phi\right) dG(\xi).$$

F.O.C yields

$$\Delta\pi(\hat{\xi}^m, i) - \phi = (1-t)\frac{1 - G(\hat{\xi}^m)}{g(\hat{\xi}^m)} \frac{\partial\Delta\pi(\hat{\xi}^m, i)}{\partial\hat{\xi}^m} > 0.$$
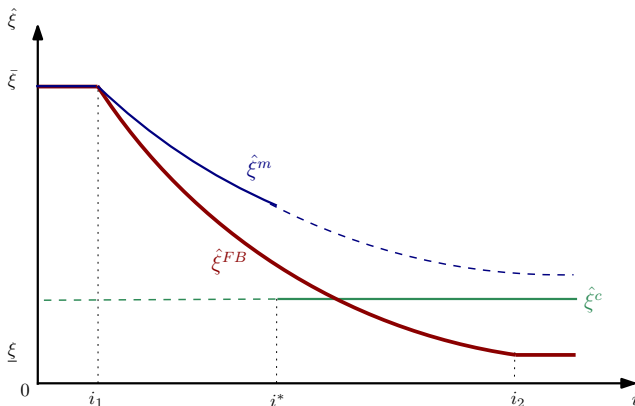
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| Planner | Money | Money + Credit | | | Credit | |

| Platform | Money | Money + Credit | Credit | | | |

$0 \quad \underline{i}_1 \quad i^* \quad i_{12} \quad i_2 \quad \bar{i}$

Credit Undersupply $\quad$ Credit Oversupply $\quad$ Credit Undersupply

Pure Credit Payment

- ξ_I determines both entry and credit provision margins.
- The platform has different trade-offs from the planner.
  - Planner: let the seller use credit or money.
  - Platform: let the seller in (and use credit) or not $\Rightarrow \xi_I$ is independent of i.
- Oversupply and undersupply of credit coexist.

Non-monotonic distortions of credit provision

- Credit adoption thresholds: $\hat{\xi}^{FB}$ (first best), $\hat{\xi}^m$ (money-entry), $\hat{\xi}^c$ (credit-entry)

- Comparing $\hat{\xi}^m$ and $\hat{\xi}^c$ with $\hat{\xi}^{FB}$, we observe that as i increases, credit provision is initially undersupplied, then oversupplied, and eventually undersupplied again.

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IV. Regulations

Regulate f or t Separately

Cap f (Credit Usage Fee)

- Capping $f = \phi$ may not resolve credit inefficiency.
- Under hybrid payment, $\frac{f}{1-t} > \phi$, yet often $f < \phi$.
- Under pure credit payment, $f = 0$.

Cap t (Transaction Fee)

- Capping t leads the platform to raise f to compensate for the loss.
- The effect on credit provision is unclear; credit provision could either increase or decrease.

- Using credit-entry strategies, the platform maximizes

$$\int_{\xi_I}^{\bar{\xi}} \Big(t\pi^c(\xi) + f - \phi \Big) dG(\xi),$$

$$\text{s.t.} \ (1-t)\pi^c(\xi_I) - f = \kappa.$$

- w/o restriction on t:

$$\max_{\xi_I \in [\underline{\xi}, \bar{\xi}]} \int_{\xi_I}^{\bar{\xi}} \left(\underbrace{\left(1 - \frac{\kappa}{\pi_c(\xi_I)}\right)}_{t(\xi_I)} \pi_c(\xi) - \phi \right) dG(\xi).$$

- imposing $t \leq \bar{t}$:

$$\max_{\xi_I \in [\underline{\xi}, \xi_I^{ub}]} \int_{\xi_I}^{\bar{\xi}} \left(\bar{t}\pi_c(\xi) + \underbrace{(1 - \bar{t})\pi_c(\xi_I) - \kappa}_{f(\xi_I)} - \phi \right) dG(\xi).$$

propos. $\xi_I^{rc} > \xi_I^c$ iff $\bar{t} < \bar{t}_1(\xi_I^c)$, viz. strong regulation reduces credit.

Jointly regulate (t, f)

The social planner's problem

$$\max_{(t,f)\in\mathbb{T}} \left\{ \int_{\xi_l}^{\hat{\xi}} \pi_m(\xi, i) dG + \int_{\hat{\xi}}^{\bar{\xi}} \left(\pi_c(\xi, i) - \phi \right) dG - (1 - G(\xi_l)) \kappa \right\},$$

$$\text{s.t.} \ (1 - t)\pi_m(\xi_l) \geq \kappa, \ \ \Delta\pi(\hat{\xi}, i) = \frac{f}{1 - t}, \ \ \Pi(t, f) \geq 0.$$

- Suppose $i \in (i_1, i_2)$, to implement first-best, (t, f) shall satisfy

  (1) upper bound for t: $t \leq 1 - \dfrac{\kappa}{\pi_m(\underline{\xi}, i)}$,

  (2) link f to t and ϕ: $f = (1 - t)\phi$.

- When $i \leq i_1$ or $i \geq i_2$, more flexibility on f but rules above still apply

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Jointly regulate (t, f) (cont.)

- Suppose $i \leq i_1$, to implement the first-best, (t, f) shall satisfy

$$\left\{ (t, f) \in \mathbb{T} \;\middle|\; t \leq 1 - \frac{\kappa}{\pi_m(\underline{\xi}, i)}, \;\; \frac{f}{1-t} \geq \Delta\pi(\bar{\xi}, i) \right\}$$

- Suppose $i \geq i_2$, to implement the first-best, (t, f) shall satisfy

$$\left\{ (t, f) \in \mathbb{T} \;\middle|\; t + \frac{f}{\pi_c(\underline{\xi})} \leq 1 - \frac{\kappa}{\pi_c(\underline{\xi})}, \;\; \frac{f}{1-t} \leq \Delta\pi(\bar{\xi}, i), \right.$$
$$\left. t \int_{\underline{\xi}}^{\bar{\xi}} \pi_c(\xi) dG - \phi + f \geq 0 \right\}$$

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5. Discussions

Proportional Credit Usage Fee

- Suppose the credit usage cost is $\phi \pi_c(\xi)$. The marginal seller has $\hat{\xi}$ satisfying

$$\Delta\pi(\hat{\xi}, i) = \phi\pi_c(\hat{\xi}) \quad \text{or} \quad \frac{\Delta\pi(\hat{\xi}, i)}{\pi_c(\hat{\xi})} = \phi.$$

- We assume that

$$\frac{\Delta\pi(\xi, i)}{\pi_c(\xi)} \text{ is strictly increasing in } \xi,$$

  This ensures more efficient suppliers have higher incentives to adopt credit.
  A sufficient condition for this is that $\pi_m(\xi, i)$ is log-submodular.

- Let the planner choose (t, f), then the marginal seller's condition becomes

$$(1 - t)\Delta\pi(\hat{\xi}, i) = f\pi_c(\hat{\xi}).$$

- Optimality requires

$$\frac{f}{1 - t} = \phi.$$

Equilibrium and Distortions

Our results continue to hold.

Propos. $\exists! i^* \in (0, i_2]$, $\Pi_m(i^*) = \Pi_c$.

Cor. $\exists \bar{\phi} > 0$. If $\phi < \bar{\phi}$, then $i^* < i_1$.

Propos. Under hybrid payment, credit provision is always too low compared to the efficient level.

Propos. Under pure credit payment, credit provision can be too high or too low compared to the efficient level.

Spinning credit provision off from the platform

- Suppose the two businesses are isolated, and the platform's credit sector competes with third-party credit providers à la Bertrand, then $f = \phi$.

- PLATFORM suffers from the spin-off.
  - when money-entry is more profitable, $f = \phi$ is set too high compared to profit maximization;
  - when credit-entry is more profitable, credit-entry is not feasible anymore

- The impact on welfare is ambiguous.
  - Since f is NOT subsidized anymore, the credit usage is even lower
  - The platform has a lower incentive to increase t which improves the efficiency of the entry margin.
  - The credit sector is smaller, and thus extract less from the extra value $t \int_{\hat{\xi}}^{\bar{\xi}} \Delta \pi(\xi, i) dG(\xi)$.

Takeaways

- Matching capacity and means of payment.

  Under directed search search, sellers of higher matching capacities have higher
  incentives to adopt credit.

- A monopolist platform may provide too much or too little credit,
  compared to the planner's solution. And there is a non-monotonic
  relationship with money-holding costs.

- To ensure efficient credit provision, the two roles should be jointly
  regulated $f = (1 - t)\phi$.

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