From Cash to Buy-Now-Pay-Later

Impacts of platform-provided credit on market efficiency

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November 2024

Motivation

- The dual role of e-commerce platforms
  - Brokerage: match buyers and sellers
  - Credit: provide credit to buyers to facilitate the trade
    - **Buy-Now-Pay-Later** (BNPL) on Amazon, Alibaba, JD.com, Shopee (SPayLater)
    - The surge of BNPL is closely related to inflation and the rise of e-commerce (Cornelli et al. 2023)
- The *EU 2023 Consumer Credit Directive* defines **BNPL** as follows: 'Buy now, pay later' schemes whereby the creditor grants credit to a consumer for the exclusive purpose of purchasing goods or services provided by a supplier, which are new digital financial tools that let consumers make purchases and pay them off over time, are often granted free of interest and without any other charges.

amazon pay   Shop with Amazon Pay >   Amazon Pay for business >   Sign in >   Business Registration

BUY NOW AND PAY OVER TIME WITH PROMOTIONAL FINANCING

Shop beyond Amazon.com with your Amazon Store Card

Here's one more reason to love the Amazon Store Card. You can use your card to make purchases beyond Amazon.com using Amazon Pay. And you have the option to choose 0% APR financing with 6 equal monthly payments on qualifying Amazon Pay purchases*.

Not an Amazon Store Card or Prime Store Card member?
Learn more about the card

Amazon Pay purchases made using your Amazon Store Card and Prime Store Card are not eligible to earn reward points.

amazon pay Shop with Amazon Pay > Amazon Pay for business > Sign in > Business Registration

BUY NOW, PAY OVER TIME

Buy what you need now and pay at your own pace — with no hidden fees

More shoppers than ever are looking for an option to pay over time. And now, with Amazon Pay and Affirm, you can get exactly what you want while making budget-friendly payments.

- 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 do not distinguish between standalone BNPL providers and hybrid intermediaries (credit + trade).

- 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 dual-role (brokerage + credit) platform

Literature

Coexistence of money and credit

- 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), Chiu and Wong (2022)

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)

1. The Microfoundation of Payment

Agents and goods

- Agents trade an **indivisible** good
- Buyers: unit demand (value u), free entry (entry cost k)
- Sellers: selling capacity 1 unit, measure one, differs in matching efficiency ξ

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Search frictions

- Directed search: prices and characteristics of sellers are observable
- Matching probability, for sellers: $\xi\alpha(x)$, for buyers: $\frac{\xi\alpha(x)}{x}$
  - $\alpha' > 0, \alpha'' < 0,\ \alpha(0) = 0, \alpha(\infty) = 1$
  - x: buyer-seller ratio (or queue length)
  - matching efficiency $\xi \in [\underline{\xi}, \bar{\xi}] < 1$ follows a continuous distribution $G(\xi)$

Means of payment

- Sellers can adopt credit technologies at cost ϕ
- with credit technologies, the matched buyer can pay by credit*

  *in the monetary framework: pay in next period and no credit limit
- without credit technologies, buyers need to hold fiat money

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Timing

1. Sellers firstly draw ξ, decide to join market or not. If join, he
   - produces one unit good at cost c
   - announces price and accepted payment methods in the market
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 market

Suppose a seller opts for credit payment

- The problem is:

$$\begin{aligned} &\max_p \ \xi\alpha(x)p \\ &\text{s.t.} \ \ \frac{\xi\alpha(x)}{x}(u-p)=k \end{aligned} \quad \Rightarrow \quad \xi\alpha'(x_c)u = k$$

- $x_c(\xi)$ 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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Suppose a seller opts for money payment

- The problem is:

$$\begin{aligned} &\max_p \ \xi\alpha(x)p \\ &\text{s.t.} \ \ \frac{\xi\alpha(x)}{x}(u-p) - ip = k \end{aligned} \quad \Rightarrow \quad x_m = x_m(\underset{-}{i}, \underset{+}{\xi})$$

- The optimized profits: $\pi_m(\xi, i) = \xi\alpha(x_m)u - x_m k - i x_m p_m$
- Money-holding costs are passed on to the seller

Equilibrium

- A seller opts for credit payment if

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

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

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

Equilibrium

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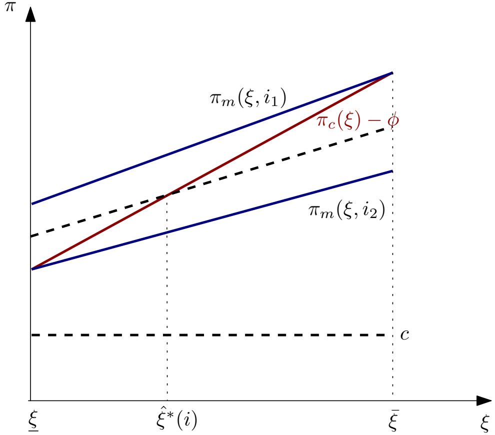
- A seller participates in the market if

$$\max\{\pi_c(\xi) - \phi, \pi_m(\xi, i)\} \geq c$$

- Assuming production cost is low, $c < \pi_c(\underline{\xi}) - \phi$, all sellers join the market

Proposition. The threshold of adopting credit satisfies $\hat{\xi}^* \in (\bar{\xi}, \underline{\xi})$ and $\Delta\pi(\hat{\xi}^*, i) = \phi$ if $i \in (i_1, i_2)$; $\hat{\xi}^* = \bar{\xi}$ if $i \leq i_1$; $\hat{\xi}^* = \underline{\xi}$ if $i \geq i_2$.



2. The Platform Economy

A monopolist platform

- Suppose the market outlined above is operated by a platform
- Sellers and buyers can not trade outside the platform
- Match-making
  - 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 technologies for the platform: $\phi > 0$

Timing

0. The platform publicly announces $(t, f) \in \mathbb{T} \equiv [0,1] \times \mathbb{R}_+$
1. Sellers draw ξ and decide to join the market or not. If join, he
   - produces one unit of market good at cost c
   - announces prices and accepted payment methods in the market
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 the market

Equilibrium

Sellers' best responses:

- Join platform iff $\max\{(1-t)\pi_m(\xi,i),(1-t)\pi_c(\xi)-f\}\geq c \;\Rightarrow\; \xi_l$
- opt for credit iff $(1-t)\Delta\pi(\xi,i)\geq f \;\Rightarrow\; \hat{\xi}$

Equilibrium

Sellers' best responses:

- Join platform iff $\max\{(1-t)\pi_m(\xi, i), (1-t)\pi_c(\xi) - f\} \geq c \;\Rightarrow\; \xi_l$
- opt for credit iff $(1-t)\Delta\pi(\xi, i) \geq f \;\Rightarrow\; \hat{\xi}$

To derive the platform's optimal strategy, we divide its strategy space:

- **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

Credit Entry

- The platform's problem:

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

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

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

- Profit maximization features $f = 0$, $t = 1 - \frac{c}{\pi_c(\xi_l)}$.
- Inserting f and t, platform faces the trade-off t and ξ_l

$$\Pi_c = \max_{\xi_l\in[\underline{\xi},\bar{\xi}]} \int_{\xi_l}^{\bar{\xi}} \left(\underbrace{\left(1 - \frac{c}{\pi_c(\xi_l)}\right)}_{\equiv t}\pi_c(\xi) - \phi\right) dG(\xi)$$

Money Entry

- The platform's problem:

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

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

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

Lemma. Under money-entry, platform profits are maximized by $\hat{\xi} = \bar{\xi}$ iff $i \leq i_1$.

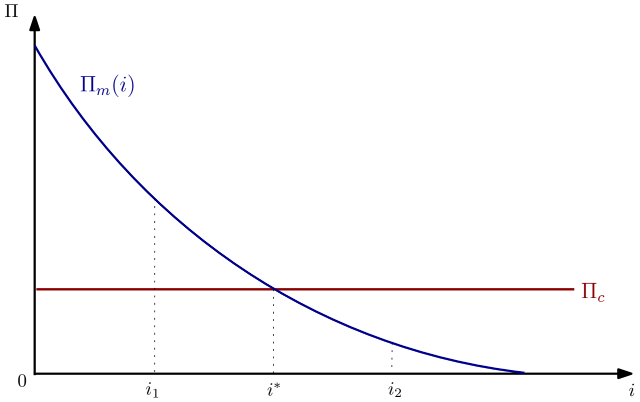
- $\hat{\xi} = \bar{\xi}$: pure monetary payment
- $i \leq i_1$: monetary payment gives higher surplus than credit payment for all ξ

Lemma. $\Pi_m(i)$ decreases in i with

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

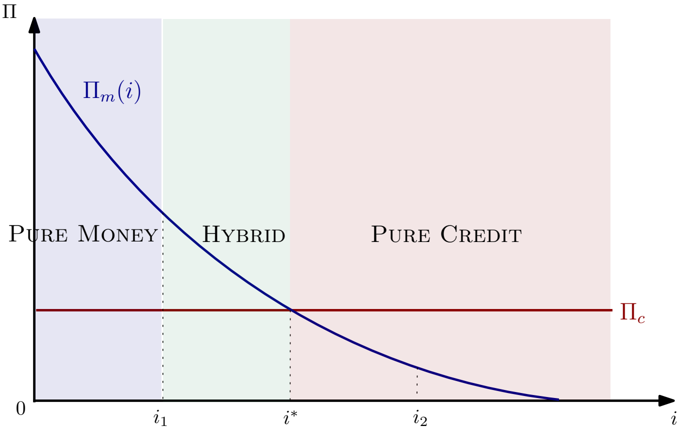
Platform profit-maximization

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



Payment mode

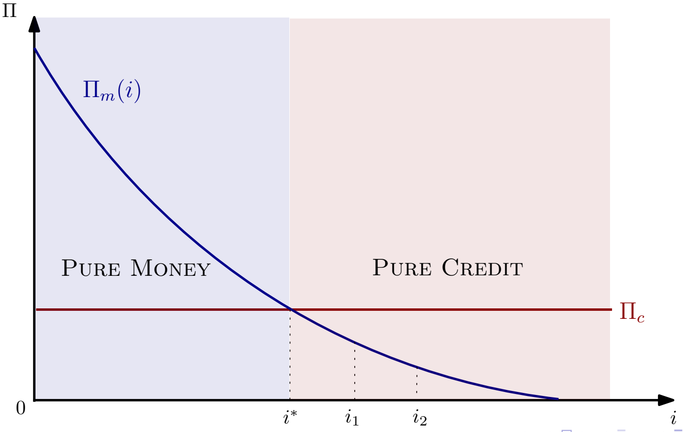
Proposition. $\exists! i^* \in (0, i_2]$ such that $\Pi_m(i^*) = \Pi_c$.



A case that credit-entry is profitable but suboptimal

Corollary. $\exists \bar{\phi} > 0$ such that 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:

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

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

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

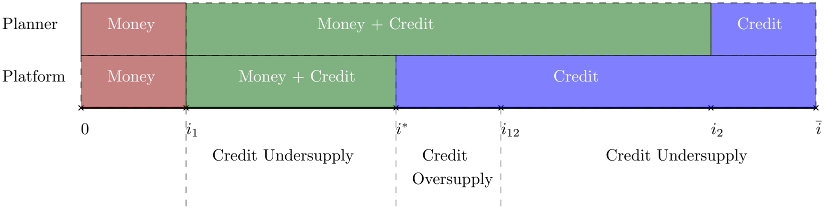
  - Platform extracts a higher share of surplus at the expense of credit provision cost ϕ

3. Distortions

Distortions on two margins

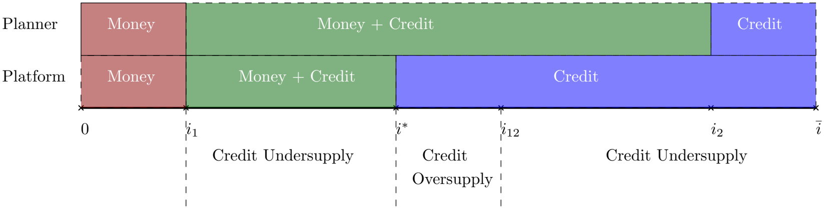
1. Entry margin: efficiency requires $\xi_I = \underline{\xi}$
2. Credit adoption margin: efficiency requires $\phi = \Delta\pi(\hat{\xi}, i)$

- Under Money Entry, the two margins are separate
- Under Credit Entry, entry margin $=$ adoption margin
- Here focus on the case where hybrid payment is possible



Pure Monetary Payment

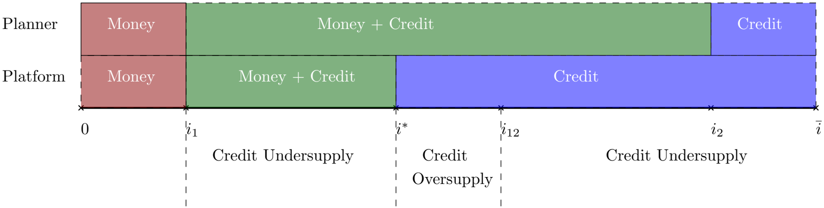
- insufficient entry of sellers $\xi_I > \underline{\xi}$



Hybrid Payment (Money + Credit)

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

- The platform charges f higher than socially optimal level $(1-t)\phi$, despite that f might be less than the cost $(f < \phi)$
- In other words, the platform subsidizes sellers, but not sufficiently

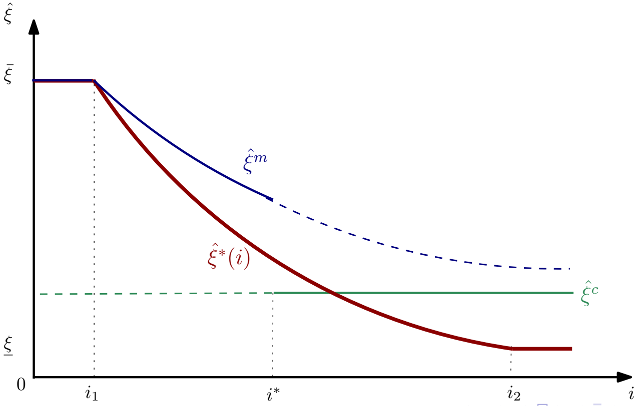


Pure Credit Payment

- The platform has different trade-offs from the planner's
  - 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: $\hat{\xi}^*(i)$ (efficiency), $\hat{\xi}^m$ (money-entry), $\hat{\xi}^c$ (credit-entry)
- Comparing $\hat{\xi}^m$ and $\hat{\xi}^c$ with $\hat{\xi}^*(i)$, we observe that as i increases, credit is initially undersupplied, then oversupplied, and eventually undersupplied



4. 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

$$\int_{\xi_l}^{\bar{\xi}} \Big(t\pi^c(\xi) + f - \phi \Big) dG(\xi),$$
$$\text{s.t.} \;\; (1-t)\pi^c(\xi_l) - f = c$$

- w/o restriction on t:

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

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

$$\max_{\xi_l \in [\underline{\xi}, \xi_l^{ub}]} \int_{\xi_l}^{\bar{\xi}} \Bigg(\bar{t}\pi_c(\xi) + \underbrace{(1-\bar{t})\pi_c(\xi_l) - c}_{f(\xi_l)} - \phi \Bigg) dG(\xi)$$

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

Jointly regulate (t, f)

- Suppose the planner can choose $t(\xi)$ and $f(\xi)$ dependent on ξ
- Many possibilities of $\{t(\xi), f(\xi)\}$ to achieve the second best
- Suppose $\hat{\xi}^*(i) \in (\underline{\xi}, \overline{\xi})$

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- Suppose $\hat{\xi}^*(i) \in (\underline{\xi}, \overline{\xi})$
- All surplus goes to the platform:

	$t(\xi)$	$f(\xi)$
$\xi \in [\underline{\xi}, \hat{\xi}^*)$	$1 - \frac{c}{\pi_m(\xi)}$	0
$\xi \in [\hat{\xi}^*, \overline{\xi}]$	1	$-c$

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$\xi \in [\hat{\xi}^*, \overline{\xi}]$	1	$-c$

- All surplus goes to the sellers:

	$t(\xi)$	$f(\xi)$
$\xi \in [\underline{\xi}, \hat{\xi}^*)$	0	0
$\xi \in [\hat{\xi}^*, \overline{\xi}]$	0	ϕ

Jointly regulate (t, f) (cont.)

- The same participation and credit adoption can be achieved even with uniform (t, f) across sellers
- The social planner's problem

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

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

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

$$\text{(1) upper bound for } t\text{: } t\leq 1-\frac{c}{\pi_m(\underline{\xi},i)}$$

$$\text{(2) link } f \text{ to } t \text{ and } \phi\text{: } f=(1-t)\phi$$

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

Jointly regulate (t, f) (cont.)

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

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

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

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

5. Discussions

a. Alternative Microfoundation

- Buyers demand each good independently.
- At each seller, buyers match with probability ξ, draw $u \sim U[0,1]$ if matched.
- Seller's profit under credit:

$$\pi_c(\xi) = \max_p \ \xi p(1-p), \quad \text{s.t.} \quad \xi \, \mathbb{E}[u - p \mid u > p] \geq k.$$

- Seller's profit under money:

$$\pi_m(\xi, i) = \max_p \ \xi p(1-p), \quad \text{s.t.} \quad \xi \mathbb{E}[u - p \mid u > p] - ip \geq k.$$

Proposition. If $k > \bar{\xi}/4$ (binding participation constraint), then $\Delta\pi(\xi, i) = \pi_c(\xi) - \pi_m(\xi, i)$ increases in ξ and i.

- Given that u follows a uniform dist., $\mathbb{E}[u|u > p] - p = \frac{1-p}{2}$.
- Under credit, participation constraint: $p \leq 1 - \frac{2k}{\xi}$. Then:

$$\pi_c(\xi) = \frac{(\xi - 2k)2k}{\xi}.$$

- Under money, participation constraint: $p \leq \frac{\xi - 2k}{\xi + 2i}$. Then:

$$\pi_m(\xi, i) = \frac{\xi}{(\xi + 2i)^2}(\xi - 2k)(2i + 2k).$$

- Taking logs and then difference gives:

$$\Delta \log \pi \equiv \log \pi_c - \log \pi_m = \log 2k - 2 \log \xi - \log(2i + 2k) + 2 \log(\xi + 2i).$$

- Then

$$\frac{\partial \Delta \log \pi}{\partial \xi} = \frac{4i}{\xi(\xi + 2i)} > 0.$$

b. 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

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

which ensures higher ξ sellers have higher incentives to adopt credit.

- A sufficient condition for this is that $\pi_m(\xi, i)$ is log-submodular:

$$\frac{\Delta\pi(\xi, i)}{\pi_c(\xi)} \approx -\frac{\partial \log \pi^m(\xi, i)}{\partial i} \Rightarrow \frac{\partial^2 \log \pi^m(\xi, i)}{\partial i \partial \xi} < 0.$$

Our results continue to hold.

- Social planner solution requires

$$f = (1 - t)\phi.$$

- $\exists! i^* \in (0, i_2]$, $\Pi_m(i^*) = \Pi_c$. And $\exists \bar{\phi} > 0$. If $\phi < \bar{\phi}$, then $i^* < i_1$.
- Under hybrid payment, credit provision is always too low compared to the efficient level.
- Under pure credit payment, credit provision can be too high or too low compared to the efficient level.

c. Third-party (3P) credit providers

- Assume a third-party creditor offers credit to buyers at price ϕ_3 (paid by sellers).

lemma If $\phi_3 \geq \phi$, then platform profit-maximizing requires inactive 3P credit.

3P credit is equivalent to setting $f = \phi_3$, which generally does not maximize profit.

- If $\phi_3 < \phi$, the platform may opt for 3P credit ($f > \phi_3$) in money-entry or/and credit-entry mode.
- It continues to hold: Under money entry, credit is undersupplied, while under credit entry, it may be under- or oversupplied.

d. Spinning credit provision off from the platform

- Suppose the platform's credit sector is separated and competes with third-party providers à la Bertrand, then $f = \phi$.
- PLATFORM suffers but the impact on WELFARE is ambiguous.
- f is not subsidized anymore, the credit usage is even lower
- The platform has a lower incentive to increase t, because increasing t extracts lower surplus from a smaller credit sector, $t \int_{\hat{\xi}}^{\bar{\xi}} \Delta\pi(\xi, i) dG(\xi)$. Therefore, the entry margin is improved.

Takeaways

- A microfoundation of payment:

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

- The monopolist platform may provide too much or too little credit compared to the planner's solution (non-monotonic with nominal interest rate)

- Platform regulation effectiveness (e.g., caps on t and f) depends on monetary policy (long-run inflation target i)

- To ensure efficient credit provision, brokerage and credit provision should be jointly regulated with $f = (1 - t)\phi$

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