The Implementation of Buy-Online-and-Pick- up-in-Store (BOPS)

第六組
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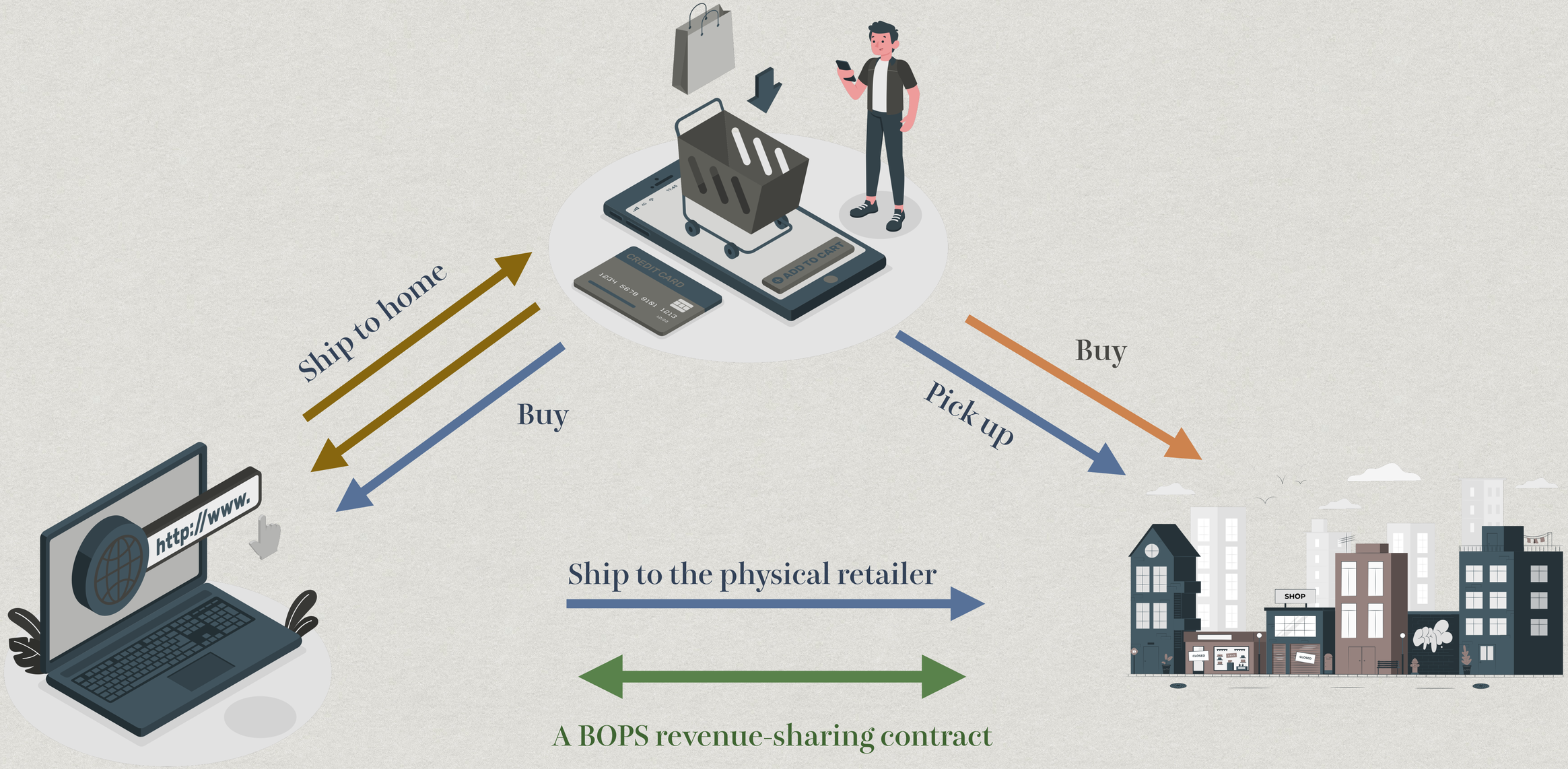
Ship to home

Buy

Buy

An online retailer

A physical retailer



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Agenda

01. Literature Review

02. Model

03. Analysis

01. Literature Review

1. FIRST empirical study: Gallino & Moreno 2014
2. FIRST modeling study: Gao & Su 2017

- Cross-selling effect: Gallino & Moreno 2014, Gao & Su 2017
- Inconsistent pricing strategy: Konga et al. 2020
- Online and offline retailers under the BOPS mode: Chen et al. 2016
- BOPS with revenue-sharing : Saha & Bhattacharya 2020

02. Model

Online Retailer

Physical Retailer

Customers

Profit with or without BOPS

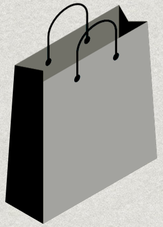
Without BOPS

$$\pi_o^N = \mathbb{E}[D_o](p_o - w_o + \gamma_o)$$

With BOPS

$$\pi_o^B = \mathbb{E}[D_o](p_o - w_o + \gamma_o) + \mathbb{E}[D_b][(1-\alpha)p_o - w_o]$$

An online retailer



Earn from selling the product

- p_o : unit selling price
- w_o : unit cost (exogenous)

Earn from the shipping-to-home service

- γ_o : online shipping fee (exogenous)

Provide a BOPS contract to share revenue with the physical retailer

- $\{1-\alpha, \alpha\}$: BOPS revenue-sharing contract

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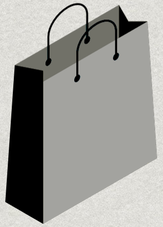

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A physical retailer

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Earn from cross-selling

- b : cross-selling profit margin (exogenous, different across physical retailers)

Earn from providing BOPS service

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Three shopping methods

1. Buy from the physical retailer

$$u_s = v - k_s - p_s \,.$$

2. Buy online and choose to ship to home

$$u_o = v - k_o - p_o + \delta - \gamma_o \,.$$

3. Buy online and pick up at the physical retailers store

$$u_b = v - k_s - p_o + \delta - \gamma_b \,.$$

Customers

All of them have the same value on the product v

Inconvenience level of shipping to home

$k_o \in \{k_{oL}, k_{oH}\}$

Inconvenience level of heading to a physical store

$k_s \in \{k_{sL}, k_{sH}\}$

Extra preference for online shopping

$\delta \in [-0.5, 0.5]$

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Timeline

1. The online retailer offers a BOPS revenue-sharing contract $\{1-\alpha, \alpha\}$.
2. The physical retailer chooses whether to accept it or not.
3. The online retailer and physical retailer sets price p_s, p_o at the same time.
4. Given available shopping methods, each customer chooses the optimal one.

03. Analysis

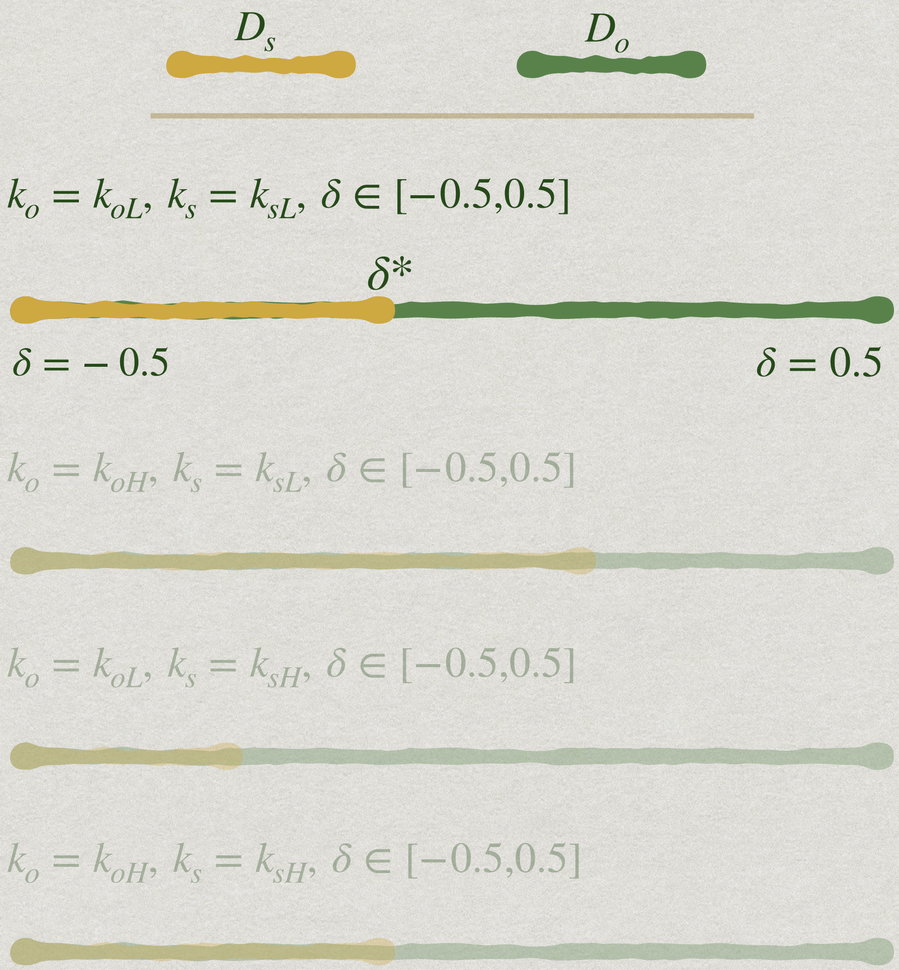
Without BOPS

With BOPS

Revenue-sharing Contract

Observations from numerical study

Without BOPS



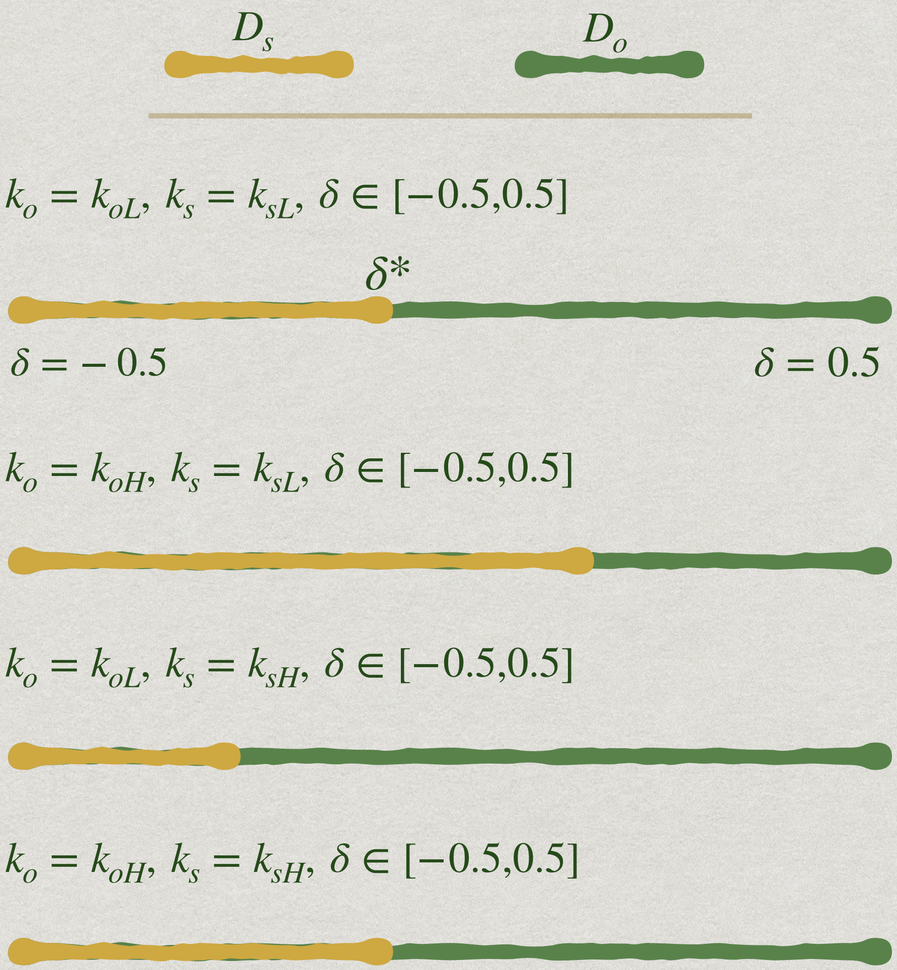
- Suppose v is sufficiently large
- There are four subgroups of customers with the same size
- A customer buys from online if $u_o \geq u_s$

$$v - k_o - p_o + \delta - \gamma_o \geq v - k_s - p_s$$

- Market demand is partitioned into two parts:

$$\delta \geq \delta^* = (k_o - k_s) + (p_o - p_s) + \gamma_o$$

Without BOPS



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- Let $\bar{k} = \frac{1}{2}(k_{oH} + k_{oL} - k_{sH} - k_{sL})$, the expected demand $\mathbb{E}[D_s]$ is $\frac{1}{2} - p_o + p_s - \gamma_o - \bar{k}$

Without BOPS

- Maximization problems:

$$\max_{p_s} \pi_s^N = \mathbb{E}[D_s](p_s - w_s + b) \qquad \max_{p_O} \pi_o^N = \mathbb{E}[D_o](p_o - w_o + \gamma_o)$$

- Optimal prices:

$$\begin{cases} p_s^{N*} = \frac{1}{2} + \frac{2}{3}w_s + \frac{1}{3}w_o - \frac{2}{3}b + \frac{1}{3}\bar{k} \\ p_o^{N*} = \frac{1}{2} + \frac{1}{3}w_s + \frac{2}{3}w_o - \gamma_o - \frac{1}{3}b - \frac{1}{3}\bar{k} \end{cases}$$

- Profits:

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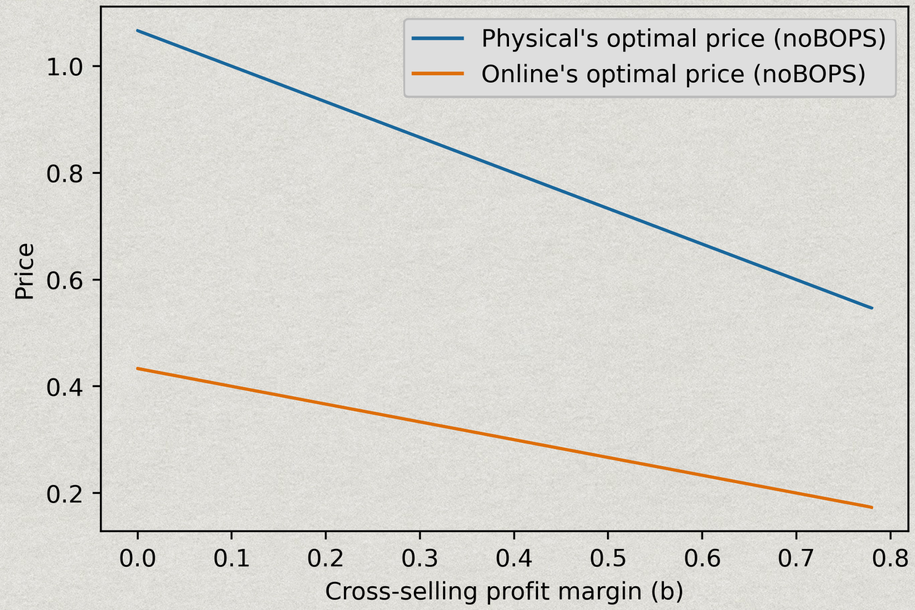

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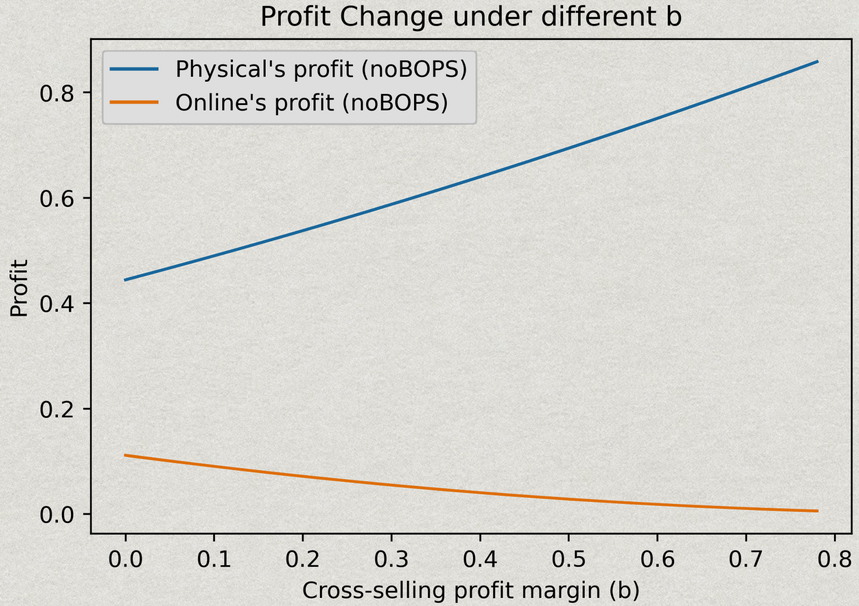
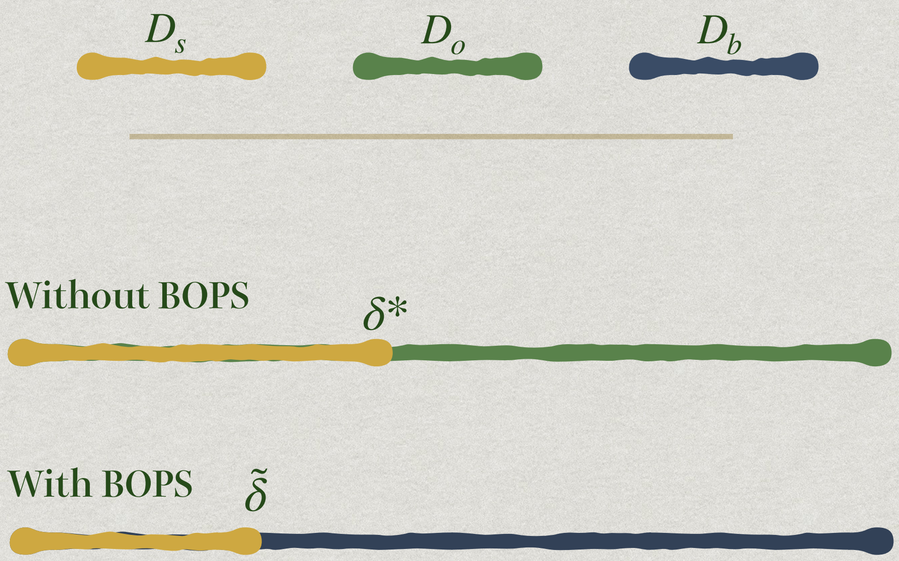


With BOPS



$$D_b = \frac{1}{2} - p_o + p_s - \gamma_b$$

$$D_s = \frac{1}{2} + p_o - p_s + \gamma_b$$

- Suppose $k_{oH} > k_{oL} > k_{sH} > k_{sL} \implies \bar{k} \geq 0$
- Suppose $\gamma_o \geq \gamma_b$
- An original physical-retail-buyer will turn to BOPS if $u_b \geq u_s$

$$\delta \geq p_o - p_s + \gamma_b \equiv \tilde{\delta}$$

- An original online-retail-buyer will turn to BOPS if $u_b \geq u_o$

$$(k_o - k_s) + (\gamma_o - \gamma_b) \geq 0$$

- All original online-retail-buyers will turn to BOPS

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$$\begin{cases} p_s^{B*} = \frac{1}{3-\alpha}[\frac{3+\alpha}{2} + (3-\alpha)\gamma_b + \frac{1+\alpha}{1-\alpha}w_o + 2w_s] \\ p_o^{B*} = \frac{1}{3-\alpha}[\frac{3}{2} + \frac{2}{1-\alpha}w_o + w_s] \end{cases}$$

- **Profits:**

Denote $\eta = \frac{3}{2} - w_o + w_s$

$$\begin{cases} \pi_s^{B*} = \gamma_b + b + (\frac{1}{3}\eta + \frac{1}{2})^2 + \frac{3}{4} - \eta \\ \pi_o^{B*} = \frac{1}{9}\eta^2 \end{cases}$$

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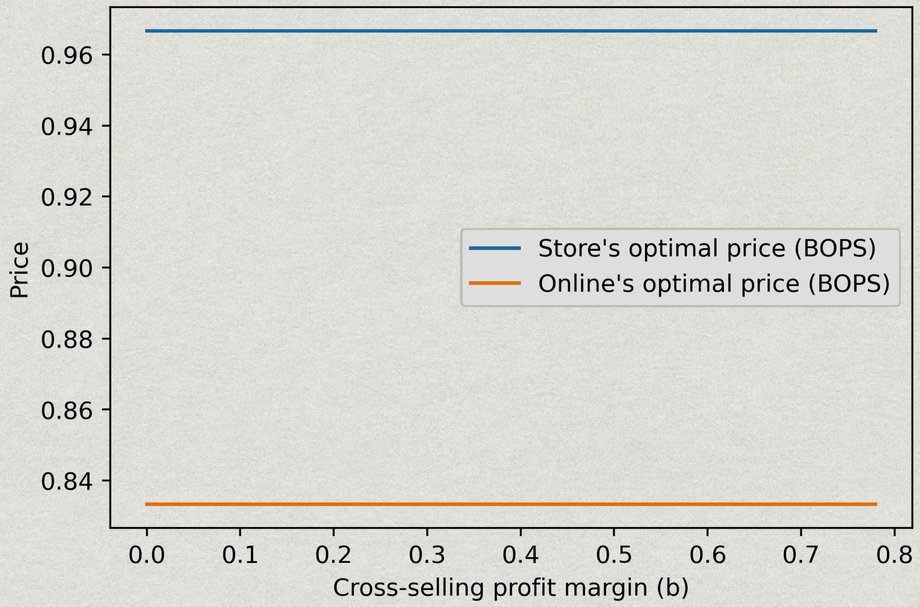
A larger b will no longer cause price competition



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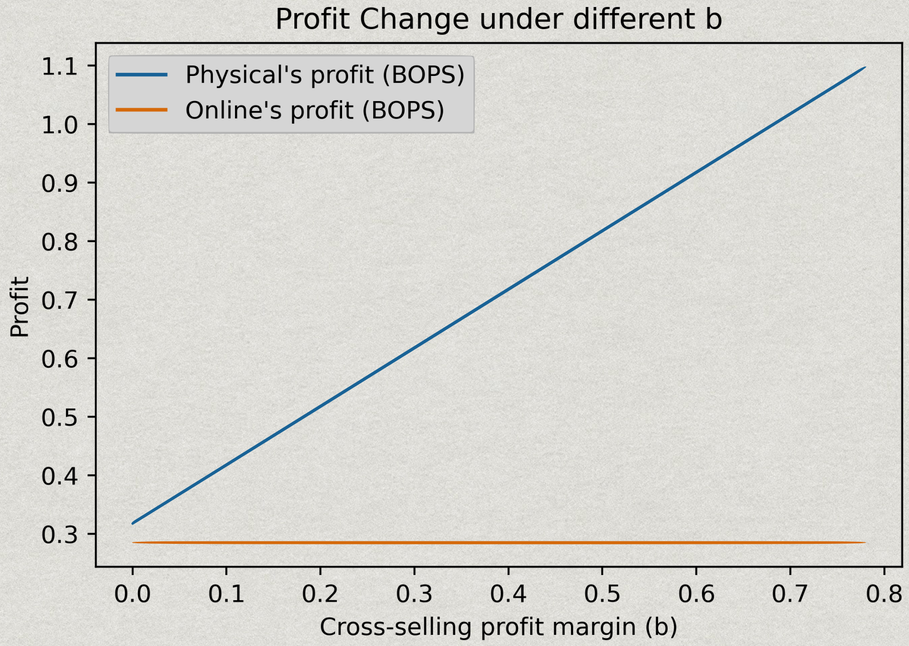

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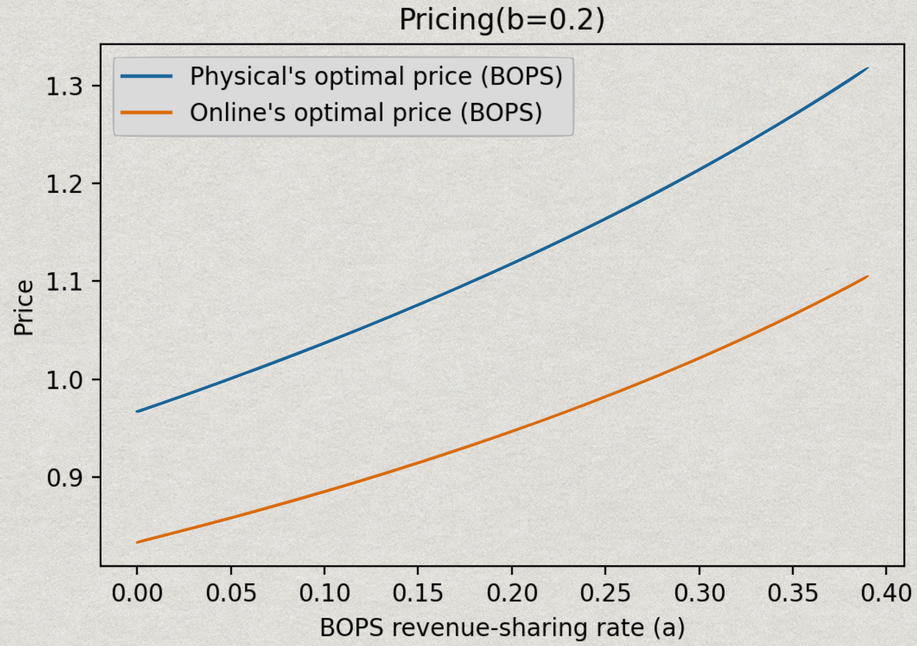


Revenue-sharing Contract

Why BOPS works, consider $\alpha = 0$

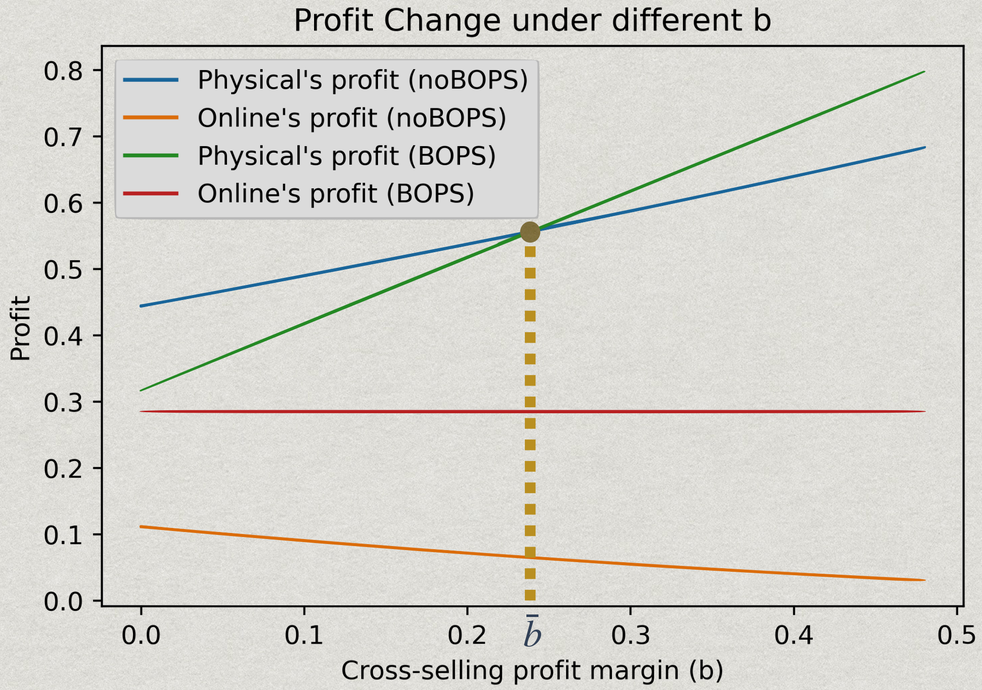
- As our assumption, $b, \bar{k} \geq 0 \implies \pi_o^{B*} \geq \pi_o^{N*}$.
- $\pi_s^{B*} \geq \pi_s^{N*}$ when

  $$b \geq \eta - \bar{k} + \frac{3}{2} - \frac{1}{2}\sqrt{(2\eta+3)^2 + 36(\gamma_b - \bar{k})} \equiv \bar{b}$$

- There possibly exists a $\bar{b}$,

  s.t. $\forall b \geq \bar{b},\ \pi_s^{B*} \geq \pi_s^{N*}$

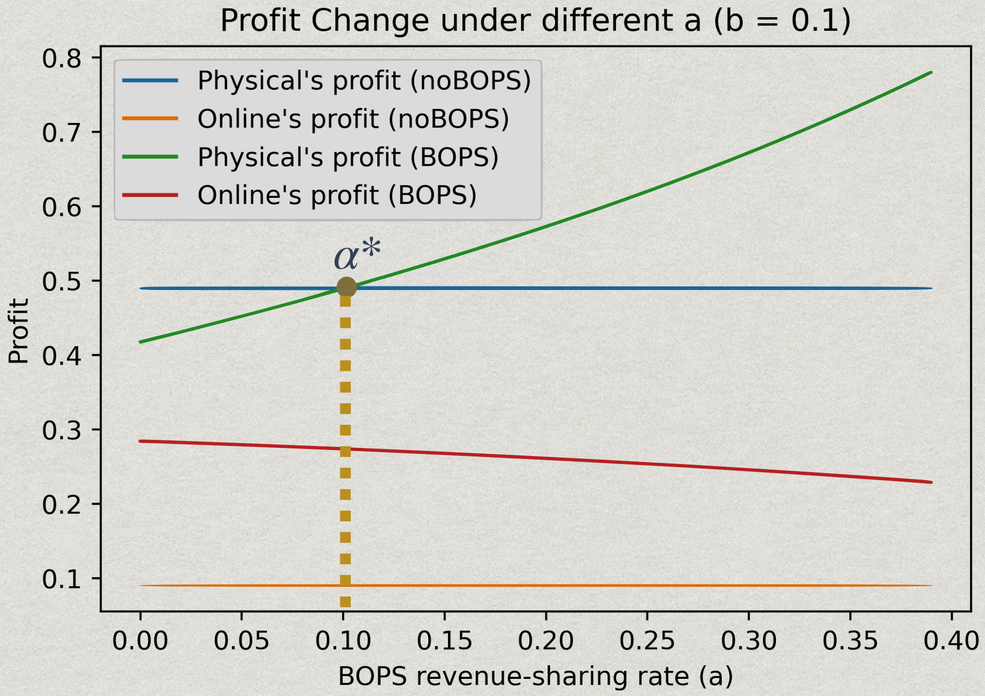
- Under the parameter setting, $\bar{b} = 0.24$ here.



Revenue-sharing Contract

Why the contract helps?

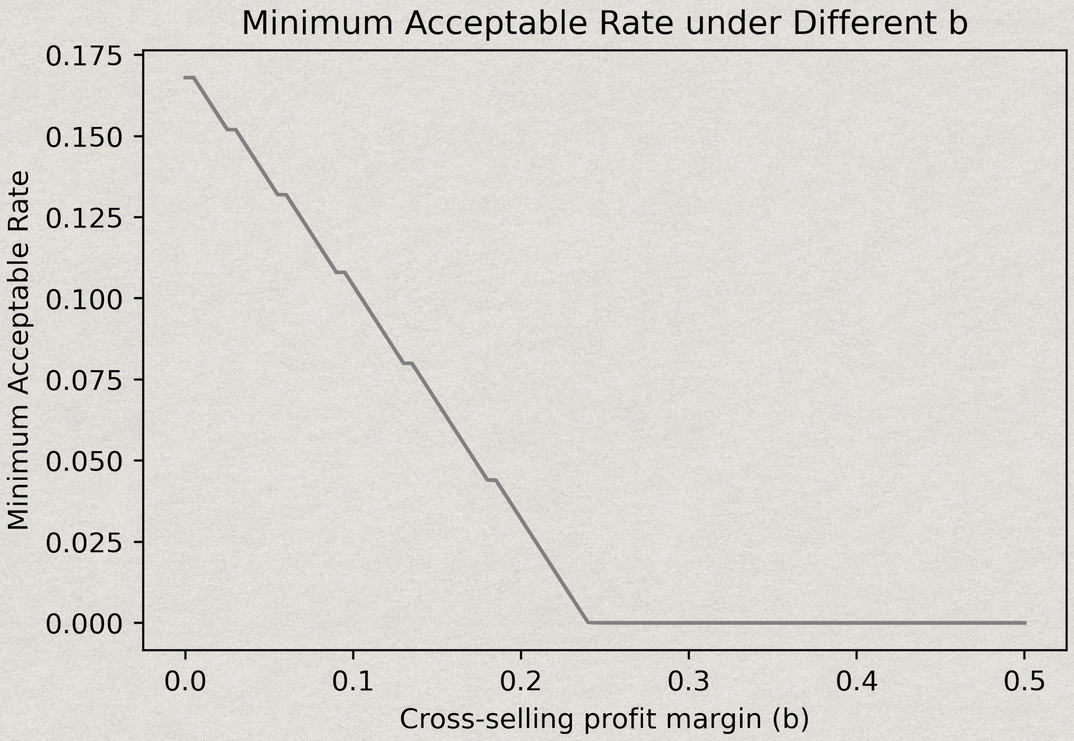
- For physical retailers whose $b < \bar{b}$, the physical retailer is not better off after BOPS.
- The online retailer still has strong incentives to adopt BOPS.
- The revenue-sharing contract $\{1-\alpha, \alpha\}$ helps!
- When $b = 0.1$, the minimum acceptable revenue-sharing rate α^* is 10.1%.
- A contract is successfully signed if α is affordable for the online retailer, he would not make himself worse-off by a contract.



Observations from Numerical Study

Minimum Acceptable Rate (α^*)

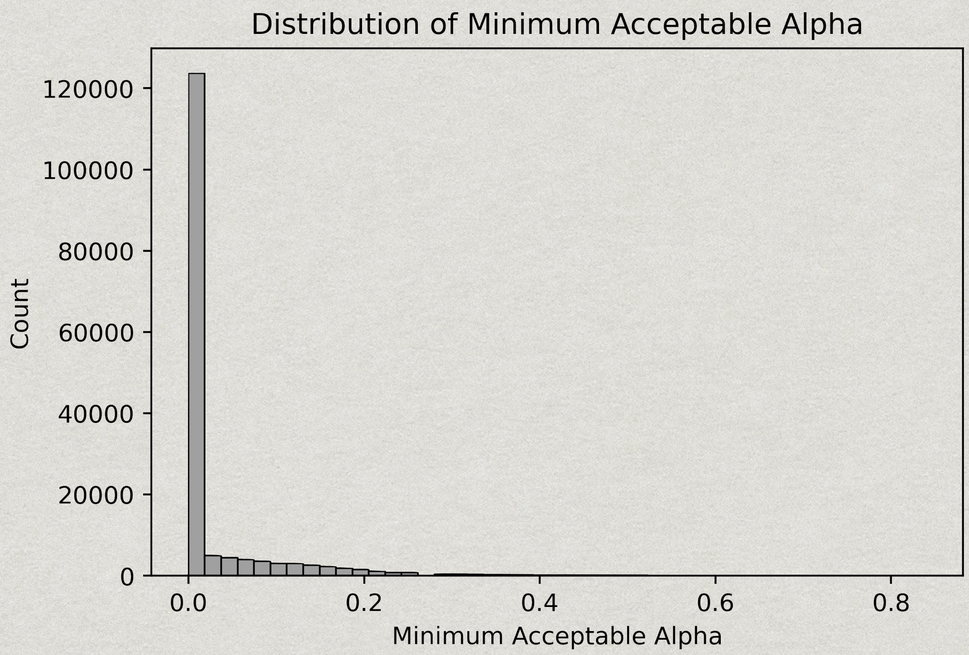
- The graph shows the corresponding minimum acceptable rate (α^*) under different cross-selling b .



Observations from Numerical Study

Will BOPS universally work ?

- One might argue that BOPS will only be implementable under certain parameter tricks.
- We consider all combinations of $\{w_o, w_s, \gamma_o, \gamma_b, \bar{k}\}$ that satisfy our assumption, $(k_{oL} - k_{sH}) + (\gamma_o - \gamma_b) \geq 0$.
- The numerical study shows that there must be a minimum acceptable rate α^* under each parameter setting.
- Besides, the online retailer is still better off after it shares α^* proportion of its revenue.



Conclusion

- BOPS benefits the online retailer
- The physical retailer might reject BOPS due to a low cross-selling profit margin b
- A revenue-sharing contract $\{1-\alpha, \alpha\}$ leads to a win-win situation.
- The minimum acceptable rate α^* is decreasing with cross-selling profit margin b

Q&A

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Research paper

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