Dynamic Platform Competition: Optimal Pricing and Piggybacking under Network Effects

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Platform Competition Getting Heated

Platform Strategies – Pricing Controls: Freemium

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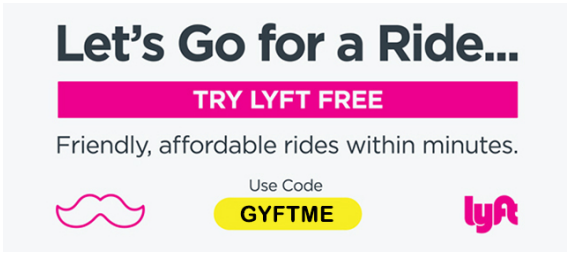

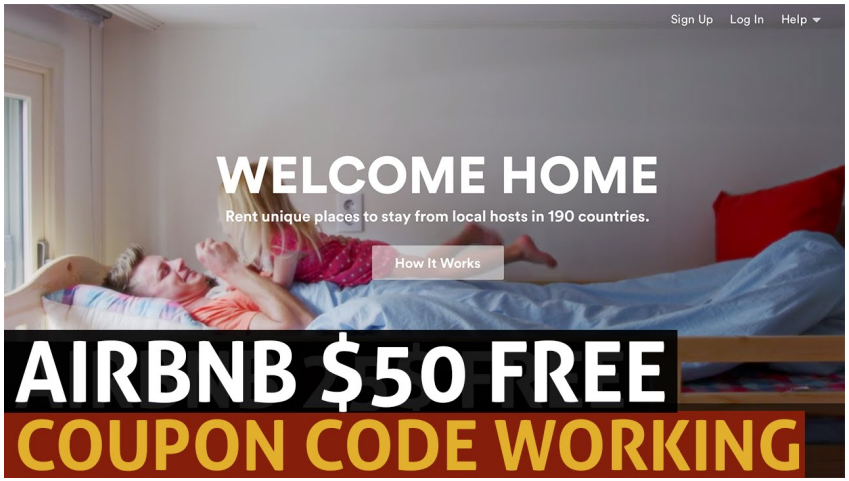

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Platform Strategies – Non-Pricing Controls: Piggybacking

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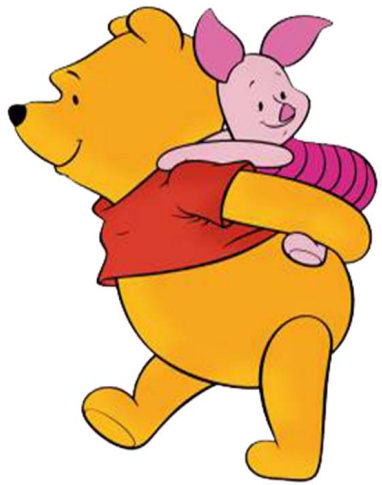

Piggybacking - Importing Adopters from A Different Platform

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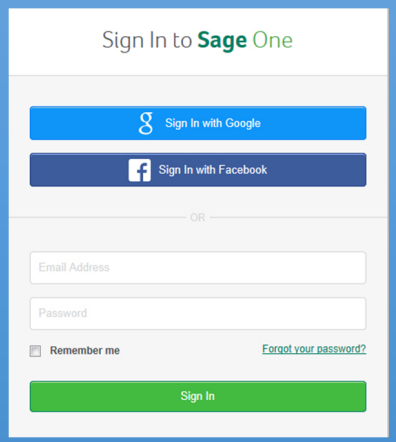
Shared Access



Embedding in A Bigger Platform	Strategic Poaching	Business Model Transformation

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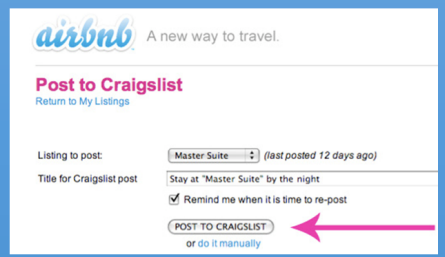

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Business Model Transformation

Our Research Questions

In platform competition with network effects:

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  - Complementary or substitutable between offering lower discount and importing external traffic?

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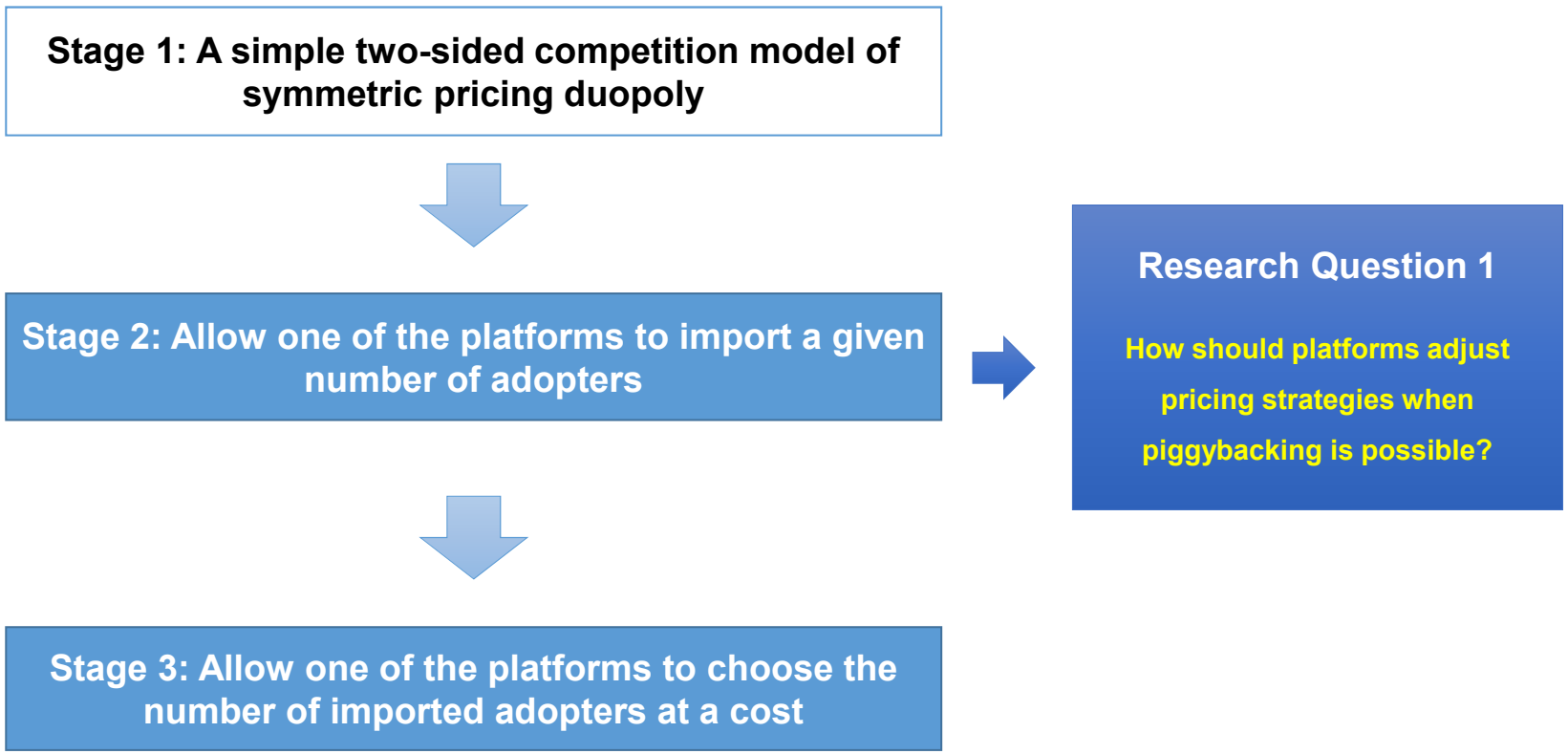

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Stage 1: A simple two-sided competition model of symmetric pricing duopoly

Stage 2: Allow one of the platforms to import a given number of adopters

Stage 3: Allow one of the platforms to choose the number of imported adopters at a cost

Research Question 1

How should platforms adjust pricing strategies when piggybacking is possible?

Research Question 2

What are the optimal piggybacking/Pricing Strategies?

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  - integrating user base with a complementary platform (Li and Agarwal 2016)
- This paper is the first attempt to explore piggyback strategy analytically under a multi-period and competitive setting

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- Q_{ki}^c: The cumulative consumer demand for platform k in period i, i.e., $Q_{k2}^c = \delta q_{k1}^c + q_{k2}^c$

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- "Transportation" cost: t

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- Q_{ki}^{d}: The platform demand on the provider side for platform k in period i

Multi-homing Provider: The Competitive Bottleneck

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- α: the profit made by a provider on every consumer (i.e., provider-side network effects)

Further Assumption

$$(\alpha + \beta)^2 < 4t,$$

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- which ensures the platform owner's optimization problem is well-behaved
- Standard in literature: e.g., Armstrong (2006) imposes $(\alpha_1 + \alpha_2)^2 < 4t_1t_2$, Hagiu and Halaburda (2014) impose $\alpha + \beta < 2$, etc.

Platform Profit Functions

- Using backward induction, we solve period-2 competition pricing equilibrium first

$$\max_{p^c_{k2}, p^d_{k2}} \quad \pi_{k2}(p^c_{k2}, p^d_{k2} | Q^c_{k1}) = p^c_{k2} Q^c_{k2} + p^d_{k2} Q^d_{k2}$$

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- Then solve for the period-1 pricing equilibrium

$$\max_{p_{k1}^c, p_{k1}^d} \quad \pi_{k1} + \lambda \pi_{k2} = p_{k1}^c Q_{k1}^c + p_{k1}^d Q_{k1}^d + \lambda \pi_{k2}((p_{k2}^c)^*, (p_{k2}^d)^*)$$

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- $\lambda \in [0, 1]$: The discount factor

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Proposition 1

Under two-period symmetric duopoly, the optimal pricing strategies of platform $k \in \{A, B\}$ are given by

$$(p_{k1}^c)^* = t - \frac{\alpha(3\beta+\alpha)}{8} - \frac{t\delta(1+\delta)(16t-\alpha^2-6\alpha\beta-\beta^2)\lambda}{12t-\alpha^2-4\alpha\beta-\beta^2},$$

$$(p_{k1}^d)^* = \frac{\alpha-\beta}{8};$$

$$(p_{k2}^c)^* = (1+\delta)\left[t - \frac{\alpha(3\beta+\alpha)}{8}\right], \ (p_{k2}^d)^* = \frac{(\alpha-\beta)(1+\delta)}{8}.$$

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Under symmetric duopoly, the following statements hold true:

1. *There exists a threshold $\hat{\lambda}$ such that subsidizing consumers with a negative price becomes optimal when $\lambda > \hat{\lambda}$. The subsidizing strategy is not affected by λ in period 2;*
2. *It is optimal to subsidize providers if and only if $\alpha < \beta$.*

Calibrating the Baseline Model with Prior Literature

	Consumer (Single-homing)	Provider (Multi-homing)
Period 1	Subsidize	Not Subsidize

Armstrong (2006)
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	Consumer (Single-homing)	Provider (Multi-homing)
Period 1	α, β, λ	$\beta > \alpha$
Period 2	α, β	$\beta > \alpha$

Our two-period model
Subsidize early, Charge later on the single-homing side

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Stage 2: Allow One Platform to Import A Given Number of Consumers

- Platform A (called *rider*) is endowed with an initial installed base Q_0 on consumer side in the beginning of period 1

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\begin{aligned}
Q^c_{A1} &= Q_0 + q^c_{A1} = Q_0 + \rho\left[\frac{1}{2} + \frac{\beta(Q^d_{A1} - Q^d_{B1}) - \tilde{p}^c_{A1} + \tilde{p}^c_{B1}}{2t}\right] \\
Q^c_{B1} &= \rho - q^c_{A1}.
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- We are interested in the partial derivatives $\Delta_{ki}^c = \frac{\partial(\tilde{p}_{ki}^c)^*}{\partial Q_0}$ and $\Delta_{ki}^d = \frac{\partial(\tilde{p}_{ki}^d)^*}{\partial Q_0}$ which reflect the impacts of piggybacking on pricing strategies

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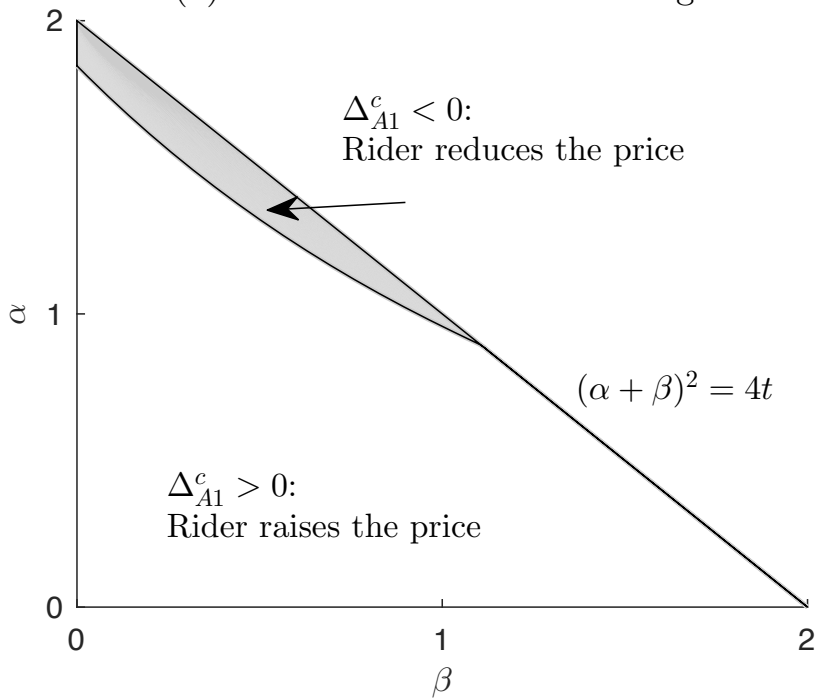
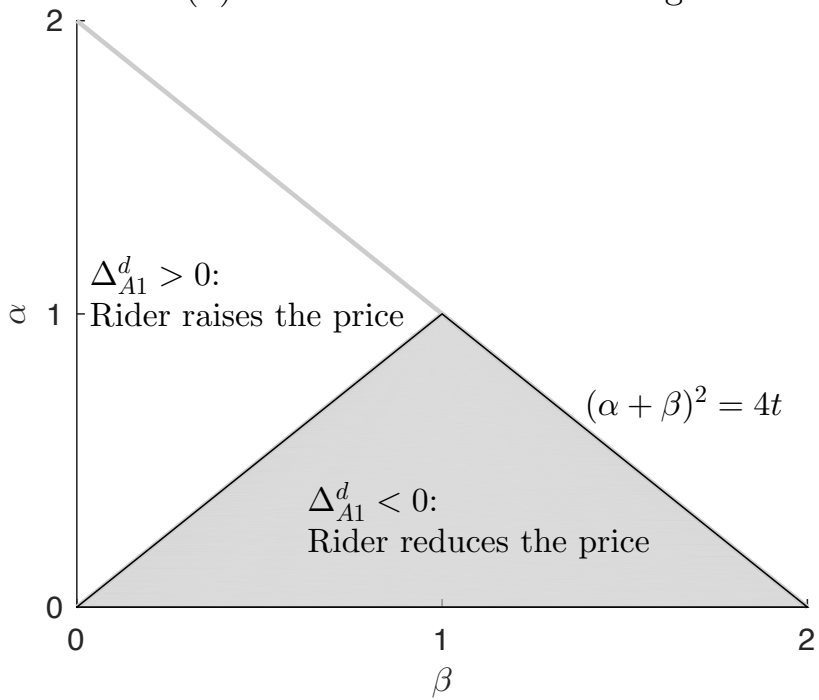
Pricing Impacts of Piggyback on Rider's Strategy in Period 1

(a). Consumer-side Price Change



(b). Provider-side Price Change



Pricing Impacts of Piggyback on Dummy's Strategy in Period 1

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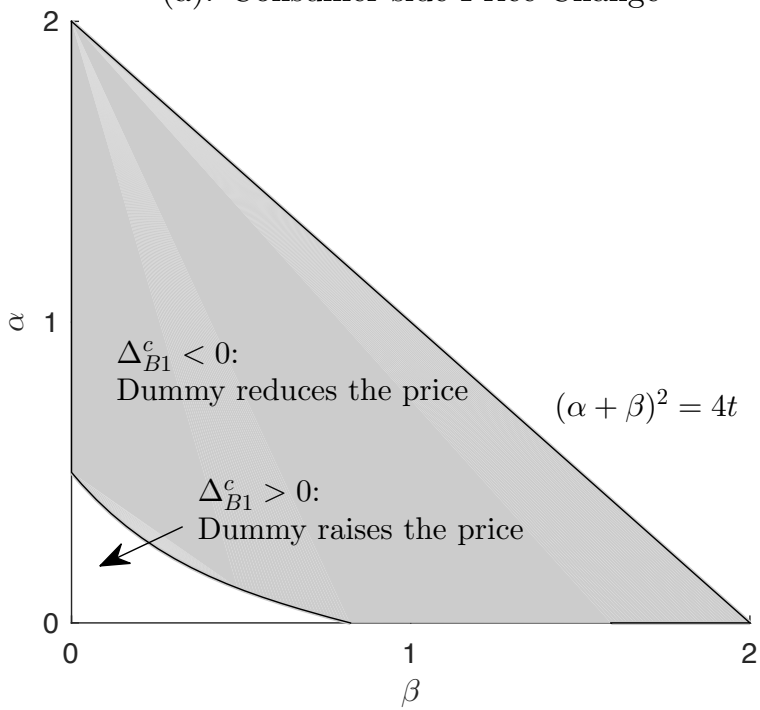

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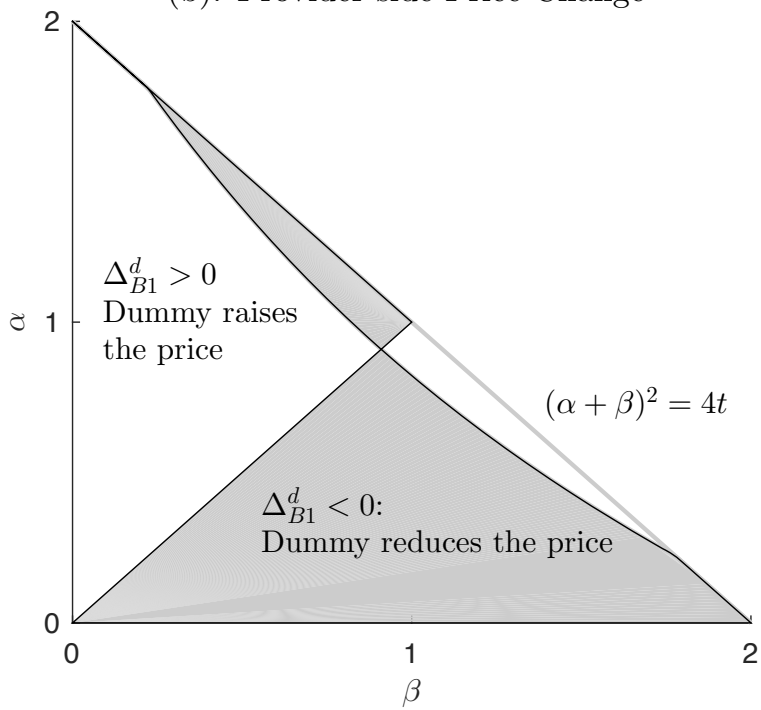
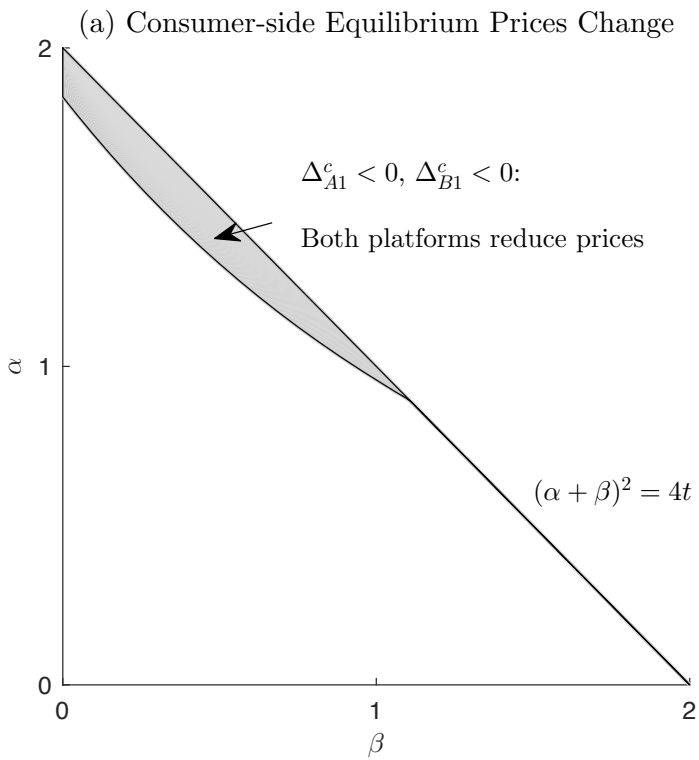
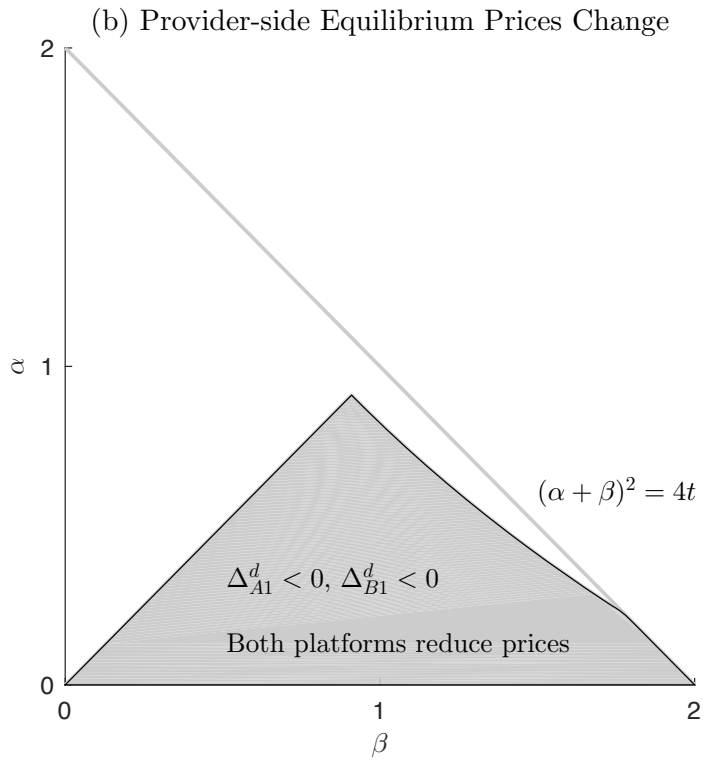


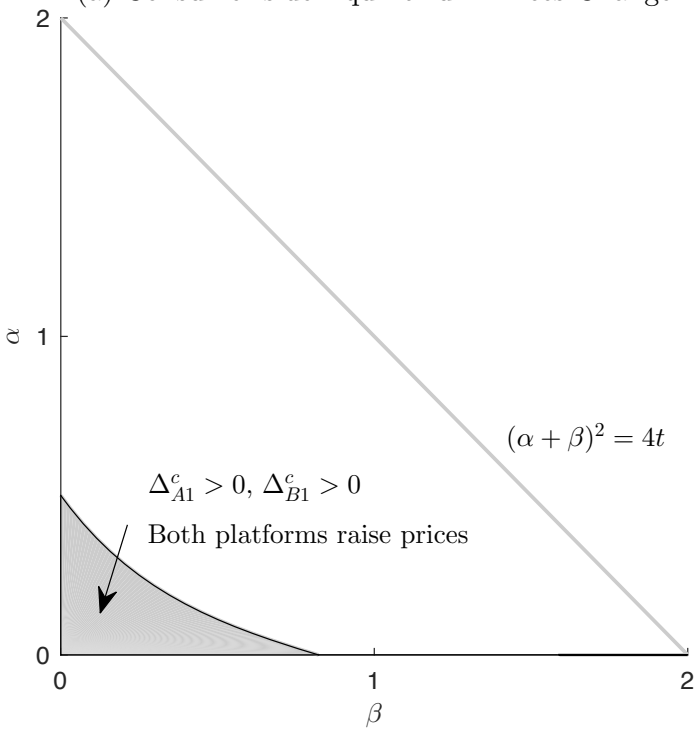
Pricing Impacts of Piggybacking - Both Platforms Lower Prices





Pricing Impacts of Piggybacking - Both Platforms Raise Prices

(a) Consumer-side Equilibrium Prices Change



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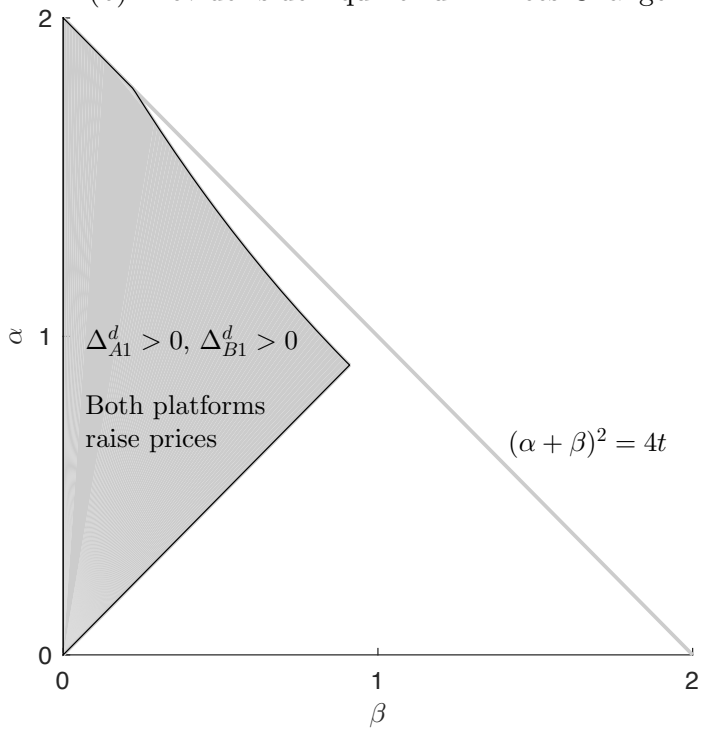

Summary - Exogenous Piggybacking

		Consumer Side	Provider Side
Period 1	Both raise prices	$\alpha >> \beta$	$\alpha < \beta$
	Both reduce prices	$\alpha \ll t, \beta \ll t$	$\alpha > \beta$
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Period 2	**Both raise prices**	**Never**	$\alpha < \beta$
	Both reduces prices	**All** $\{\alpha, \beta\}$	$\alpha > \beta$

The Logic Flow of The Research

Stage 1: A simple two-sided competition model of symmetric pricing duopoly

Stage 2: Allow one of the platforms to import a given number of adopters

Research Question 1

How should platforms adjust pricing strategies when piggybacking is possible?

Summary - Exogenous Piggybacking

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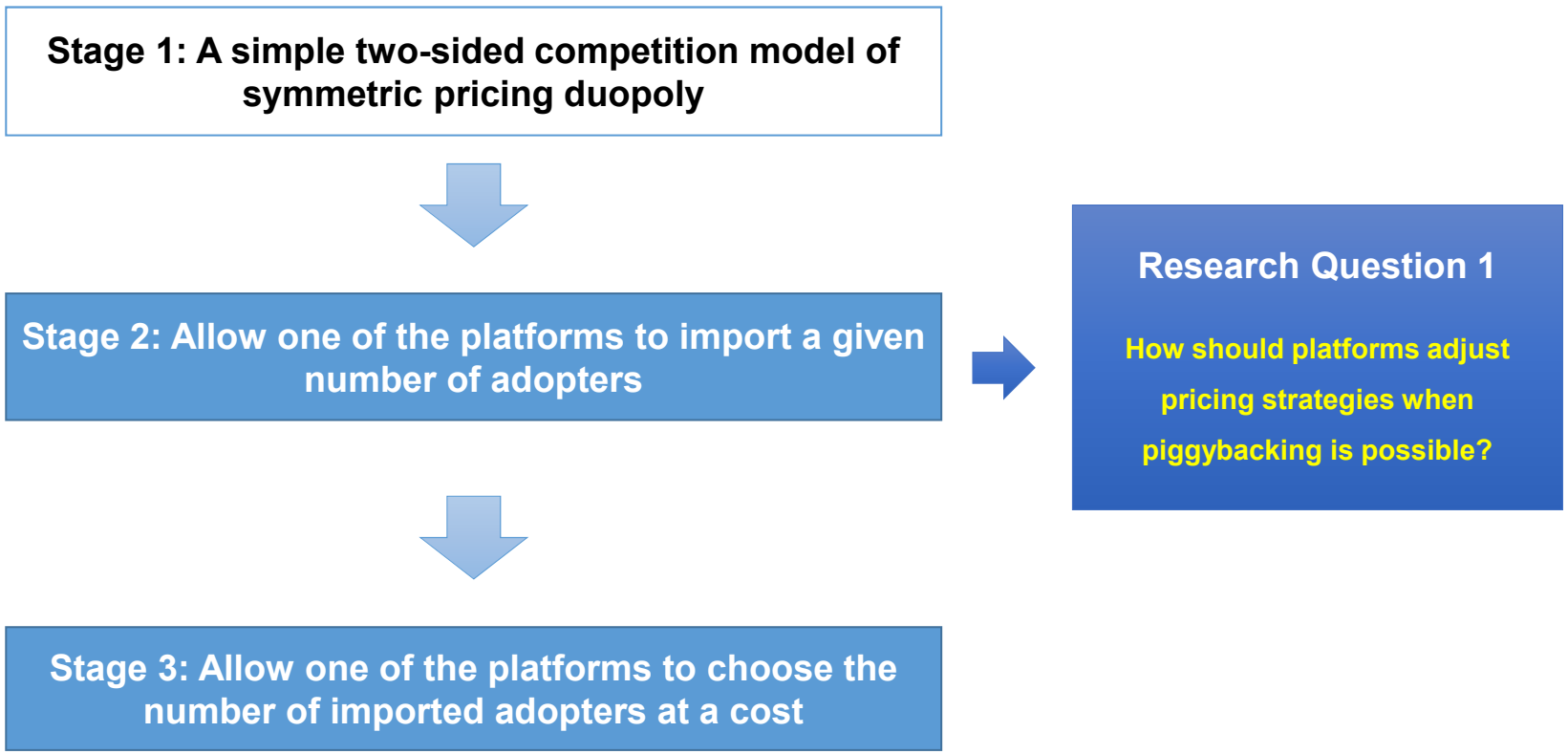
- It may lead symmetric platforms to concentrate on different sides of the markets
- In the long run (2nd period), the pricing competition becomes more intensified on the single-homing side

The Logic Flow of The Research



Stage 3: Endogenous Piggybacking

- When acquiring Q_0 is costly, we modify Rider's period 1 objective function

$$\max_{p^c_{A1}, p^d_{A1}, Q_0} \quad \Pi_{A1} = p^c_{A1} Q^c_{A1} + p^d_{A1} Q^d_{A1} - bQ_0^2 + \lambda \Pi^*_{A2},$$

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- bQ_0^2: the total investment for the acquisition of Q_0
- We are interested in the partial derivatives $\Delta^c_{ki} = \frac{\partial (\tilde{p}^c_{ki})^*}{\partial b}$ and $\Delta^d_{ki} = \frac{\partial (\tilde{p}^d_{ki})^*}{\partial b}$ which reflect the complementarity or substitutability between piggybacking and pricing strategies

Stage 3: Endogenous Piggybacking

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3. *On the provider side, they are always substitutable (i.e., $\frac{\partial(\tilde{p}_{Ai}^d)^*}{\partial b} < 0$) if and only if $\alpha > \beta$.*

Summary - Endogenous Piggybacking

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- Provider-side strategy (multi-homing): Platform should always offer a smaller discount to providers when more consumers are imported

The Logic Flow of The Research

Stage 1: A simple two-sided competition model of symmetric pricing duopoly

Stage 2: Allow one of the platforms to import a given number of adopters

Stage 3: Allow one of the platforms to choose the number of imported adopters at a cost

Research Question 1

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Research Question 2

What are the optimal piggybacking/Pricing Strategies?

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  - How to optimize pricing and piggybacking strategy in tandem
    - Import more, subsidize more

Thank You!

Q & A