Subscription Pricing and its Impact on Efficiency in Two-Sided Marketplaces

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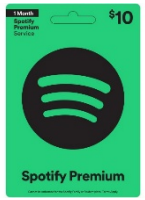
Big Picture: Advance Pricing vs Spot Pricing

- Two broad pricing paradigms in the service economy

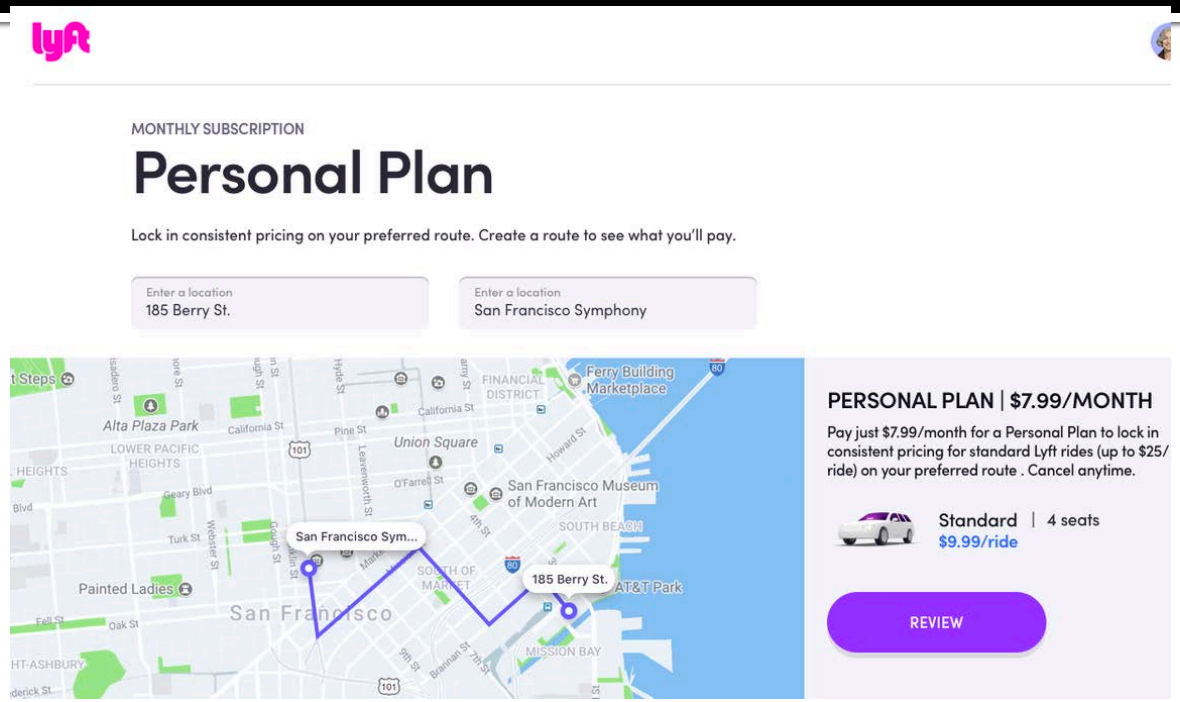


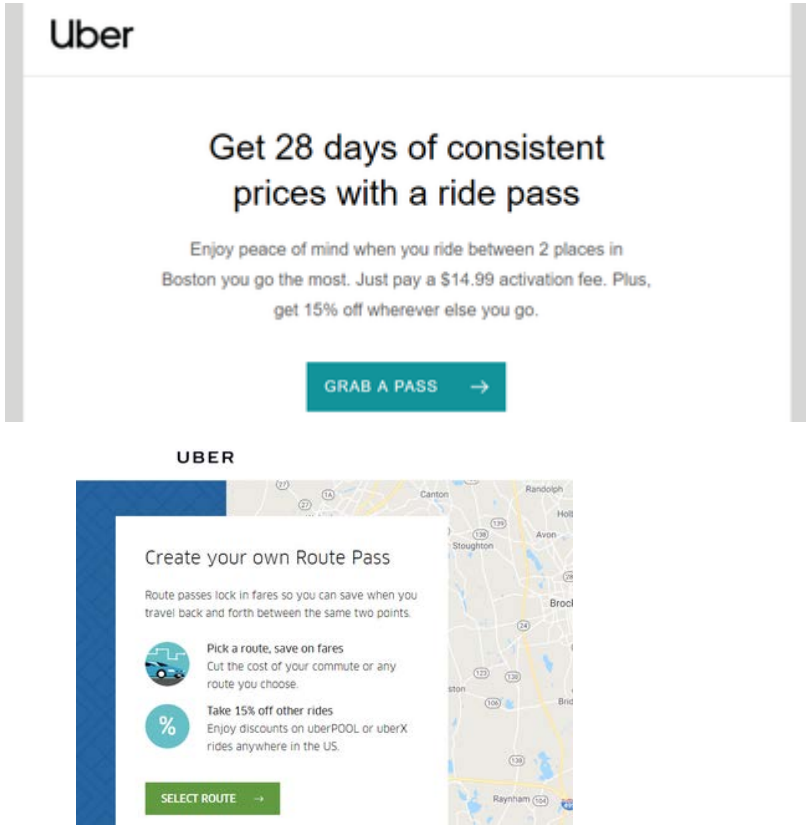
Advance Pricing (Before exact value is known)

On-Demand or Spot Pricing

Recent push in two-sided markets to integrate both advance and spot pricing

Examples: Subscription Schemes in Ride-Hailing

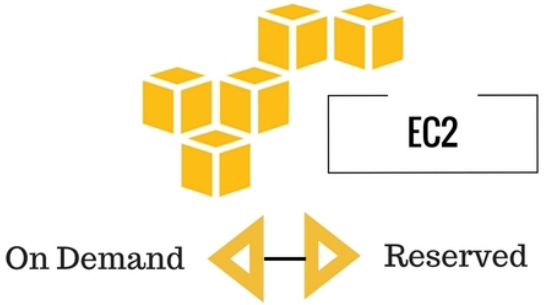




- At its core, subscription schemes require that you commit to rides (days) in advance at an upfront price
- Users can reject these subscription offers to request the service in the spot market → Both subscription and spot co-exist

Business Reasons for Subscriptions?

Interplay between subscription and on-demand can be found in other service industries



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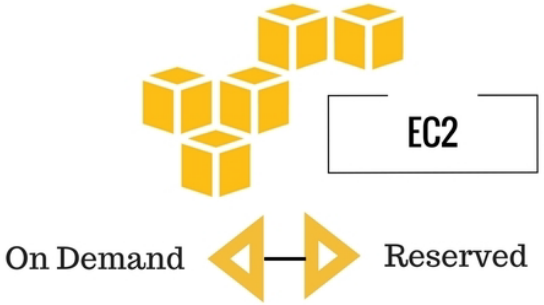

Why Platforms rely on subscriptions?

- Subscriptions allow platforms to lock-in users, reduce multi-homing
- Literature on sunk-cost effects when payment occurs before consumption
- Price reliability to buyer in the face of uncertainty but reduce future optionality

Subscription vs Spot in Two-Sided Markets

Two-sided markets

- Supply-side neither fixed nor unlimited
- Positive externalities due to network effects
- **Strategic users** on both sides of the market

Two-sided markets offer a unique setup to study effects of subscription vs spot

Subscription vs Spot in Two-Sided Markets

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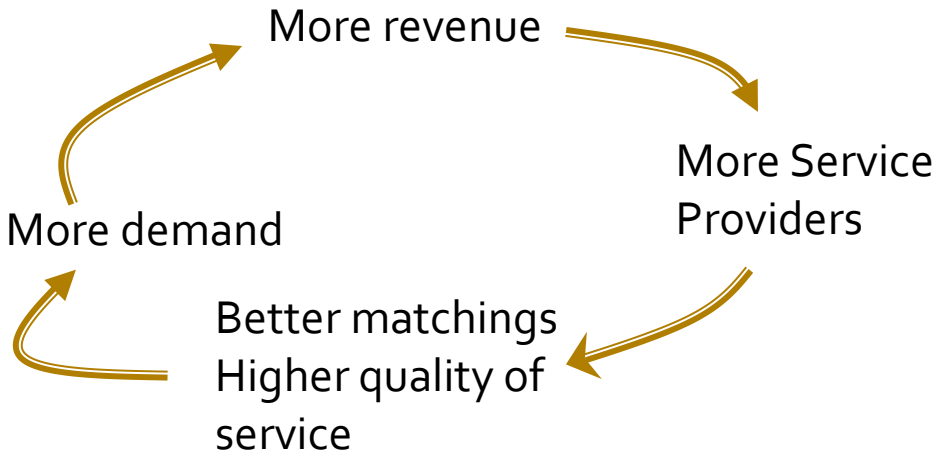
Subscribe or wait for spot?

Entry Decision:
Provide service or not?

User decisions under Subscription

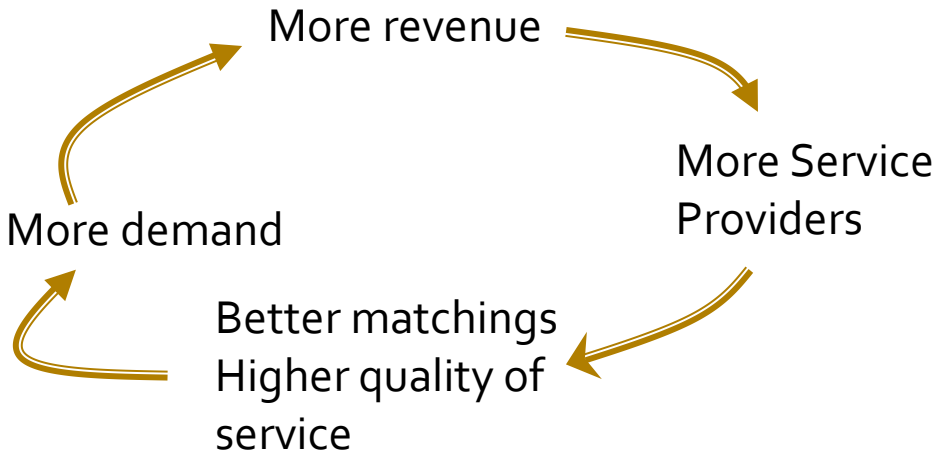
Value of subscription for users + interaction between subscription and spot less understood under these conditions

Research Question: Subscription in the time of network effects



- Subscriptions can increase volume of transactions in the market but this can be costly!

Research Question: Subscription in the time of network effects



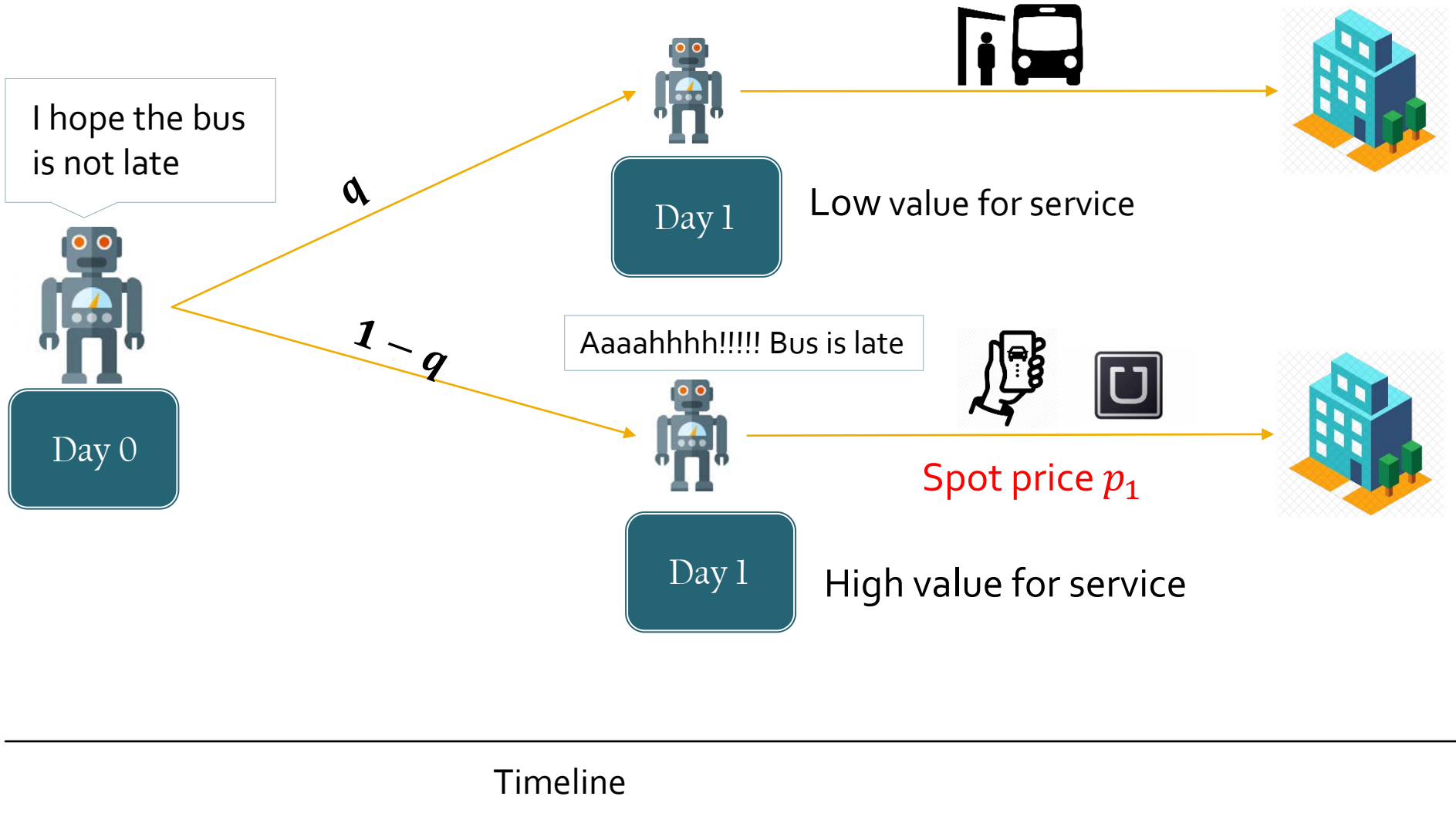
- Subscriptions can increase volume of transactions in the market but this can be costly!

Can subscriptions lead to more efficient outcomes in the market?

1) If so, why does this happen?
2) Under what conditions?

Foil: We expect spot market to be optimal since "market clearing" ➔ efficient allocation of resources?

Example: Subscription vs Spot in Ride-Sharing



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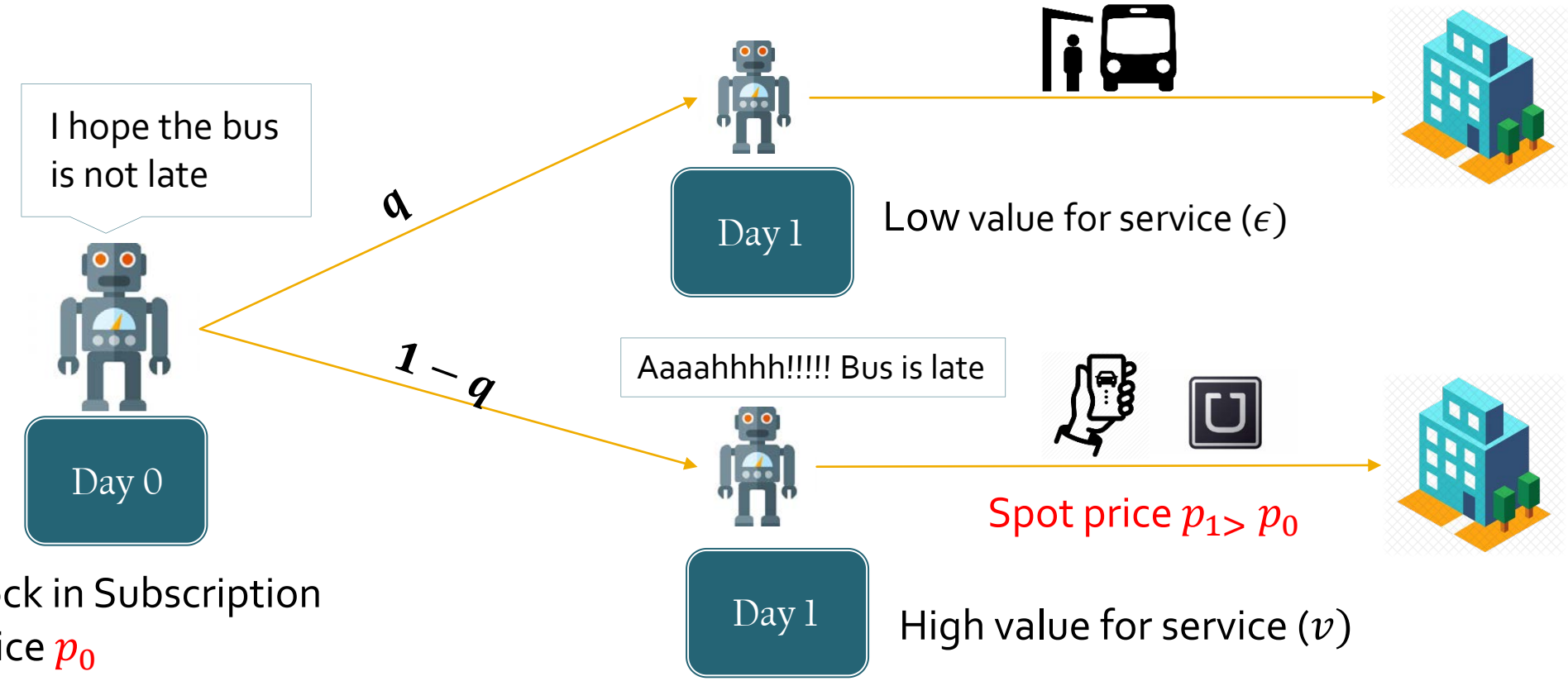


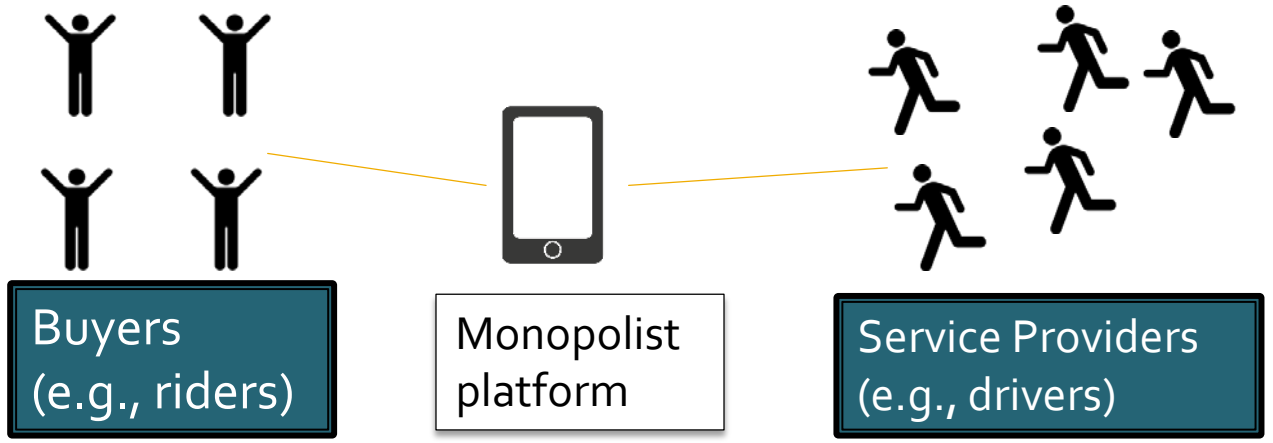
E[Utility] from subscription

E[Utility] from spot

$$v(1-q) - p_0 \geq (v - p_1)(1-q)$$

Basic Setup of Two-Sided Market

- Continuum of buyers: mass = n
- Buyers are apriori homogeneous* and $v \sim F(t_w)$ $(e.g., \mathrm{Unif}[0, V_{max} - \beta t_w])$



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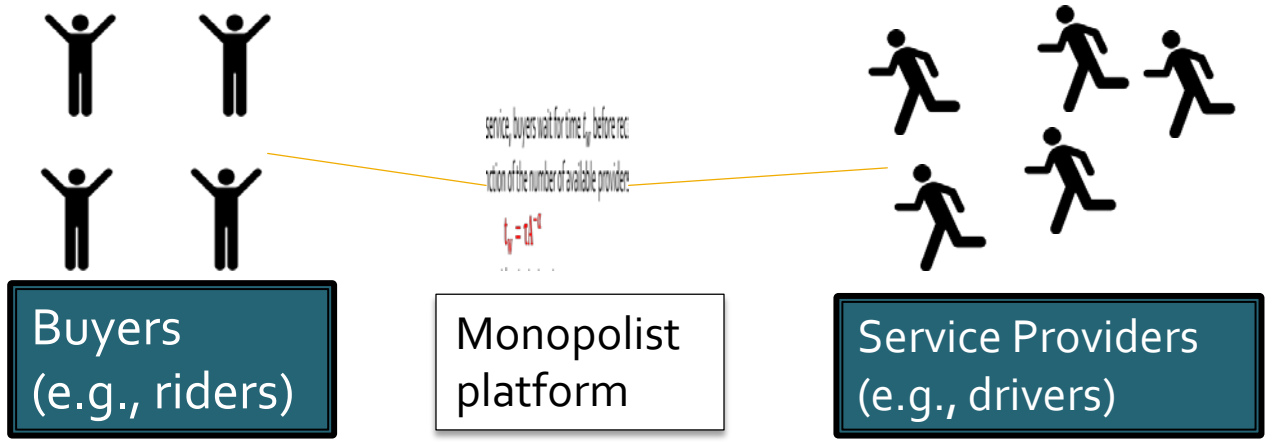
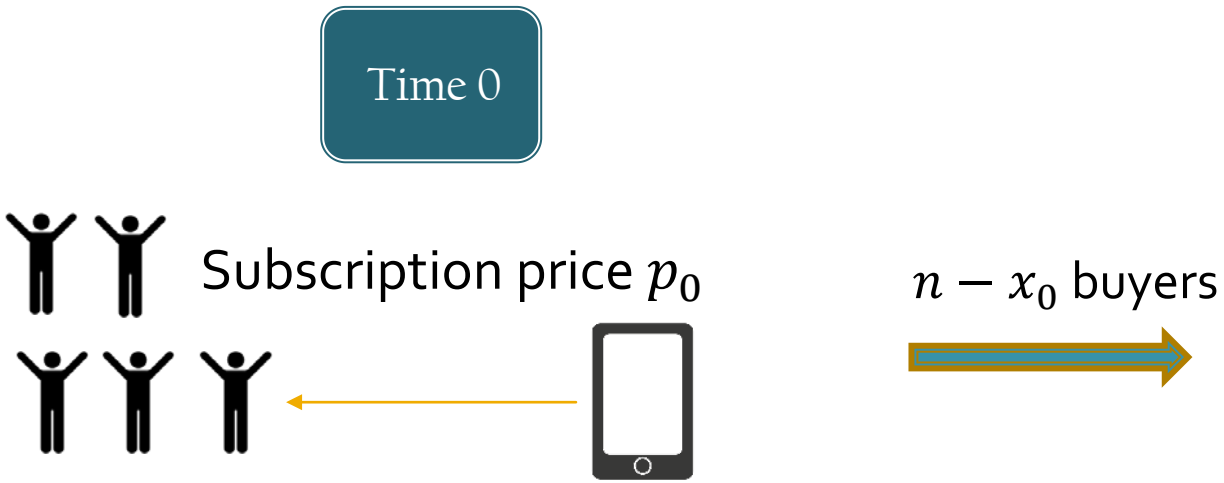


- After requesting service, buyers wait for time t_w before receiving it
- Wait time is a function of the number of available providers (A)

$$\mathbf{t_w = \tau A^{-\alpha}} \quad (\alpha = \tfrac{1}{3} \text{ in practice in ride-sharing})$$

- Marginal cost of providers/unit time is $c + \gamma s$ ⟶ Total supply

Stylistic Model of Subscription

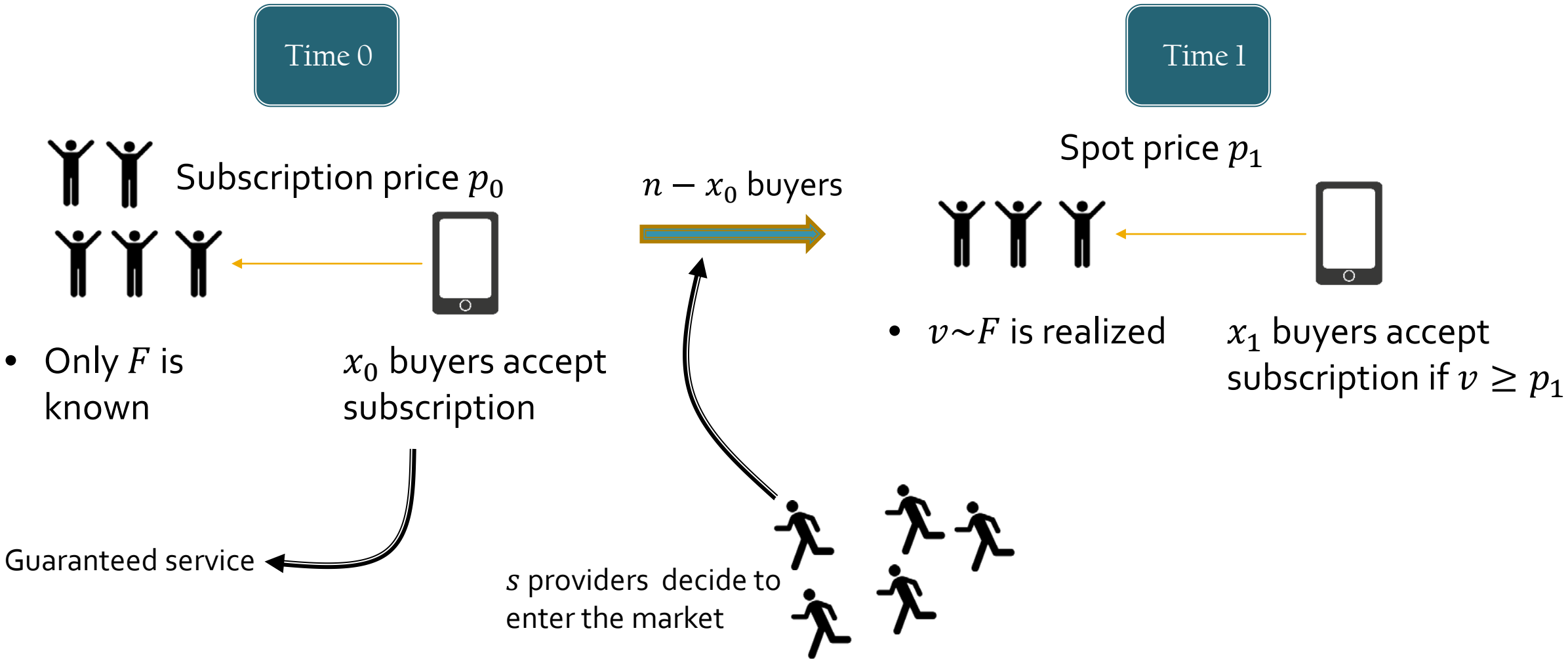


- Only F is known

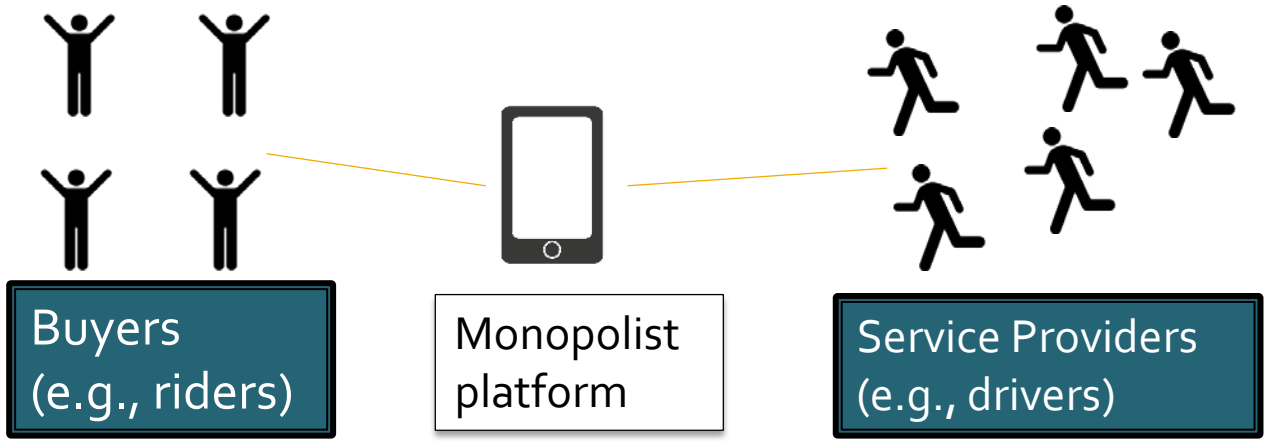
x_0 buyers accept subscription

Guaranteed service

Stylistic Model of Subscription



Equilibrium Conditions



- **Wait time (t_w) emerges out of system dynamics**

(Function of A = Total Supply – Busy Providers)

1. Buyers subscribe only if they get higher utility:

$$E[v \mid t_w] - p_0 \geq E[v - p_1 \mid v \geq p_1, t_w] \Pr(v \geq p_1)$$

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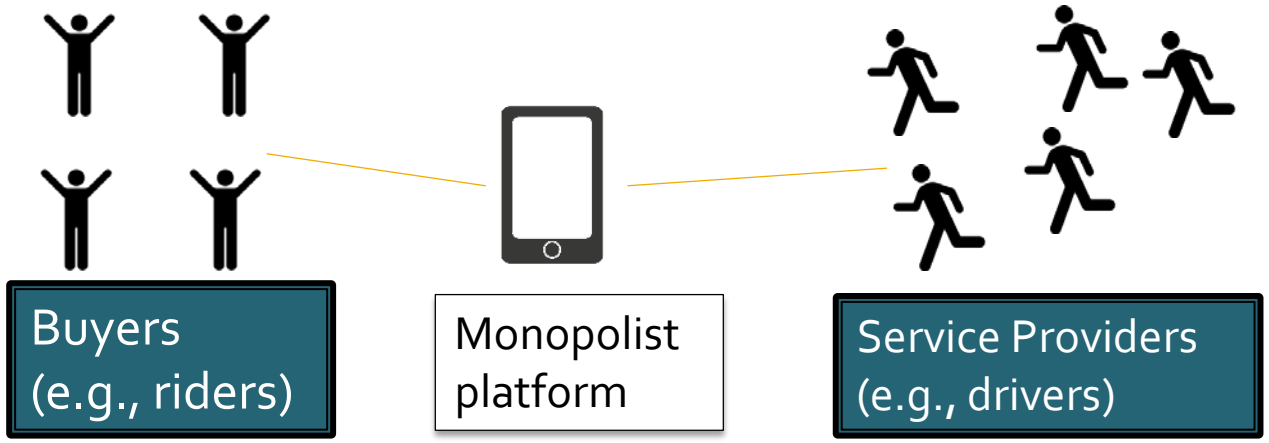

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2. Providers enter only if revenue >= marginal cost

$$\mathrm{E[Rev]} = \frac{\mathrm{Avg(p_0,p_1)}}{time} \geq c + \gamma s$$

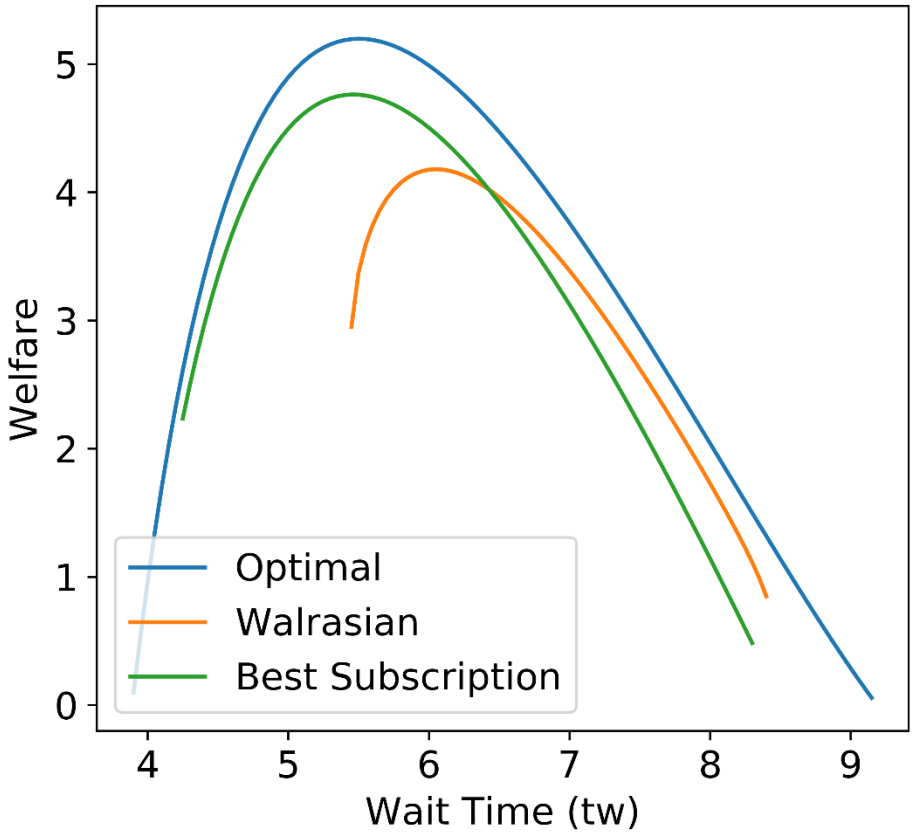
Recap: Main Question

Can subscriptions improve the social welfare for buyers, and if so why?

Benchmark: Compare subscription to a spot-price-only market that uses Walrasian market clearing prices

Can subscription help? - Insights

Welfare optimal is simply if platform can select #riders (x) and #drivers (s) such that marginal cost of drivers and riders are aligned



$\sim Unif[0, V_{max} - \beta t_w]$

- Comparing social welfare of subscription+spot pricing vs spot-only-markets (Walrasian) and the purely optimal allocation as a function of wait time

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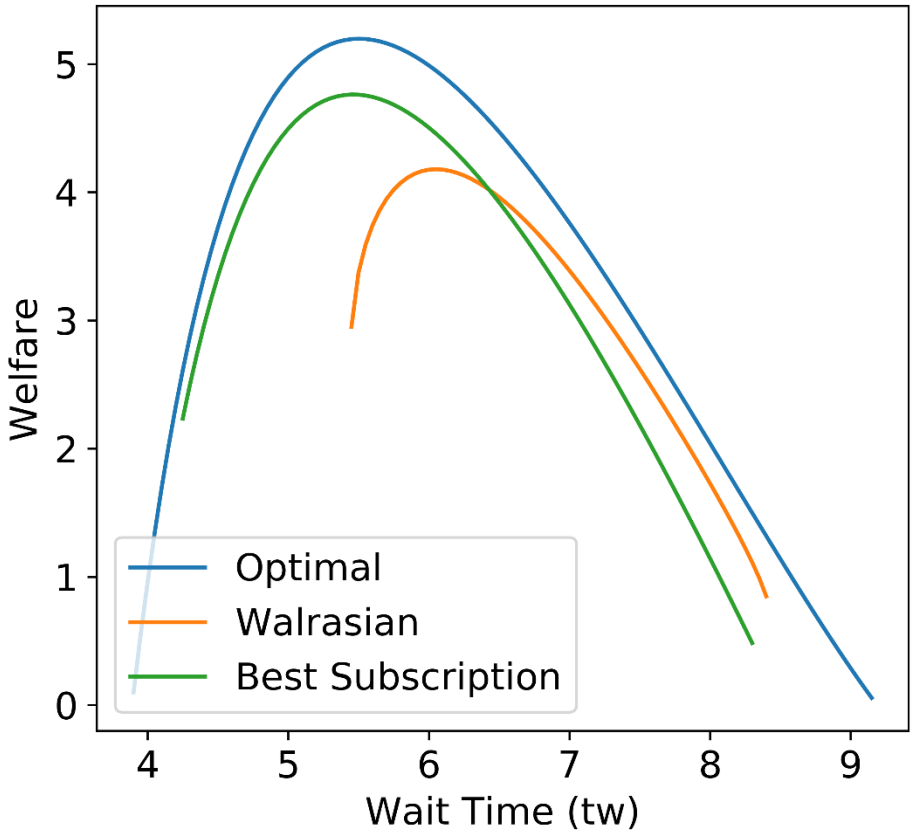


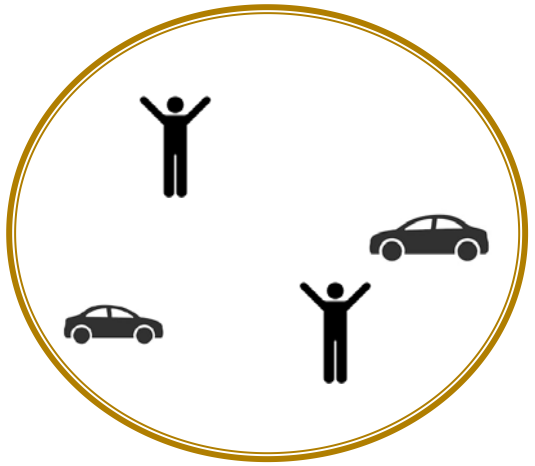
$\sim Unif[0, V_{max} - \beta t_w]$

- Equilibrium exists at a range of wait times (t_w)
- Plot shows the best subscription outcome at each t_w
- Walrasian equilibrium may not exist at low wait times (desirable region)

Intuition and Underlying Mechanism

Why does subscription help?

1) More buyers sign up ➔ greater throughput
2) More revenue collected
3) More providers enter the market
4) Smaller wait times for buyers ➔ more value for overall service
5) Less idle time for providers ➔ more revenue



Lots of drivers + Lots of riders ➔ More efficient allocation

When is subscription better?

Theorem

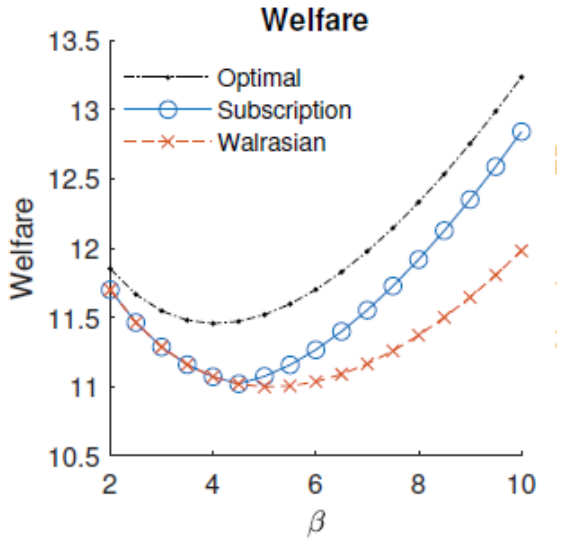
For any given instance, ∃ threshold n^*:

1) mass of buyers < n^* → Welfare (Opt. Subscription) > Welfare (Opt. Walrasian)
2) mass of buyers > n^* → Inequality is flipped

The optimal subscription always occurs at a lower wait time than optimal Walrasian

Effect of Market Parameters

- As riders become more sensitive to wait times, welfare due to subscription increases since wait times ↓ at equilibrium



Rider Time Sensitivity →

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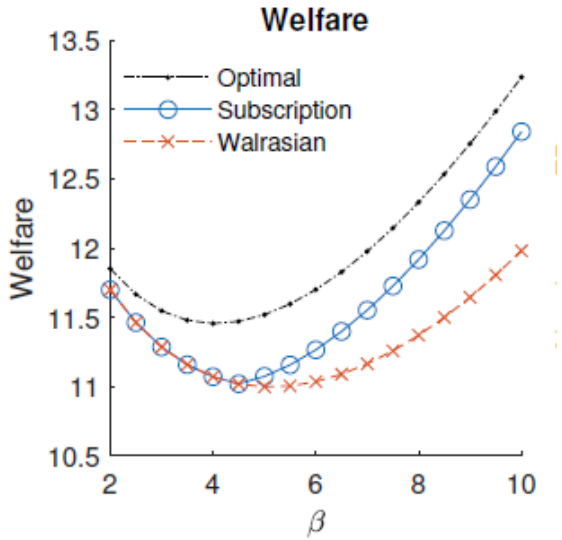

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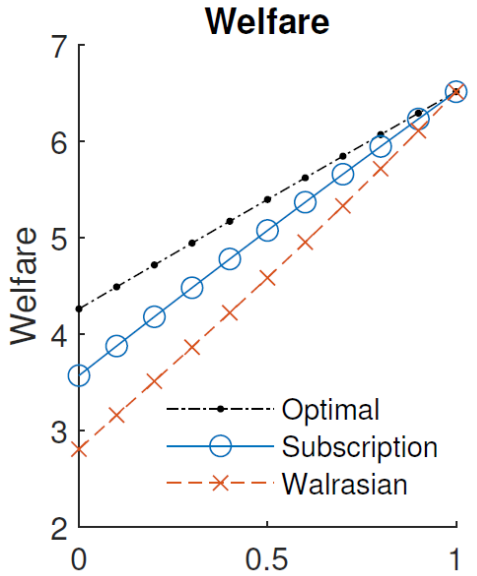


Fraction of riders with high variance →

Riders with highly uncertain valuations (large variance) prefer the spot market.

Effects of Heterogeneity in User Preferences

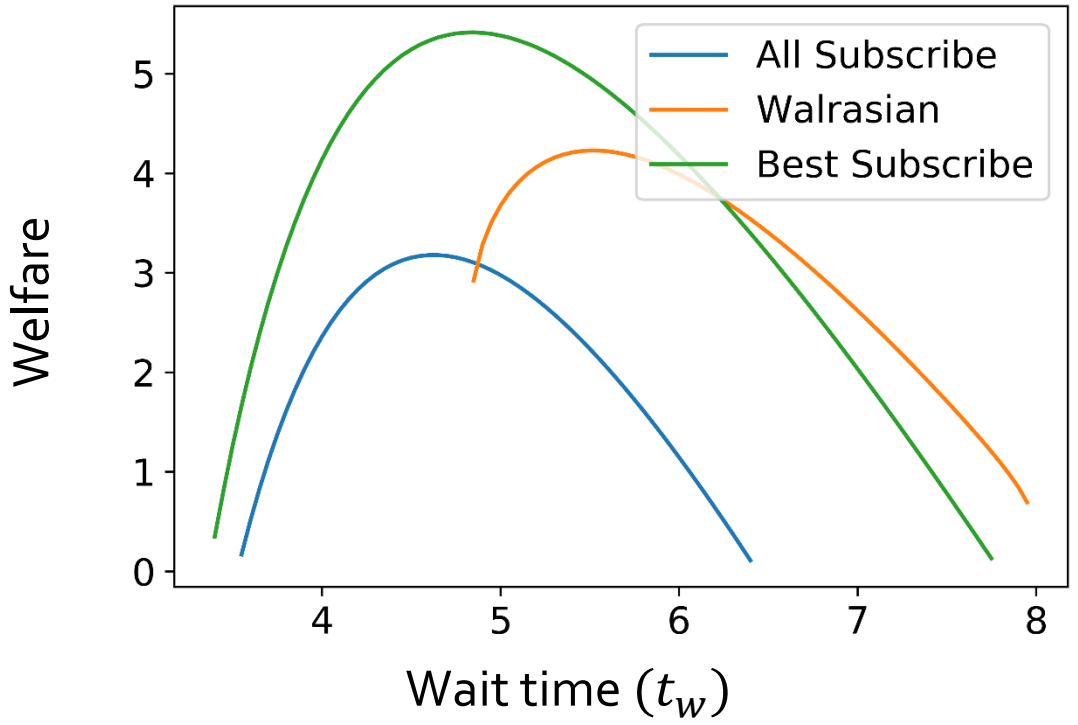
- Each buyer has two parameters: valuation $v \sim F(t_w)$ and probability of requesting service p
- Buyers known prob. p and F beforehand and use this to decide if they should subscribe

Four Types

- $p \sim \{High\ Type, Low\ Type\}$
- $E[v] \sim \{High\ Type, Low\ Type\}$

Results: Heterogeneous User Types

There exists a threshold p^* such that only high-value-type buyers with p > p^* subscribe at the optimal



Broader Implications and Next Steps

- **Main insight:** Subscription can leverage network effects to improve both welfare, throughput, and lower wait times.
- Benefits of subscription may not persist once the market is sufficiently large
- Model applicable to other two-sided markets, e.g., online labor markets (Employers and workers located on k-dim space of skills) Wait time → Fit between employer and worker
- **Next step:** Modeling a duopoly. Does subscription help under competition (e.g., Uber vs Lyft)?

Thank you!