Managing Multihoming Workers in the Gig Economy

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UC Berkeley

2024 INFORMS TIMES Best Working Paper Competition

joint work with
Gad Allon, Maxime Cohen, Ken Moon

juno

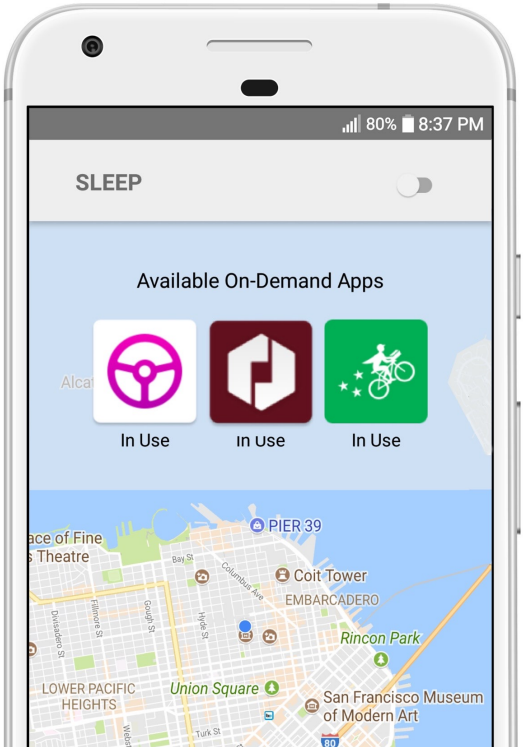
Uber Lyft Via

DOORDASH Uber Eats instacart

seamless GRUBHUB caviar

Postmates goPuff

"Multihoming"



Recruiting Workers is Hard

"Multihoming"

POLICY \ US & WORLD \ TRANSPORTATION

In major defeat for Uber and Lyft, New York City votes to limit ride-hailing cars

NYC becomes the first American city to restrict the explosive growth in for-hire vehicles

By Shoshana Wodinsky | Aug 8, 2018, 4:39pm EDT

https://www.theverge.com/2018/8/8/17661374/uber-lyft-nyc-cap-vote-city-council-new-york-taxi

Recruiting Workers is Hard

How workers make multihoming decisions?

POLICY \ US & WORLD \ TRANSPORTATION

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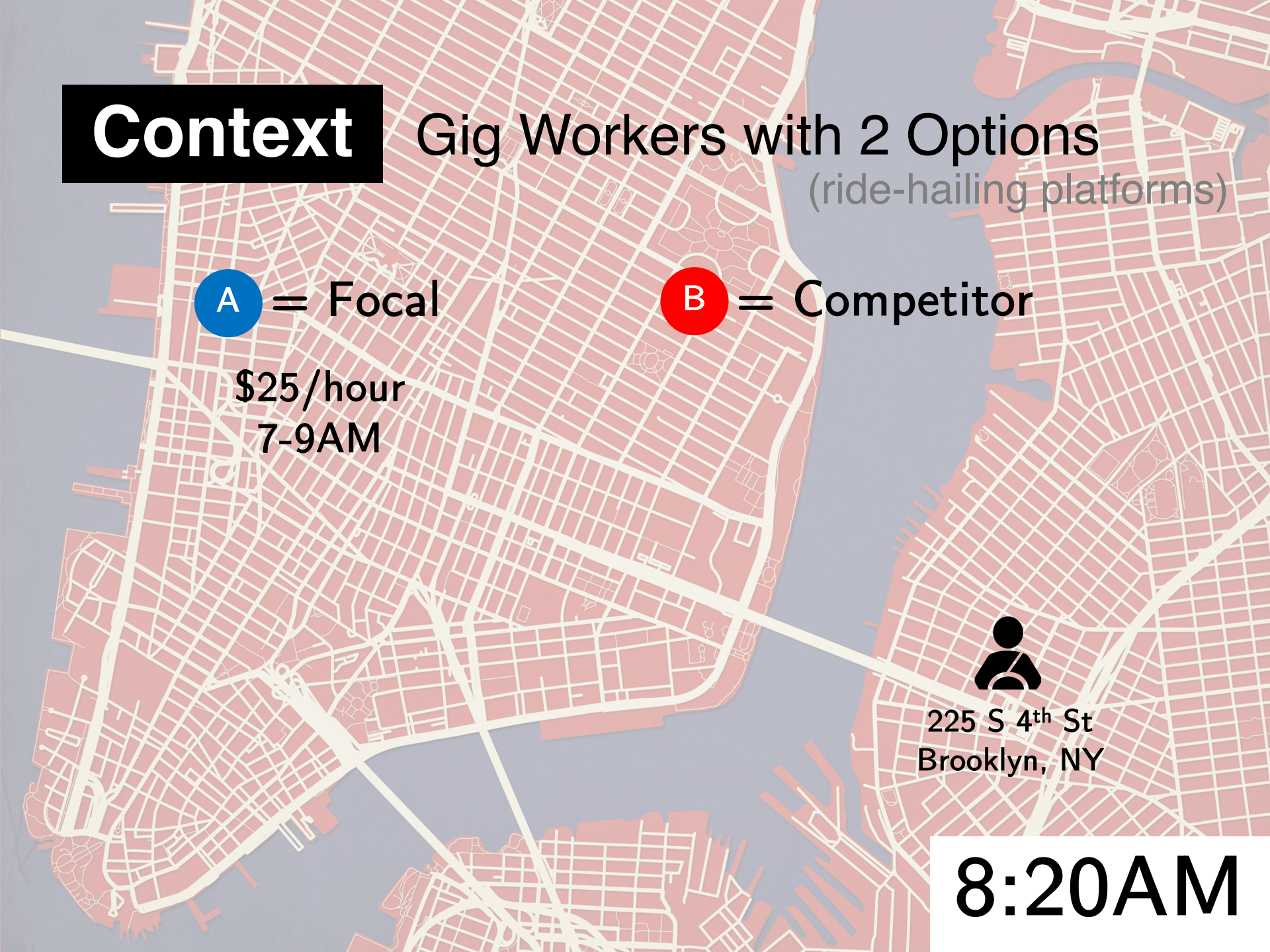
How workers make multihoming decisions?

How should platforms compete for multihoming workers?

Context
Gig Workers with 2 Options
(ride-hailing platforms)
A = Focal
B = Competitor
225 S 4th St
Brooklyn, NY
8:20AM


Context
Gig Workers with 2 Options
(ride-hailing platforms)
A = Focal
B = Competitor
$25/hour
7-9AM
225 S 4th St
Brooklyn, NY
8:20AM

Context

Gig Workers with 2 Options

(ride-hailing platforms)

A = Focal

$25/hour

7-9AM

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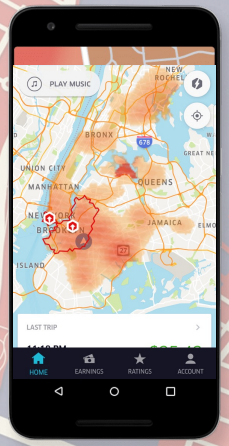


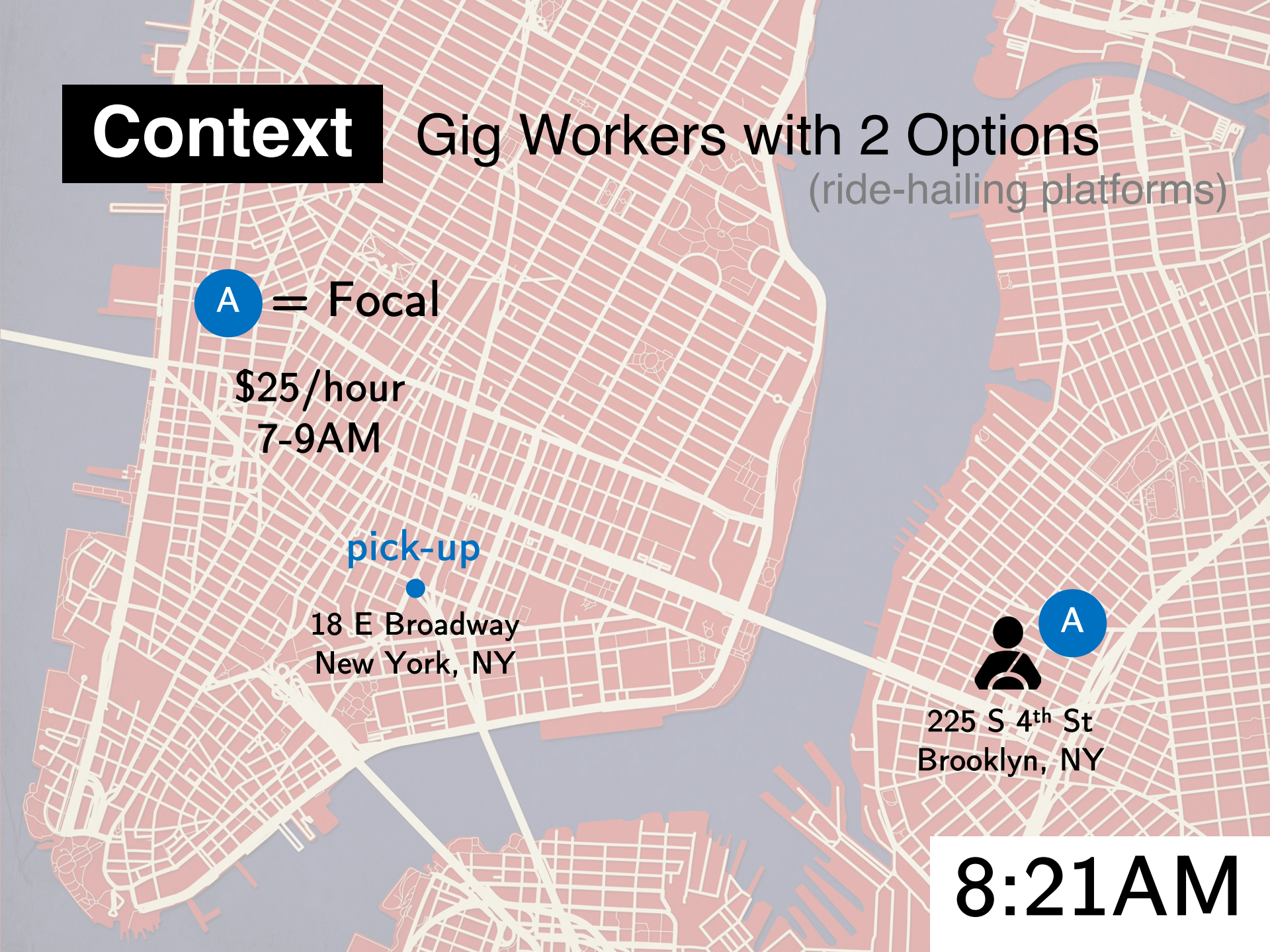
Avg. Surge

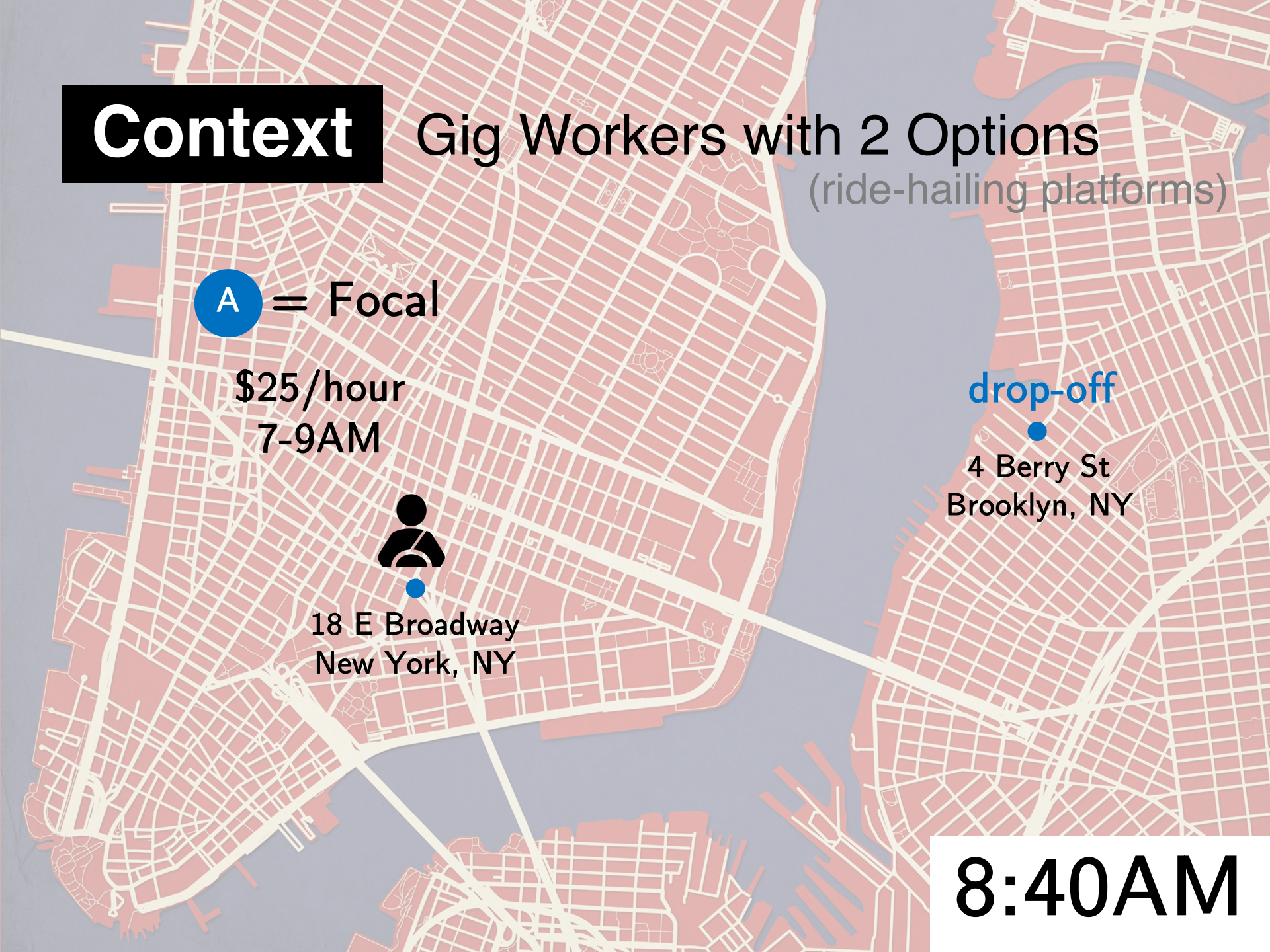
+25%

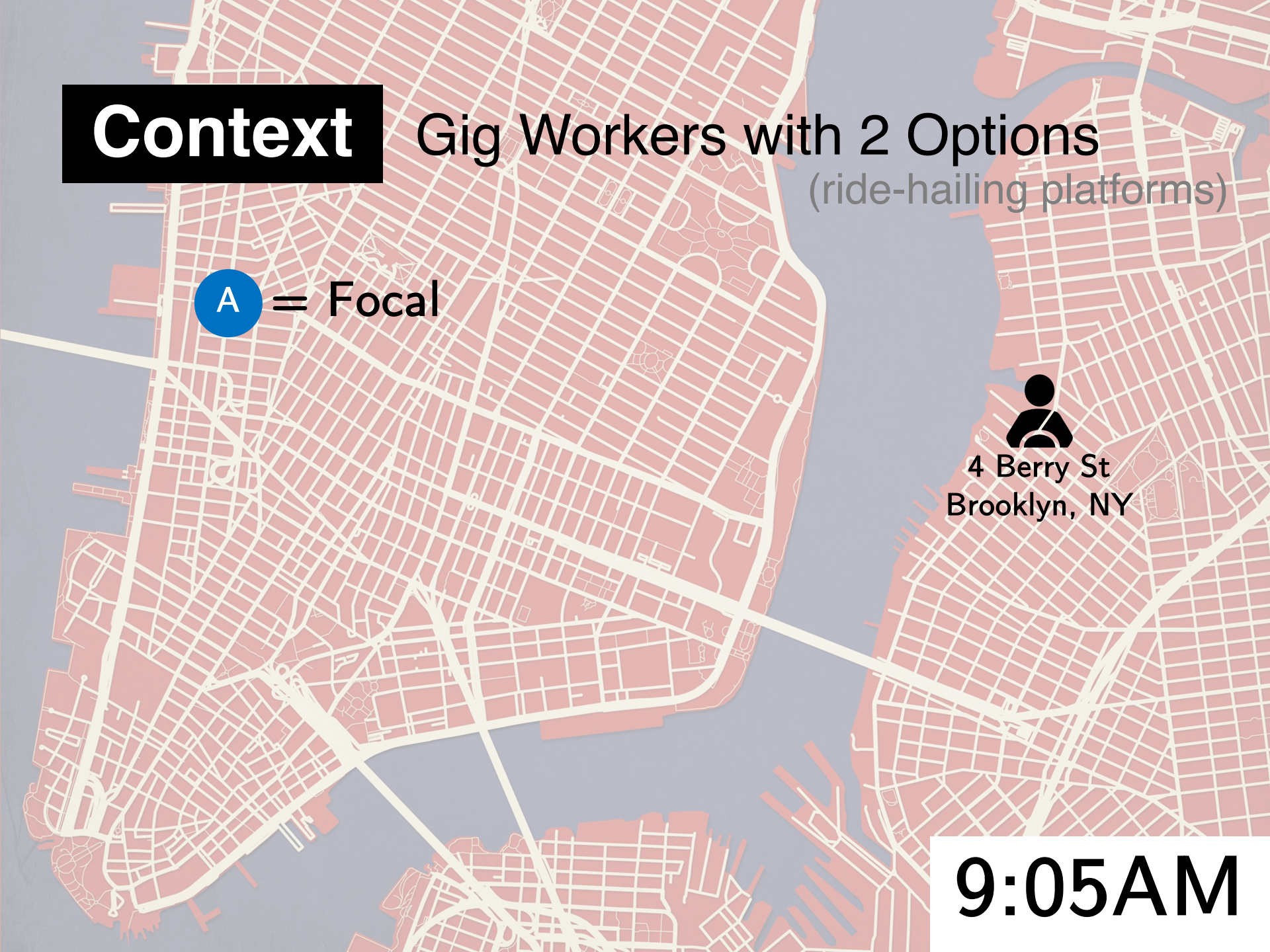
225 S 4th St

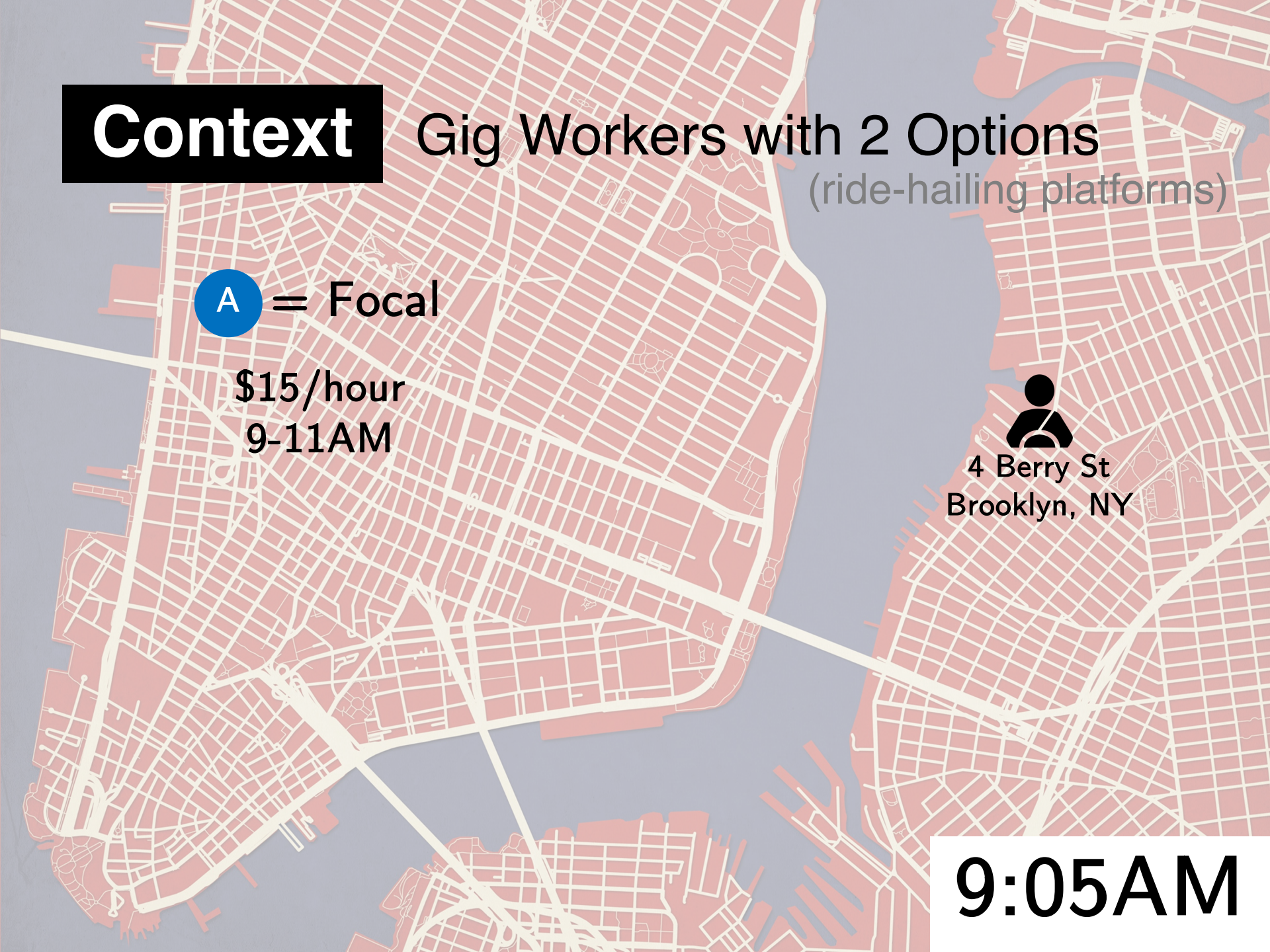
Brooklyn, NY

8:20AM


Context
Gig Workers with 2 Options
(ride-hailing platforms)
A = Focal
$25/hour
7-9AM
pick-up
18 E Broadway
New York, NY
A
225 S 4th St
Brooklyn, NY
8:21AM


Context
Gig Workers with 2 Options
(ride-hailing platforms)
A = Focal
$25/hour
7-9AM
drop-off
4 Berry St
Brooklyn, NY
18 E Broadway
New York, NY
8:40AM


Context
Gig Workers with 2 Options
(ride-hailing platforms)
A = Focal
4 Berry St
Brooklyn, NY
9:05AM


Context
Gig Workers with 2 Options
(ride-hailing platforms)
A = Focal
$15/hour
9-11AM
4 Berry St
Brooklyn, NY
9:05AM

Context

Gig Workers with 2 Options

(ride-hailing platforms)

A = Focal

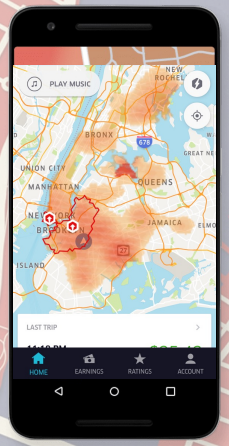
$15/hour

9-11AM

B = Competitor

Avg. Surge

+75%



4 Berry St

Brooklyn, NY

9:05AM

Context

Gig Workers with 2 Options

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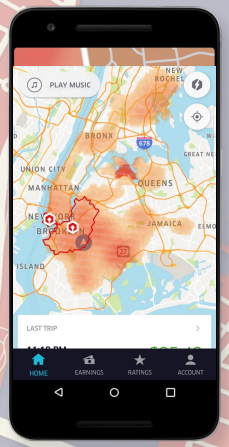
$15/hour

9-11AM

B = Competitor



B

4 Berry St

Brooklyn, NY

Avg. Surge

+75%

9:05AM

Context Gig Workers with 2 Options

(ride-hailing platforms)

A = Focal

B = Competitor

July – Sep 2017, NYC

140k work sessions
(consecutive online w/o breaks)

- 3805 drivers
- **Time** and **location** of
  first **pick-up** and ***last*** **drop-off**

- Guaranteed hourly pay

Context Gig Workers with 2 Options

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- **Time** and **location** of ***first*** **pick-up** and ***last*** **drop-off**

- Guaranteed hourly pay

Trip records data

35M ride-hailing trips

- Platform ID
- **Time** and **location** of **every pick-up/drop-off**

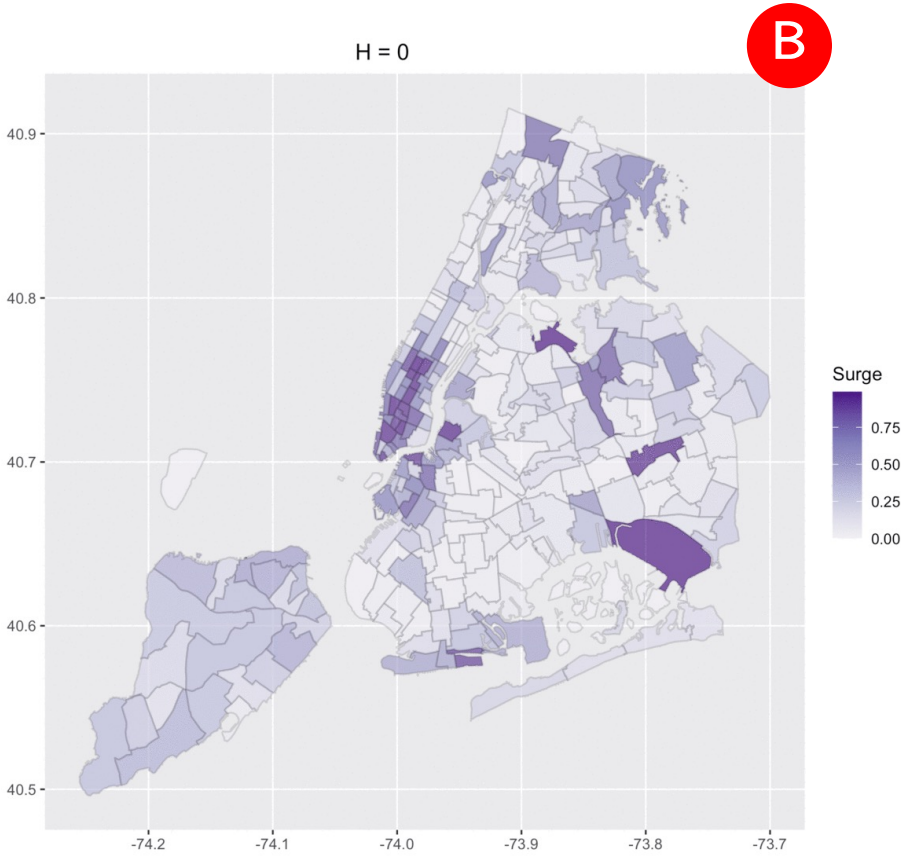
NYC Taxi & Limousine Commission

Price breakdowns B

- Pay per work

Temporal/Spatial Variations

P(Supply shortage on competitor)



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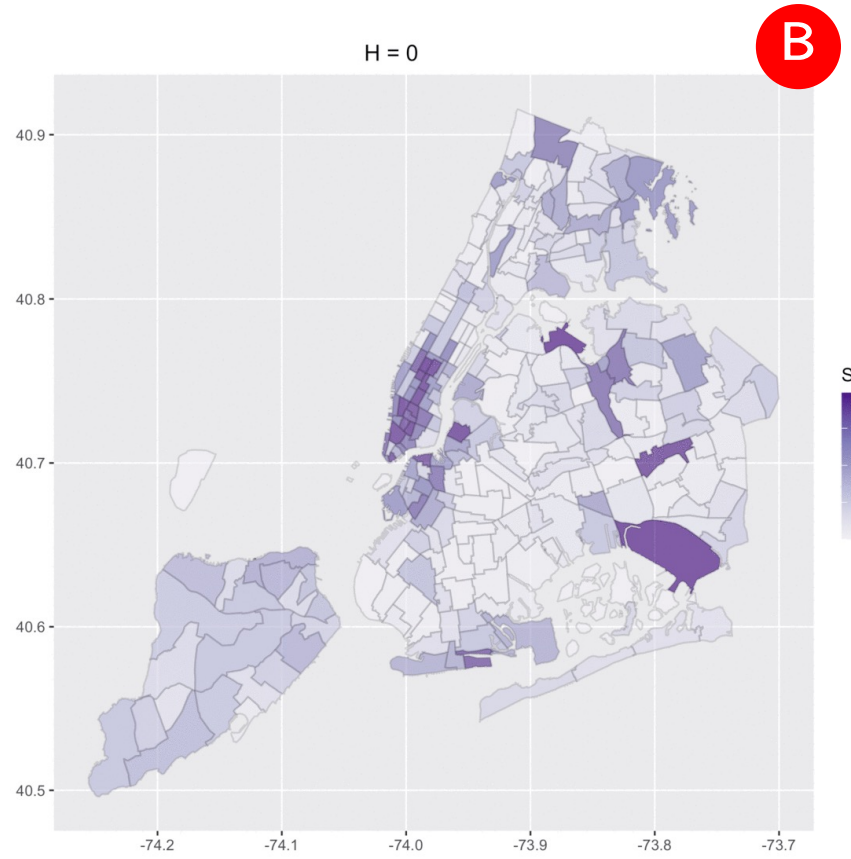
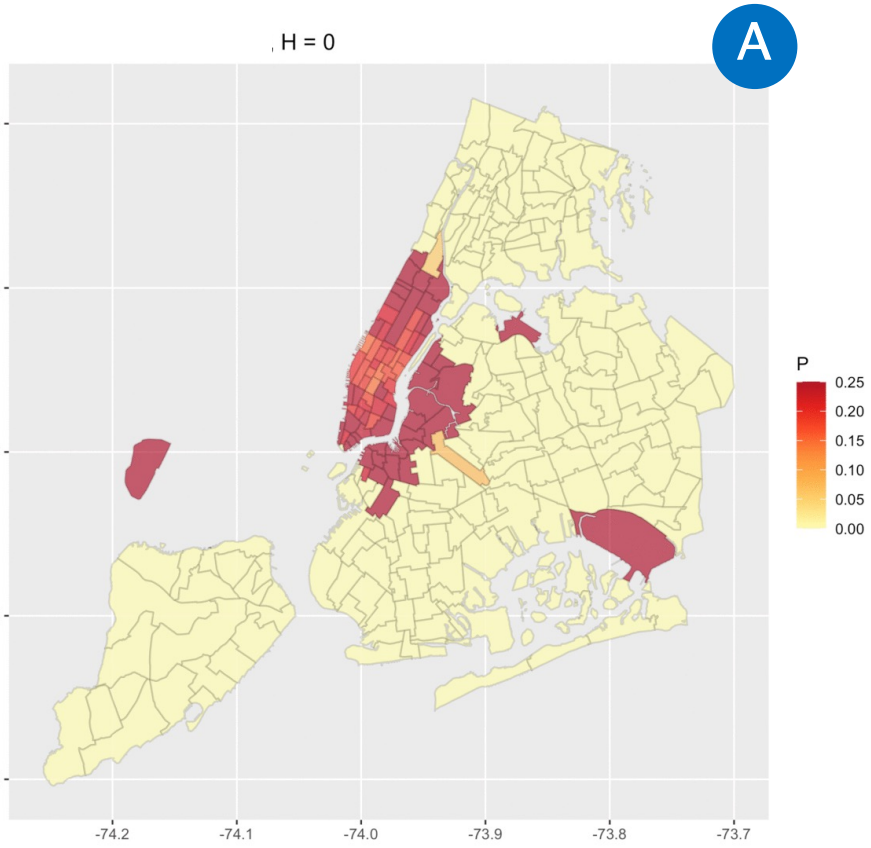
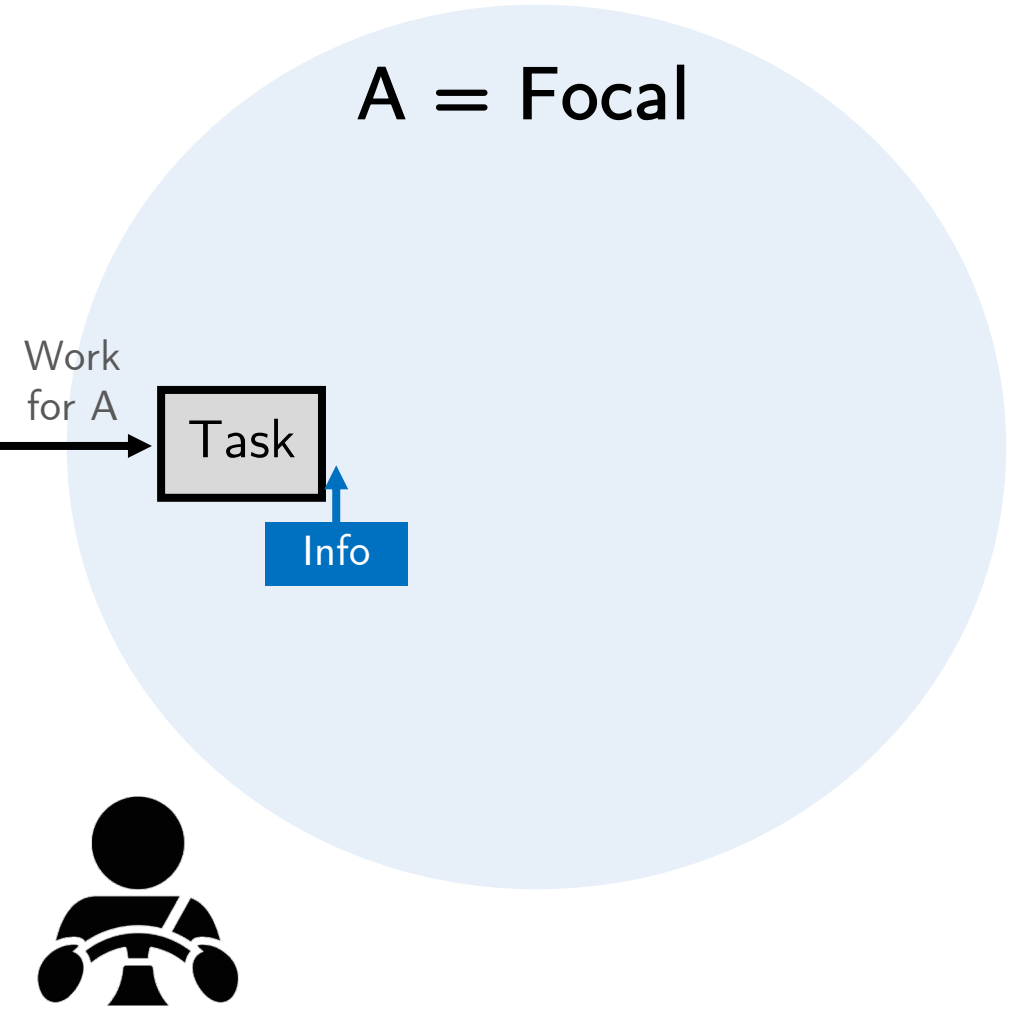


P(Leaving focal firm)



Our Model

2 firms in the same industry
Finite time horizon, every 20 mins



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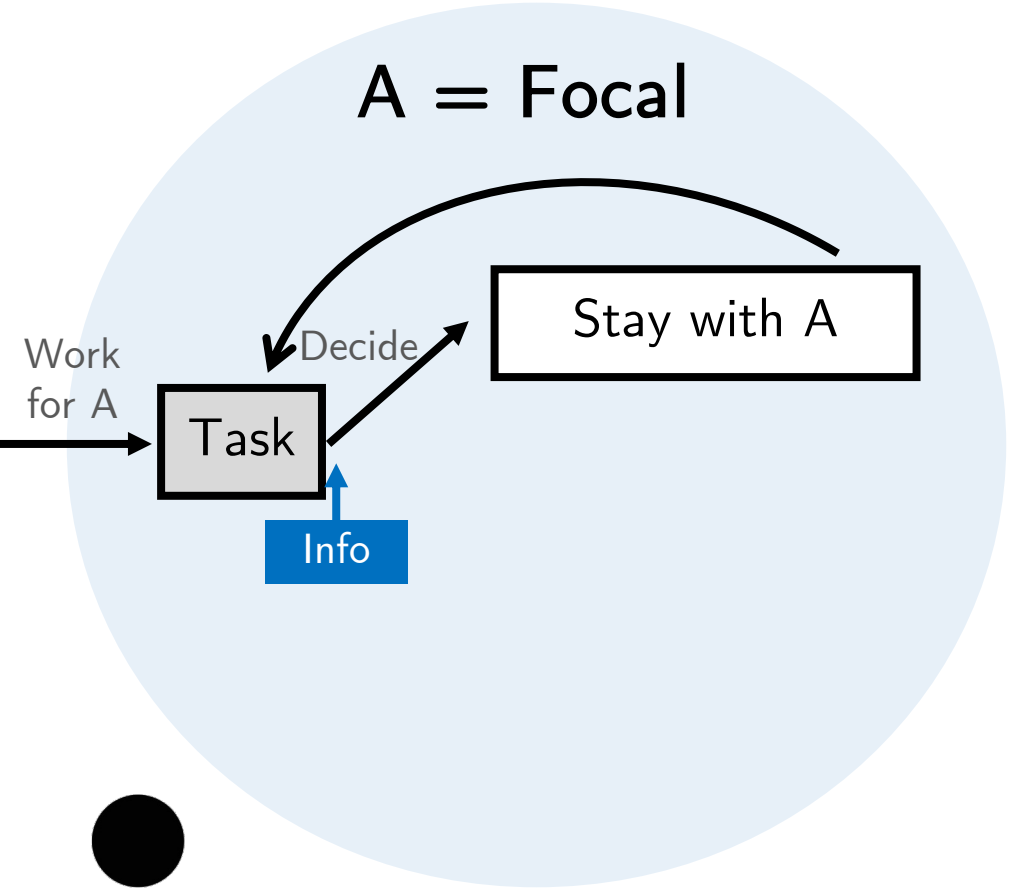

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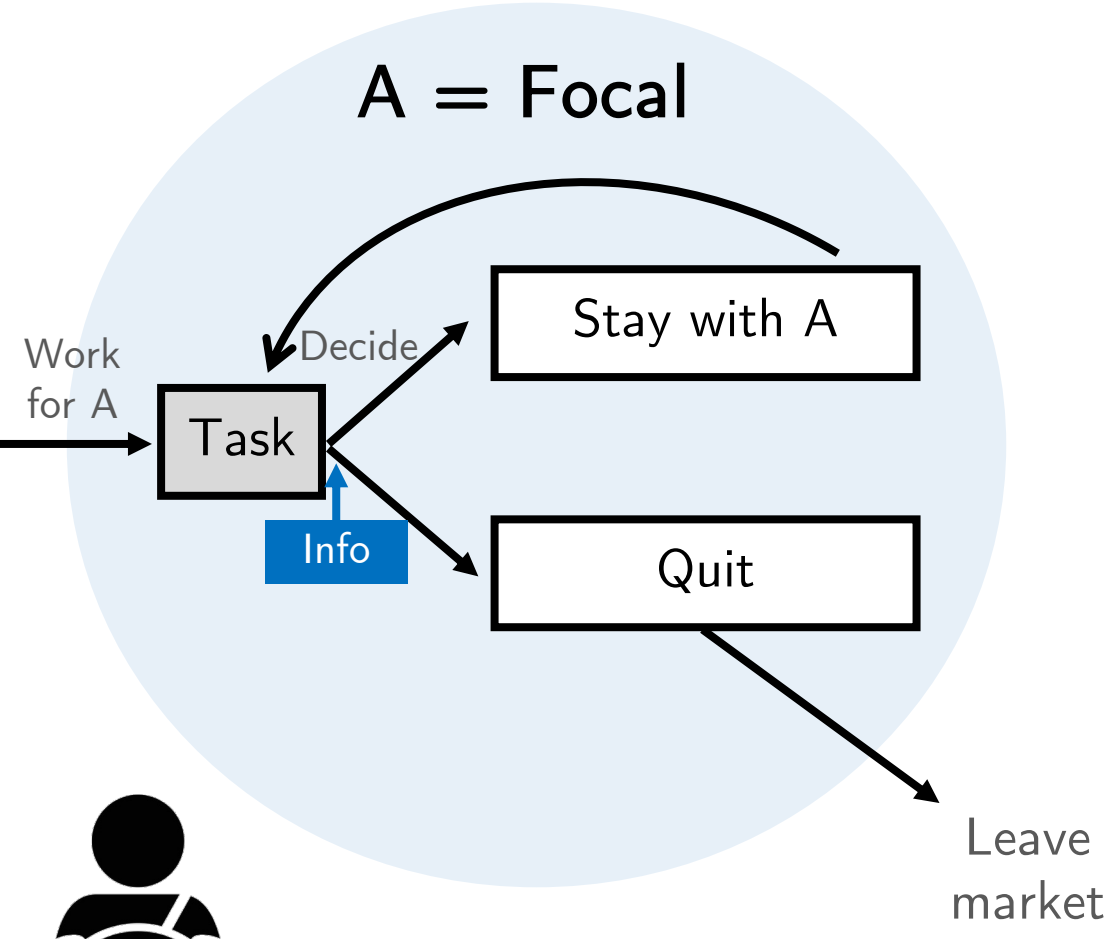

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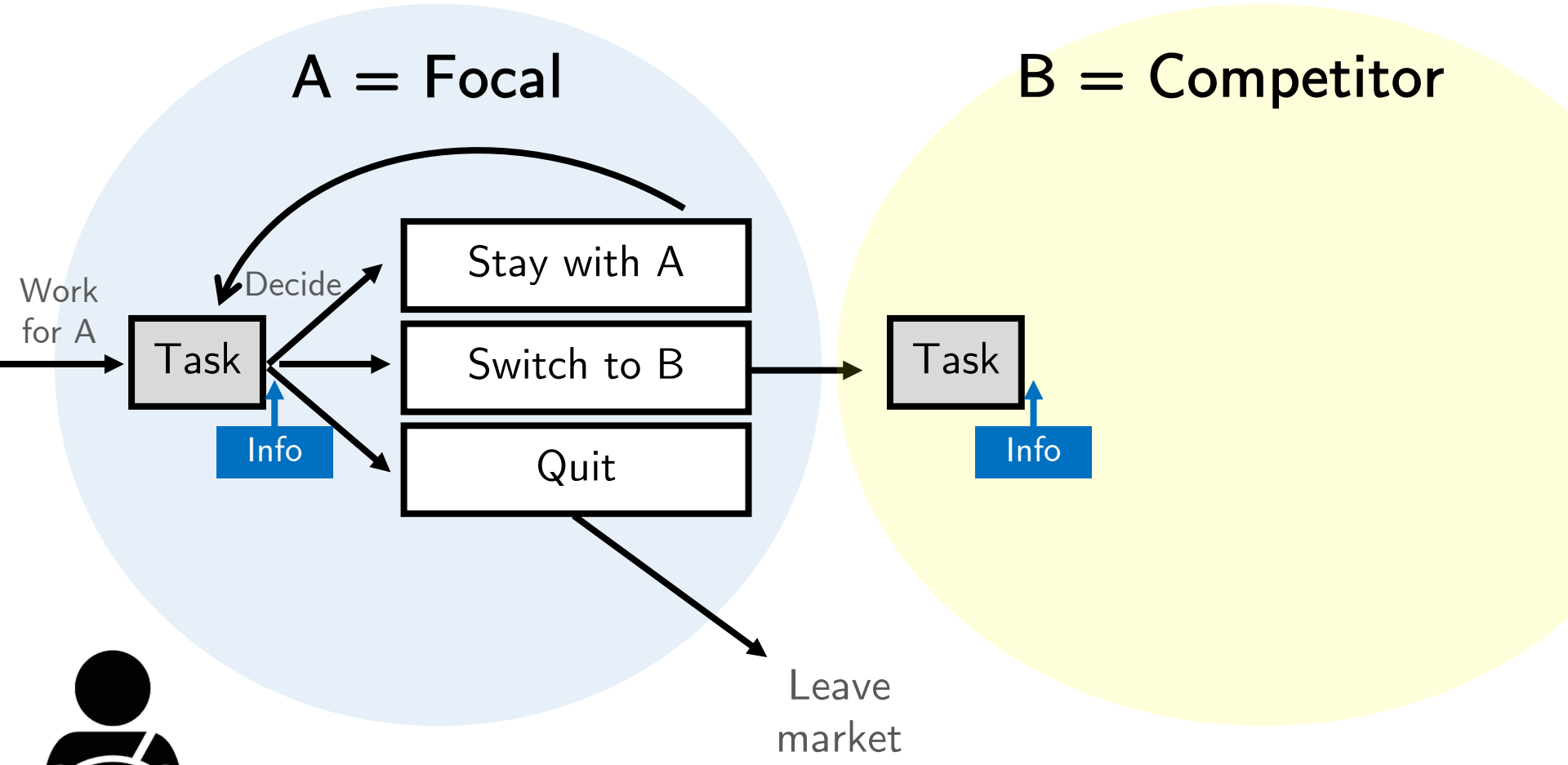

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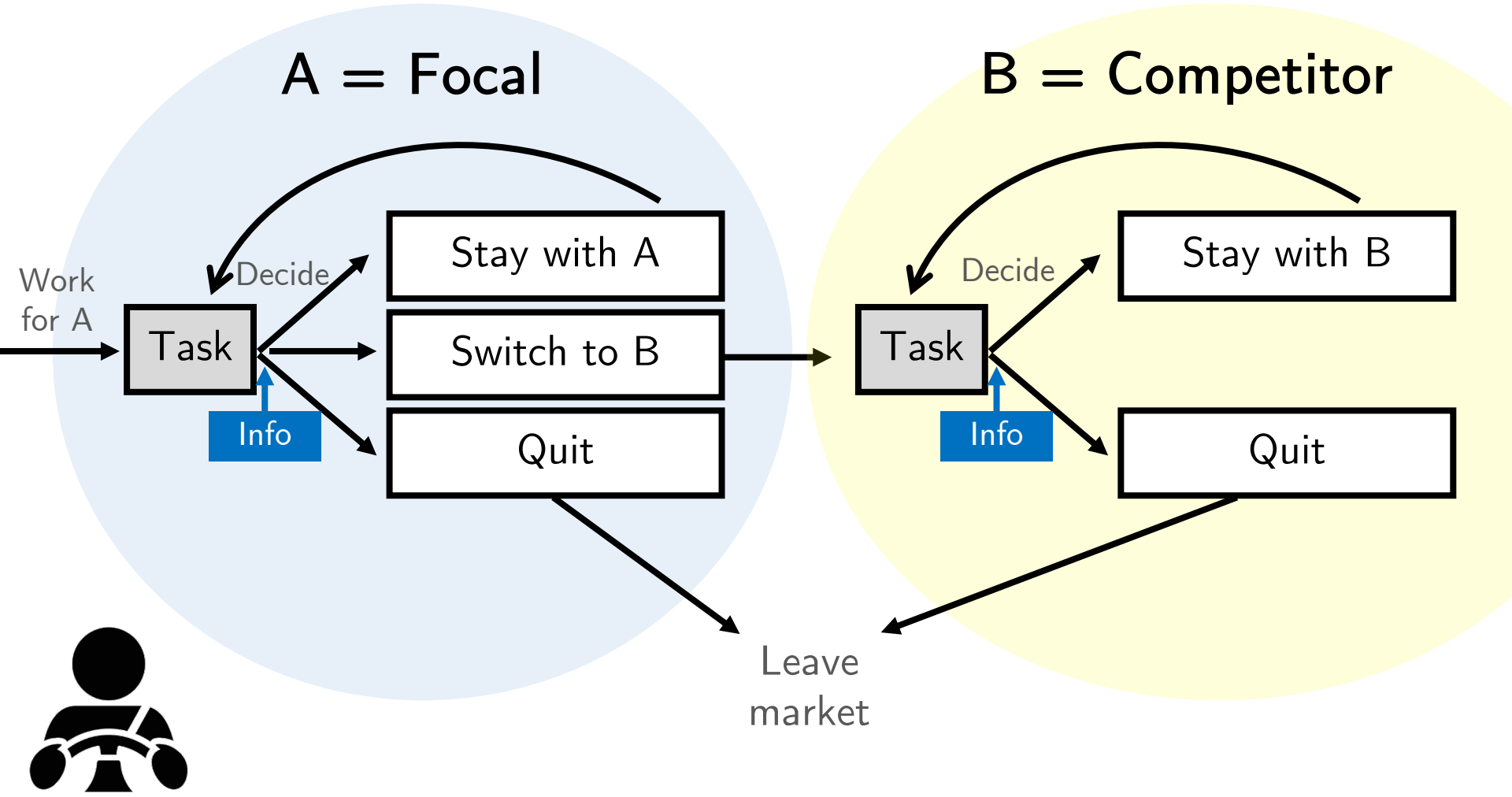

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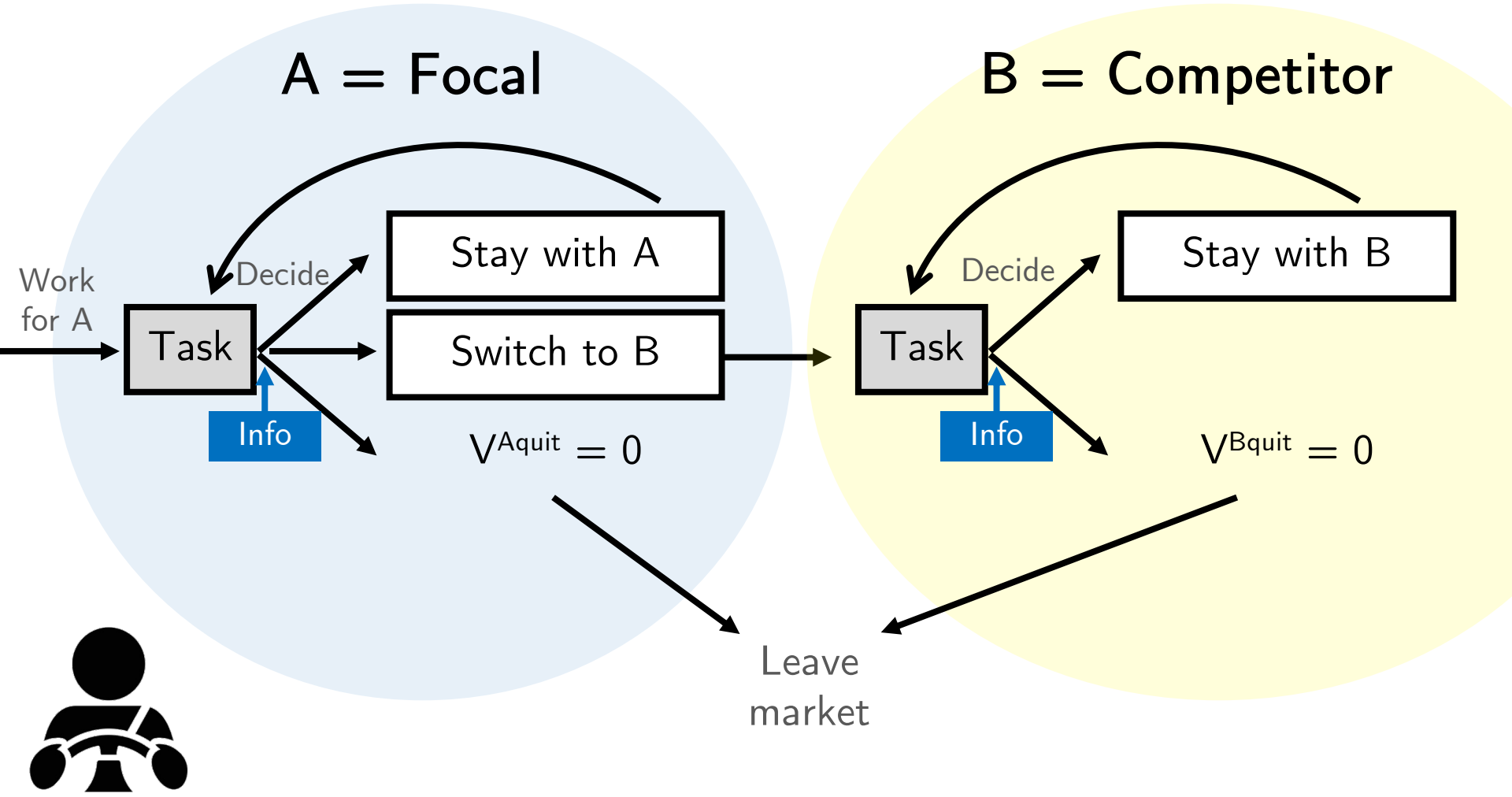

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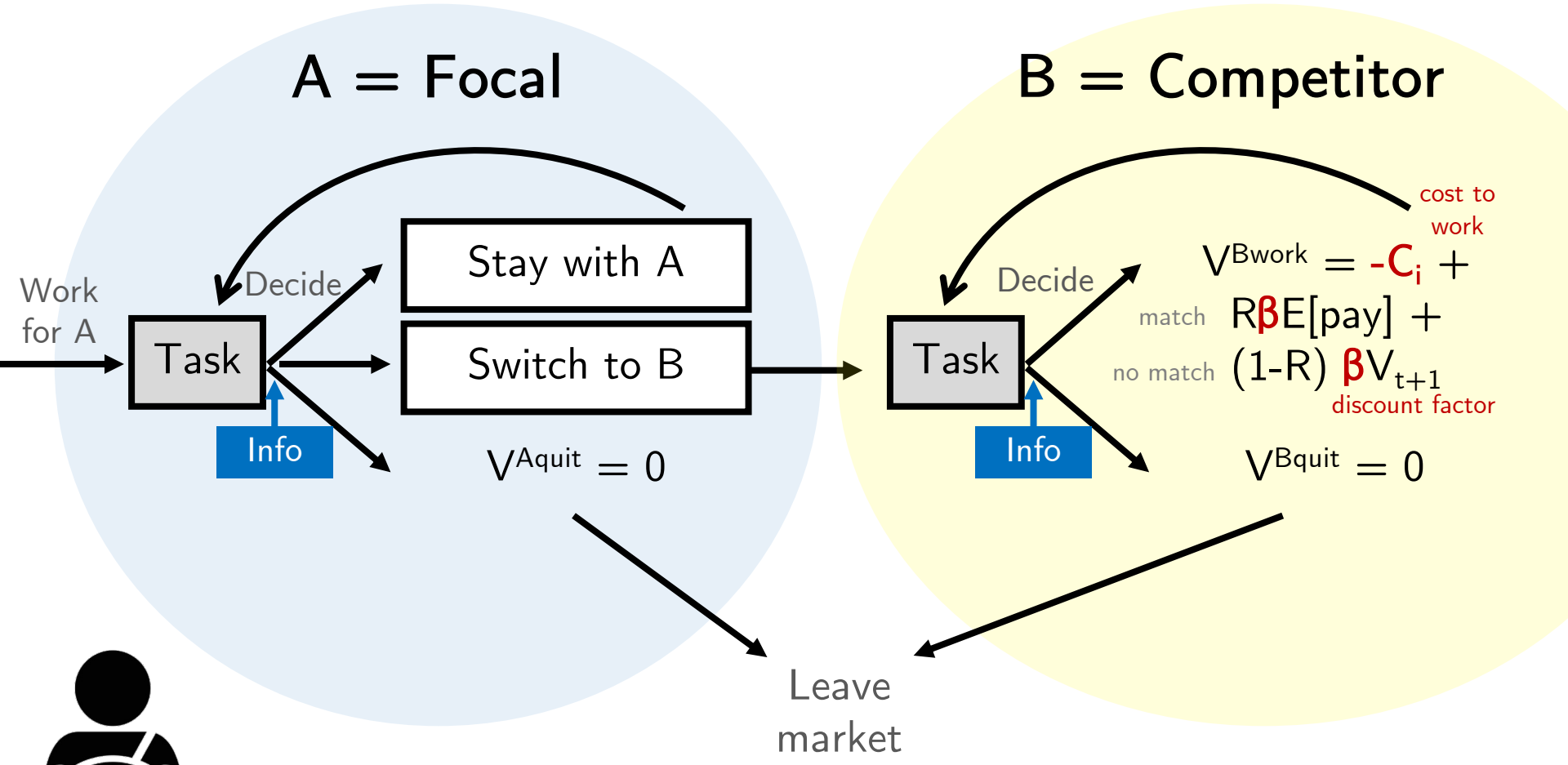

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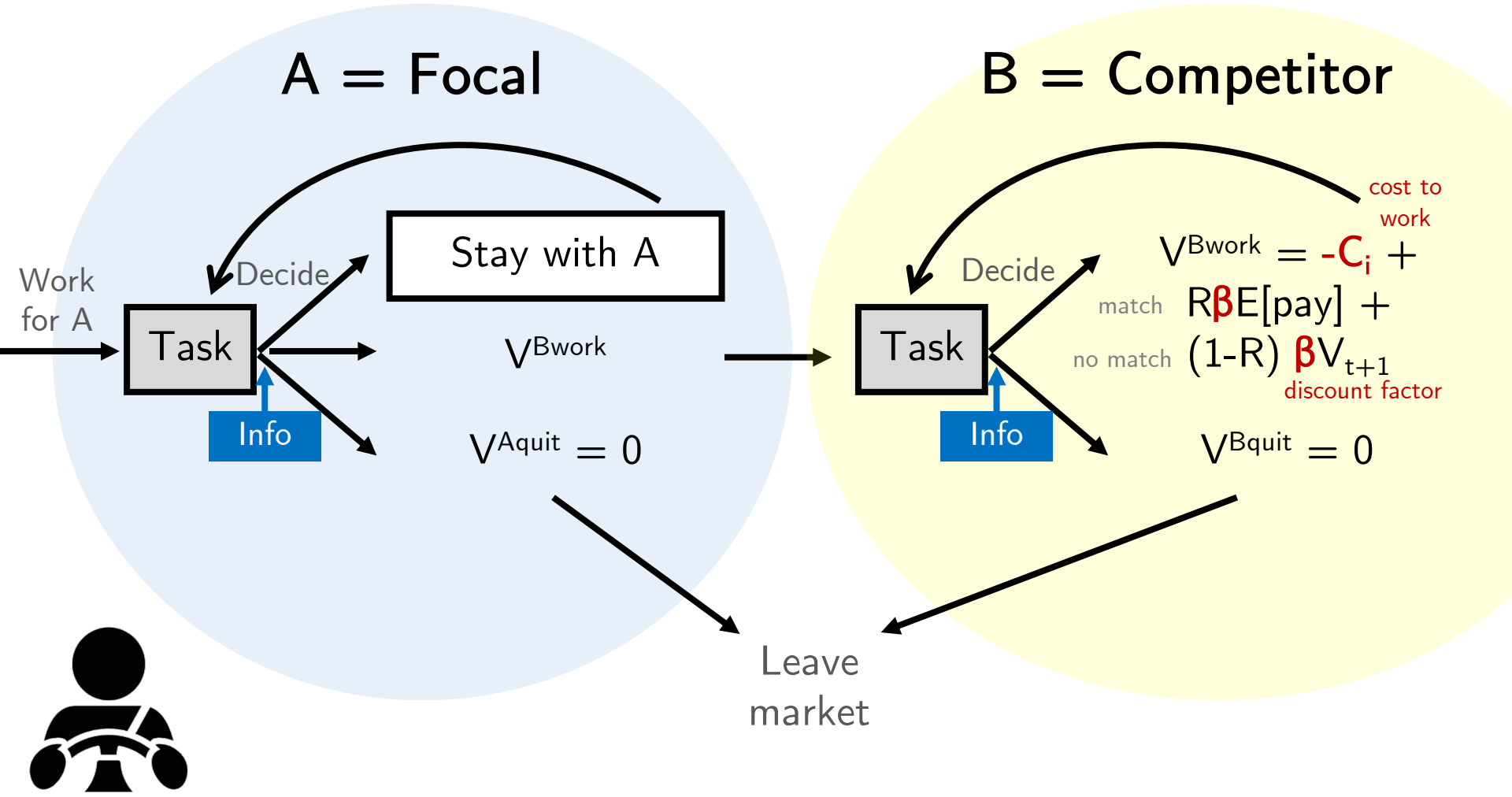

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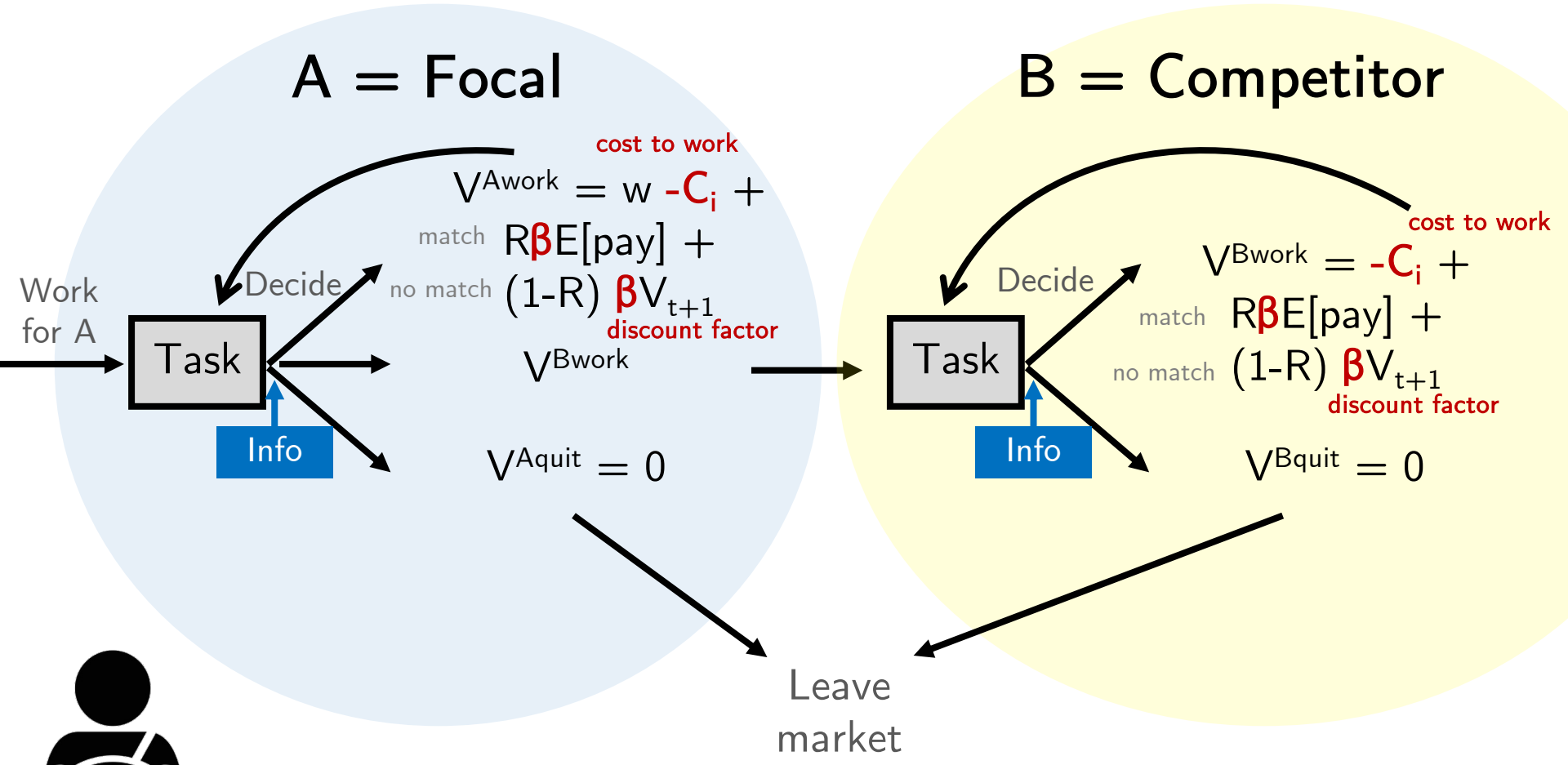


Our Model Drivers' Parameters

homogeneous β discount / forward-looking factor

heterogeneous C_i cost of working for a unit time interval

C_1

C_2

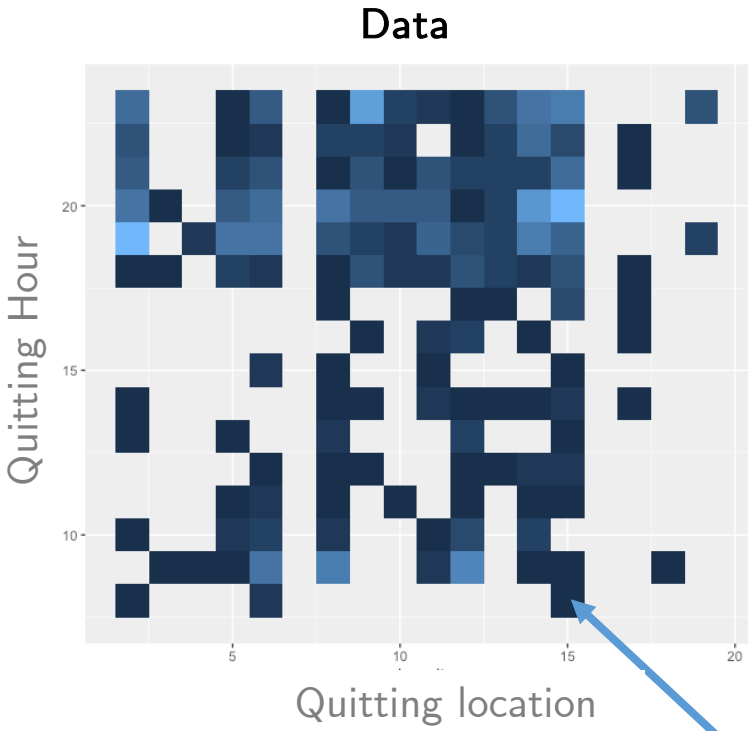
C_3

C_4

~ Truncated Normal (μ, σ^2)

Outcome of Interest

For each day, fraction of drivers quitting at (H,L)



Hours: 7am to 11pm

(Remaining left at 11:59pm)

Location: 1 of 20 regions

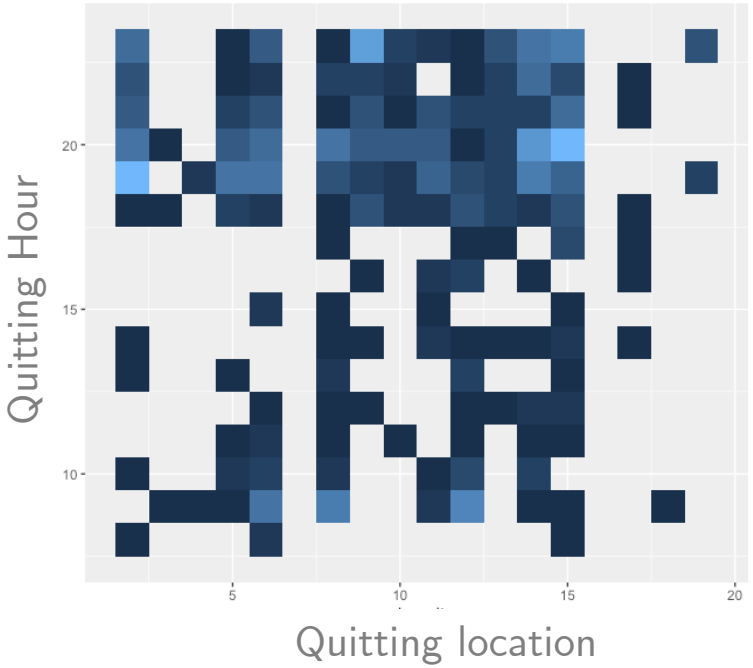
Bronx, Brooklyn, Newark, Central Park, Chelsea, Downtown, Governors Island, Gramercy, Harlem, LES, LWS, Midtown, Morningside Heights, UES, UWS, Upper Manhattan, JFK, LaGuardia, Queens, Staten Island

Each cell (H,L) is fraction of drivers quitting at location L and hour H: $f_{L,H}$

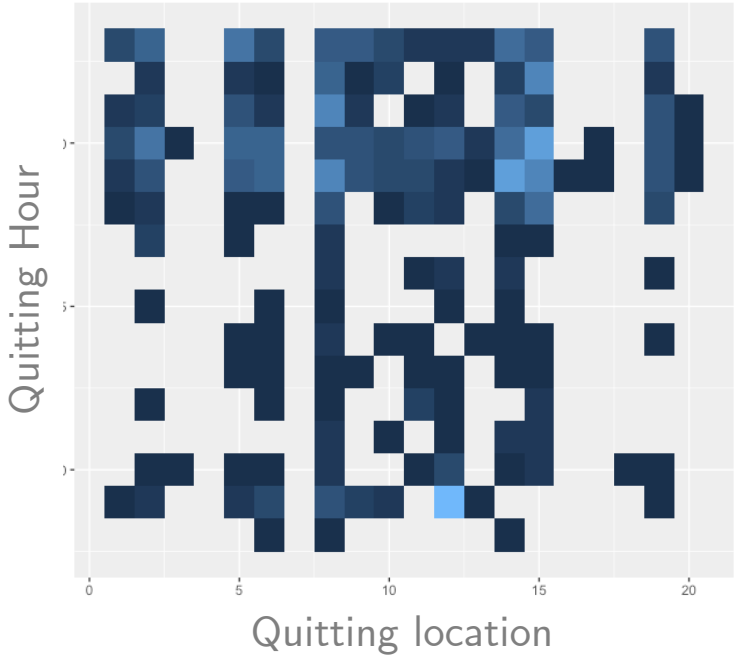
Simulation-Assisted Estimation

Find parameters θ that minimize **distance between two distributions**

Data

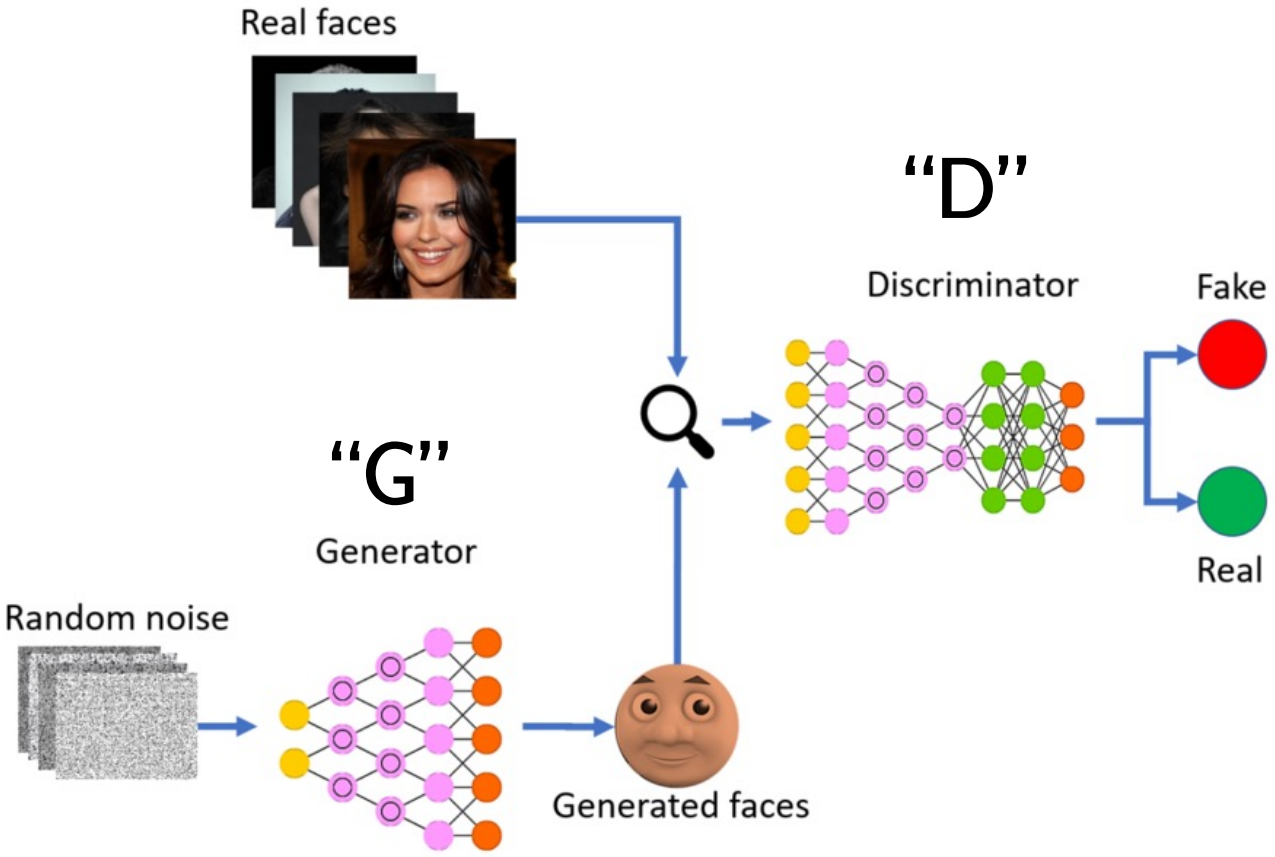


Simulation (given θ)



Goodfellow et al (2014)

Gen. Adversarial Networks



$$\min_{\{generator\}} \max_{\{discriminator\}} classification\ accuracy.$$

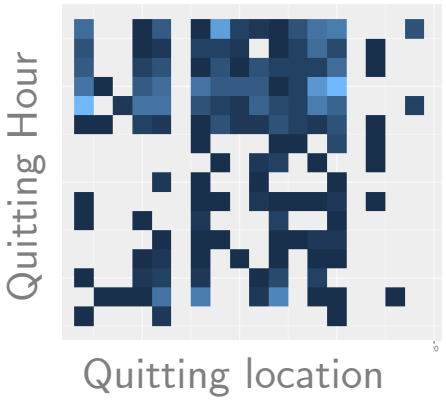
Adversarial Estimation

Real Data | Simulated Data

$$\min_{\theta} \max_{D \in \mathcal{D}} \frac{1}{N} \sum_{i=1}^{N} \log(D(X_i)) + \frac{1}{H} \sum_{i=1}^{H} \log(1 - D(X_i^{\theta}))$$

Data

X



"D"

Discriminator

Simulated

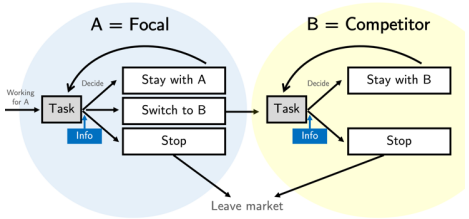
Y = 0

Y = 1

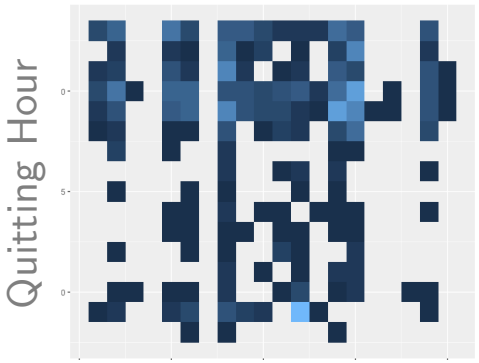
Real

Generator

Simulation (given θ)



"G" = structural model



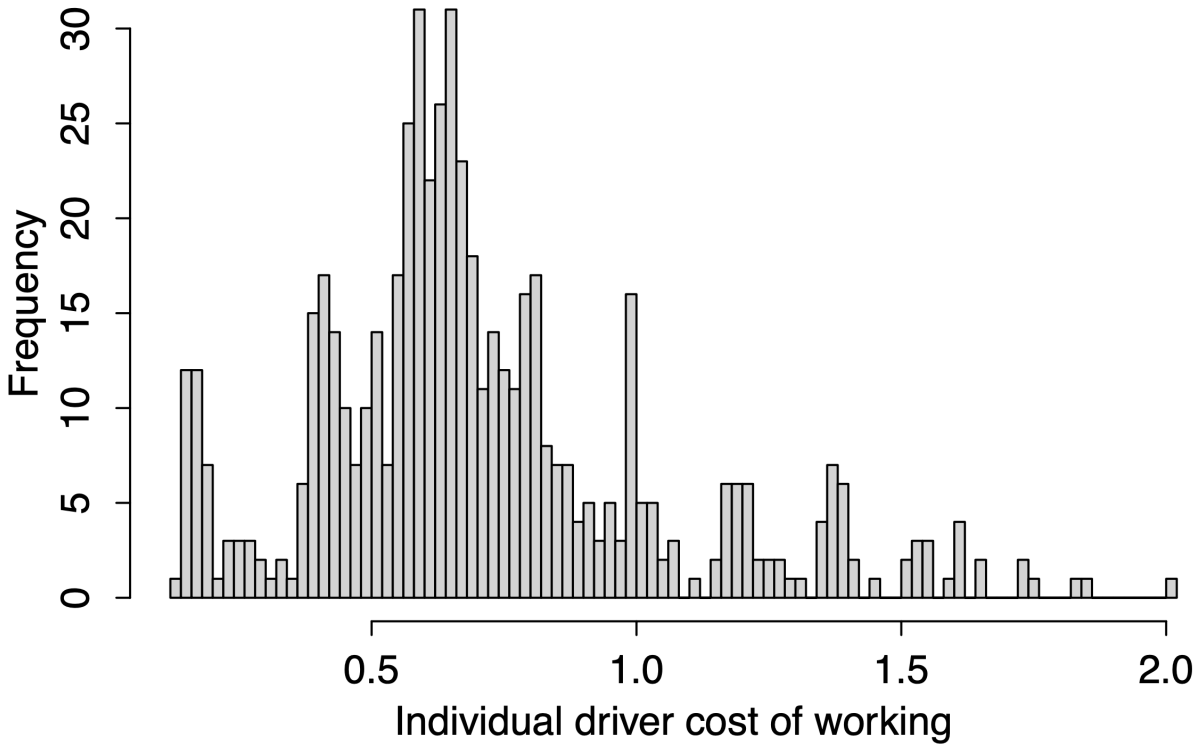
X^{θ}

implementation

Estimation Results

Discount factor	Population distribution of cost	
$\beta = 0.94985$	$\mu = 0.55358$	$\sigma = 0.664725$
(0.00187)	(0.01145)	(0.01197)

$1 in 2 hours
→ 73 cents now



Estimation Results

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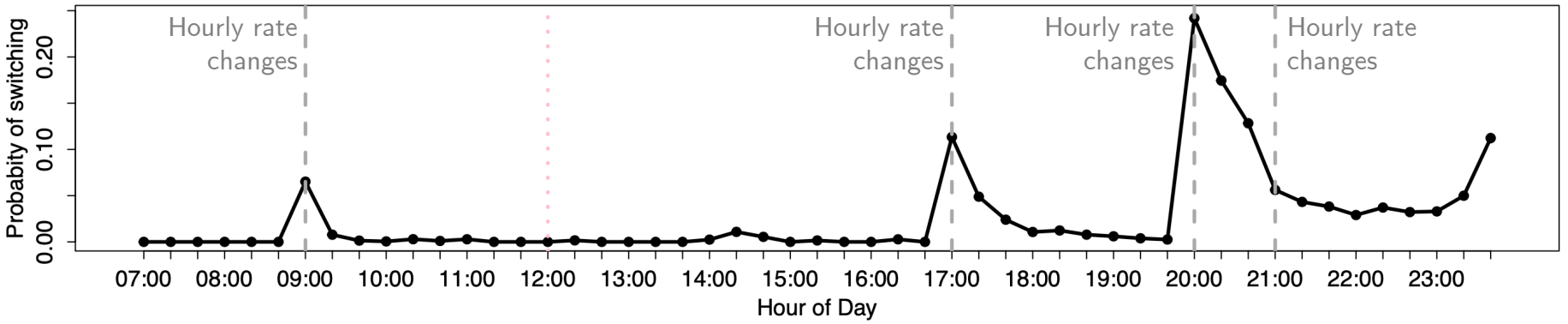
(0.00187)	(0.01145)	(0.01197)

66.59% most days

16.01% never — Fraction of workdays multihoming — 42.23% always

P(switching to B) on average weekday



Counterfactuals Control Multihoming

Firm's Policies

1. **Long-term Capacity**
   Optimal pay scheme

2. **Short-term Capacity**
   Bonuses and delays

City's Regulations

3. Impact of minimum wage policy on drivers' earnings and utilization

Case Study: NYC 2018

Counterfactuals Control Multihoming

Firm's Policies

1. **Long-term Capacity**
   Optimal pay scheme

   Pay per work 25-50% more costly to maintain work

2. **Short-term Capacity**
   Bonuses and delays

   Different policies for different demand situations

City's Regulations

3. Impact of minimum wage policy on drivers' earnings and utilization

   Case Study: NYC 2018

   One policy for all hurts
   (lower earnings, higher idleness)

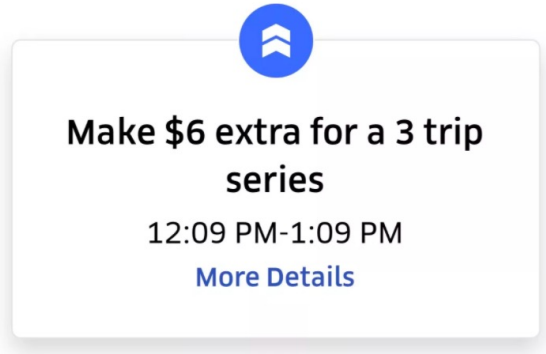
2

Firm's Policies

Managing Short-Term

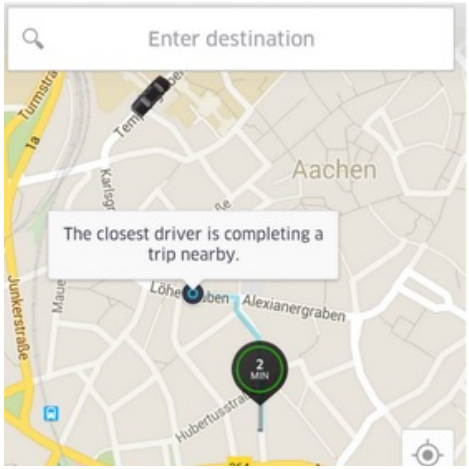
Consecutive Work Bonus

Need to work full hour
to get hourly offer



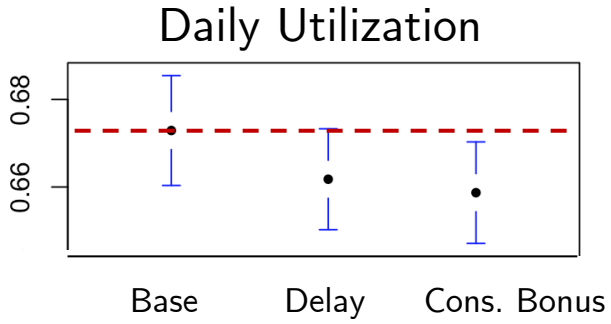
Time Delay

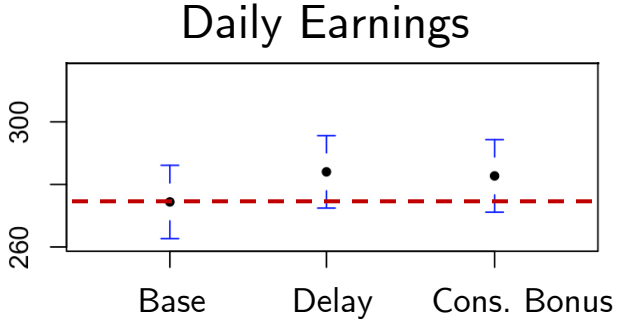
Need to wait 20 mins
Still getting paid work

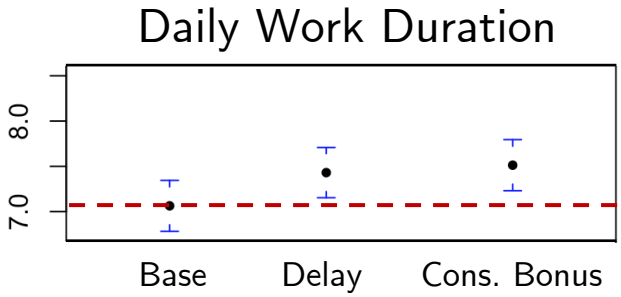


Firm's Policies

Managing Short-Term

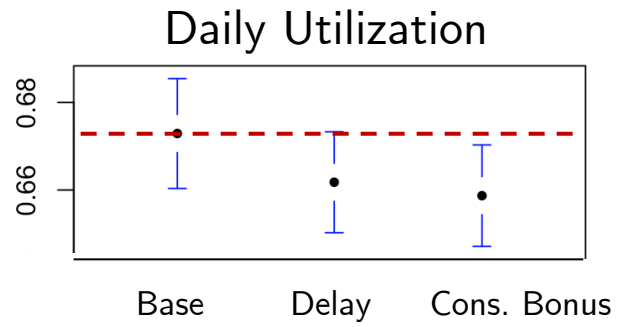


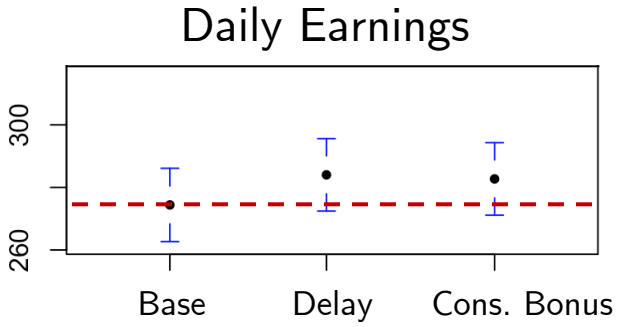


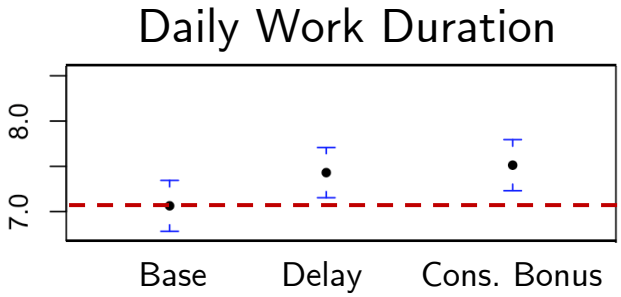


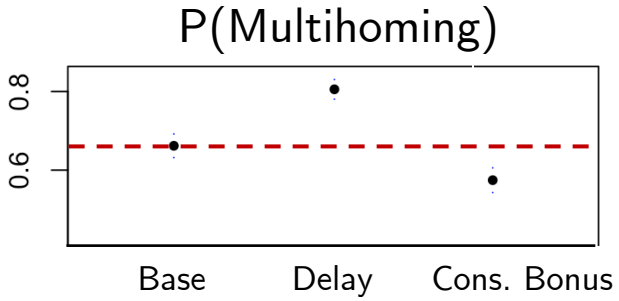
Firm's Policies

Managing Short-Term



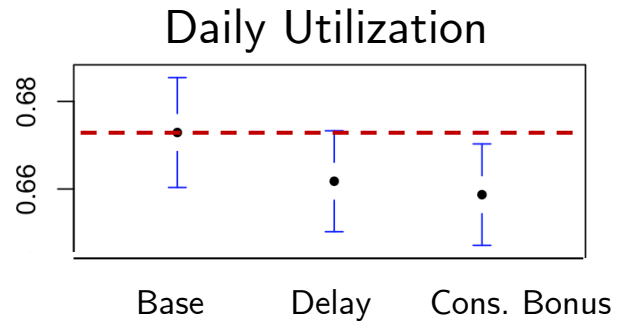


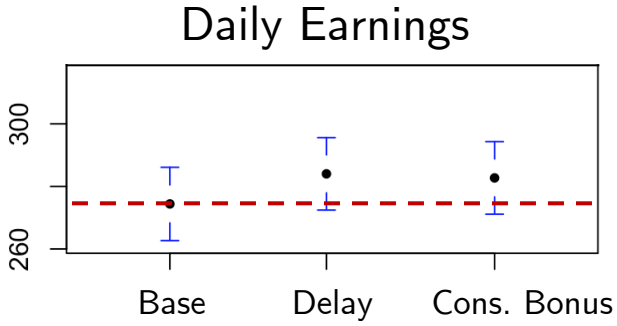


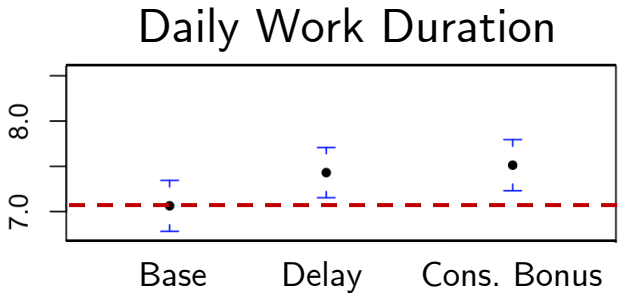


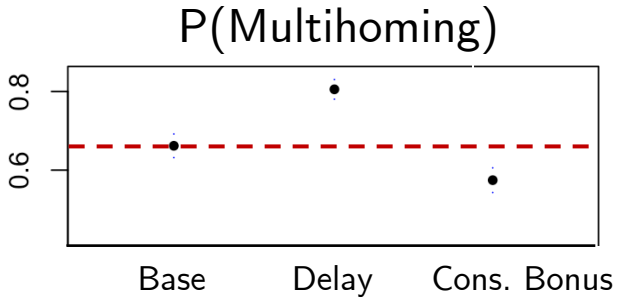
Firm's Policies

Managing Short-Term









Peak Hours

Consecutive Work Bonus

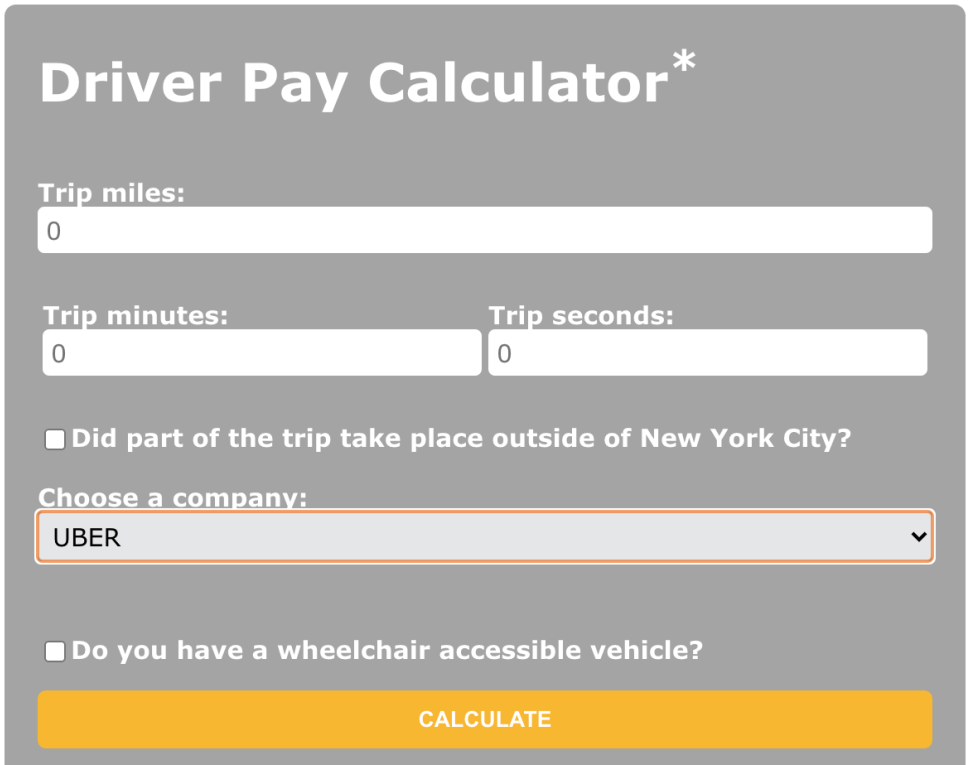
Low Demand

Time Delay

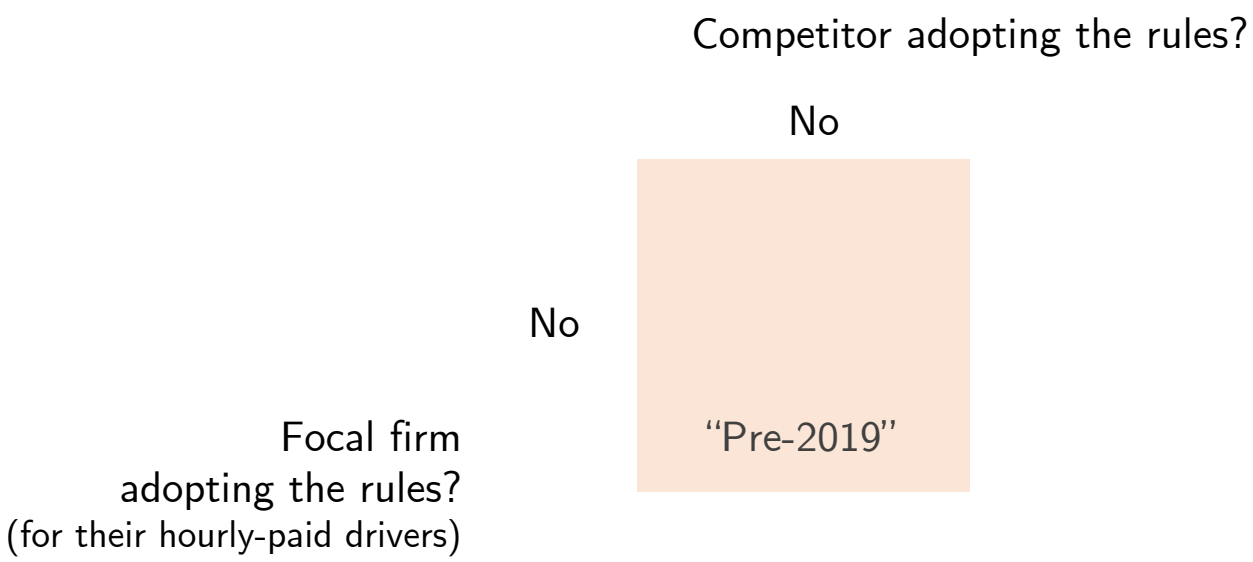
Policy Analysis Driver Income Rules

In December 2018, TLC launched new rules

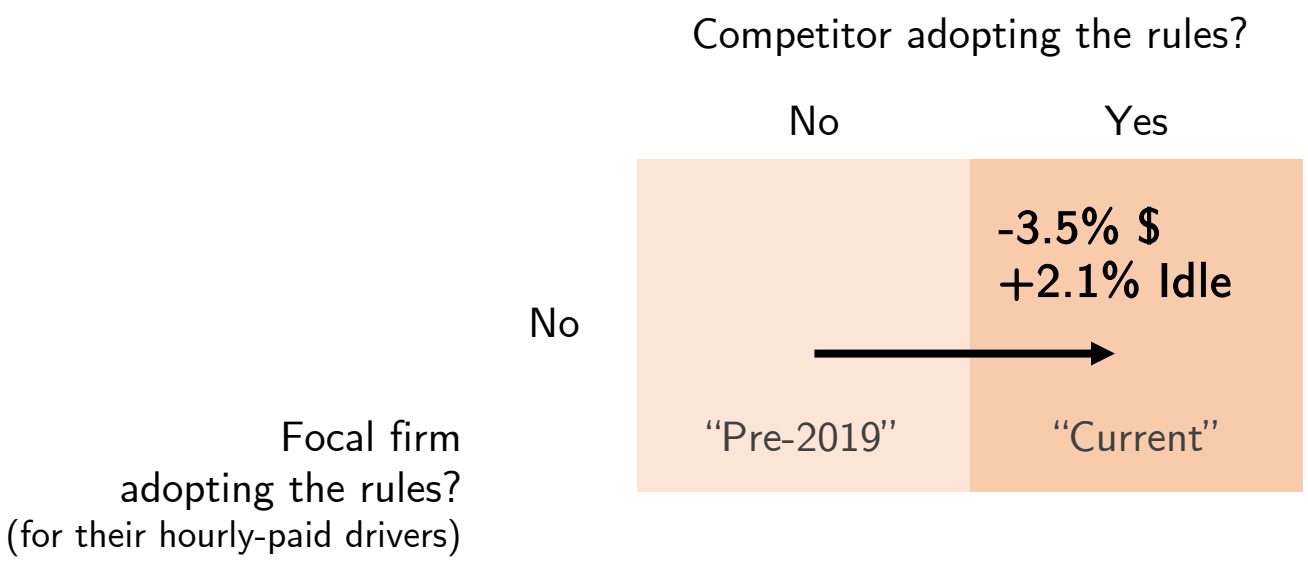
- Overall, drivers should earn **$17.22+ per hour** of working
- Must be paid at least **($1.088 x miles + $0.495 x minutes)**/trip



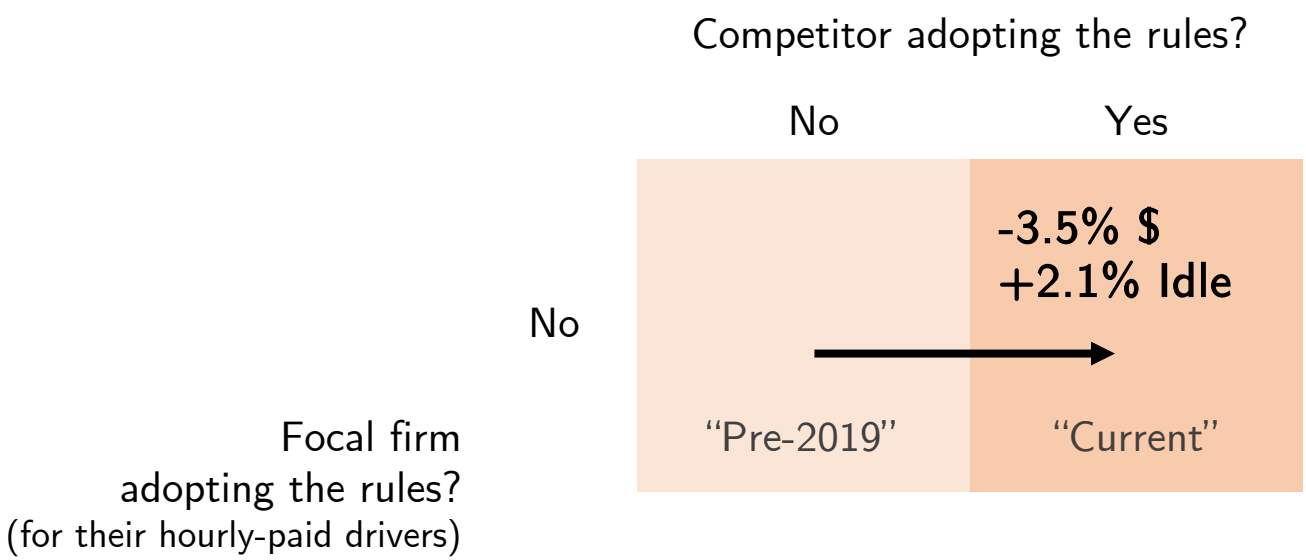
Policy Analysis Driver Income Rules



Policy Analysis Driver Income Rules



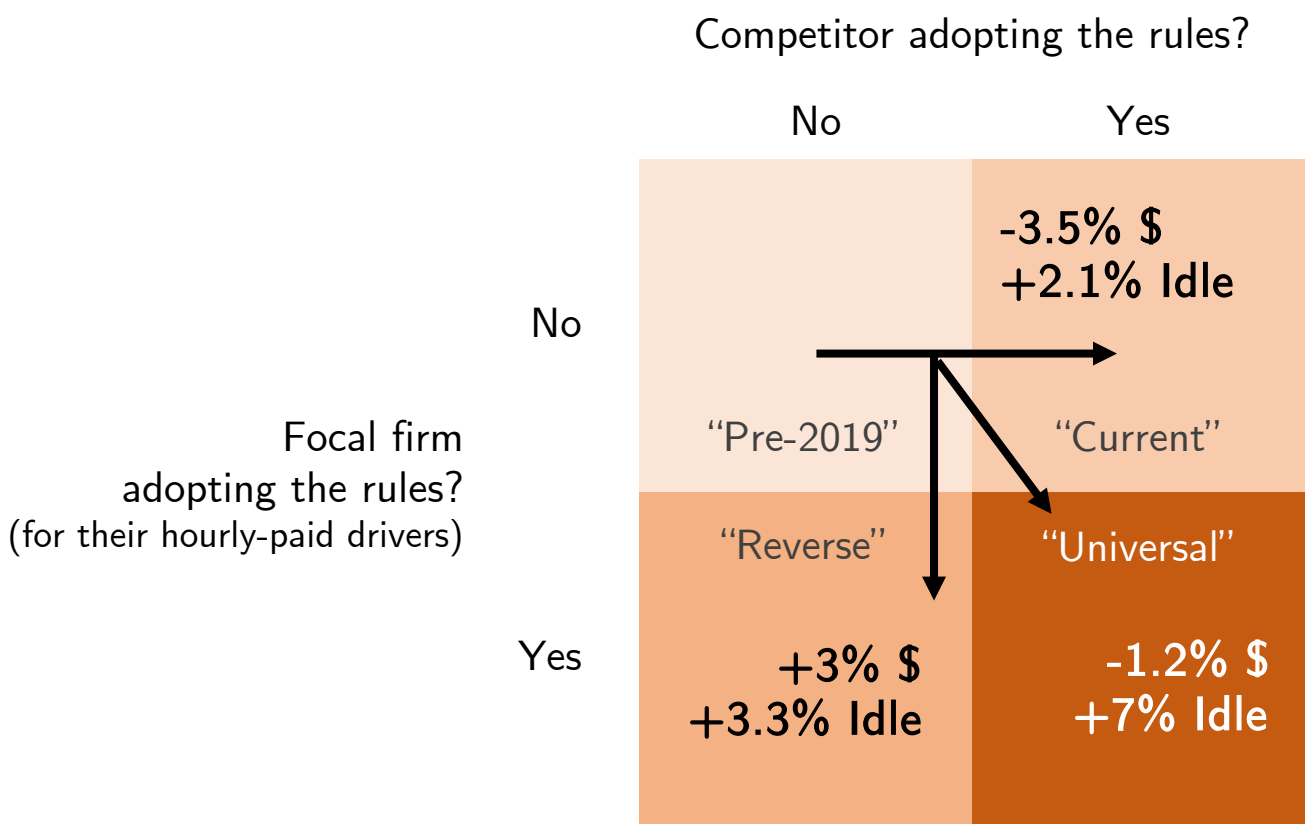
Policy Analysis Driver Income Rules



Drivers: *"Not really. Too many drivers. Too much idle time."*

Fares not necessarily higher (3-5%)
(Parrott, Reich 2018)

Policy Analysis Driver Income Rules



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(Parrott, Reich 2018)

Summary

Managing Multihoming Workers in the Gig Economy

Approach

- Structural model of dynamic decisions
- Work options depend on time/location, dynamic pay
- ML-based simulation-assisted estimation: adversarial estimation

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Findings

- 42% of drivers multihome
- More likely to switch when pay rate changes/utilization is low
- Guaranteed pay: save 25-50% from pay-per-work
- Peak hours: consecutive work bonus to retain drivers
- Low demand: add time delay to nudge earlier departure
- Policy: better predict impact of new policy on workers

Thank you!

Read more: bit.ly/mmwpaper

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