



Managing Multihoming Workers in the Gig Economy



Park Sinchaisri
UC Berkeley



joint work with
Gad Allon, Maxime Cohen, Ken Moon





Uber

lyft

via

DOORDASH

Uber Eats

instacart

seamless

GRUBHUB

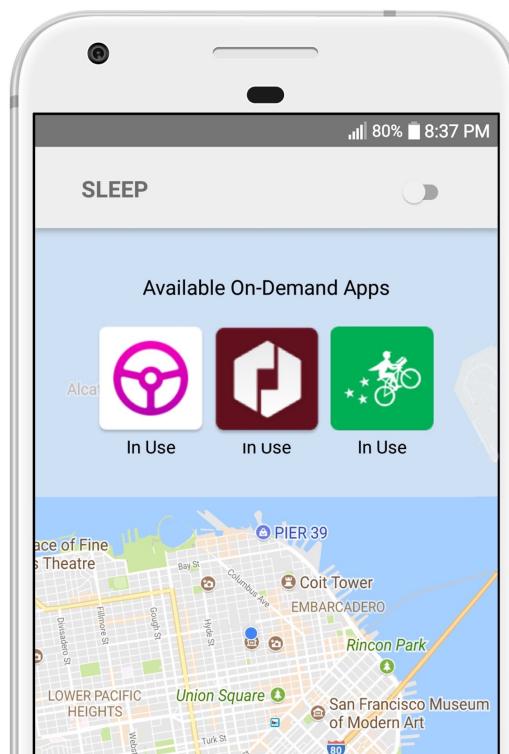
caviar



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

Recruiting Workers is Hard



How workers make
multihoming decisions?

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

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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

\$25/hour
7-9AM

B = Competitor



225 S 4th St
Brooklyn, NY

8:20AM

Context

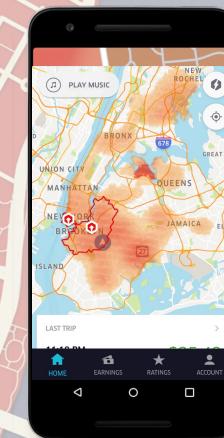
Gig Workers with 2 Options

(ride-hailing platforms)

A = Focal

\$25/hour
7-9AM

B = Competitor



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



18 E Broadway
New York, NY

drop-off

•
4 Berry St
Brooklyn, 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

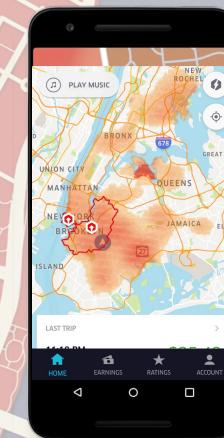
(ride-hailing platforms)

A = Focal

\$15/hour
9-11AM

Avg. Surge
+75%

B = Competitor



4 Berry St
Brooklyn, NY

9:05AM

Context

Gig Workers with 2 Options

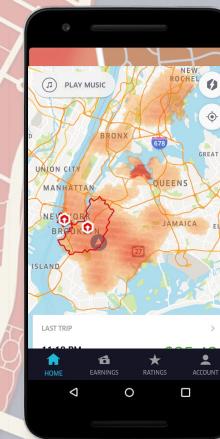
(ride-hailing platforms)

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4 Berry St
Brooklyn, NY

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 (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

Trip records data

35M ride-hailing trips

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



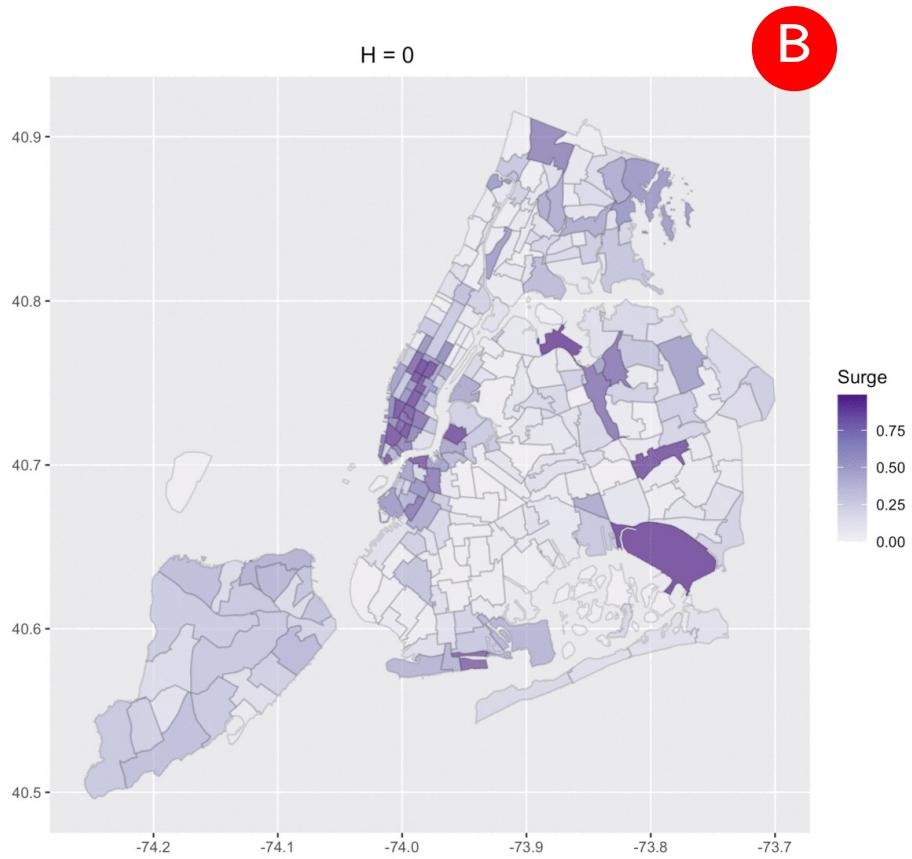
Price breakdowns

- Pay per work

B

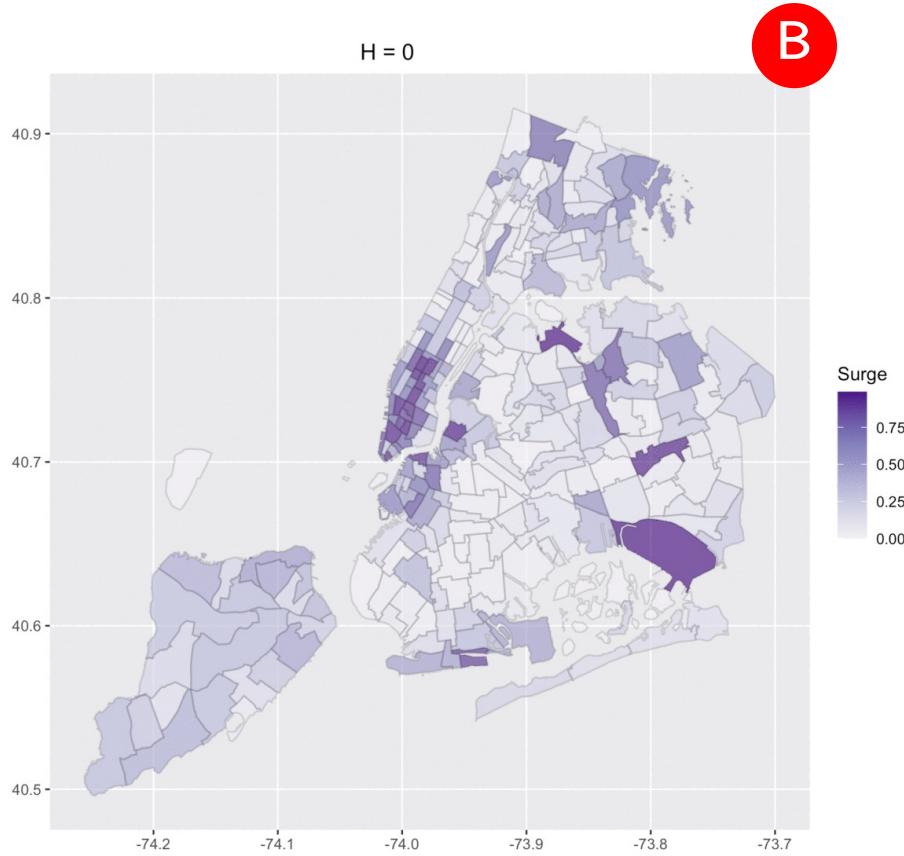
Temporal/Spatial Variations

$P(\text{Supply shortage on competitor})$

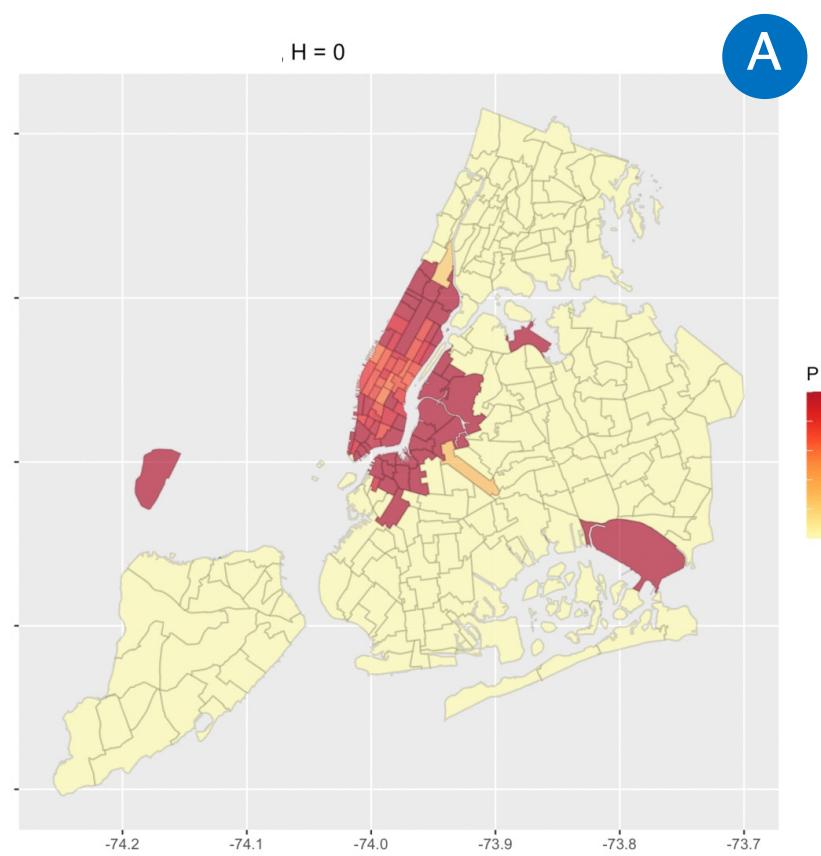


Temporal/Spatial Variations

$P(\text{Supply shortage on competitor})$

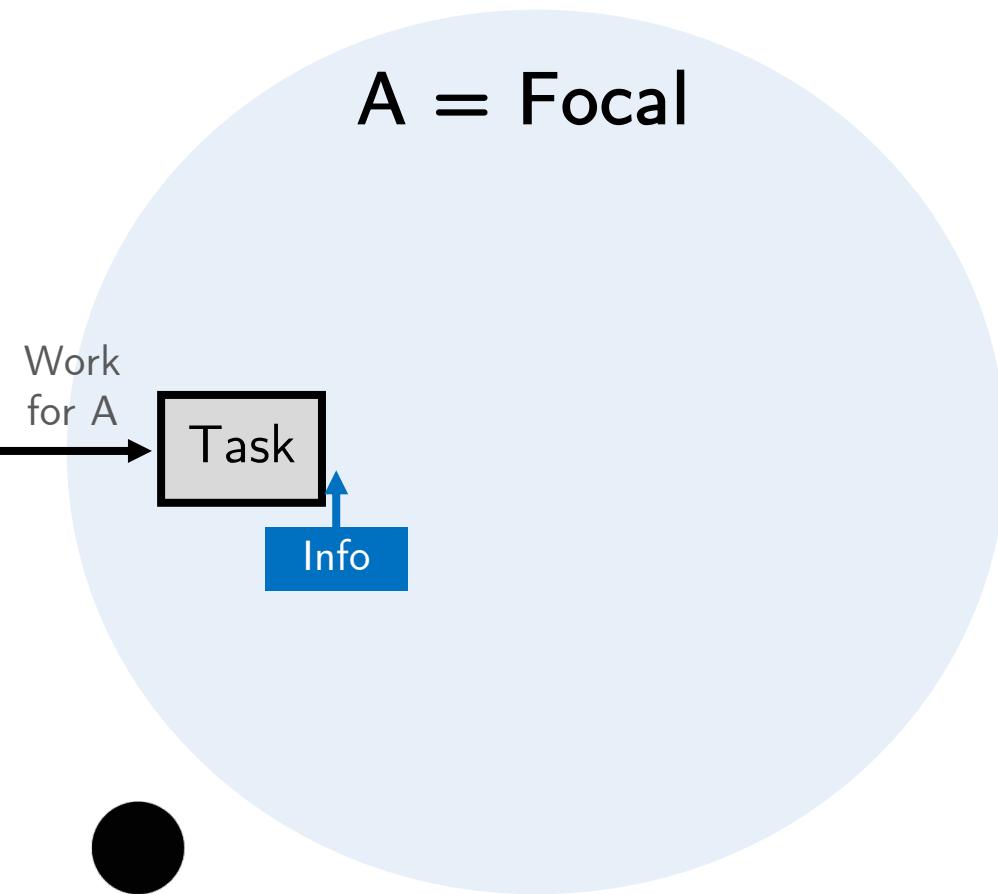


$P(\text{Leaving focal firm})$



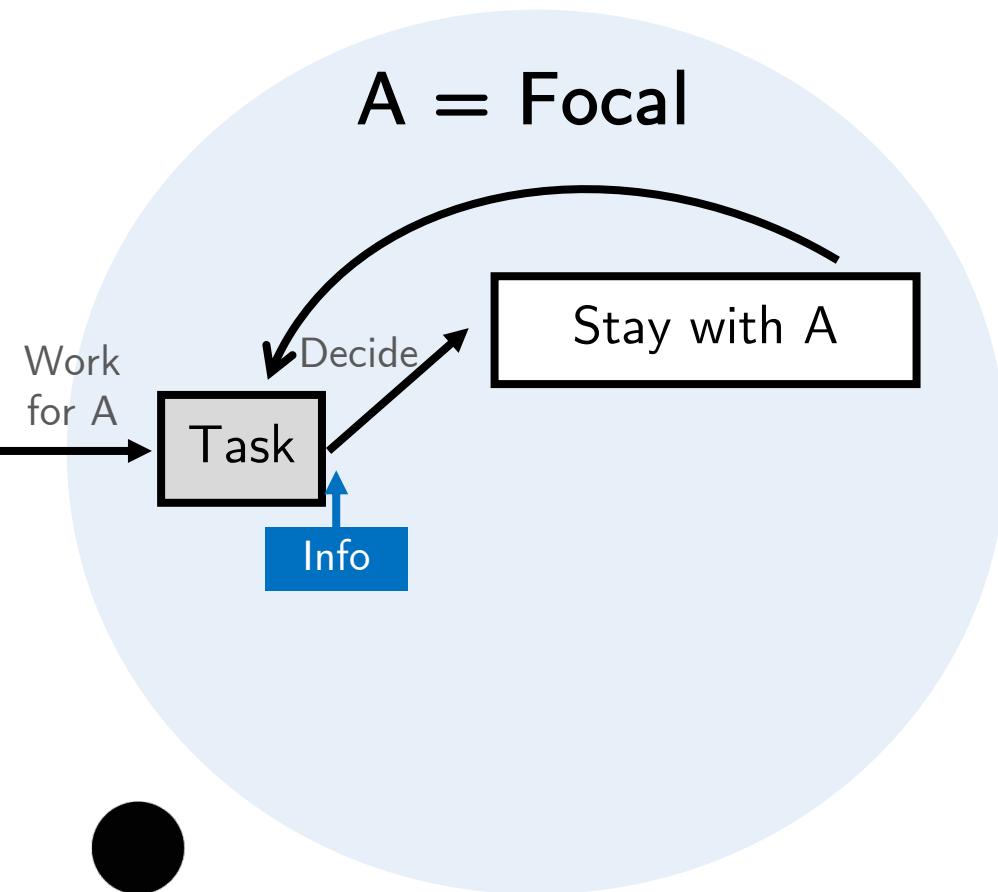
Our Model

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



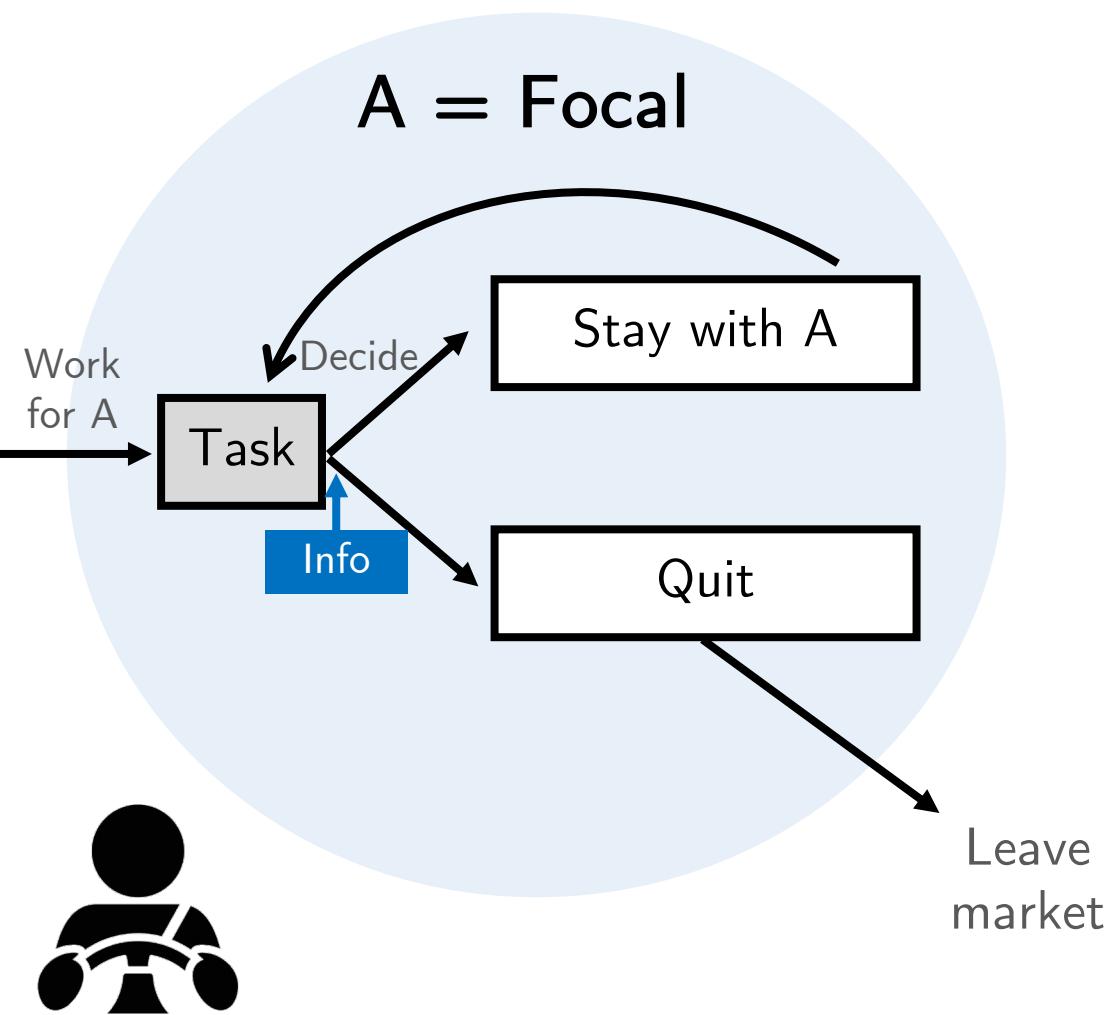
Our Model

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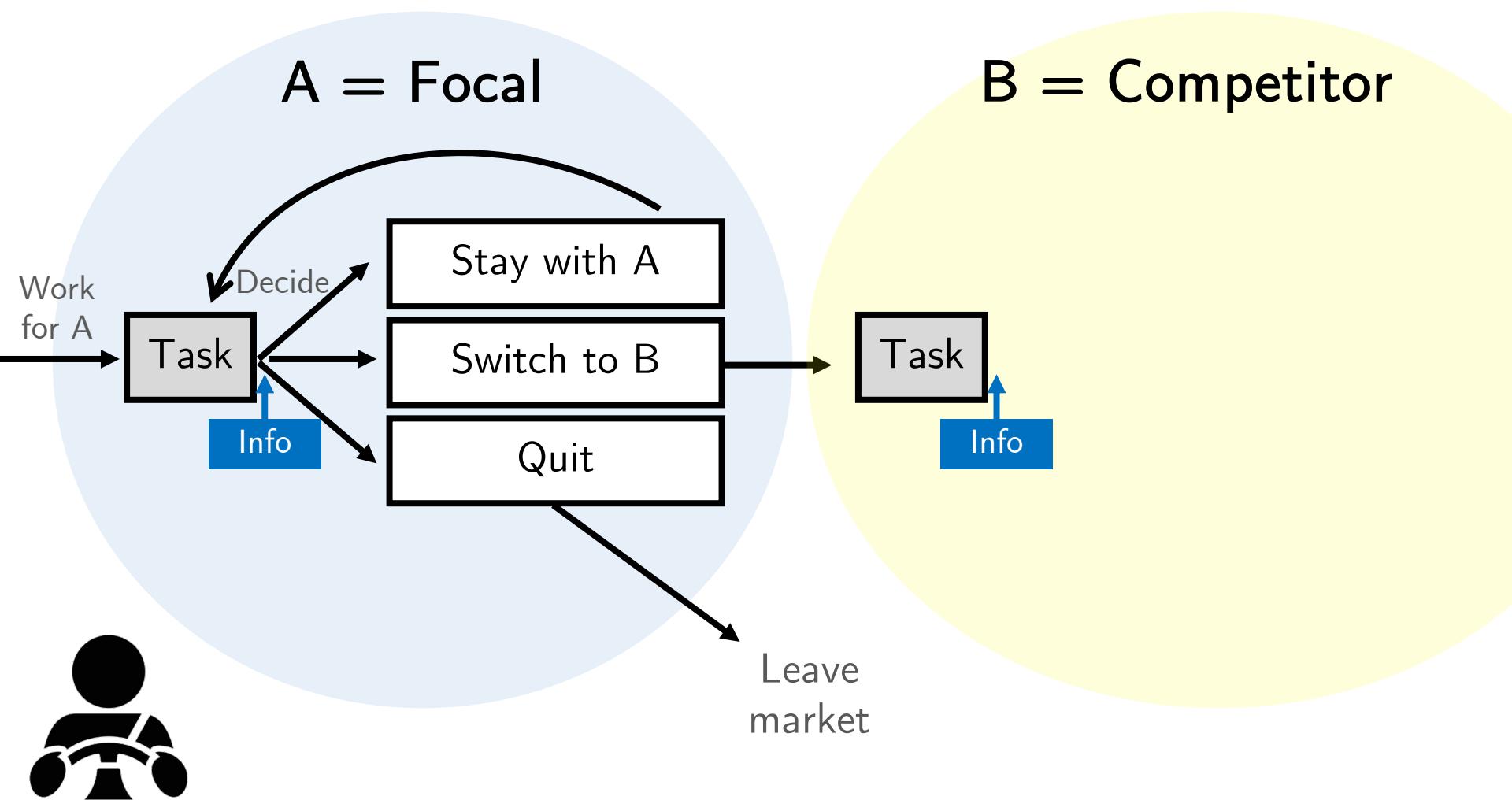
Our Model

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



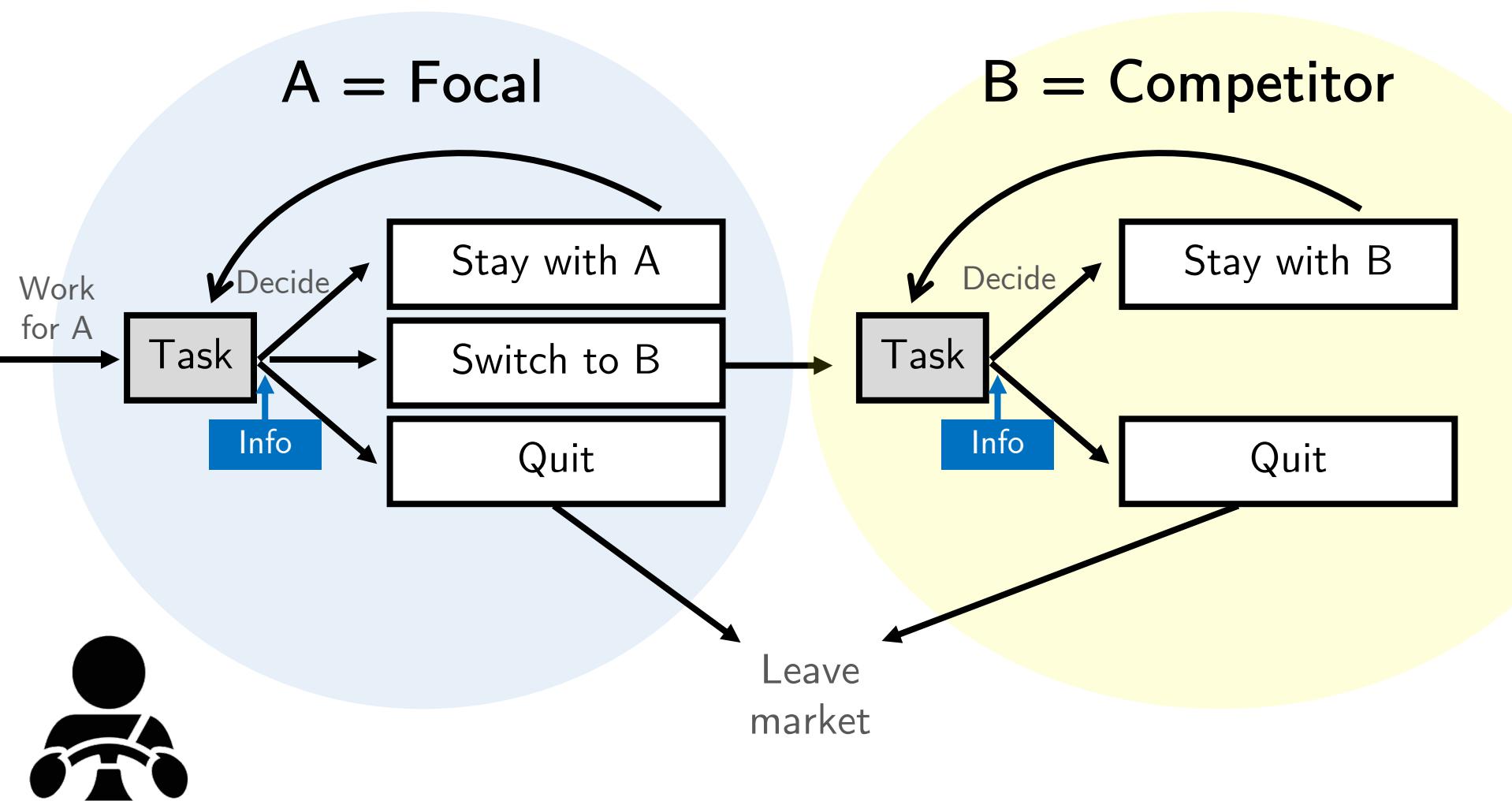
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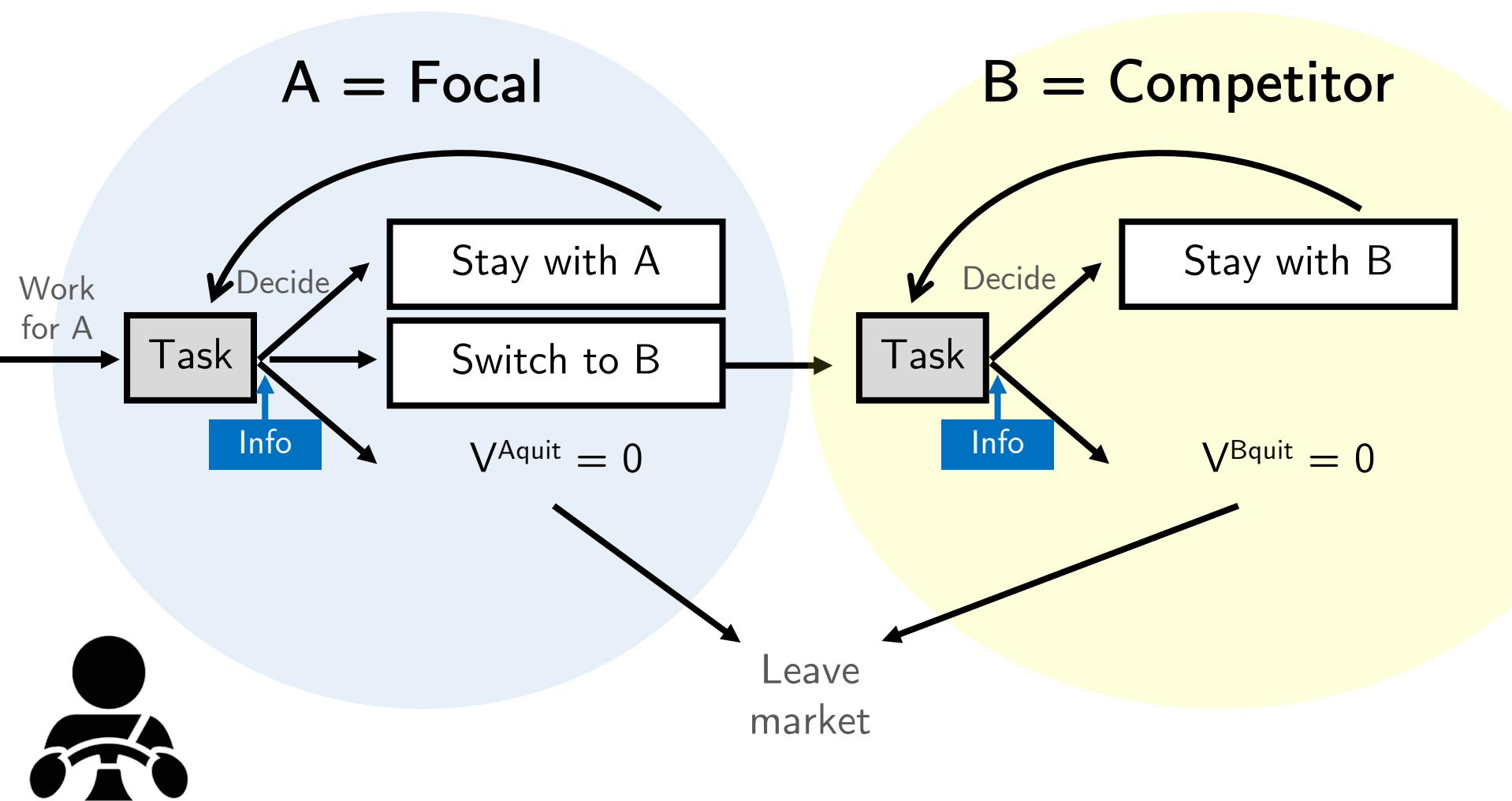
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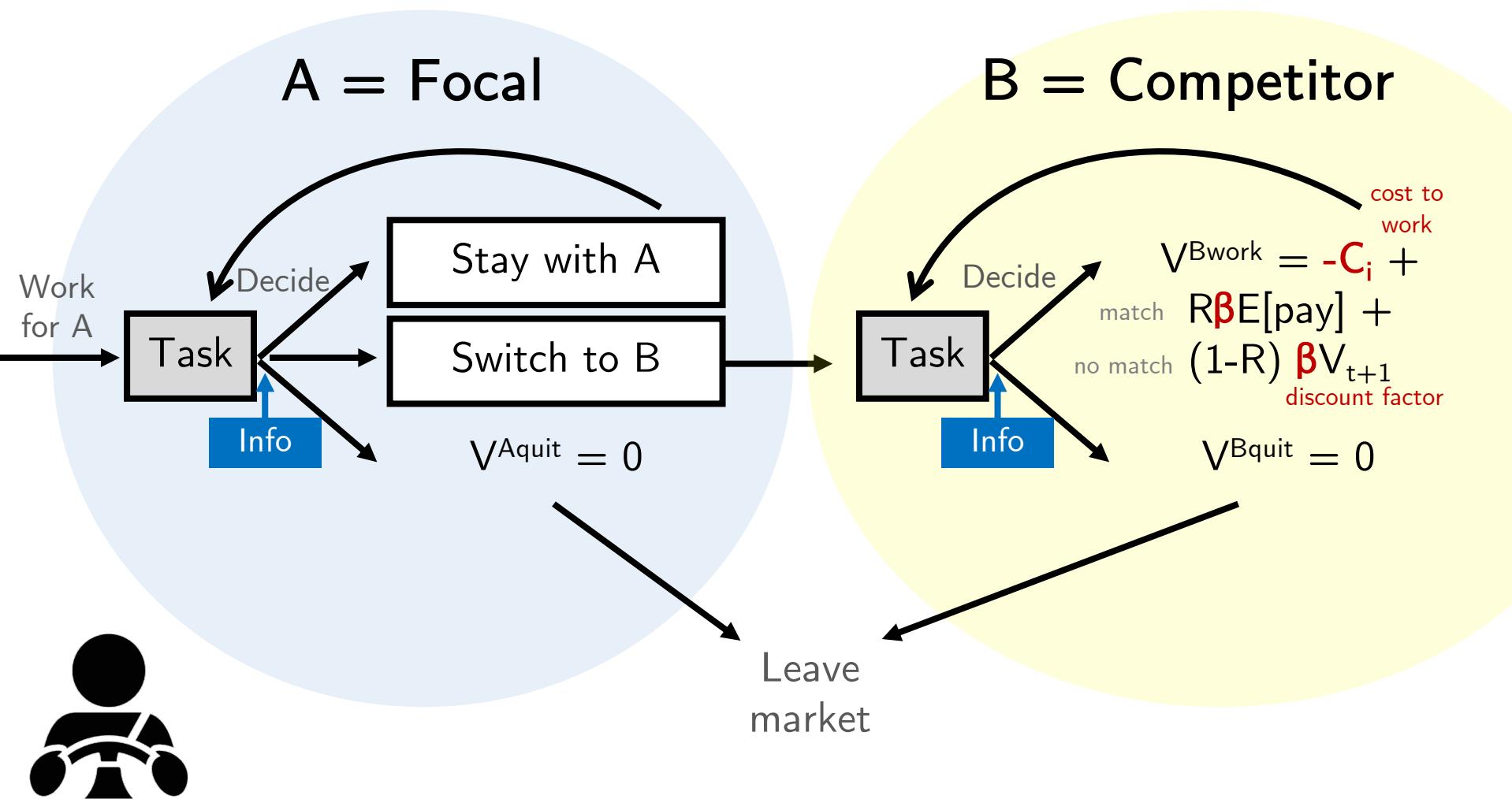
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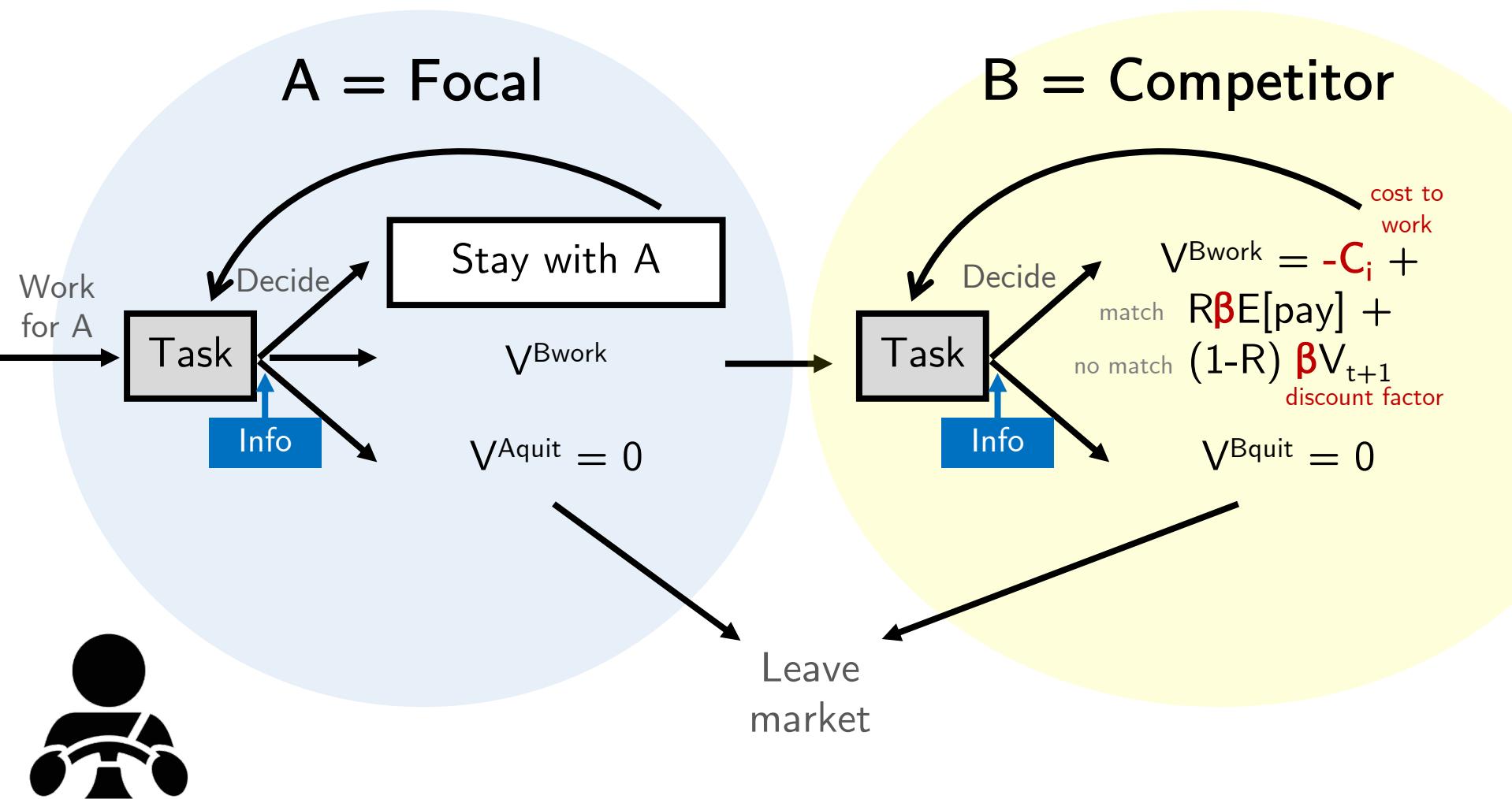
Our Model

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



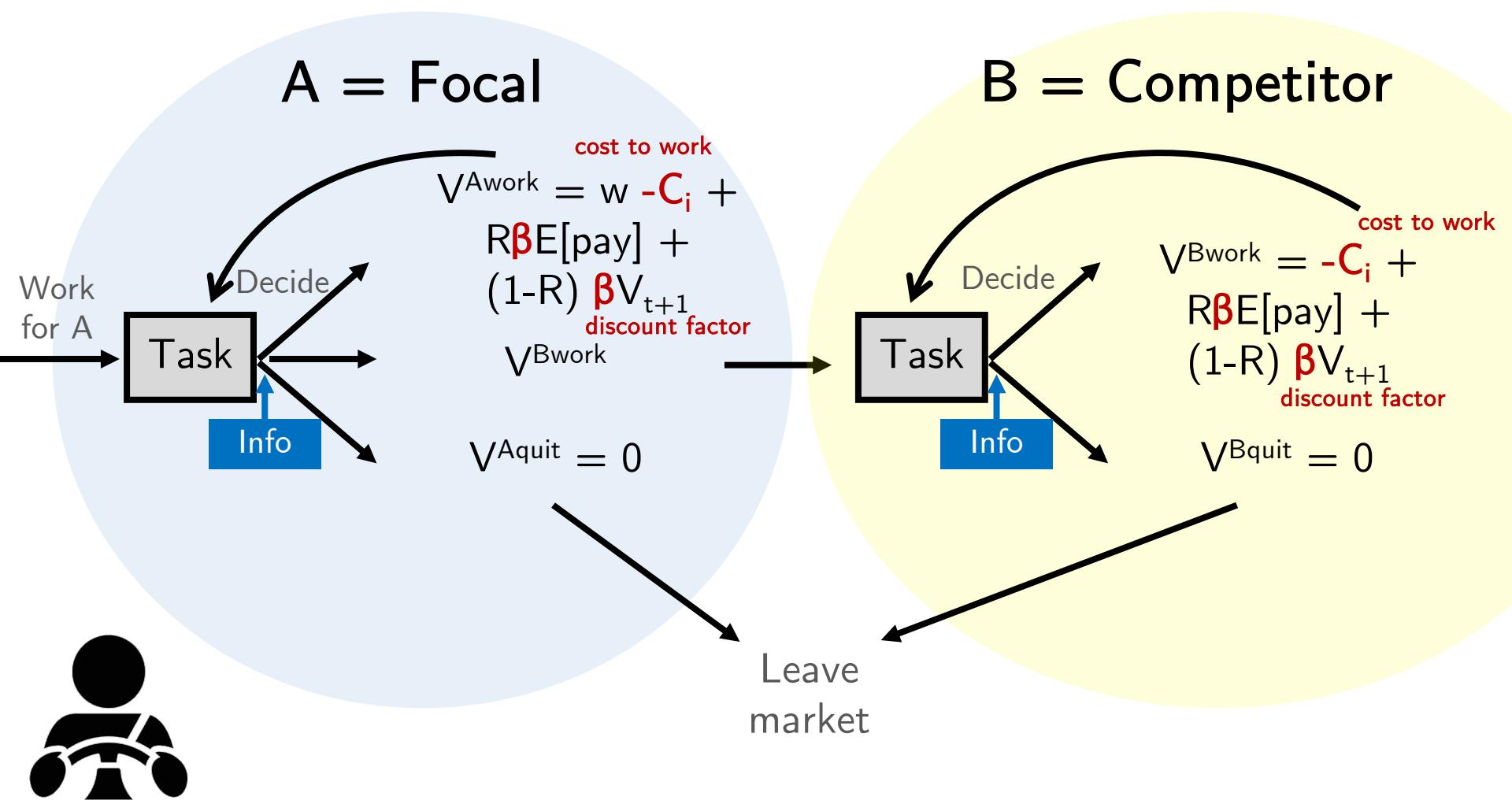
Our Model

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



Our Model

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



Our Model

Drivers' Parameters

homogeneous

$$\beta$$

discount / forward-looking factor

heterogeneous

$$C_i$$

cost of working for a unit time interval

$$C_1$$



$$C_2$$



$$C_3$$



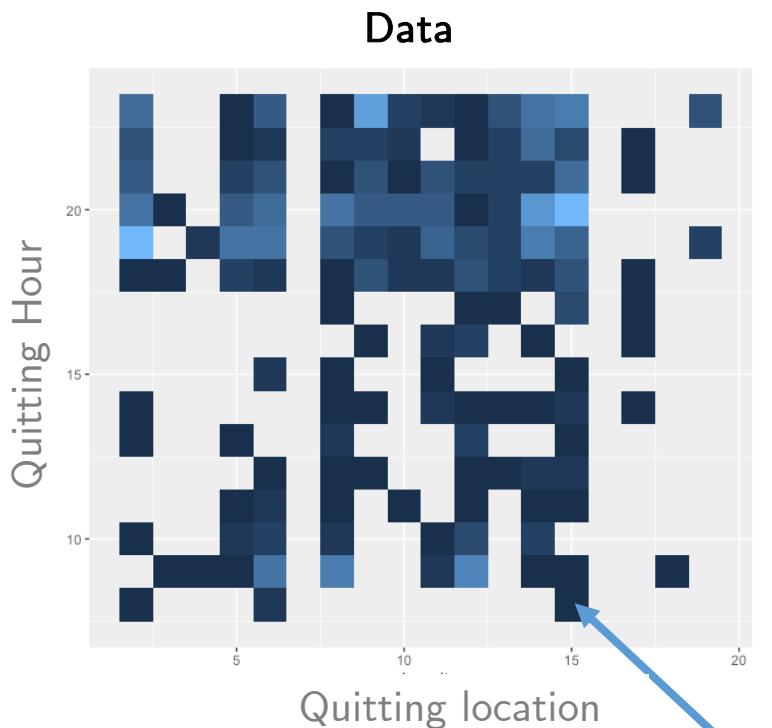
$$C_4$$



\sim 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)

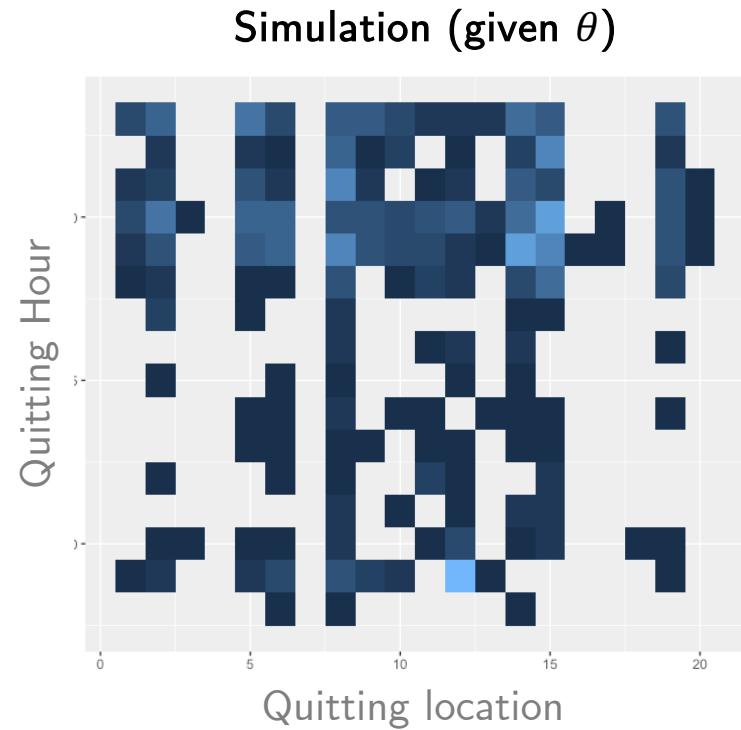
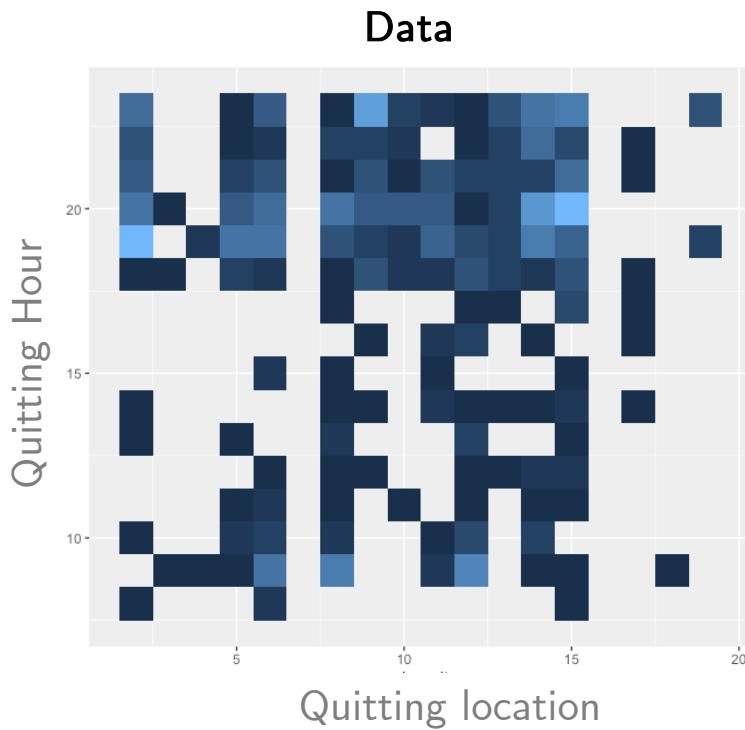
Location: 1 of 20 regions

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

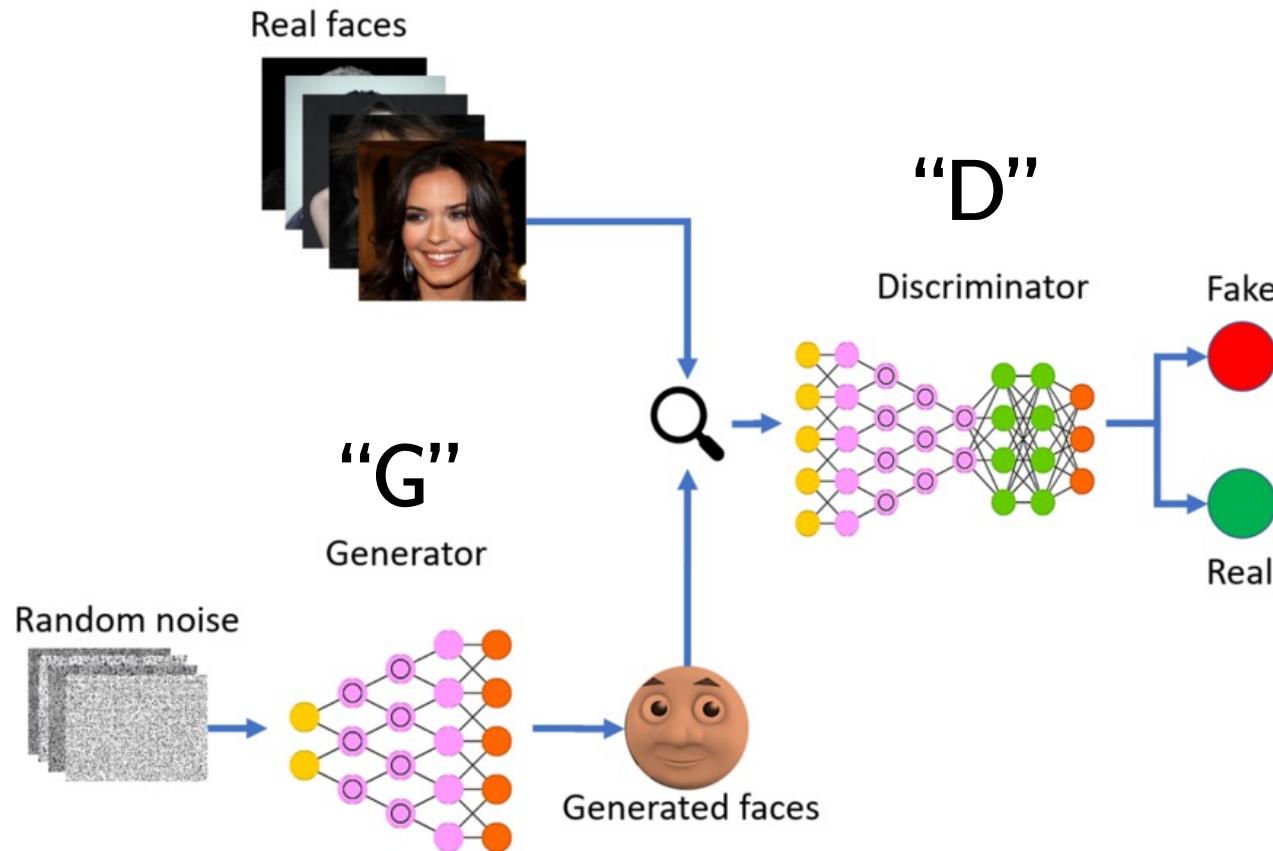
Each cell (H,L) is fraction of drivers quitting at location L and hour H : $f_{L,H}$

Simulation-Assisted Estimation

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

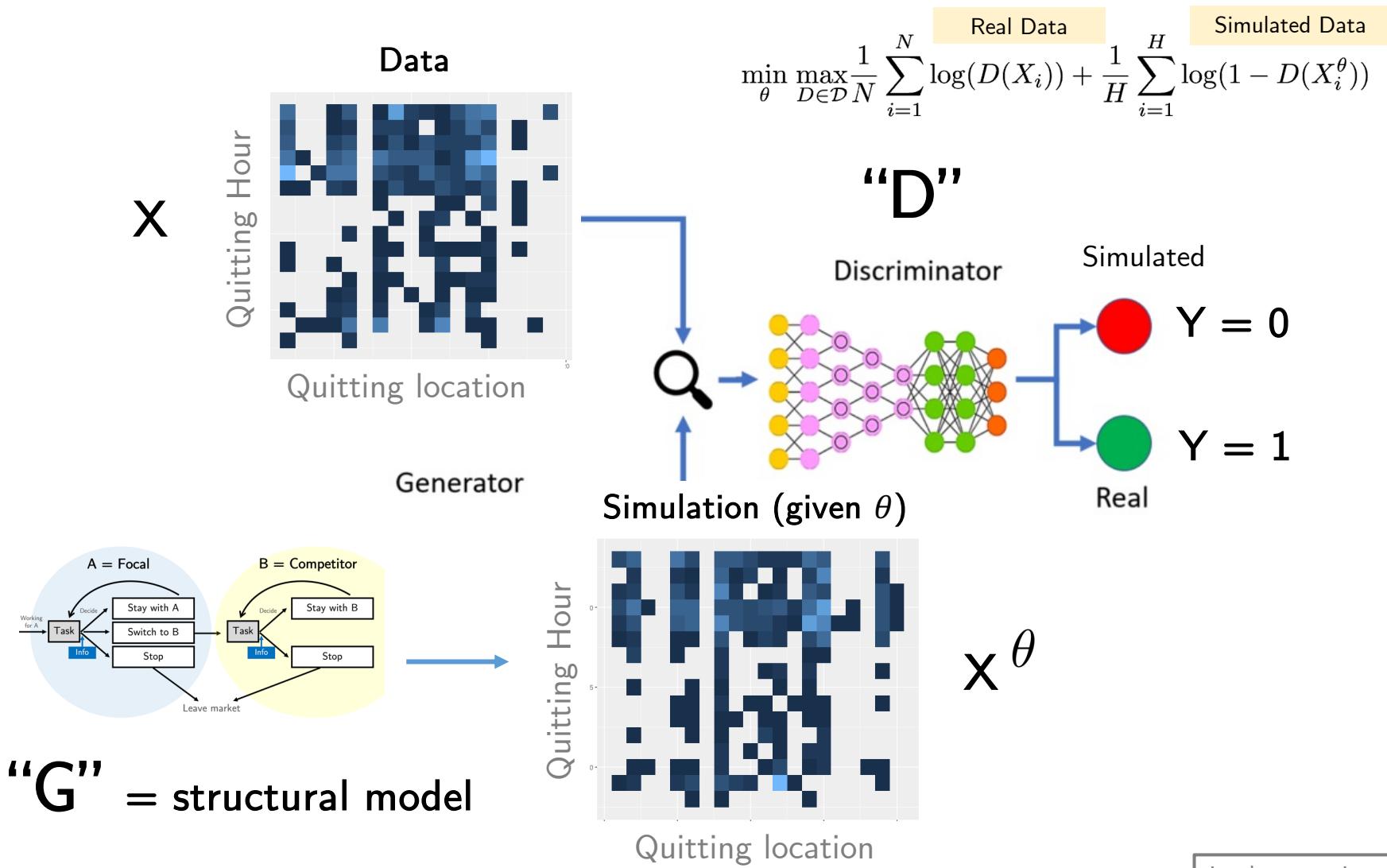


Gen. Adversarial Networks



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

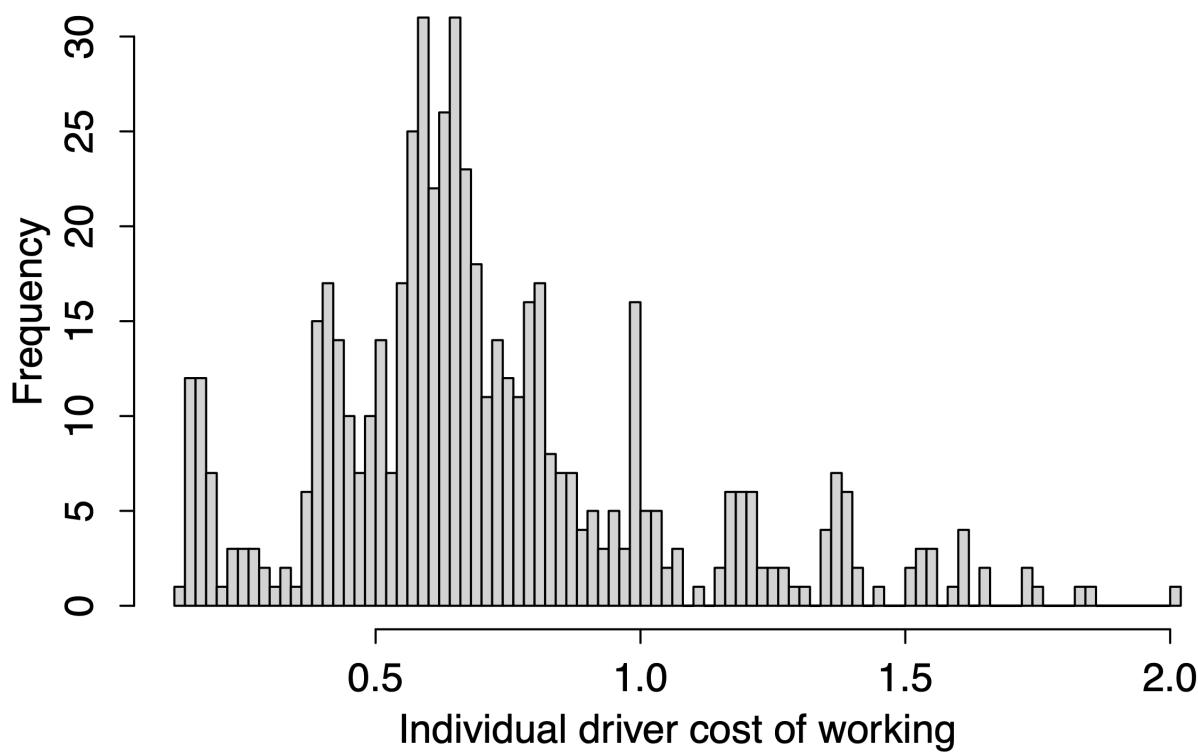
Adversarial Estimation



Estimation Results

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

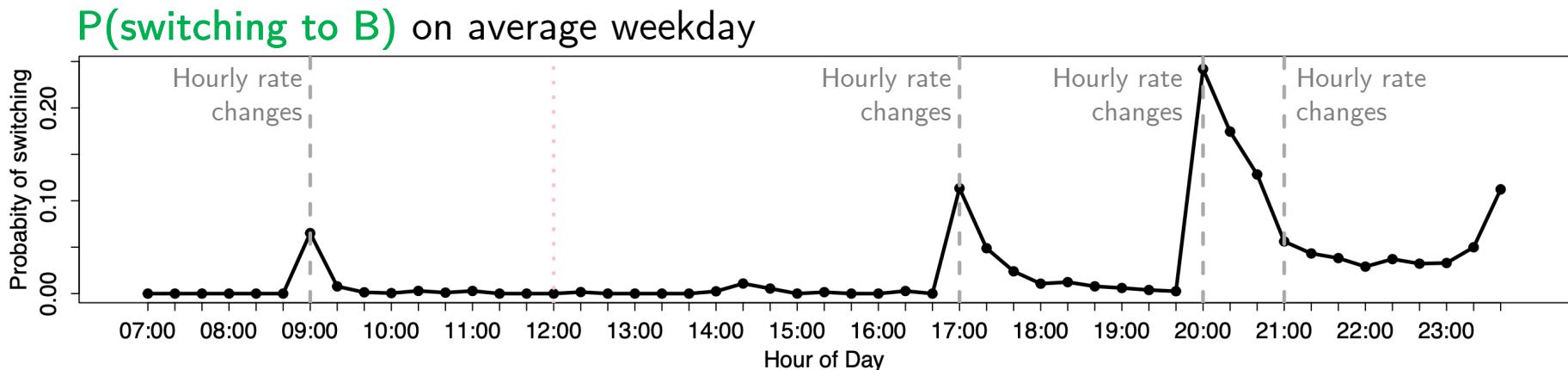
\$1 in 2 hours
→ 73 cents now



Estimation Results

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

16.01% never Fraction of workdays multihoming 42.23% always
 66.59% most days



Counterfactuals

Control Multihoming

Firm's Policies

- 1 Long-term Capacity
Optimal pay scheme
- 2 Short-term Capacity
Bonuses and delays

City's Regulations

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

Impact of minimum
wage policy on
drivers' earnings
and utilization

Case Study: NYC 2018

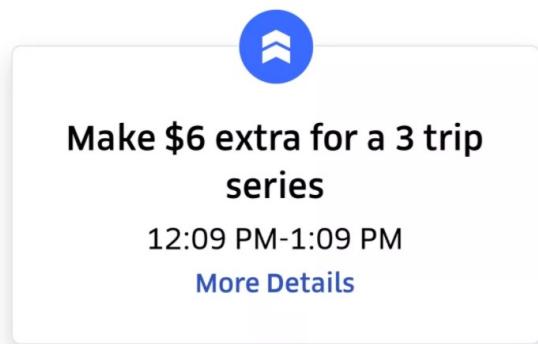
One policy for all hurts
(lower earnings, higher idleness)

Firm's Policies

Managing Short-Term

Consecutive Work Bonus

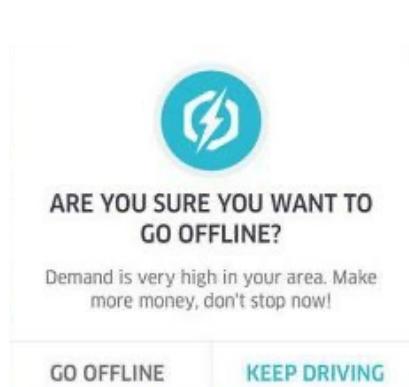
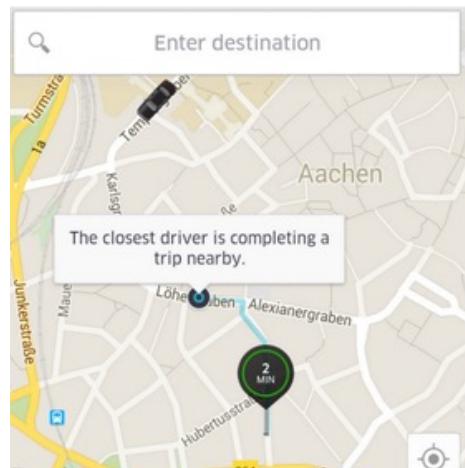
Need to work full hour
to get hourly offer



A screenshot of an Uber driver app notification. It features a blue circular icon with a white double arrow symbol. Below it, the text reads: "Make \$6 extra for a 3 trip series" and "12:09 PM-1:09 PM". At the bottom is a blue "More Details" button.

Time Delay

Need to wait 20 mins
Still getting paid work

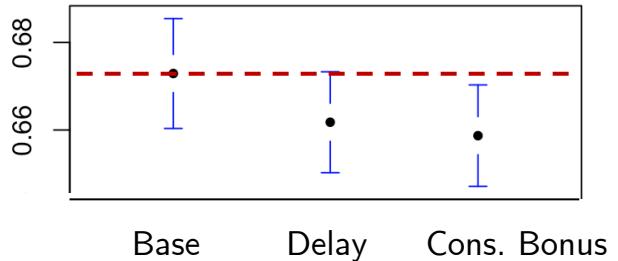


A screenshot of an Uber driver app overlay asking if the driver wants to go offline. It features a teal circular icon with a white lightning bolt symbol. The text reads: "ARE YOU SURE YOU WANT TO GO OFFLINE? Demand is very high in your area. Make more money, don't stop now!" At the bottom are two buttons: "GO OFFLINE" and "KEEP DRIVING".

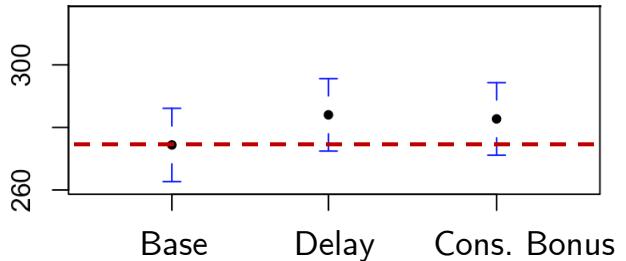
Firm's Policies

Managing Short-Term

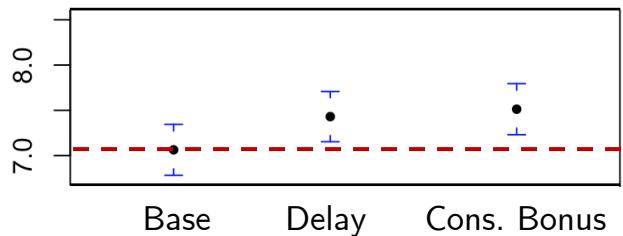
Daily Utilization



Daily Earnings



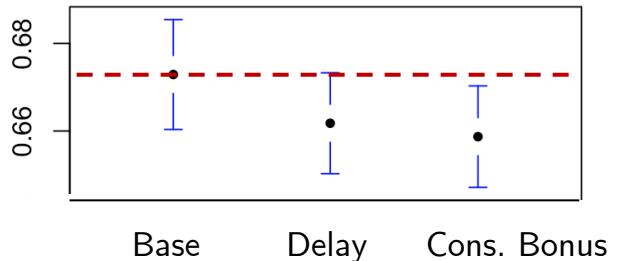
Daily Work Duration



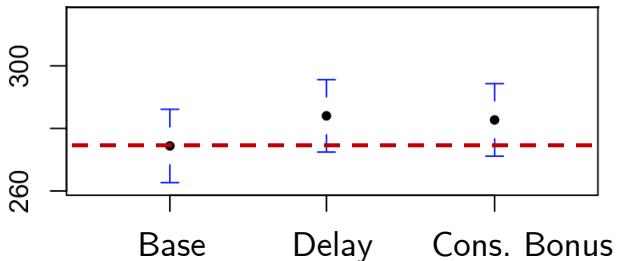
Firm's Policies

Managing Short-Term

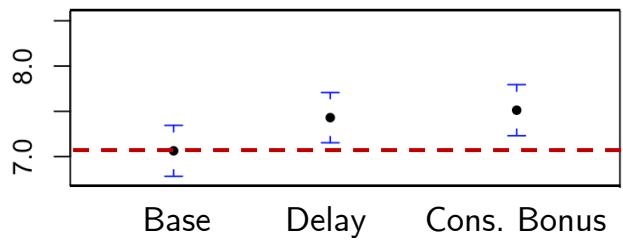
Daily Utilization



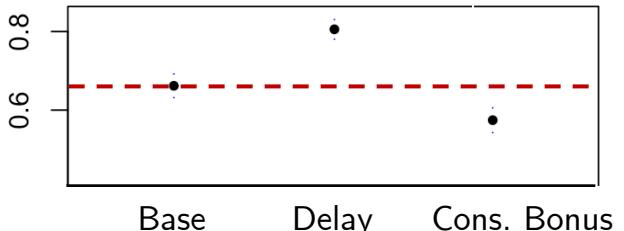
Daily Earnings



Daily Work Duration



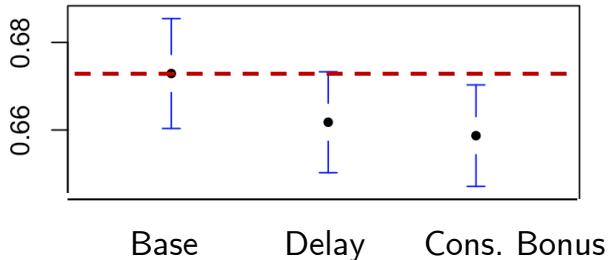
P(Multihoming)



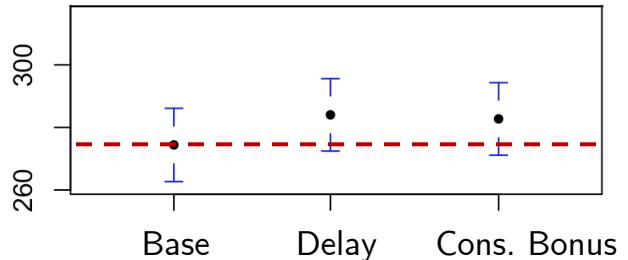
Firm's Policies

Managing Short-Term

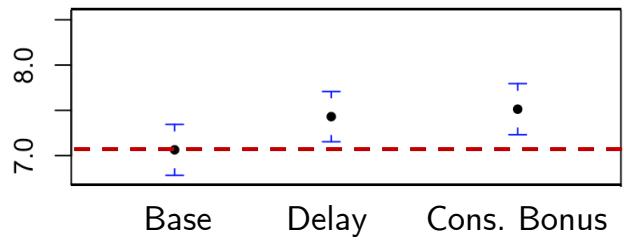
Daily Utilization



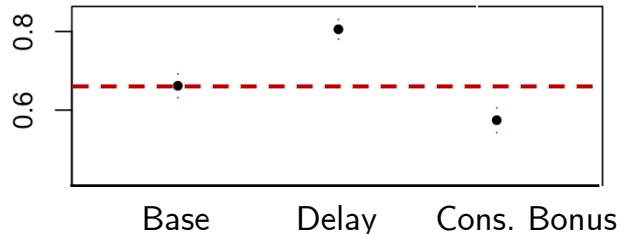
Daily Earnings



Daily Work Duration



P(Multihoming)



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 **($\$1.088 \times \text{miles} + \$0.495 \times \text{minutes}$) / trip**

Driver Pay Calculator*

Trip miles:

Trip minutes: Trip seconds:

Did part of the trip take place outside of New York City?

Choose a company:

Do you have a wheelchair accessible vehicle?

CALCULATE

Policy Analysis

Driver Income Rules

Competitor adopting the rules?

No

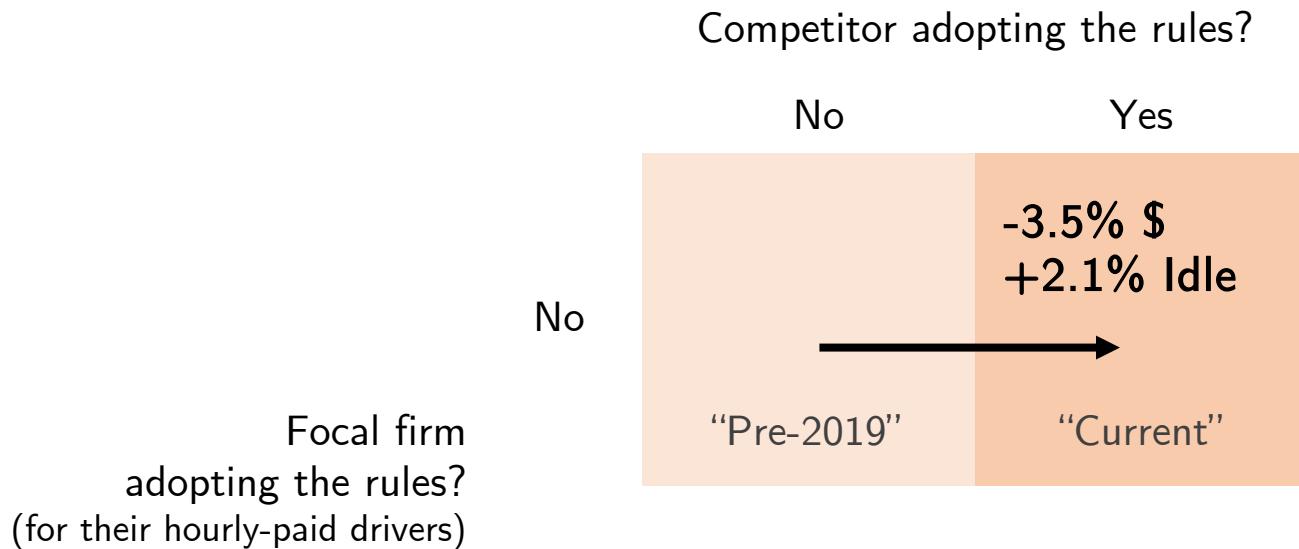
No

Focal firm
adopting the rules?
(for their hourly-paid drivers)

“Pre-2019”

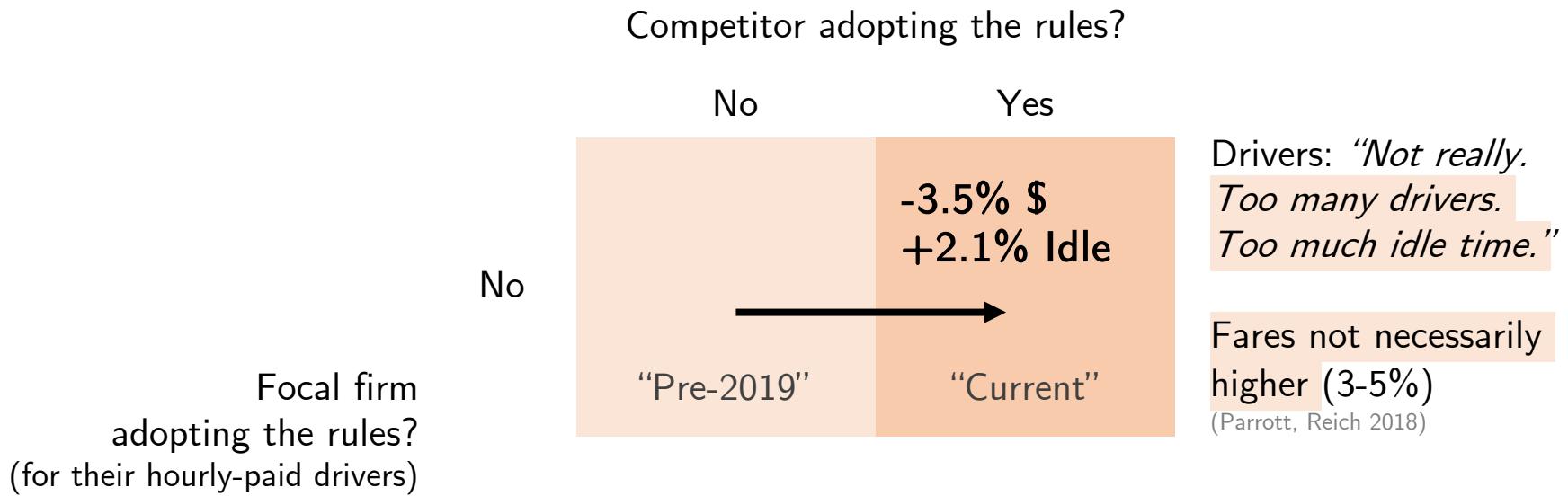
Policy Analysis

Driver Income Rules



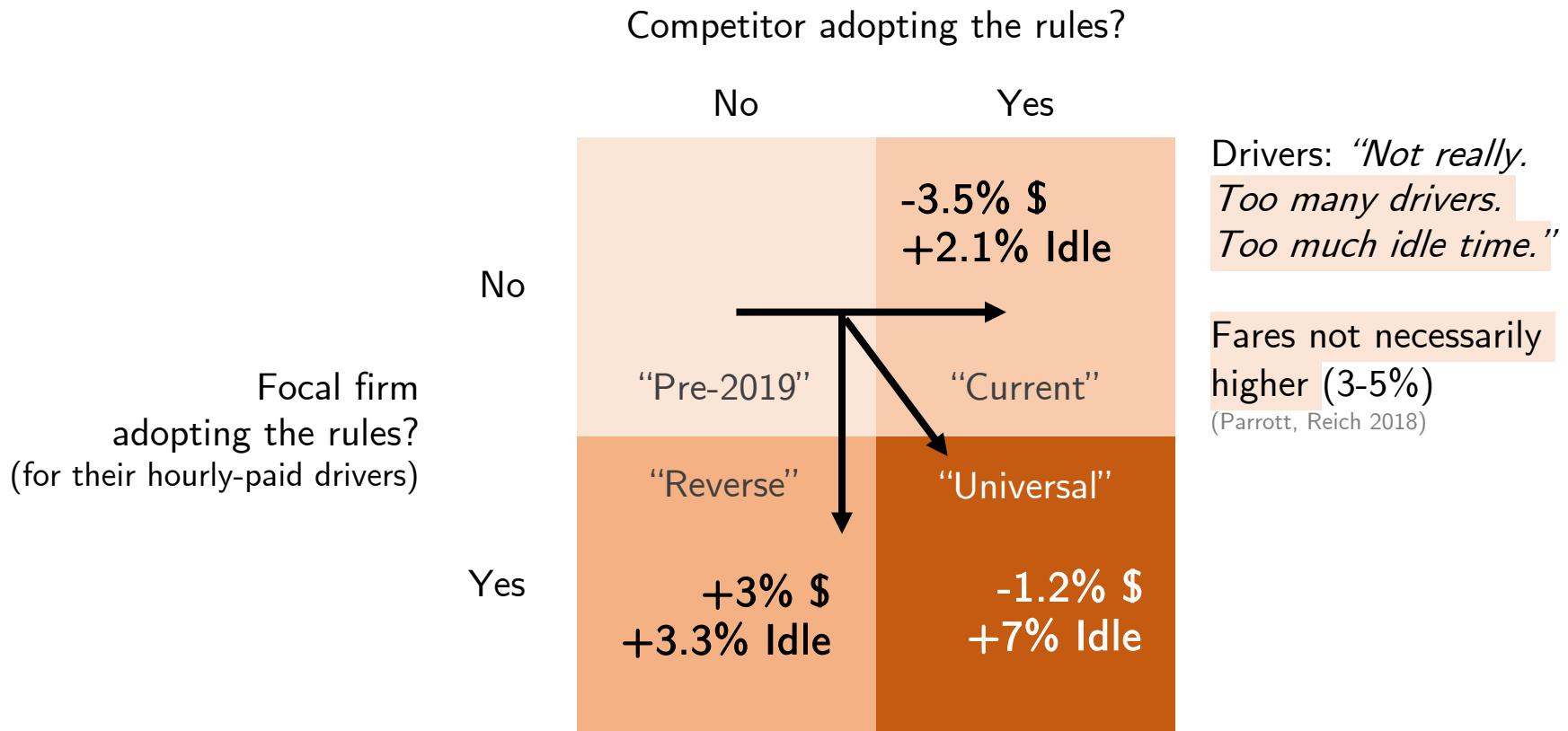
Policy Analysis

Driver Income Rules



Policy Analysis

Driver Income Rules



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

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](http://bit.ly/mmwpaper)