

Managing Multihoming Workers in the Gig Economy



Park Sinchaisri
UC Berkeley



joint work with
Gad Allon, Maxime Cohen, Ken Moon

Multihoming Workers



Multihoming Workers



caviar

GRUBHUB

seamless

goPuff

DOORDASH

Uber Eats

instacart

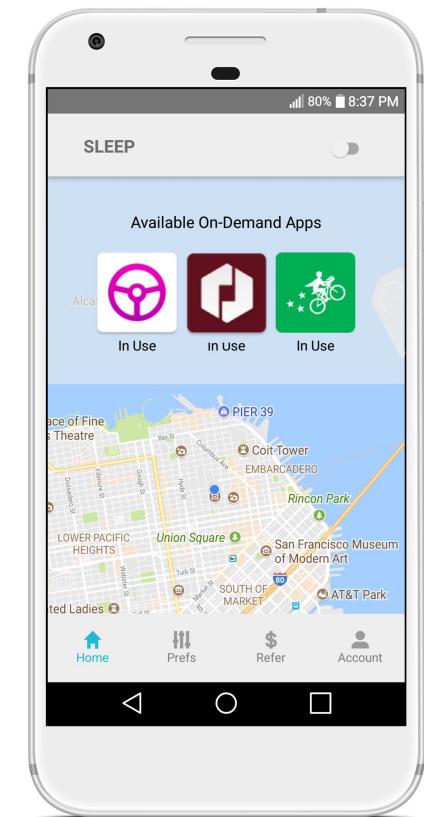
Postmates

Uber

lyft

VIA

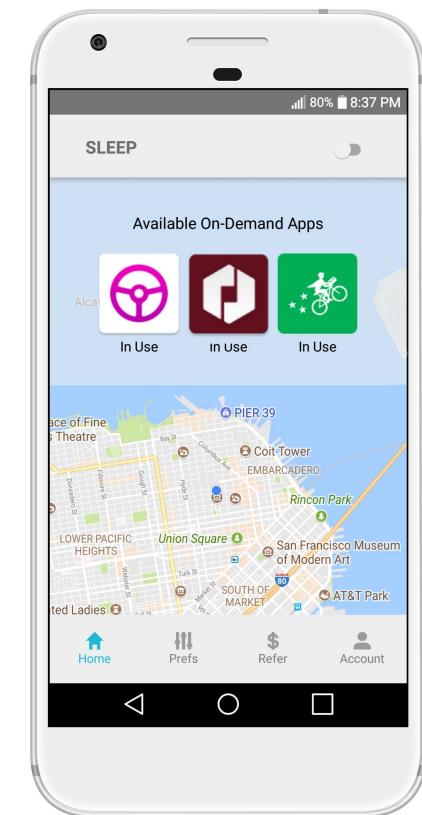
Multihoming Workers



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



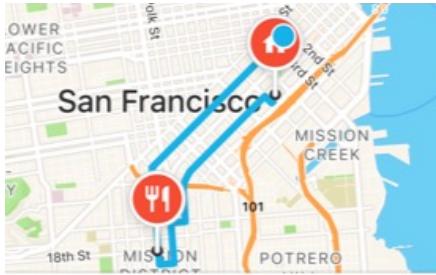
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How should platforms compete for multihoming workers?



Mission Chinese Food
\$22.78 subtotal (2 items)

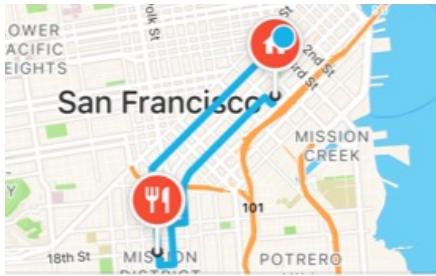
BUSY PAY: +\$1.50

4.1 miles total

Accept Order



How should platforms
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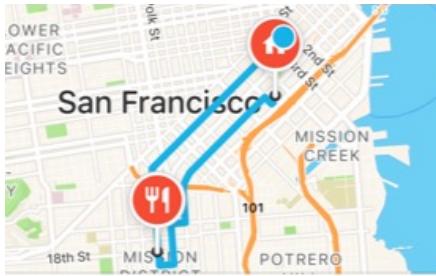
Make \$6 extra for a 3 trip series

12:09 PM-1:09 PM

[More Details](#)

Uber

How should platforms compete for multihoming workers?



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 DOORDASH



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12:09 PM-1:09 PM

[More Details](#)

Uber

The New York Times

DoorDash, Shifting Business Model, Will Offer Drivers Hourly Pay

The company said the option would give couriers greater choice. It could also help DoorDash find people who will make less desirable deliveries.

How should platforms compete for multihoming workers?

**How workers make
multihoming decisions?**



**How should platforms
compete for multihoming workers?**

Context Ride-Hailing w/ Diff. Pay

A = Focal

B = Competitor

Context Ride-Hailing w/ Diff. Pay

A = Focal

B = Competitor

dynamic
guaranteed hourly
pay

(e.g., \$25/hour if online
between 7-9am)

Context Ride-Hailing w/ Diff. Pay

A = Focal

dynamic
guaranteed hourly
pay

(e.g., \$25/hour if online
between 7-9am)

B = Competitor

dynamic
per-trip
pay

(e.g., base fare
+ extra \$/minute
+ extra \$/distance)

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

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\$25/hour
7-9AM

B = Competitor



225 S 4th St
Brooklyn, NY

8:20AM

Context

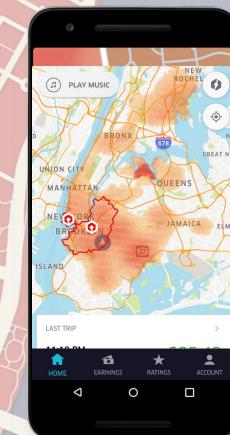
Gig Workers with 2 Options

(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

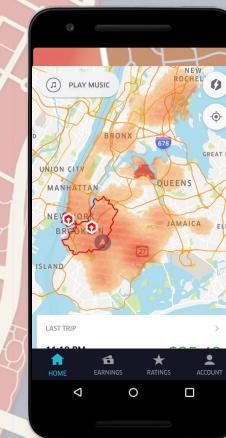
(ride-hailing platforms)

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)

A = Focal

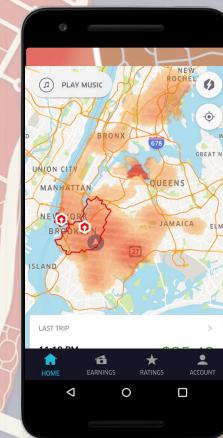
\$15/hour
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Avg. Surge
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B = Competitor

B

4 Berry St
Brooklyn, NY



9:05AM

Data

A

= Focal

B

= Competitor

July 2017, NYC

45k work sessions
(consecutive online w/o breaks)

- 2,875 drivers
- **Time and location of *first* pick-up and *last* drop-off**
- Guaranteed hourly pay

Data

A

= Focal

July 2017, NYC

- 45k work sessions
(consecutive online w/o breaks)
- 2,875 drivers
- **Time and location of first pick-up and last drop-off**
- Guaranteed hourly pay

B

= Competitor

Trip records data

- 35M ride-hailing trips
 - Platform ID
 - **Time and location of every pick-up/drop-off**
 - Per-trip pay
- (Price breakdowns B)



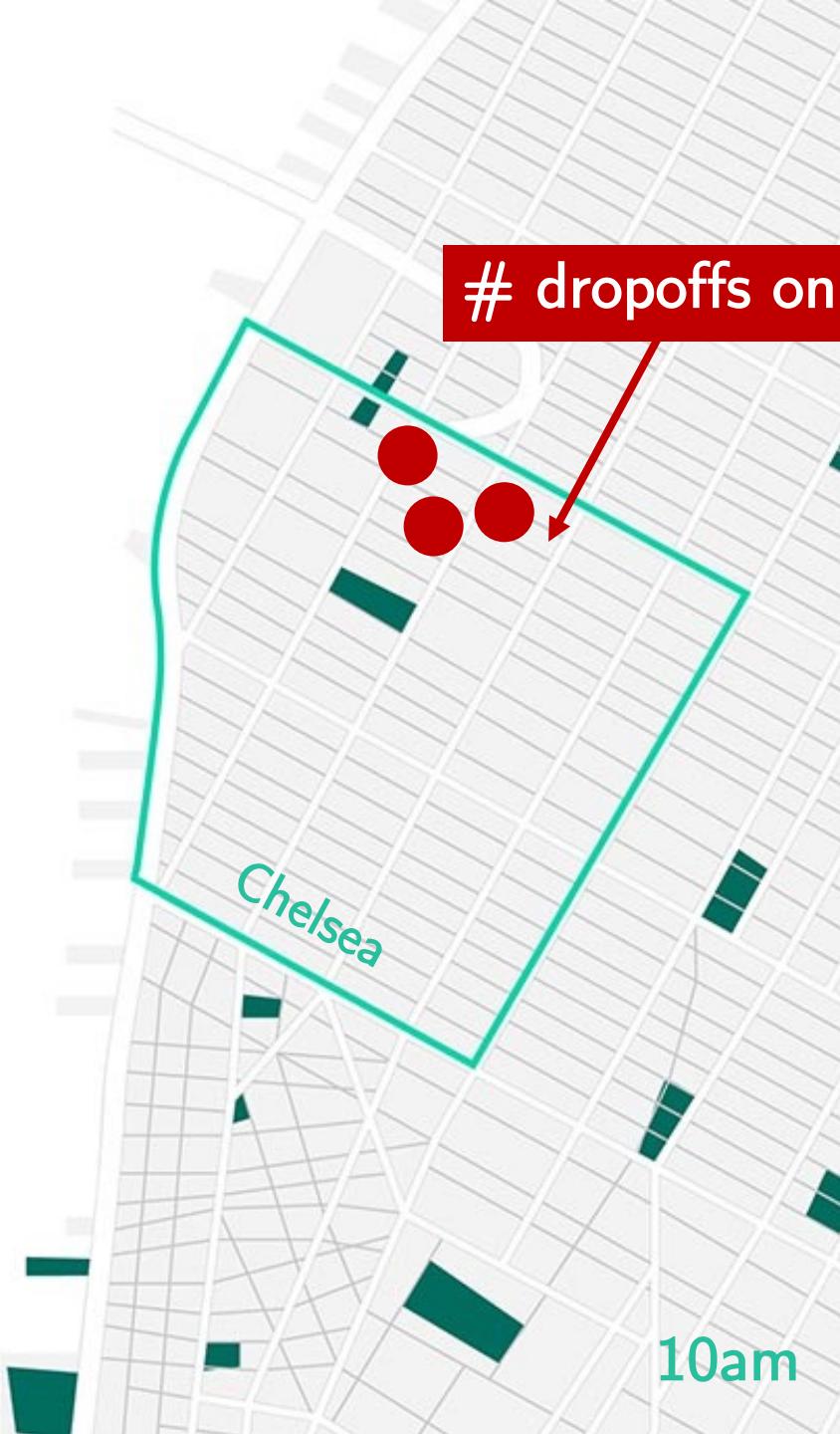


Trip records data

35M ride-hailing trips

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



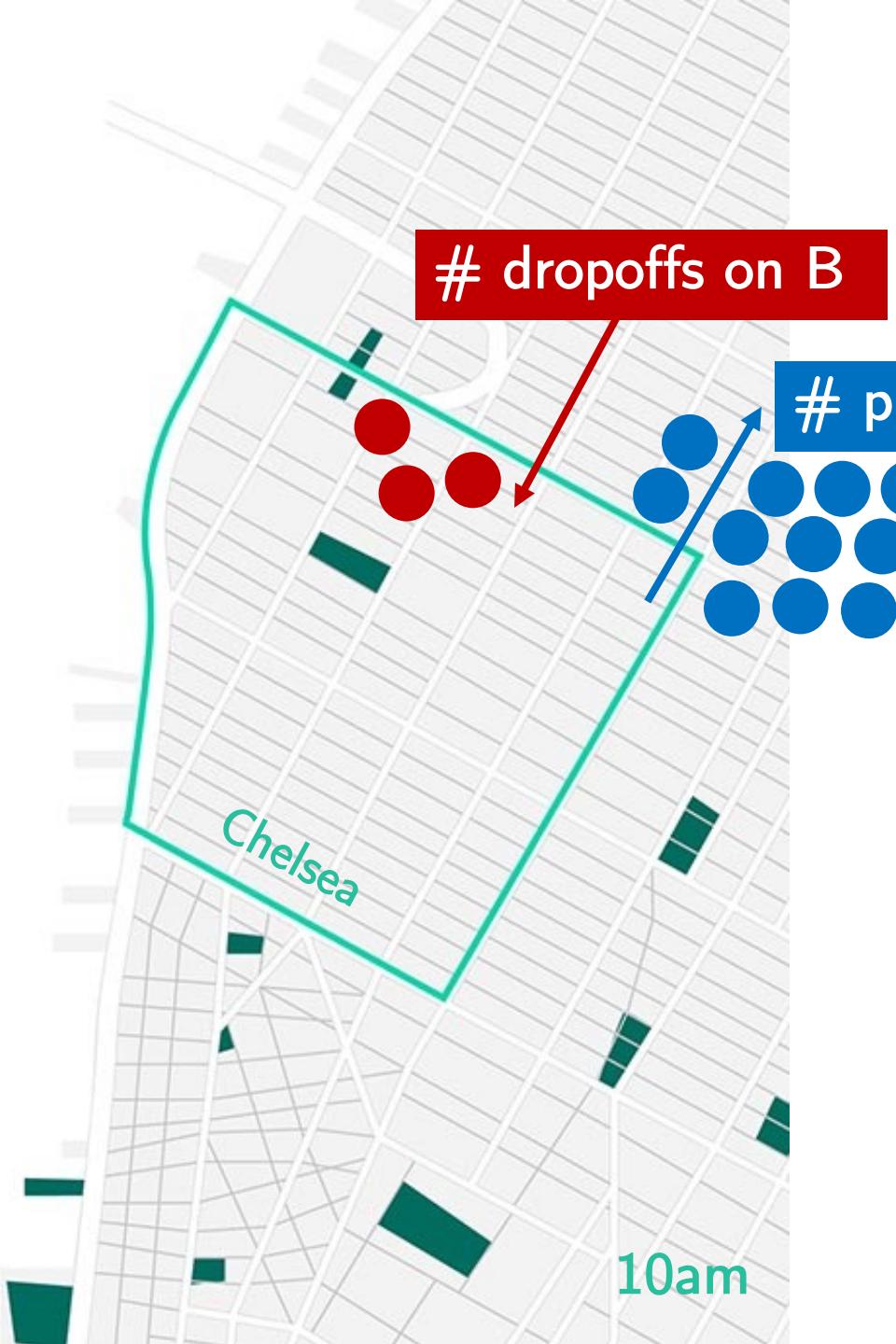


Trip records data

35M ride-hailing trips

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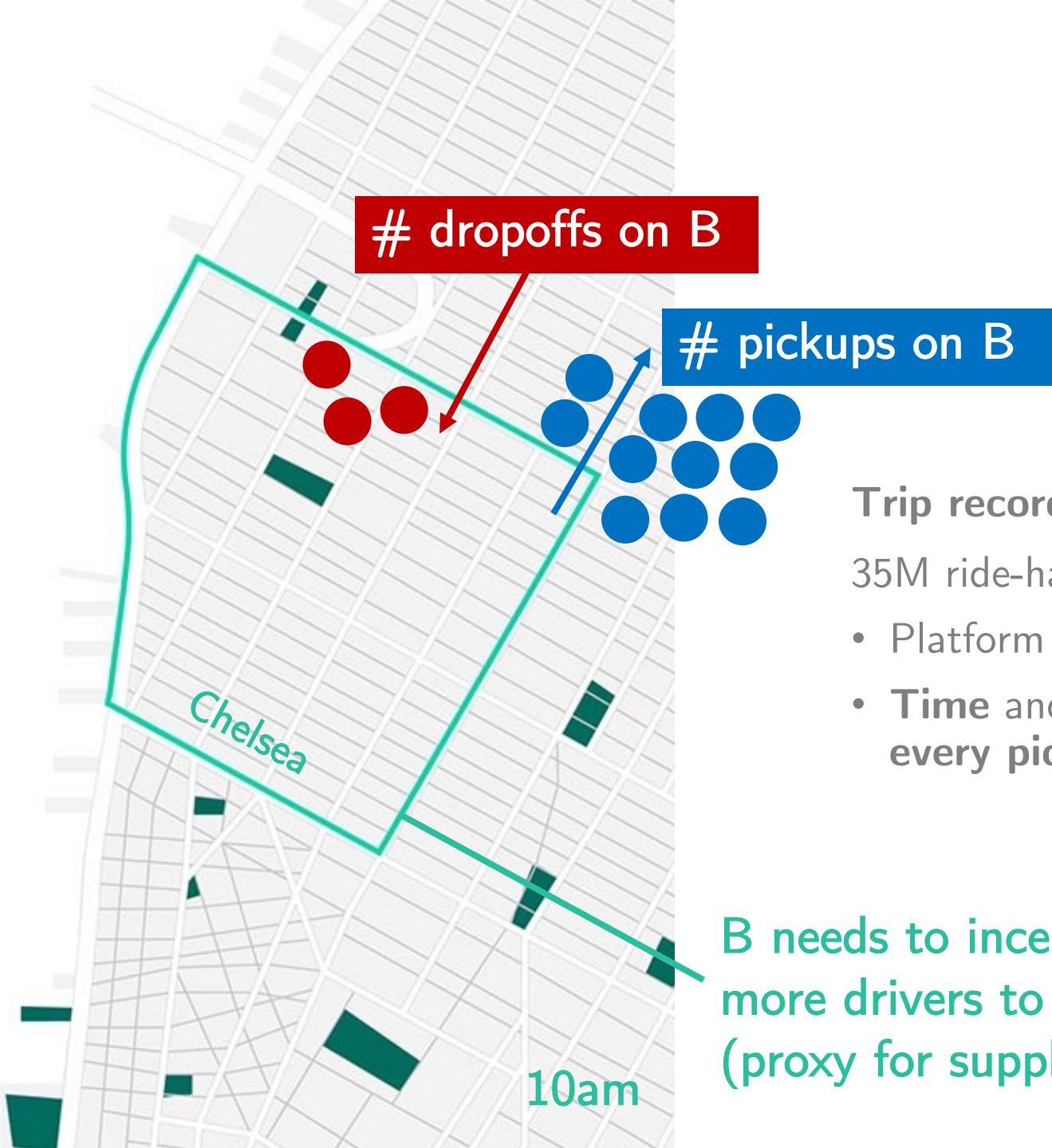


Trip records data

35M ride-hailing trips

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





Trip records data

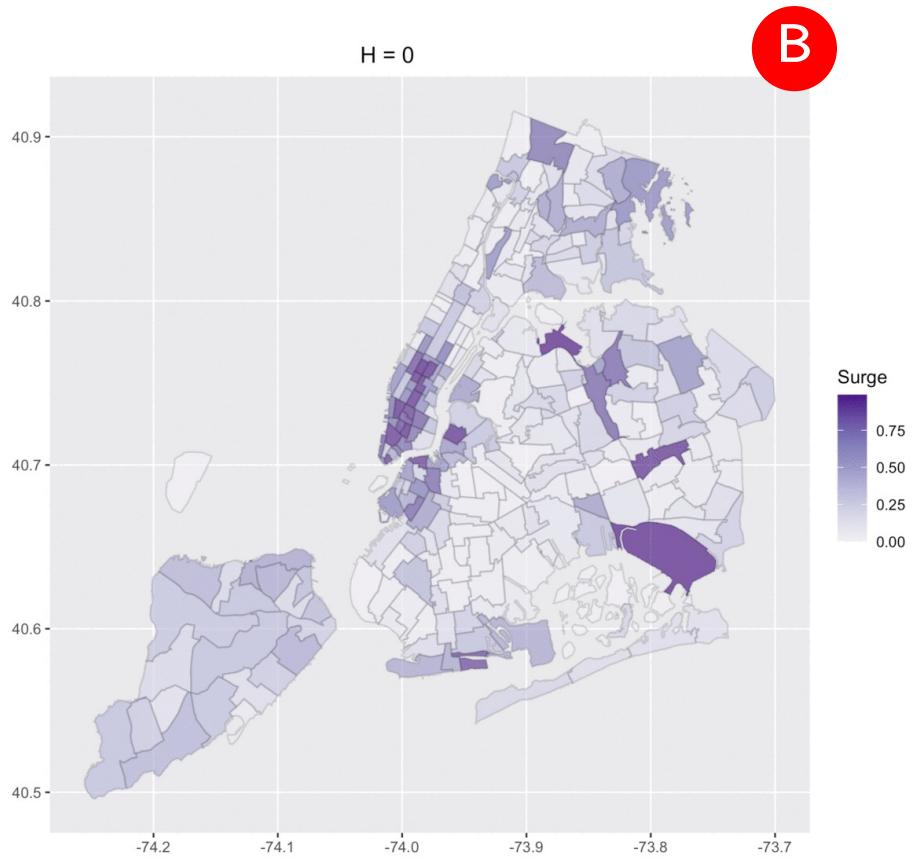
35M ride-hailing trips

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



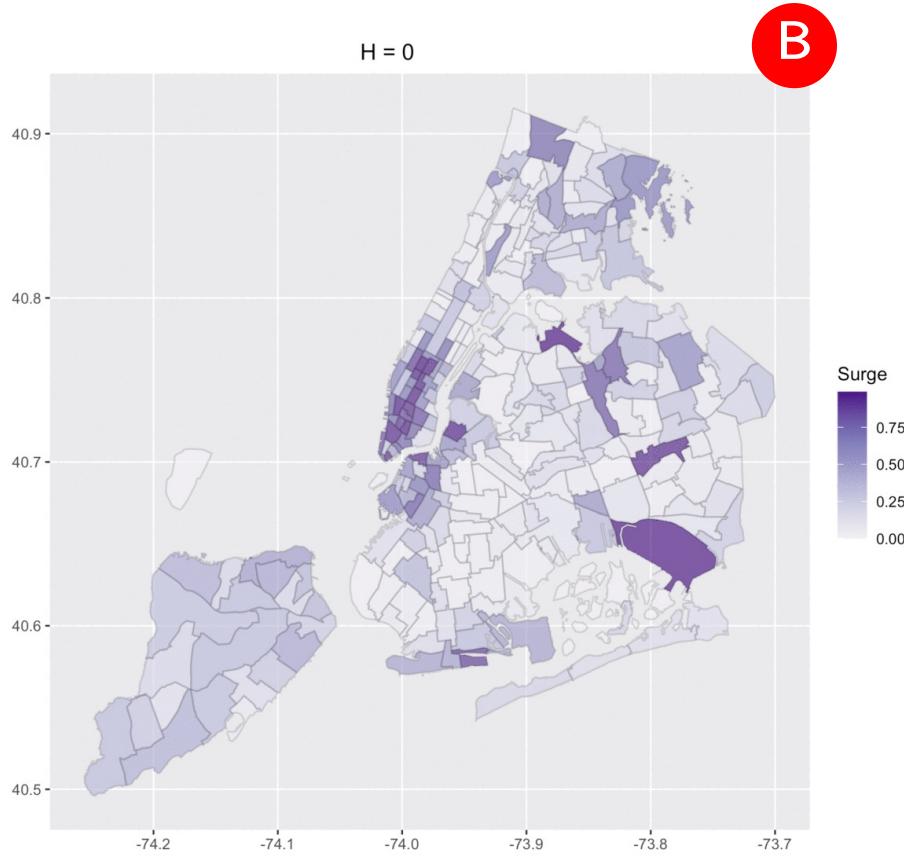
B needs to incentivize
more drivers to start working here
(proxy for supply shortage)

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

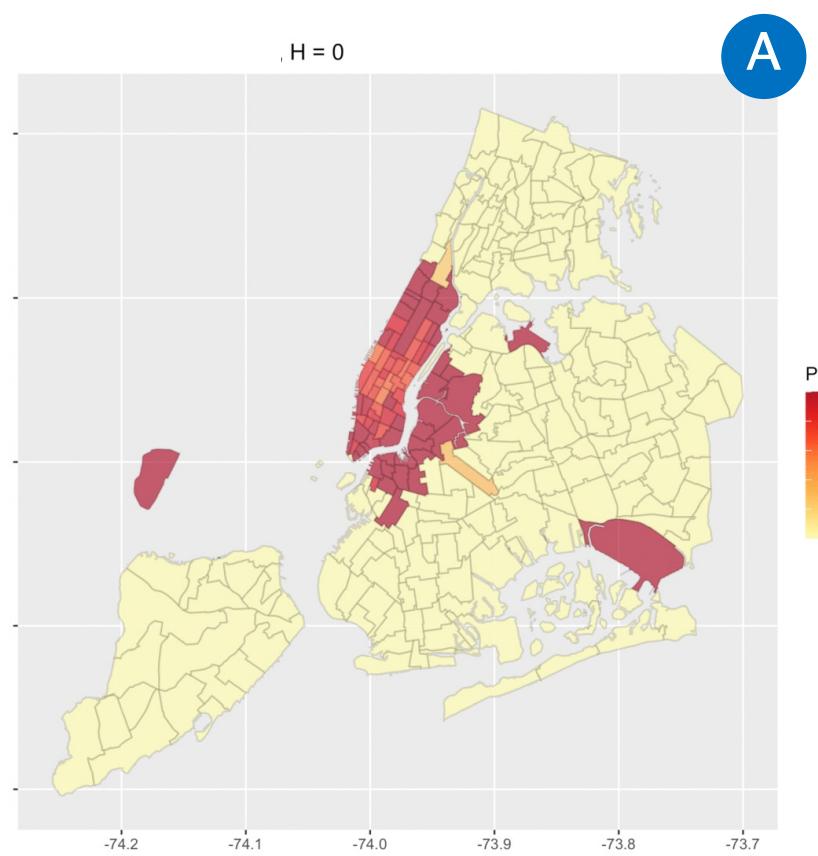


Temporal/Spatial Variations

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

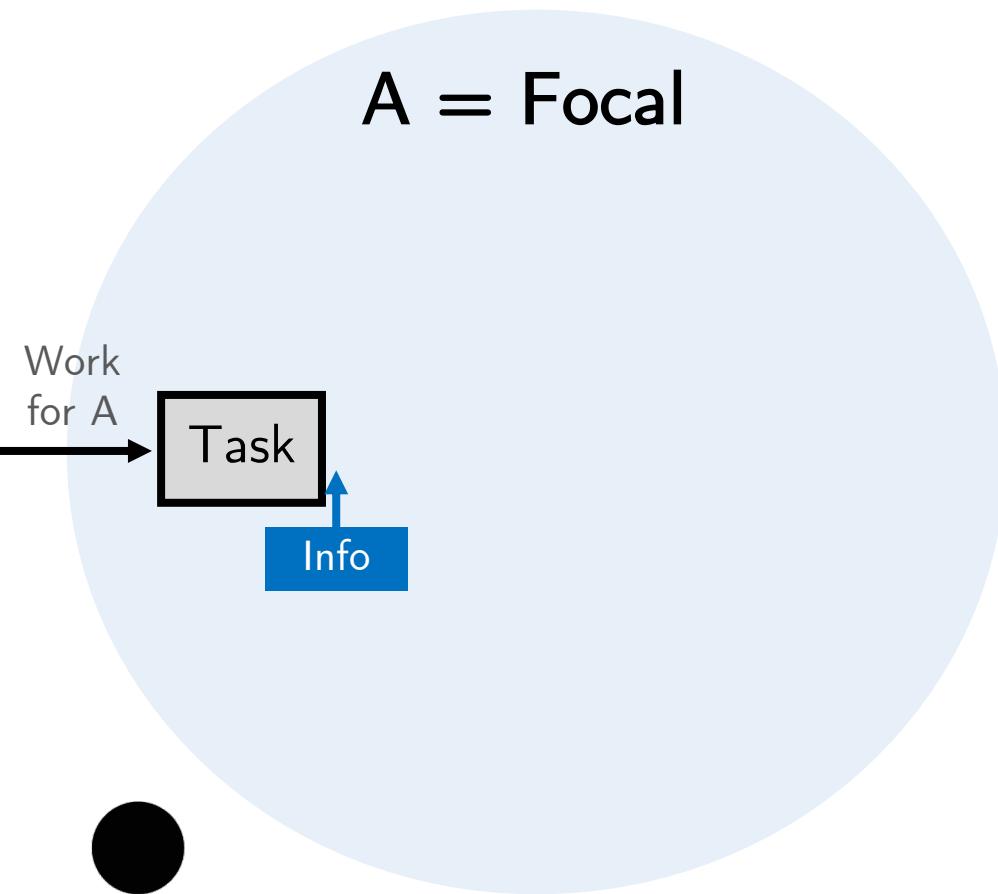


$P(\text{Leaving focal firm})$



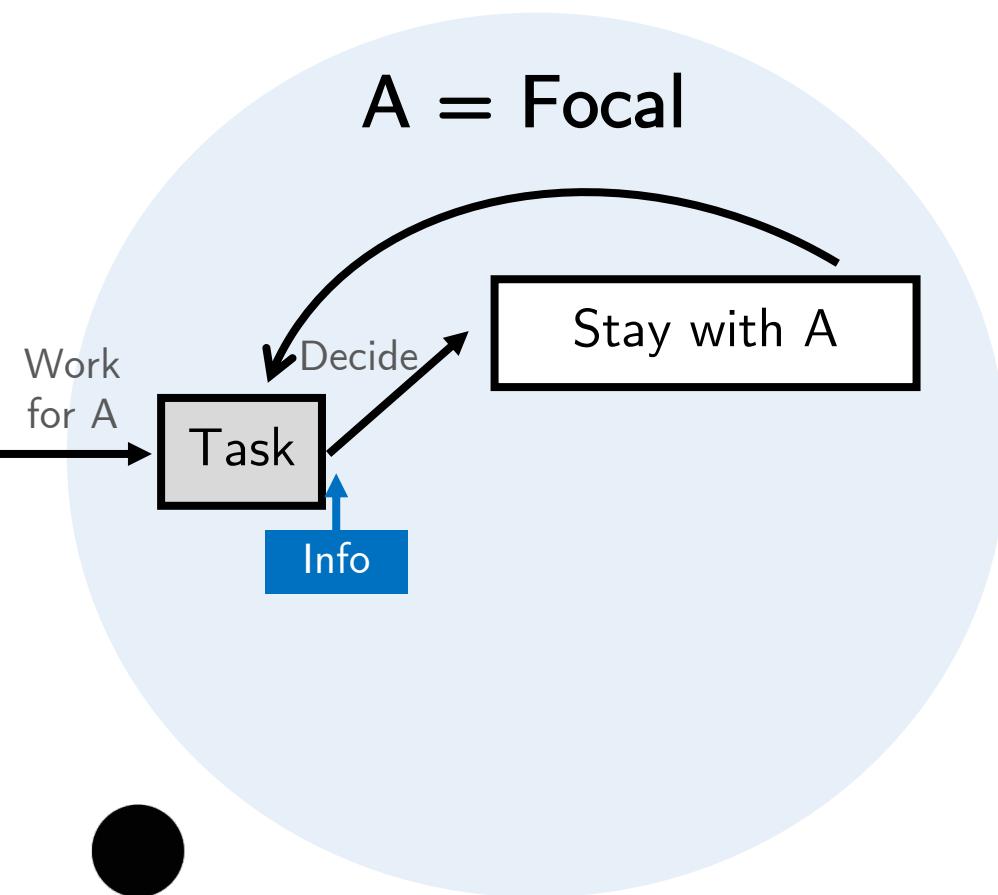
Our Model

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



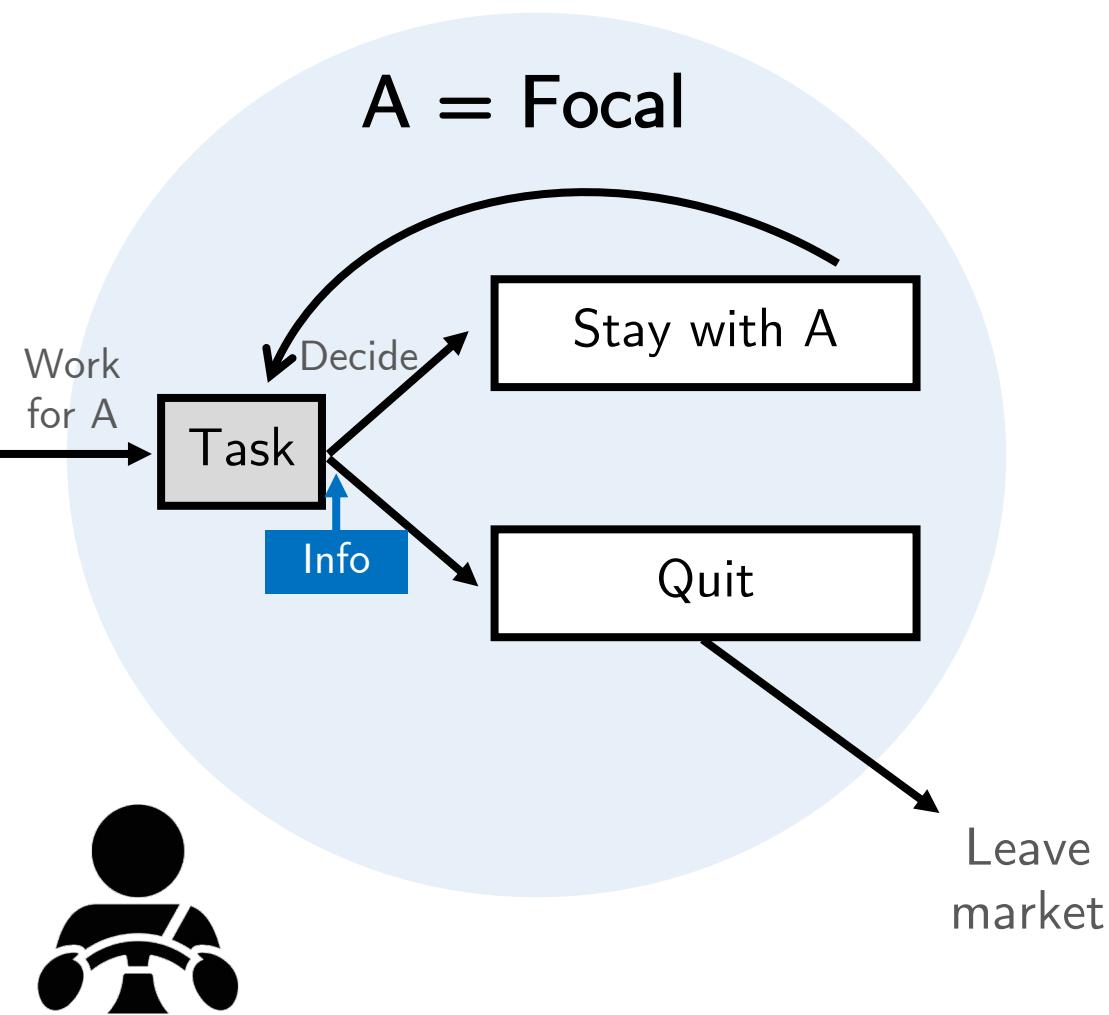
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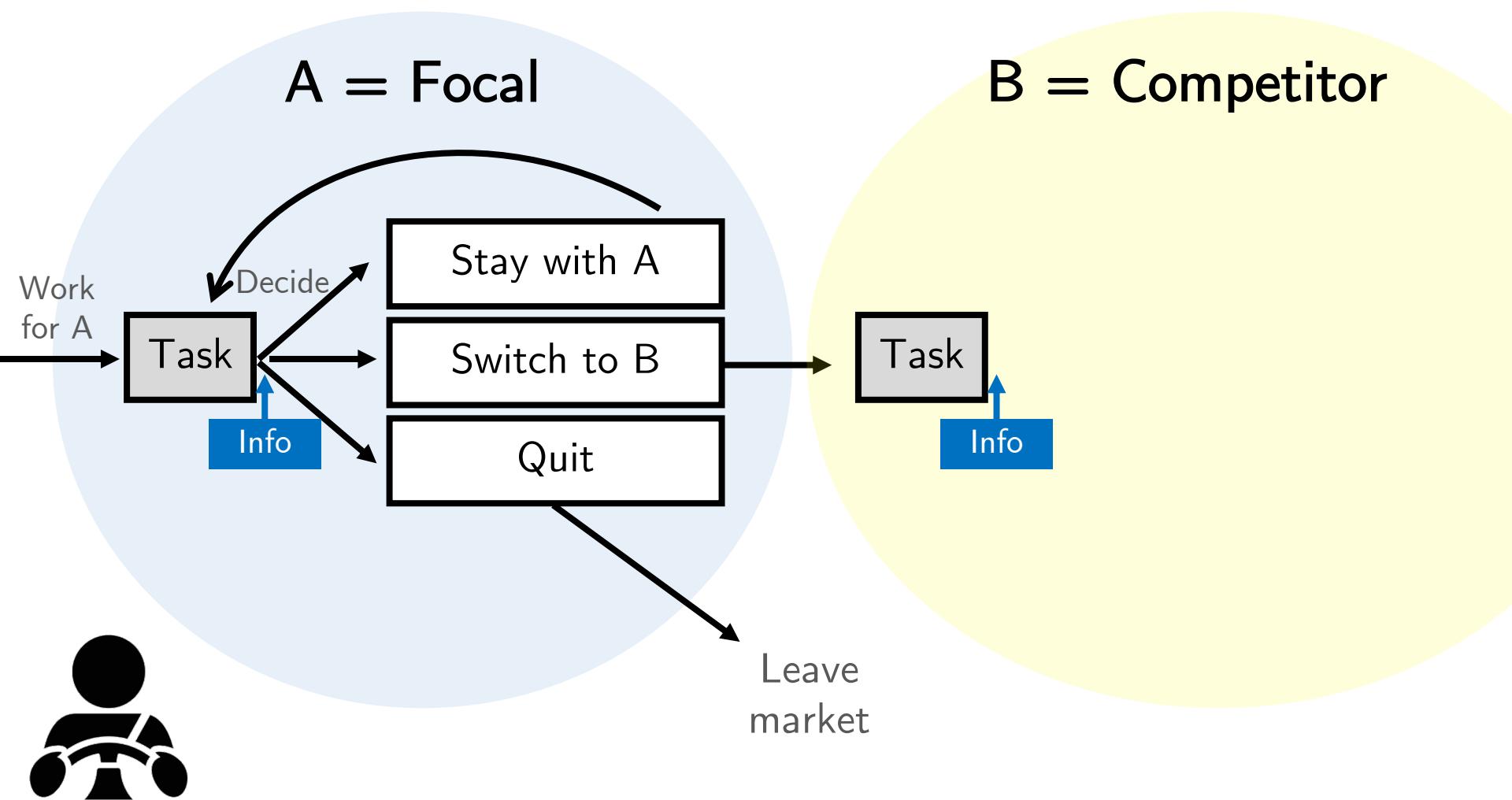
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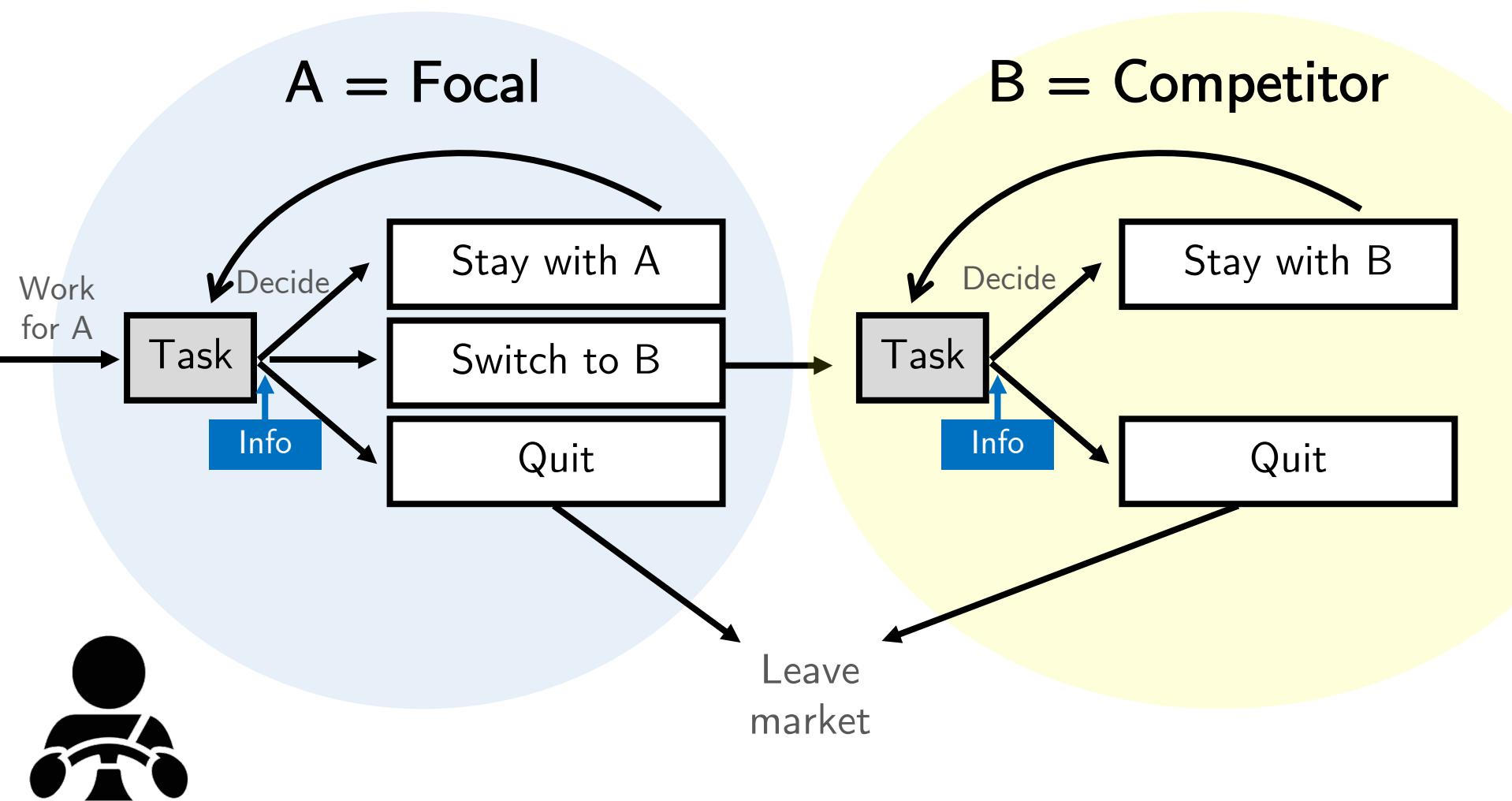
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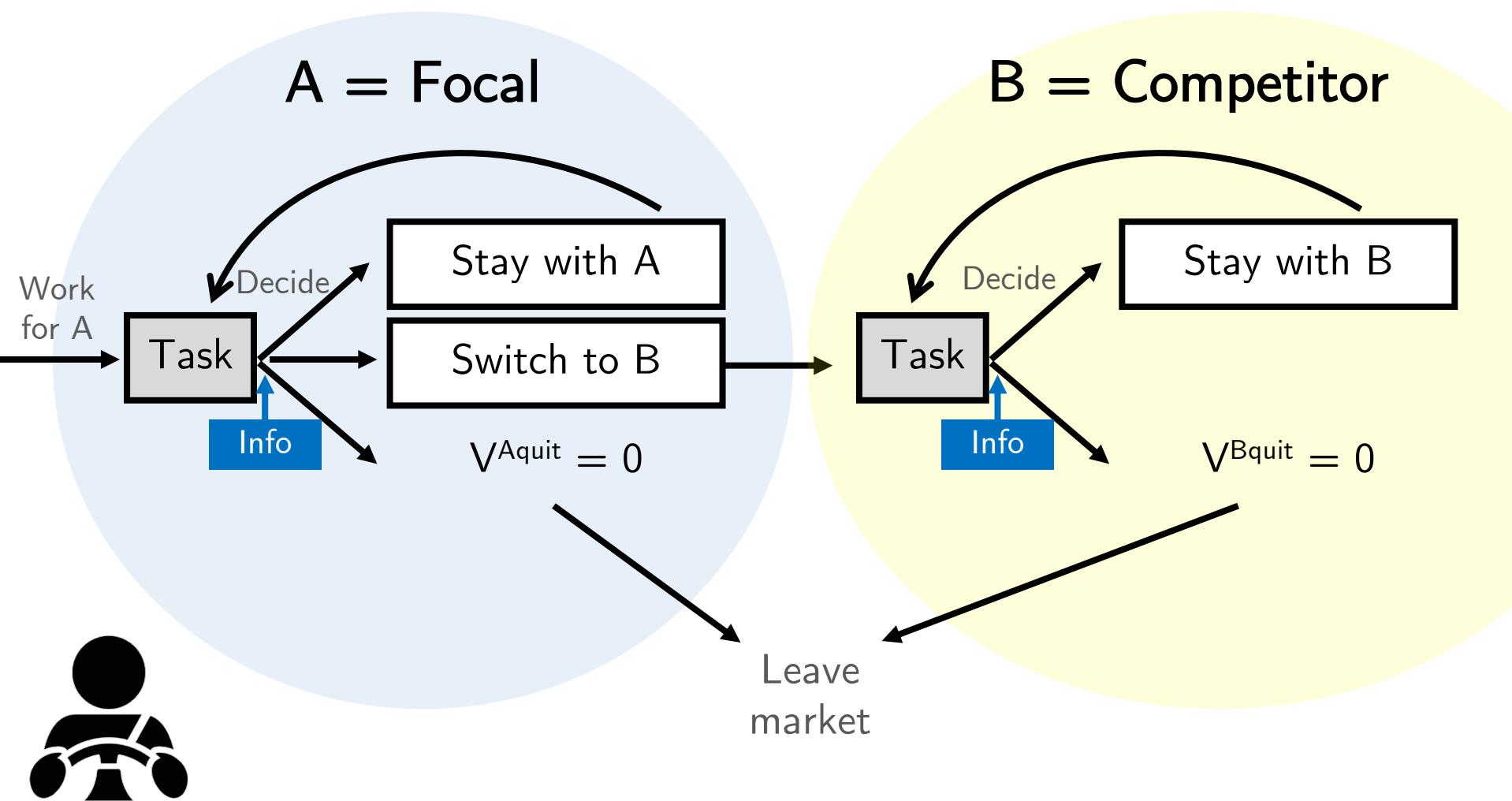
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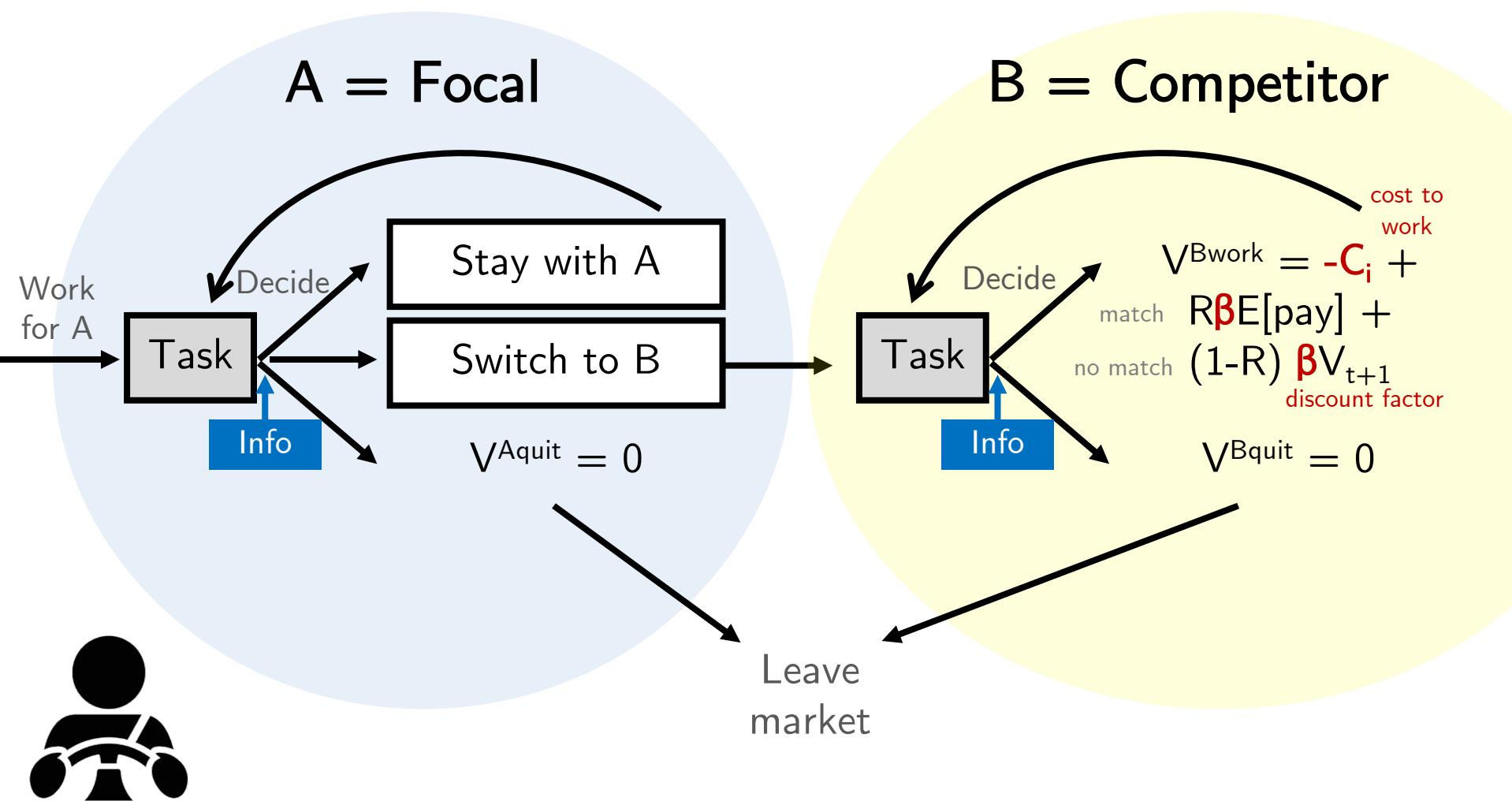
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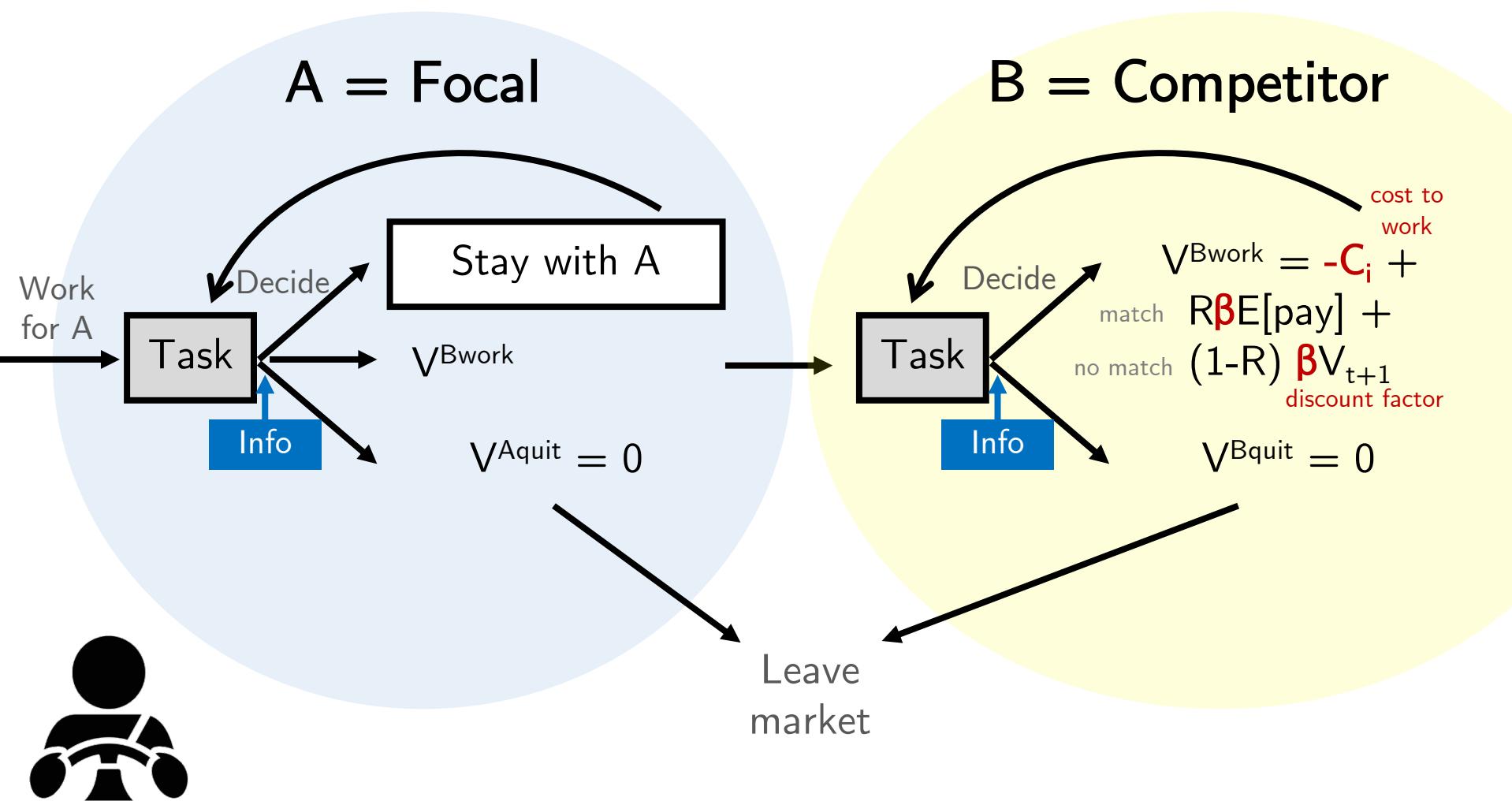
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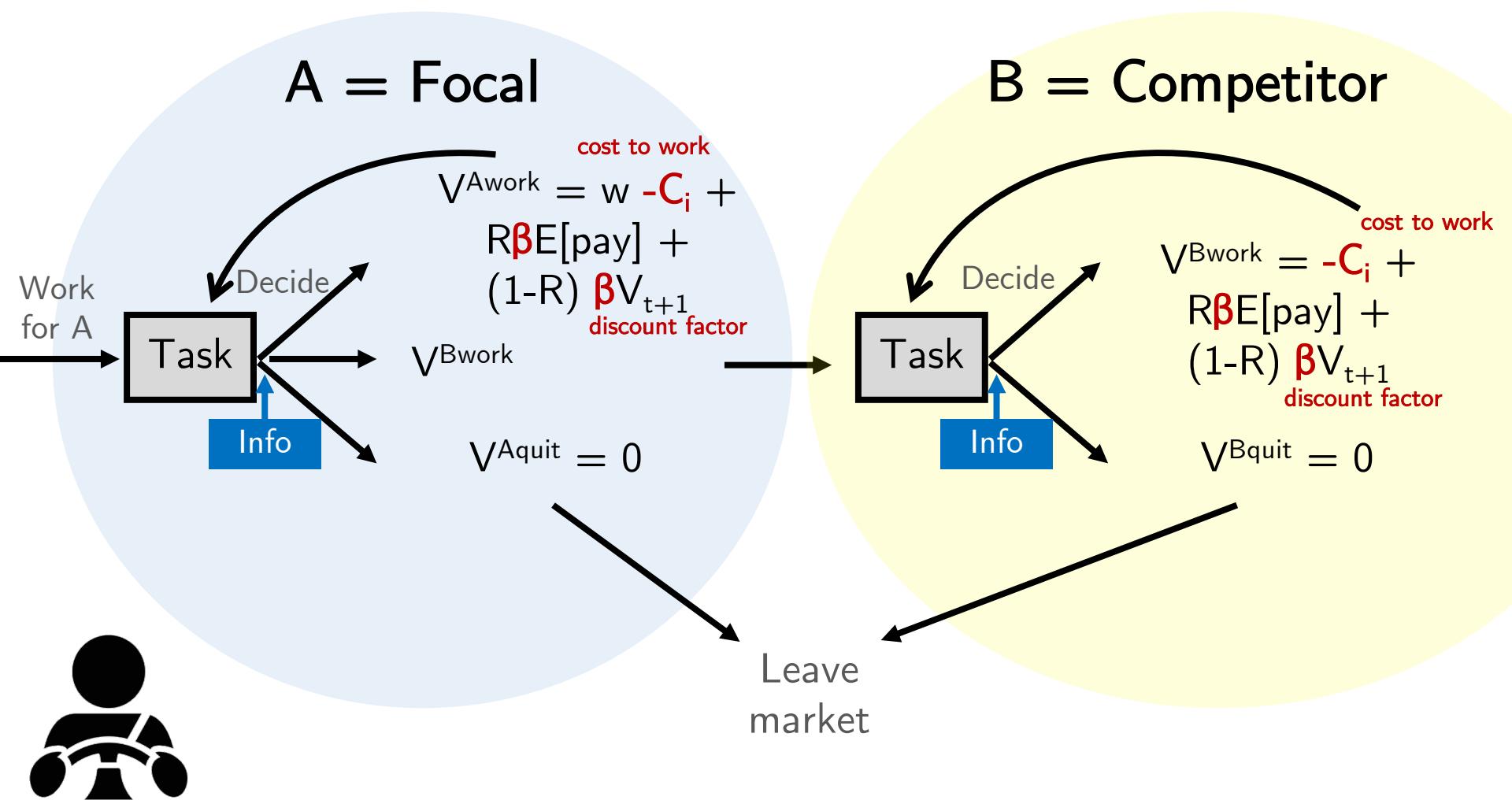
Our Model

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

 β

discount / forward-looking factor

Our Model

Drivers' Parameters

homogeneous

β discount / forward-looking factor

heterogeneous

C_i cost of working for a unit time interval

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)

Estimation

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)

Data

Quitting Hour

$H \times L$

Quitting location

Hours: 7am to 11pm

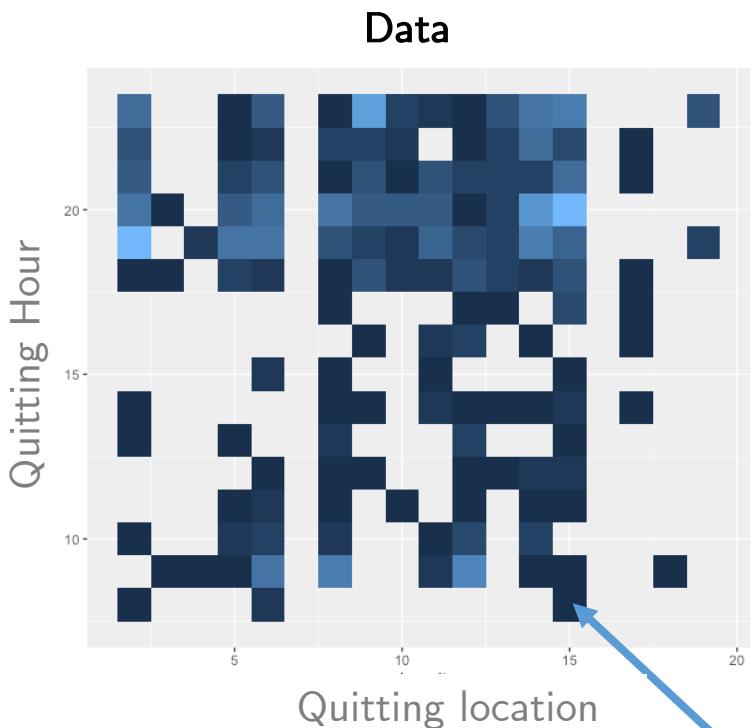
(Remaining left at 11:59pm)

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

Outcome of Interest

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



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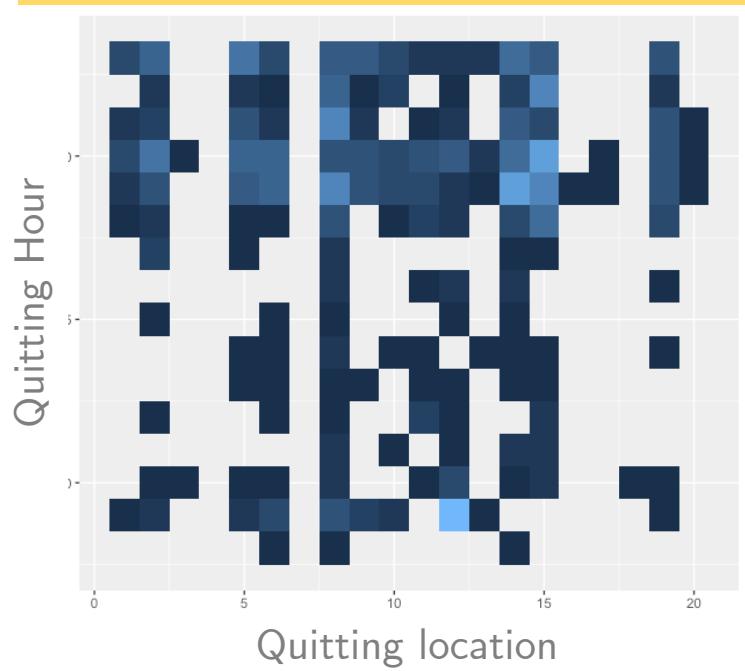
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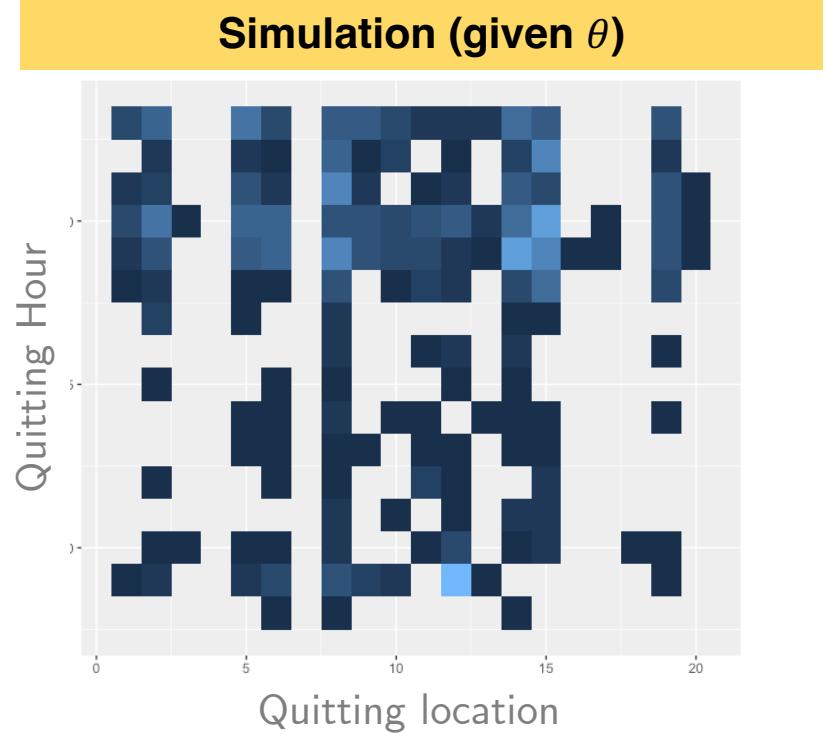
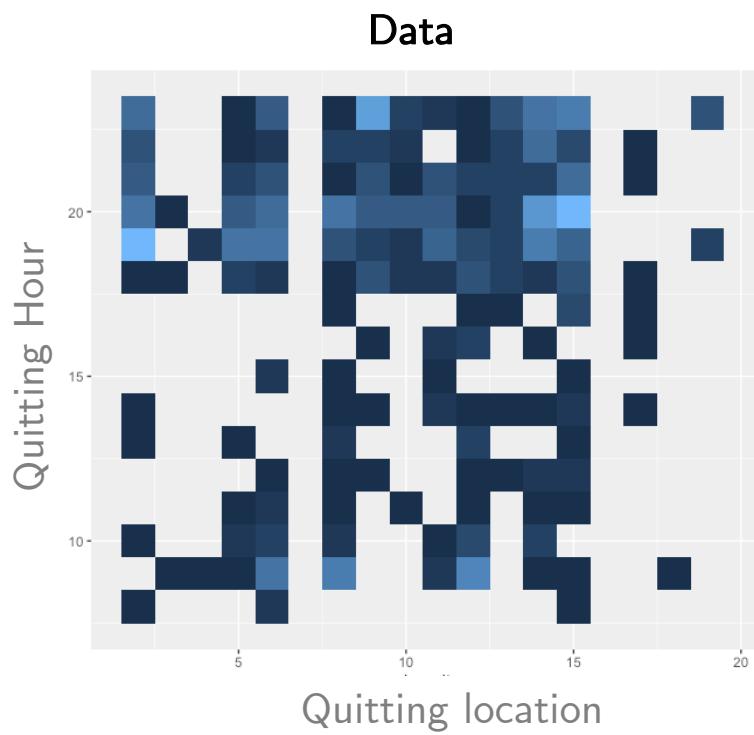
Each cell (H,L) is fraction of drivers quitting at location L and hour H : $f_{L,H}$

Data



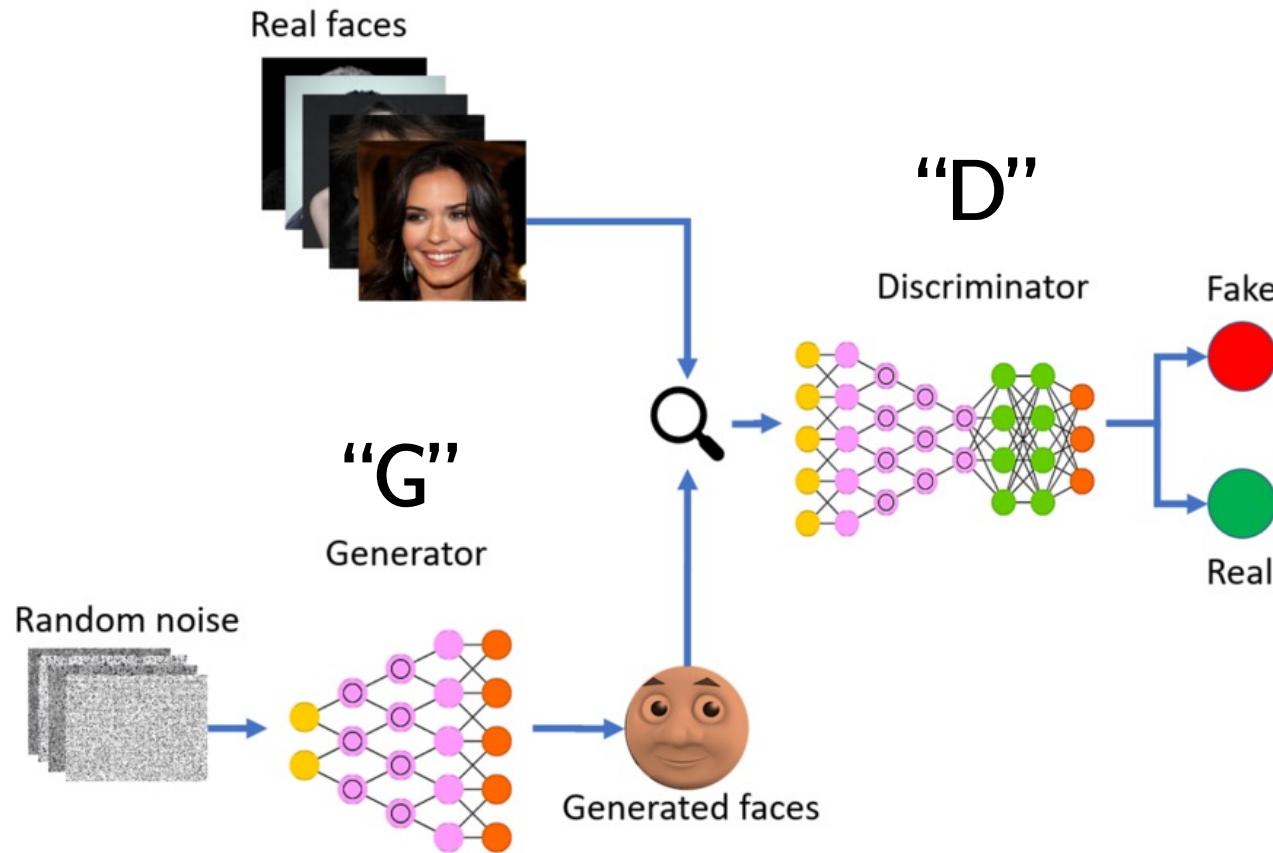
Simulation (given θ)





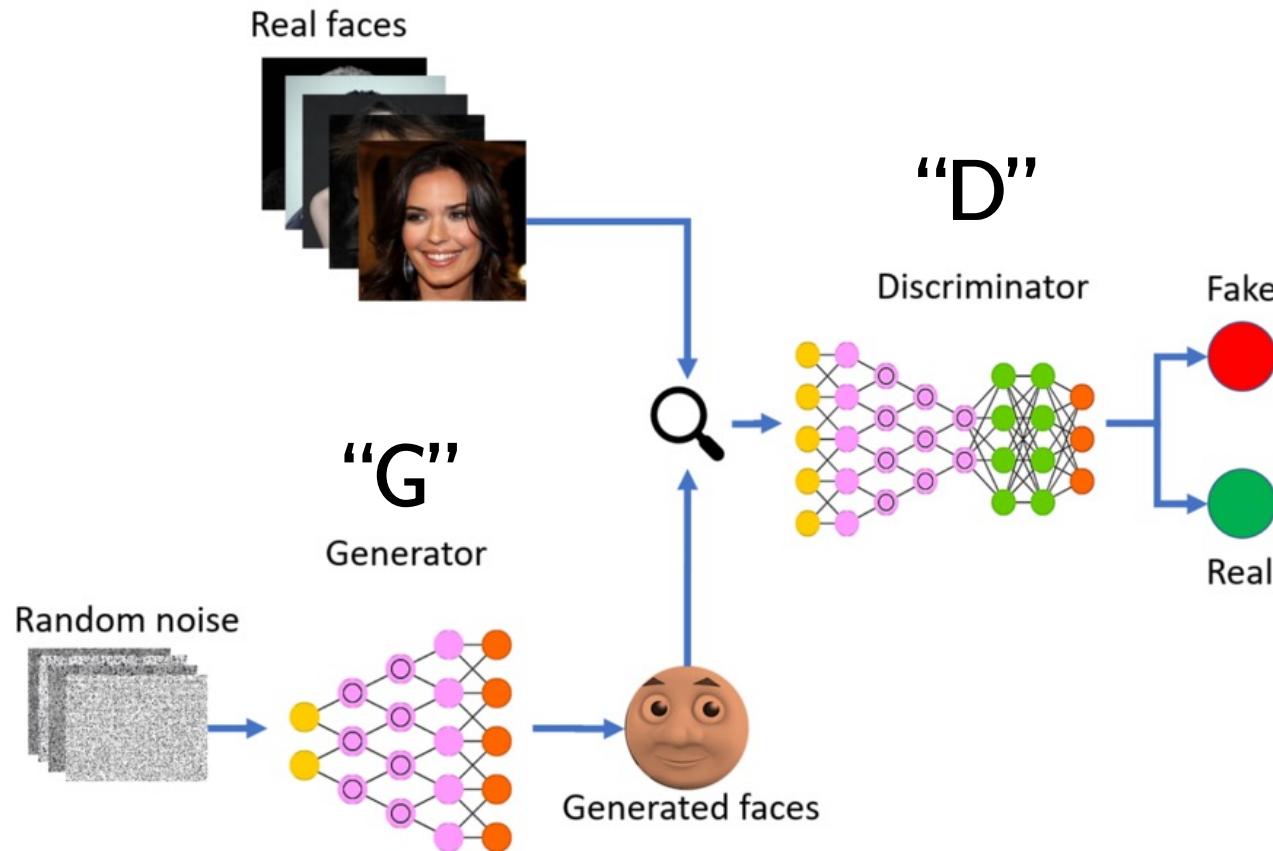
← →
Find θ that minimizes distance

Gen. Adversarial Networks

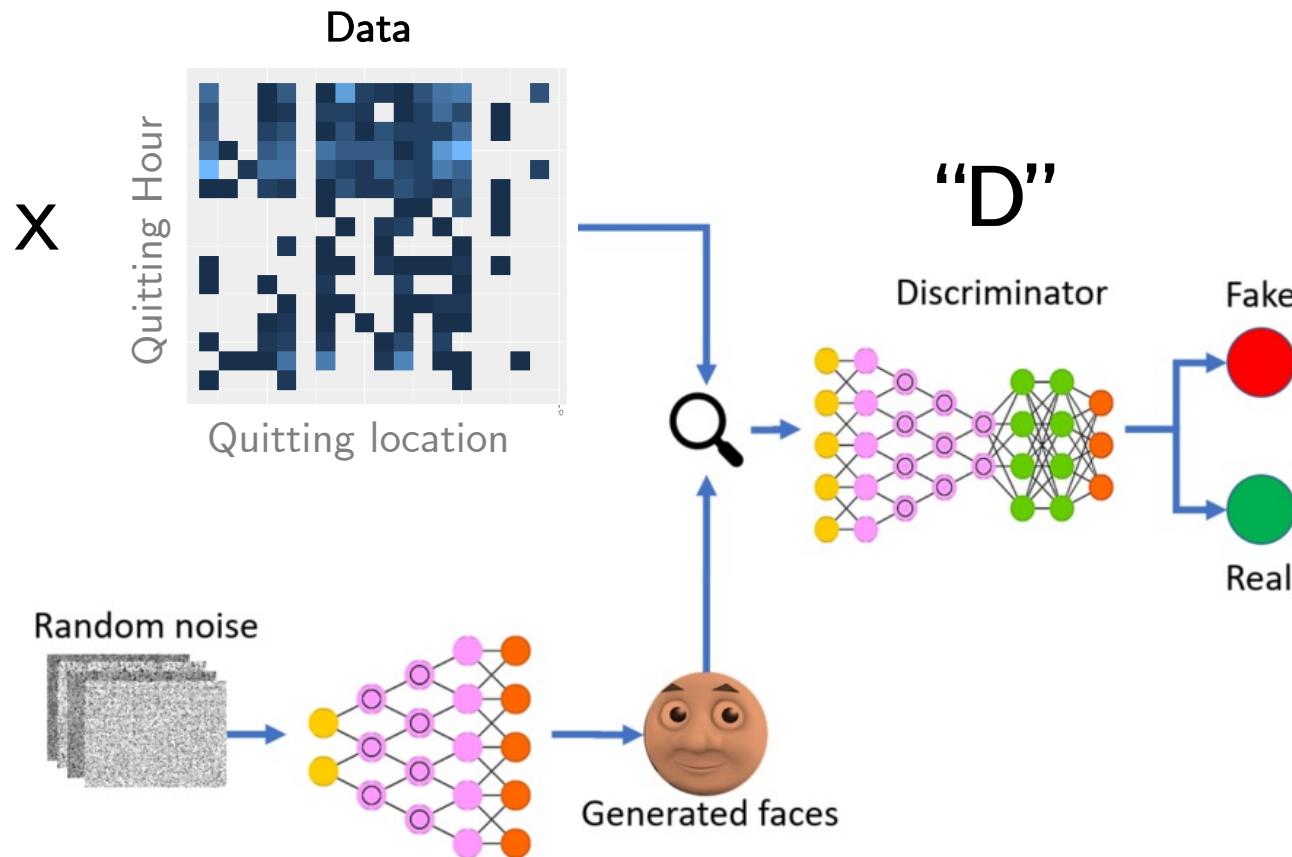


$$\min_{\{\text{generator}\}} \max_{\{\text{discriminator}\}} \text{classification accuracy.}$$

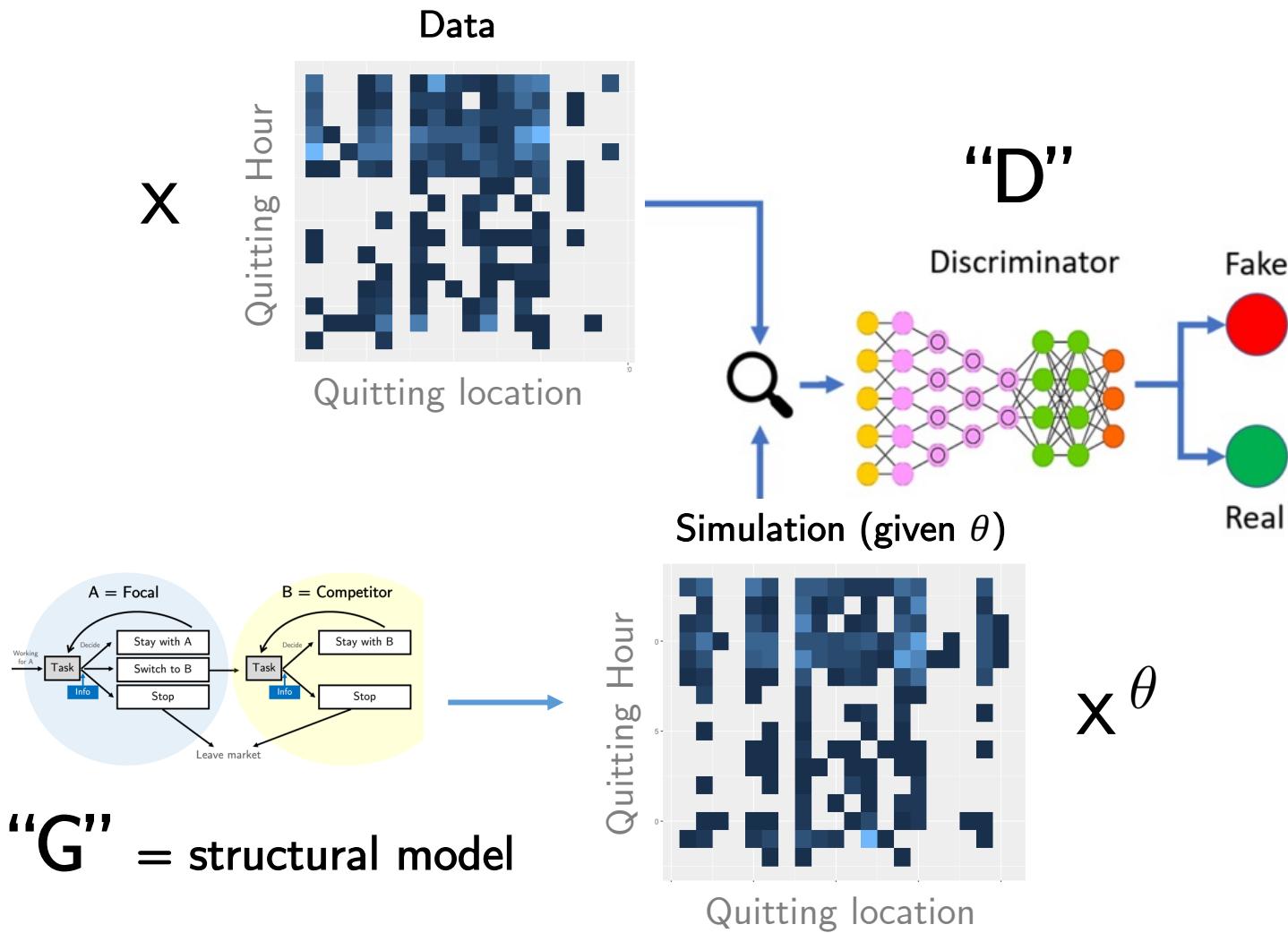
Adversarial Estimation



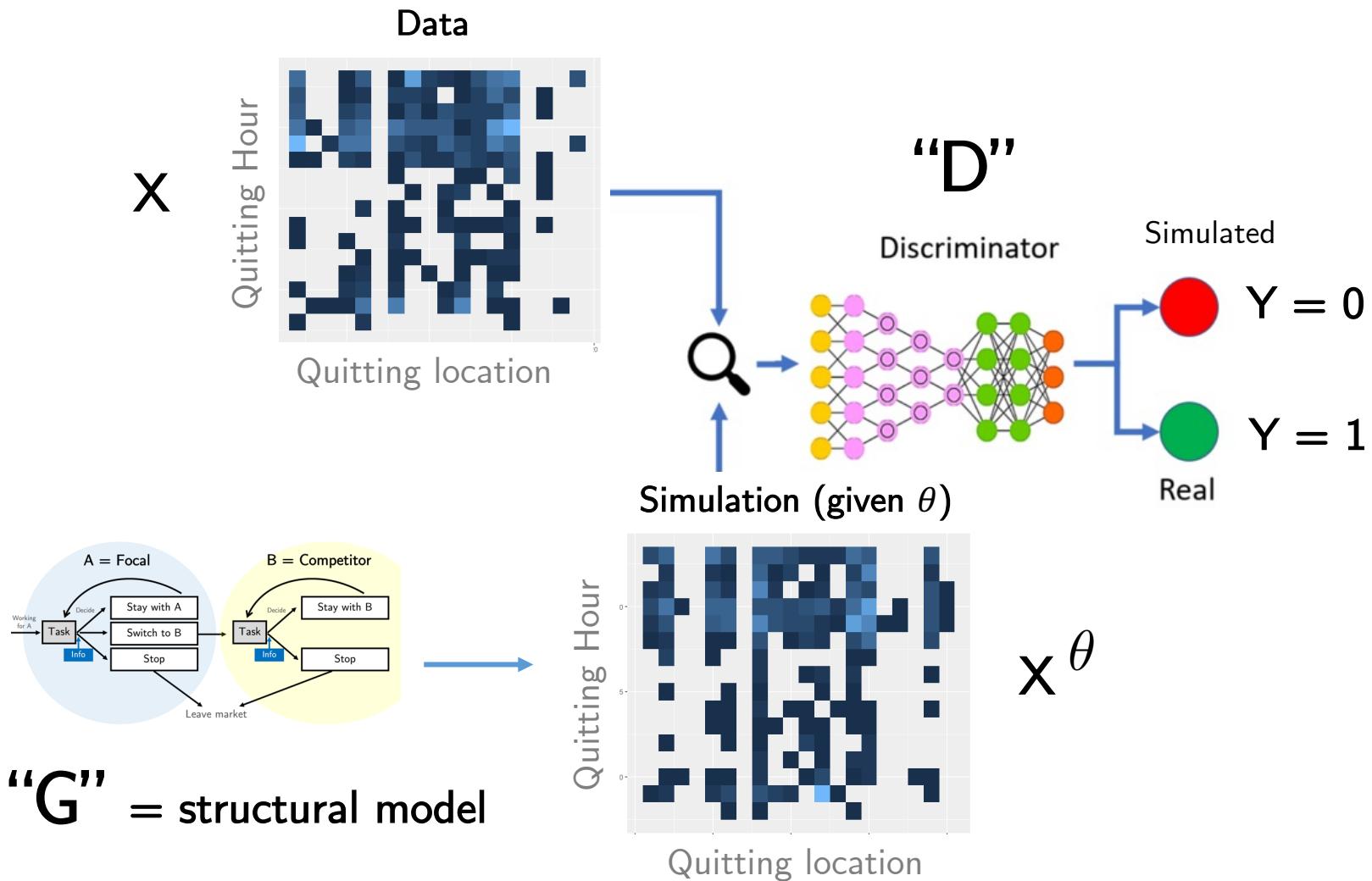
Adversarial Estimation



Adversarial Estimation



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)

Estimation Results

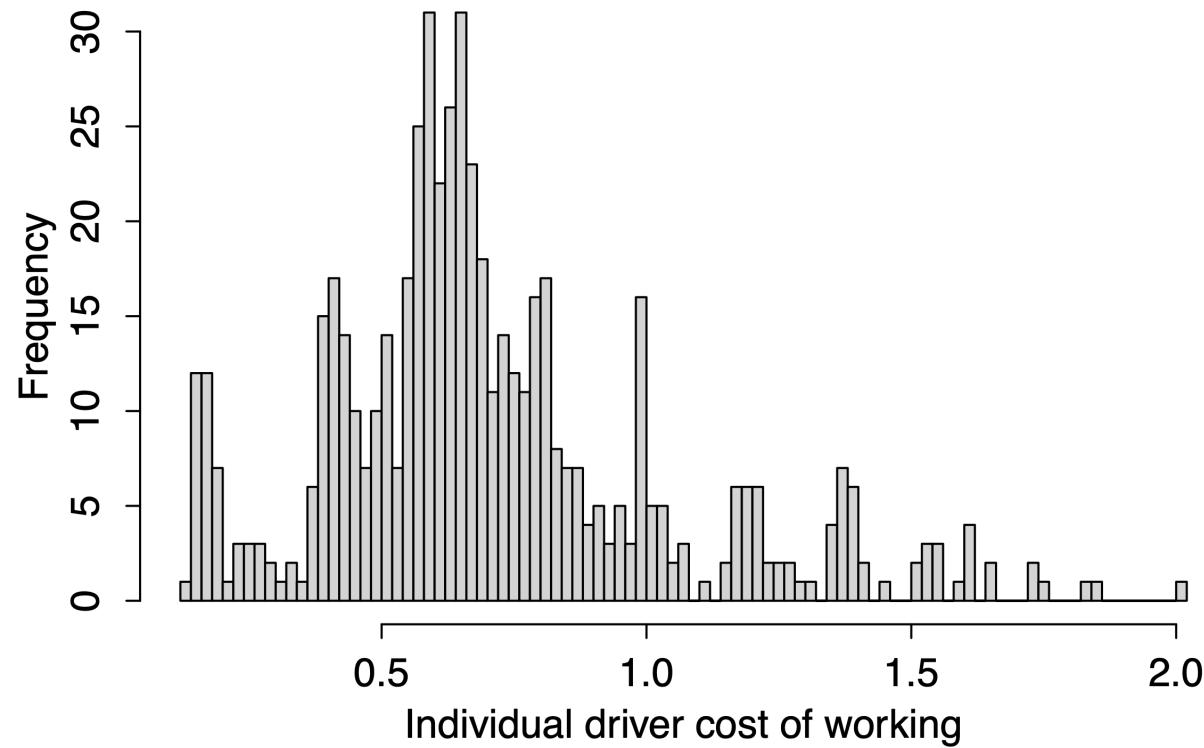
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\$1 in 2 hours
→ 73 cents now

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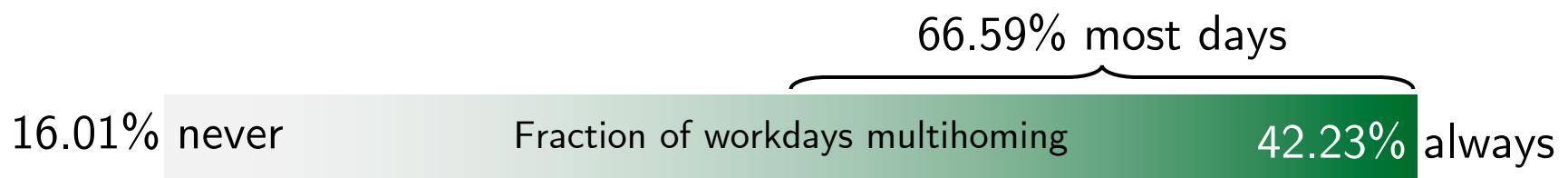


Estimation Results

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<p>66.59% most days</p> <p>Fraction of workdays multihoming</p>		

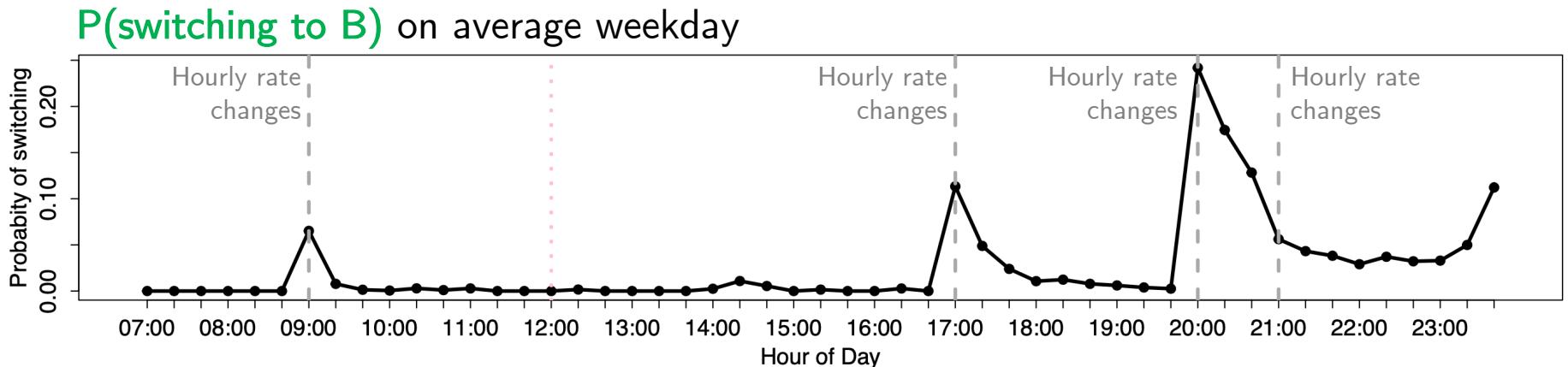
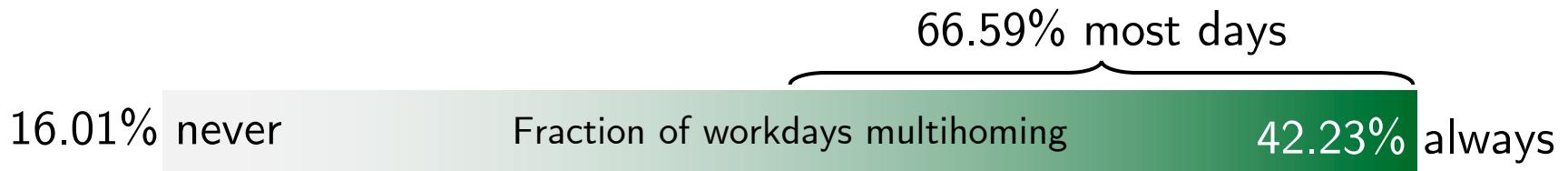
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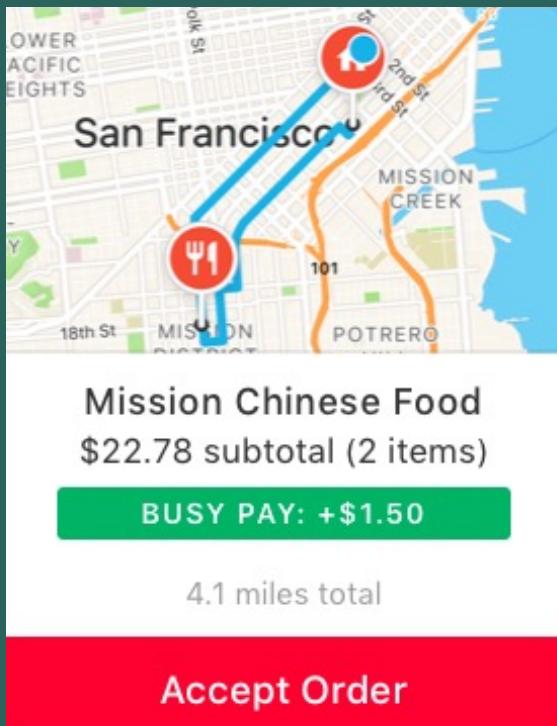
“Drivers strongly prioritize short-term earnings with significant reaction to differences in short-run earnings across platforms.”

How to Control Multihoming?

“Drivers strongly prioritize short-term earnings with significant reaction to differences in short-run earnings across platforms.”

How to Control Multihoming?

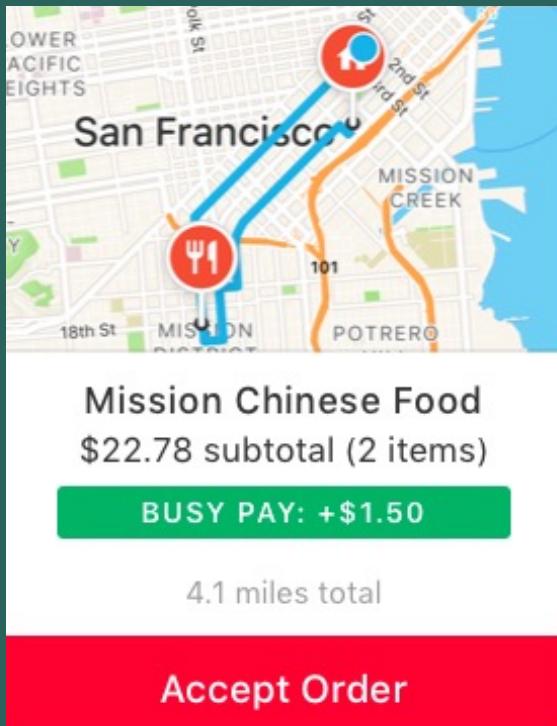
dynamic pay per work?



“Drivers strongly prioritize short-term earnings with significant reaction to differences in short-run earnings across platforms.”

How to Control Multihoming?

dynamic pay per work?



dynamic guaranteed pay?

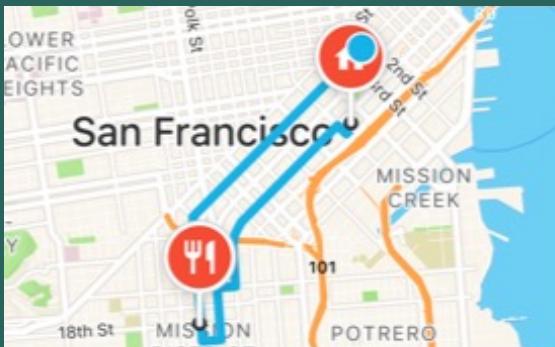
You can earn by time now

- ⌚ **Guaranteed hourly pay with tips**
The hourly rate will be shown at the start of your dash. You'll earn this guaranteed rate while delivering including travel and store wait time plus 100% of tips and promotions on top. The rate will factor in that tips on these orders are less frequent.
- ⌚ **Earn more with less wait time**
You'll be able to accept more offers, which maximizes your earnings by reducing idle time.

“Drivers strongly prioritize short-term earnings with significant reaction to differences in short-run earnings across platforms.”

How to Control Multihoming?

dynamic pay per work?



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BUSY PAY: +\$1.50

4.1 miles total

Accept Order

dynamic guaranteed pay?

Counterfactual #1

which pay is better?
(long-term capacity)



You can earn by time now

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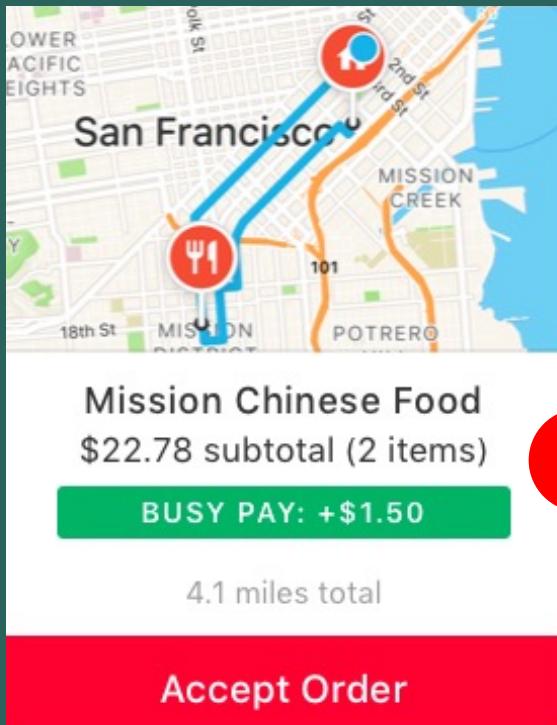
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How to Control Multihoming?

dynamic pay per work?



dynamic guaranteed pay?

Counterfactual #1

which pay is better?
(long-term capacity)

B

A

what happens when the focal firm switches to pay per work?



You can earn by time now

⌚ Guaranteed hourly pay with tips

The hourly rate will be shown at the start of your dash. You'll earn this guaranteed rate while delivering including travel and store wait time plus 100% of tips and promotions on top. The rate will factor in that tips on these orders are less frequent.

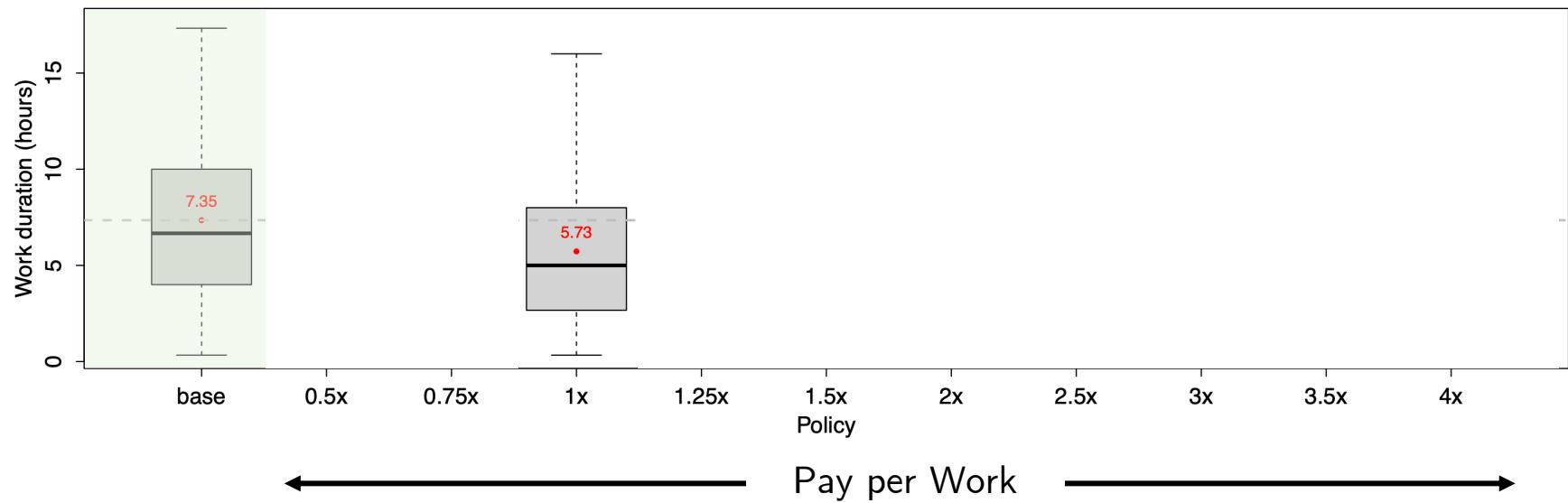
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Counterfactual #1 Pay Scheme

Guaranteed Pay

Work Duration (hours)

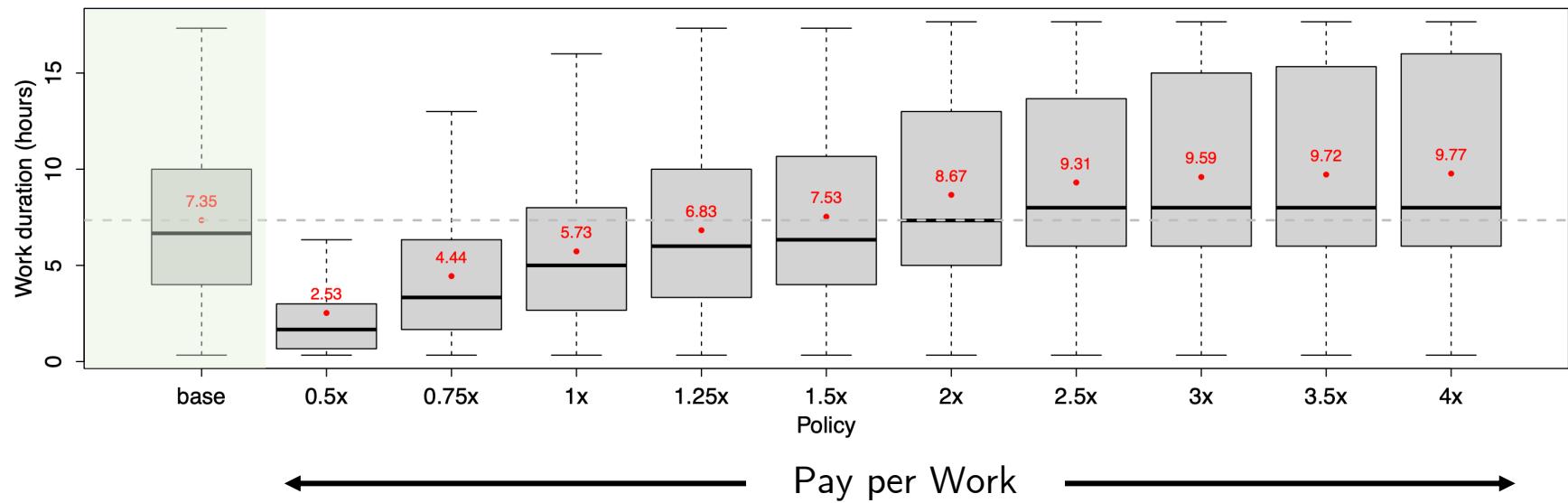


Switching from guaranteed pay → pay per work
of equivalent rate = reduces work duration

Counterfactual #1 Pay Scheme

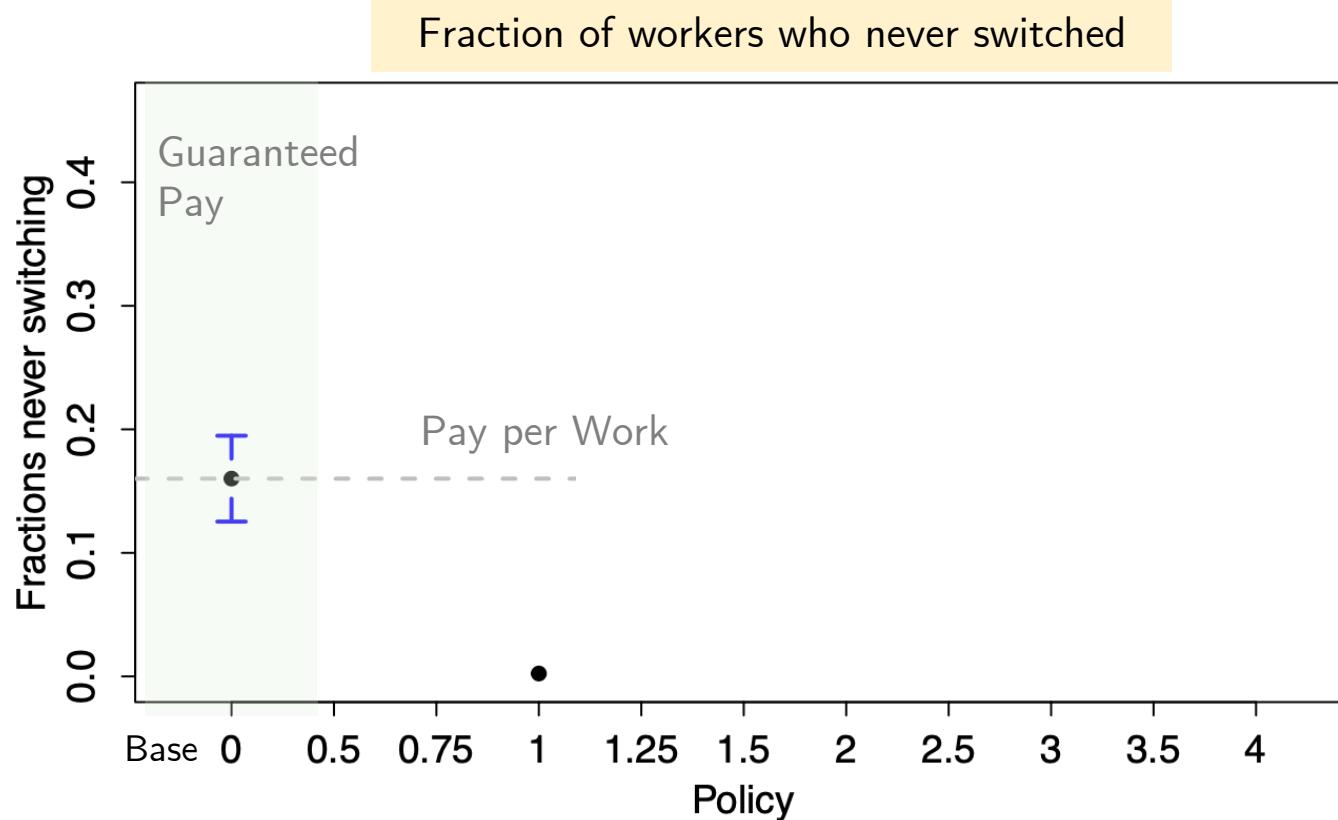
Guaranteed Pay

Work Duration (hours)

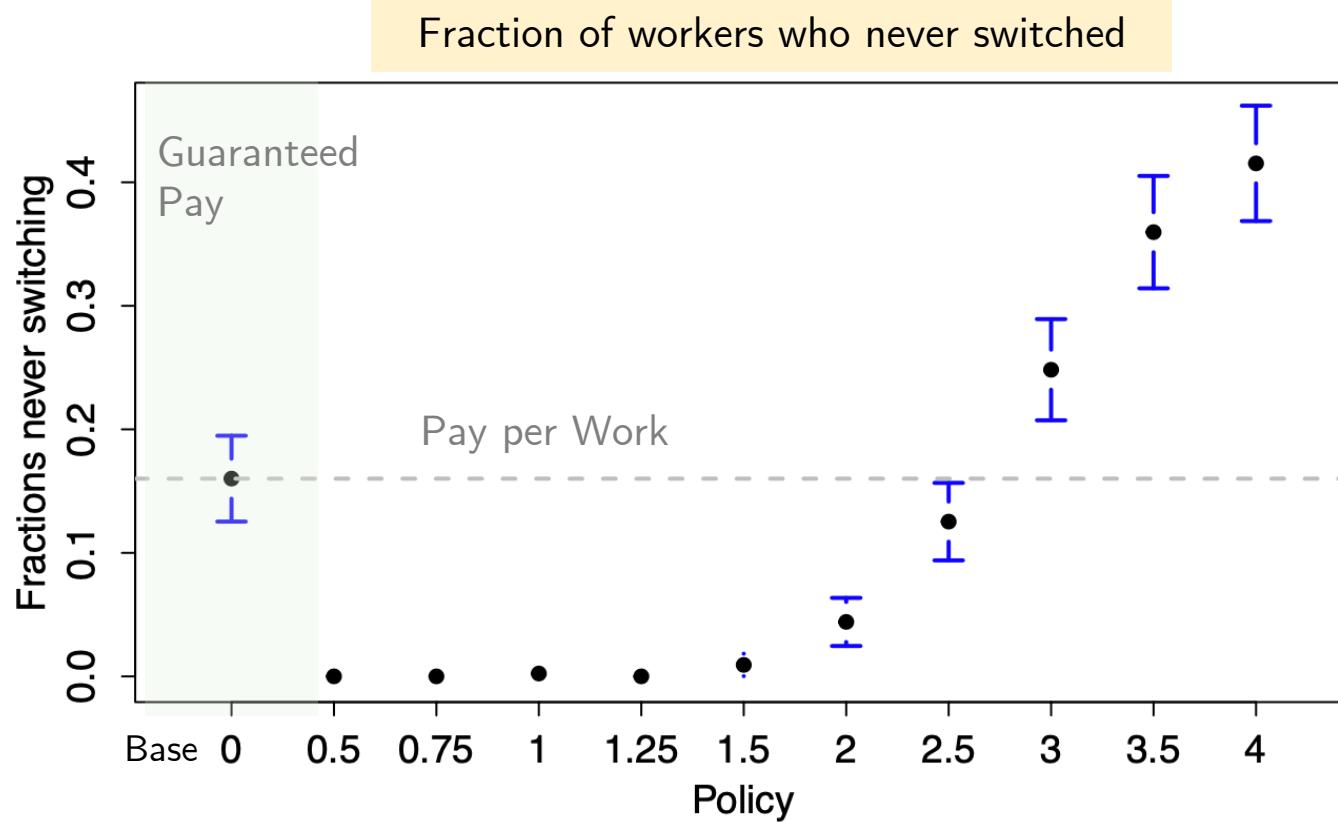


Switching from guaranteed pay → pay per work,
need 1.25-1.5x rate to match prior work duration

Counterfactual #1 Pay Scheme



Counterfactual #1 Pay Scheme



Need 2.5-3x rate to
keep the most dedicated workers

“Pay is not the only lever that platforms currently use to influence worker behavior”

How to Control Multihoming?

“Pay is not the only lever that platforms currently use to influence worker behavior”

How to Control Multihoming?

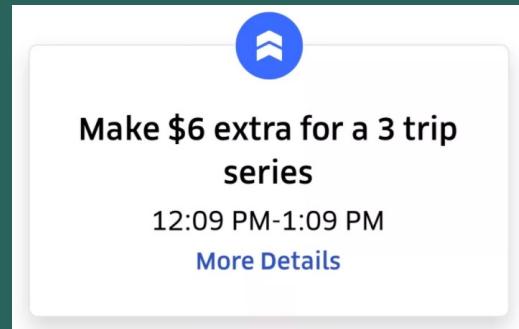
Counterfactual #2

impact of incentives
to stay longer?
(short-term capacity)

“Pay is not the only lever that platforms currently use to influence worker behavior”

How to Control Multihoming?

Streak Bonus



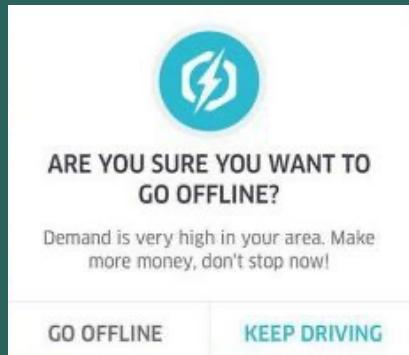
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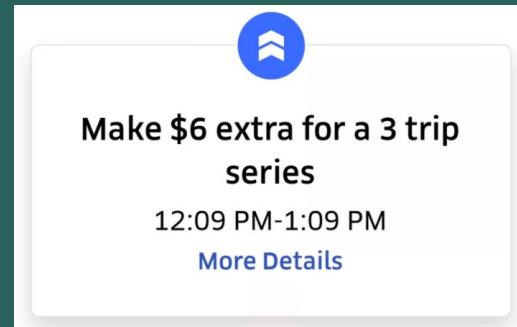
“Pay is not the only lever that platforms currently use to influence worker behavior”

How to Control Multihoming?

Time Delay



Streak Bonus



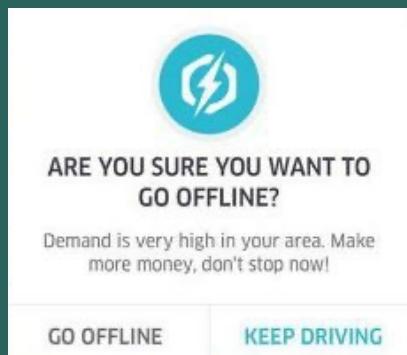
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(short-term capacity)

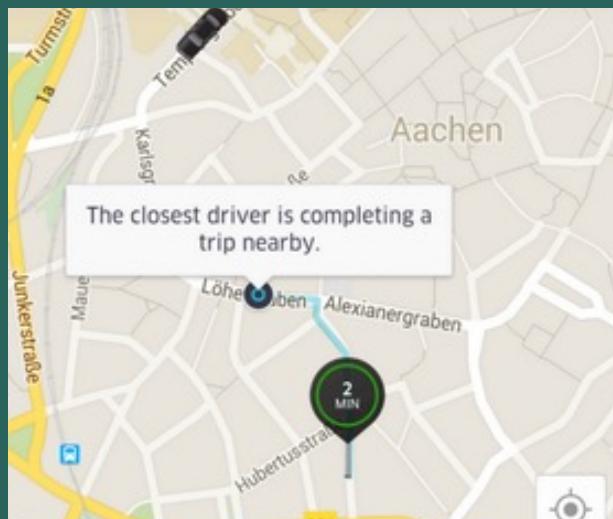
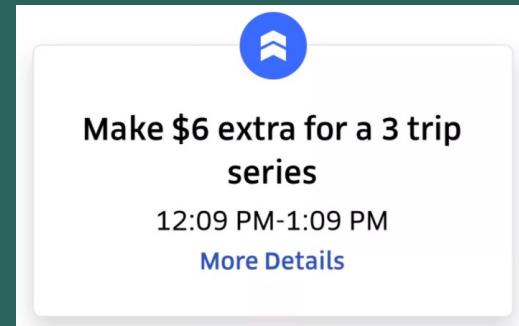
"Pay is not the only lever that platforms currently use to influence worker behavior"

How to Control Multihoming?

Time Delay



Streak Bonus



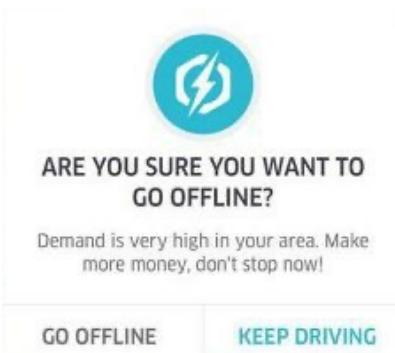
Counterfactual #2

impact of incentives
to stay longer?
(short-term capacity)

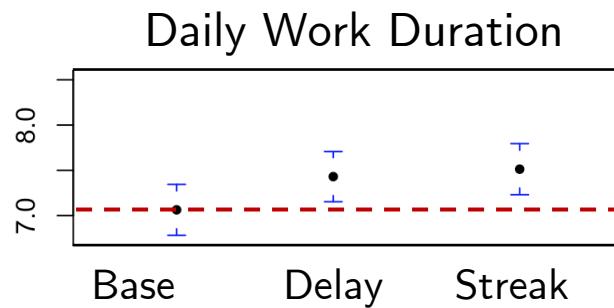
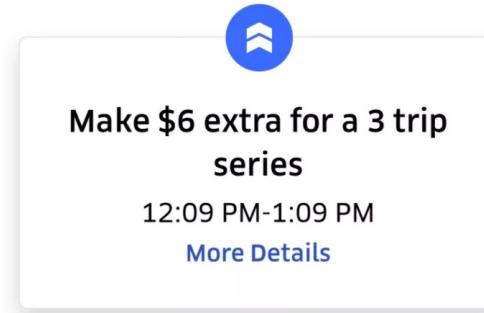
Counterfactual #2

Short-Term

Time Delay



Streak Bonus



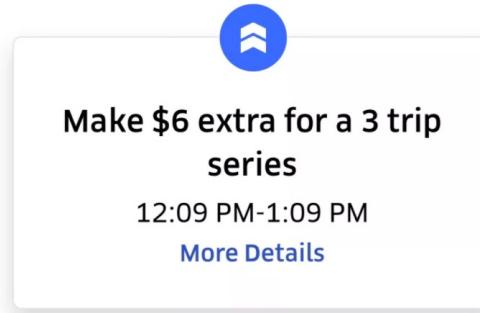
Counterfactual #2

Short-Term

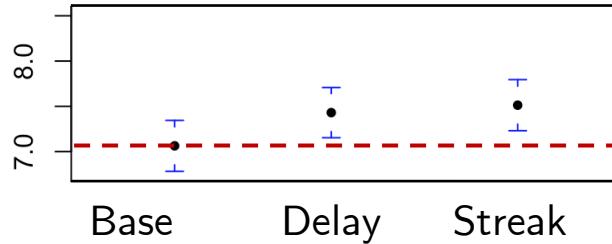
Time Delay



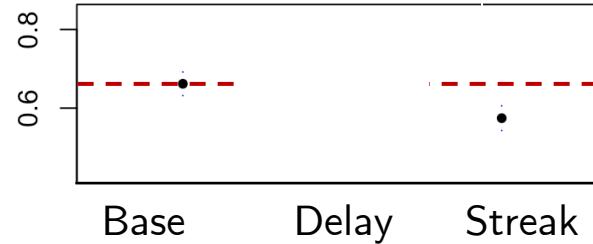
Streak Bonus



Daily Work Duration



P(Multihoming)



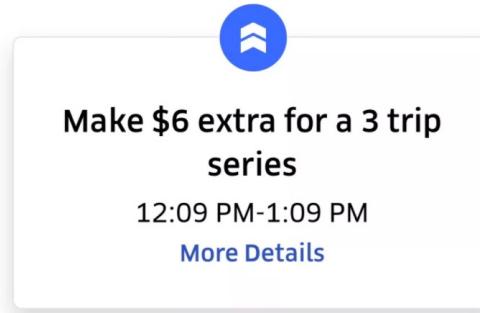
Counterfactual #2

Short-Term

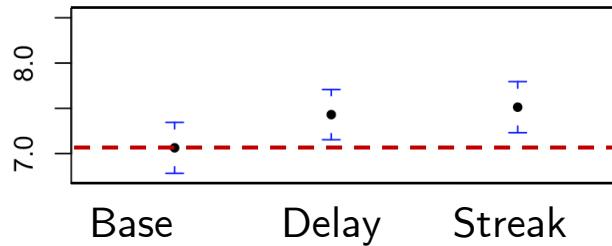
Time Delay



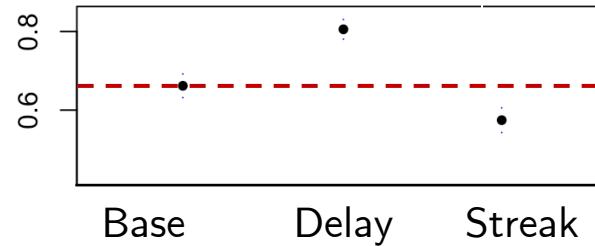
Streak Bonus



Daily Work Duration



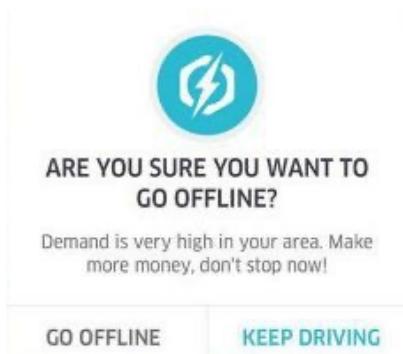
P(Multihoming)



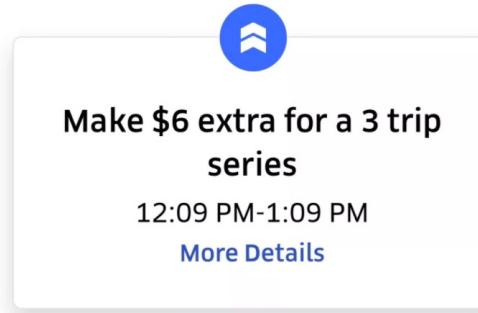
Counterfactual #2

Short-Term

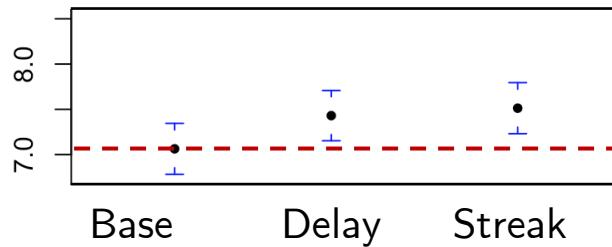
Time Delay



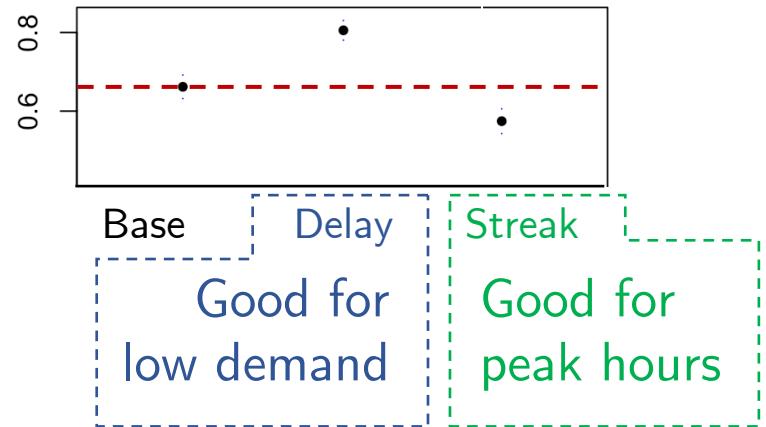
Streak Bonus



Daily Work Duration



P(Multihoming)



POLITICS

New York City passes nation's first minimum pay rate for Uber and Lyft drivers

The new rule will likely give drivers an extra \$5 an hour.

by **Alexia Fernández Campbell**

Dec 5, 2018, 11:10 AM PST

Vox



For 2019, only applied to
pay-per-work platforms

POLITICS

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POLITICS

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The new rule will likely give dr

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Dec 5, 2018, 11:10 AM PST

Driver Pay Calculator*

Trip miles:

0

Trip minutes:

0

Trip seconds:

0

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

Choose a company:

UBER

Do you have a wheelchair accessible vehicle?

CALCULATE

Counterfactual #3

Policy Analysis

POLITICS

New York City passes nation's first minimum pay rate for Uber and Lyft drivers

The new rule will likely give dr

by Alexia Fernández Campbell

Dec 5, 2018, 11:10 AM PST

What happens when
the rule is applied
universally?

Driver Pay Calculator*

Trip miles:

0

Trip minutes:

0

Trip seconds:

0

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

Choose a company:

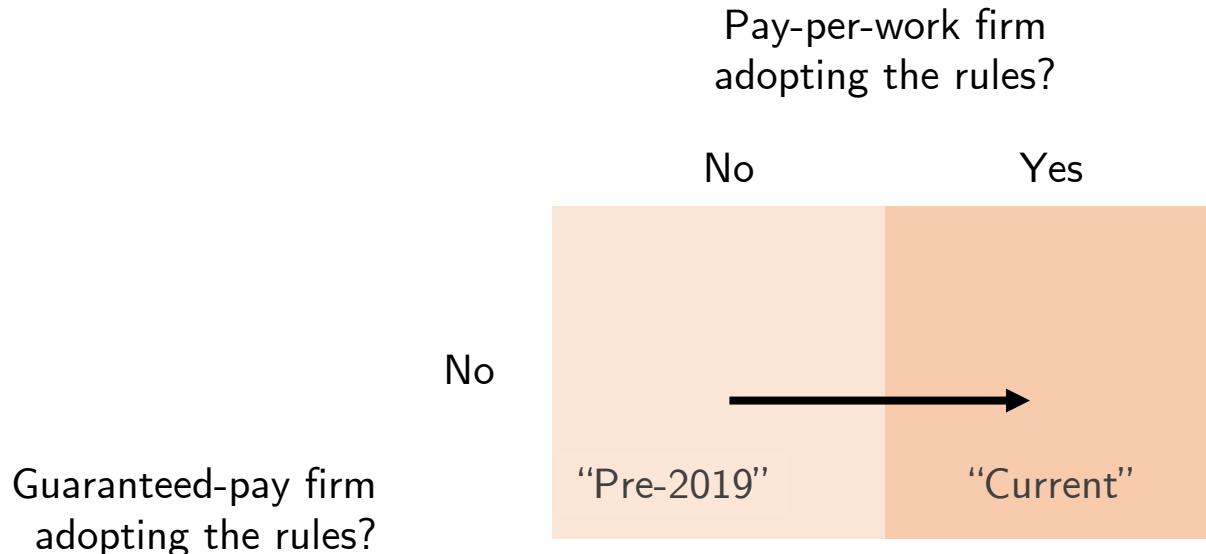
UBER

Do you have a wheelchair accessible vehicle?

CALCULATE

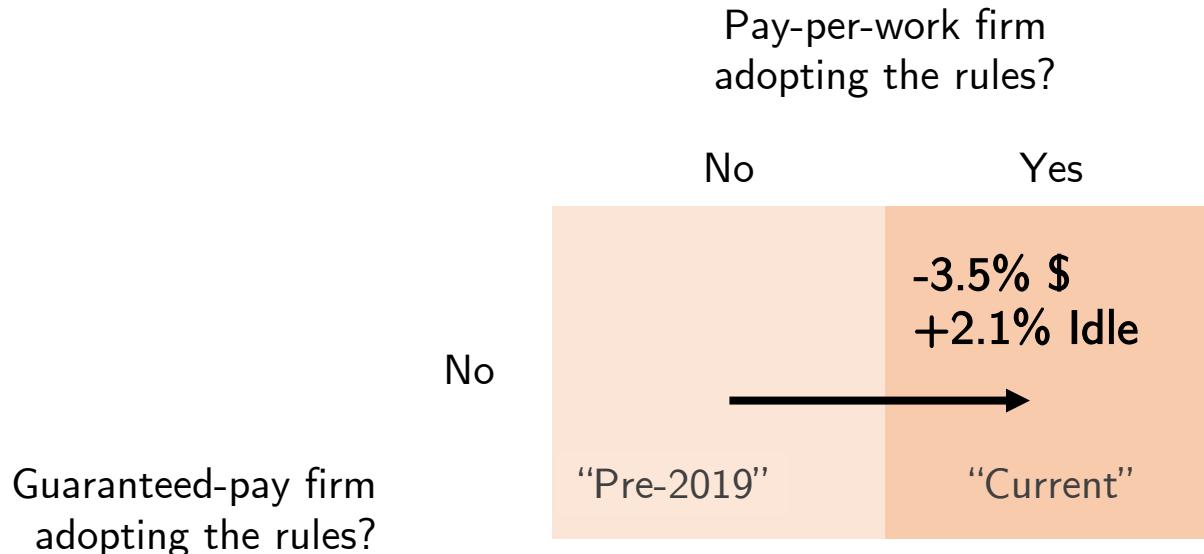
Policy Analysis

Driver Income Rules



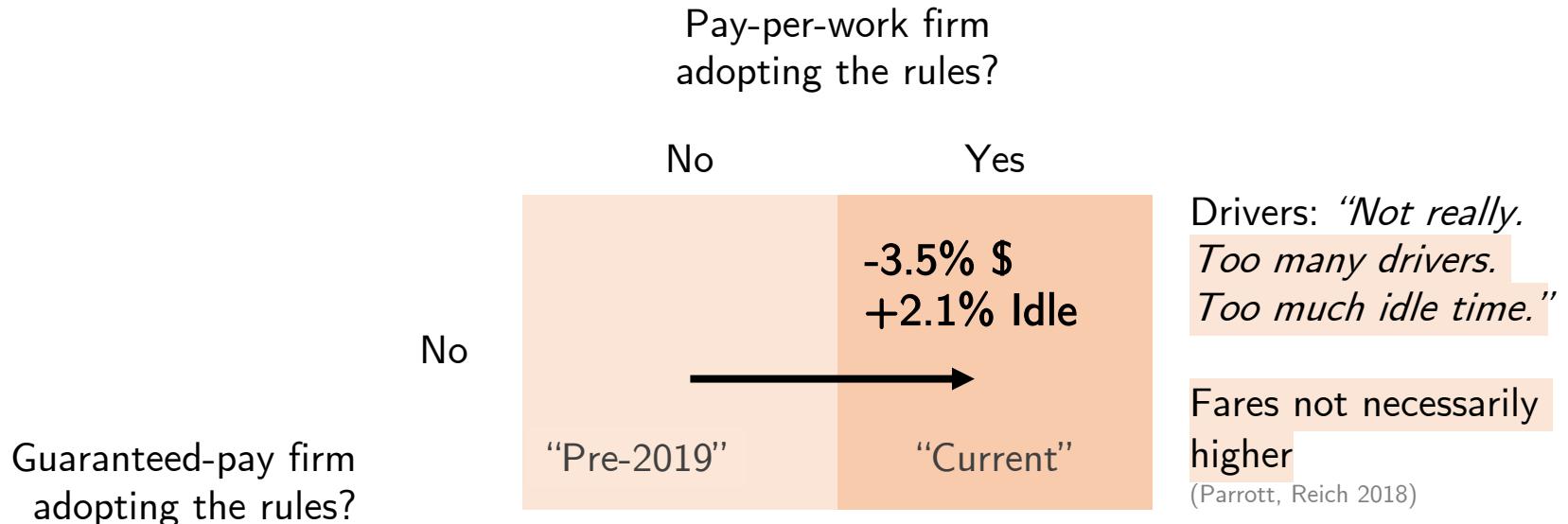
Policy Analysis

Driver Income Rules



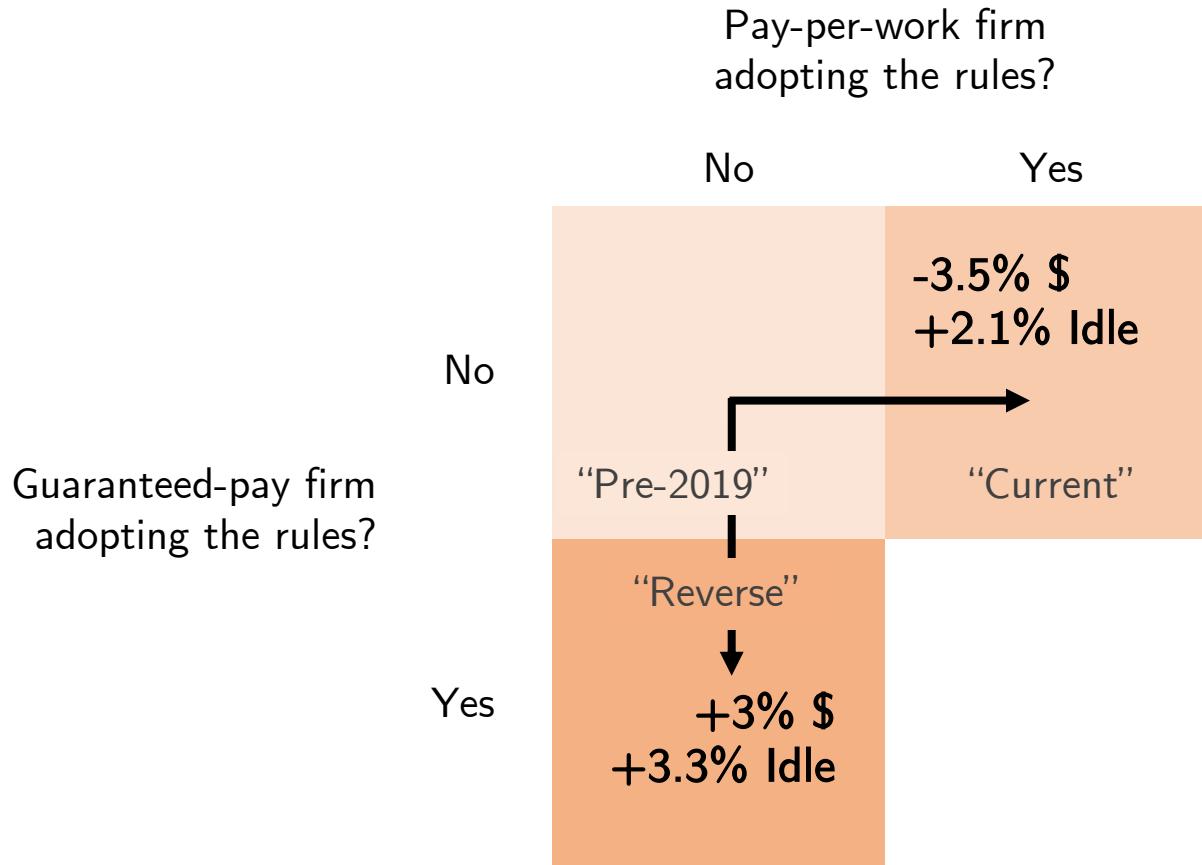
Policy Analysis

Driver Income Rules



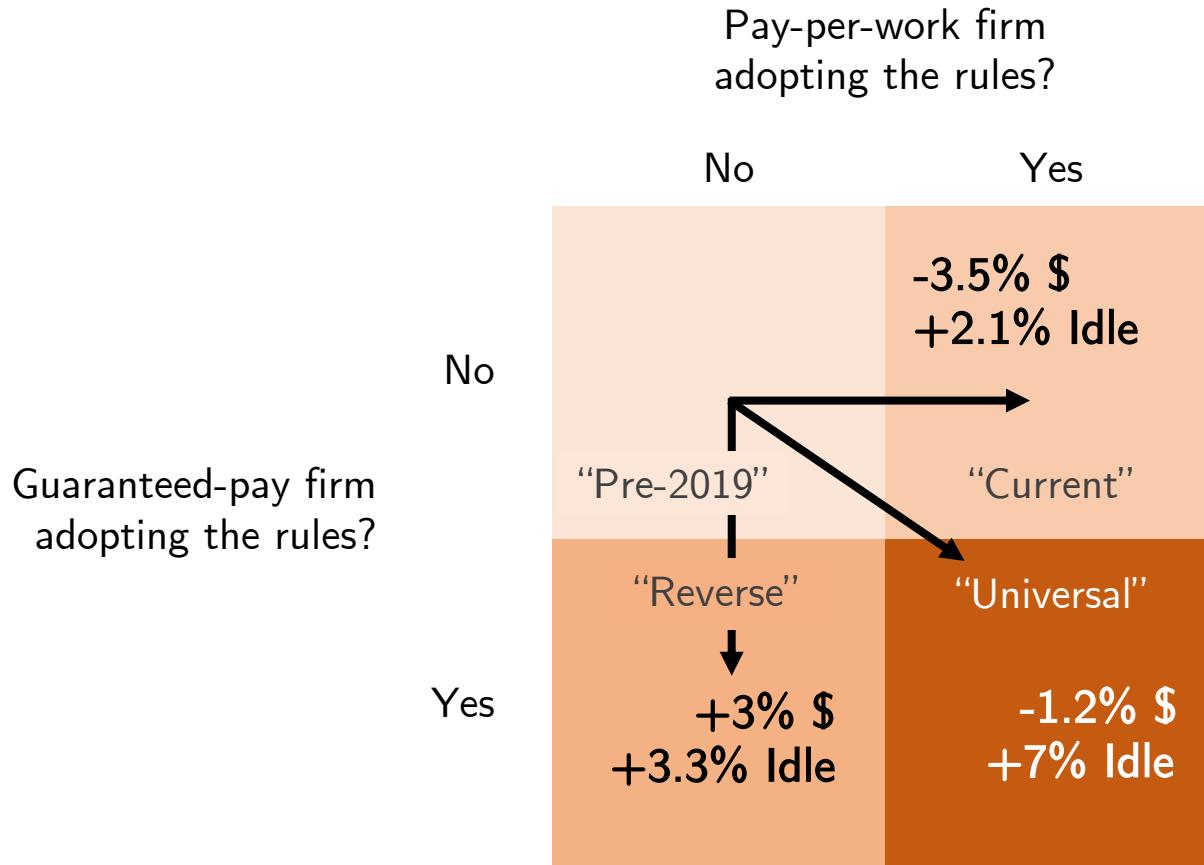
Policy Analysis

Driver Income Rules



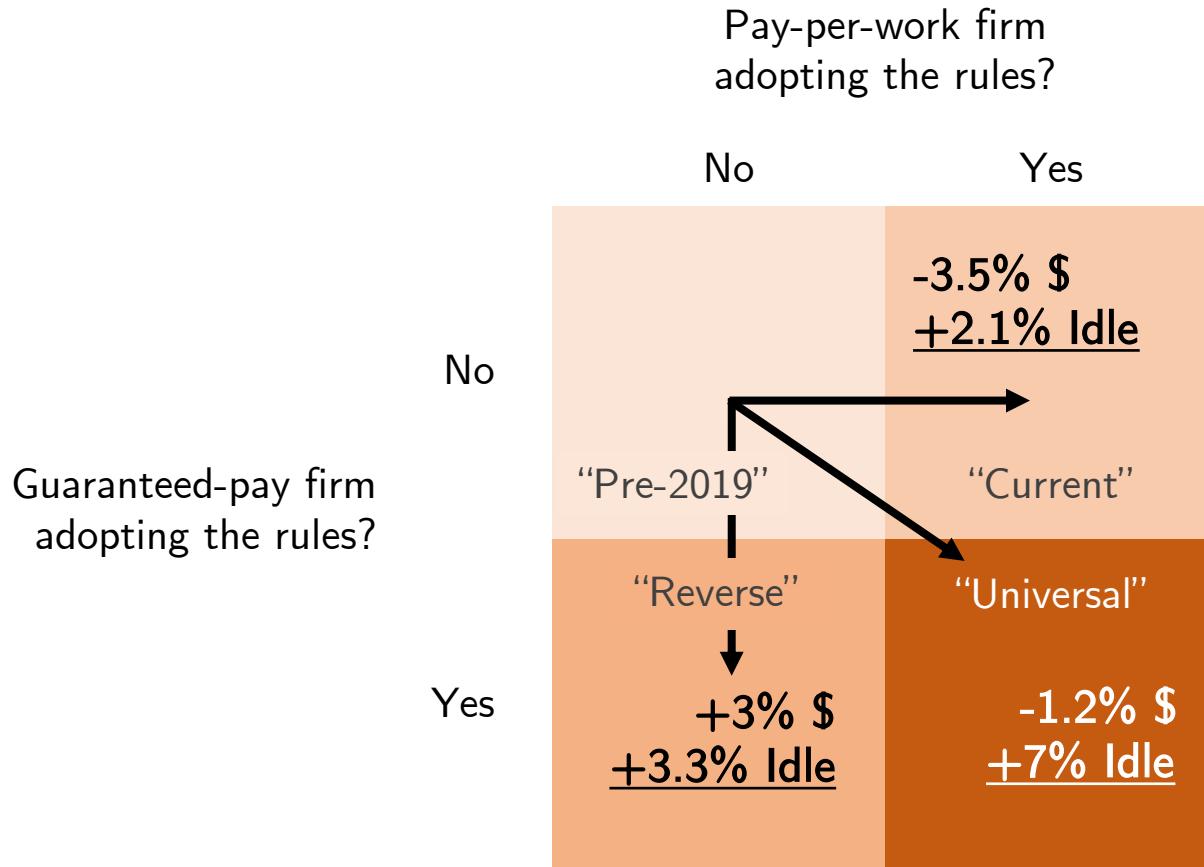
Policy Analysis

Driver Income Rules



Policy Analysis

Driver Income Rules



Summary

Structural modeling of gig workers' multihoming decisions

Insights

- ML/GAN-based adversarial estimation (historically hard to trace)
- 42% of drivers always multihome, 2/3 on most days
- Drivers are strongly myopic; responding to short-term incentives
- Guaranteed pay: save 25-50% from pay-per-work
- Peak hours: streak bonus to retain drivers
- Low demand: time delay to nudge earlier departure
- Our model helps predict impact of policy

Thank you!



Read more:
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mmwpaper](https://bit.ly/mmwpaper)

Gad Allon, Maxime Cohen, Ken Moon, Park Sinchaisri (parksinchaisri@berkeley.edu)