



The Impact of Behavioral and Economic Drivers on Gig Economy Workers

BDRM 2018



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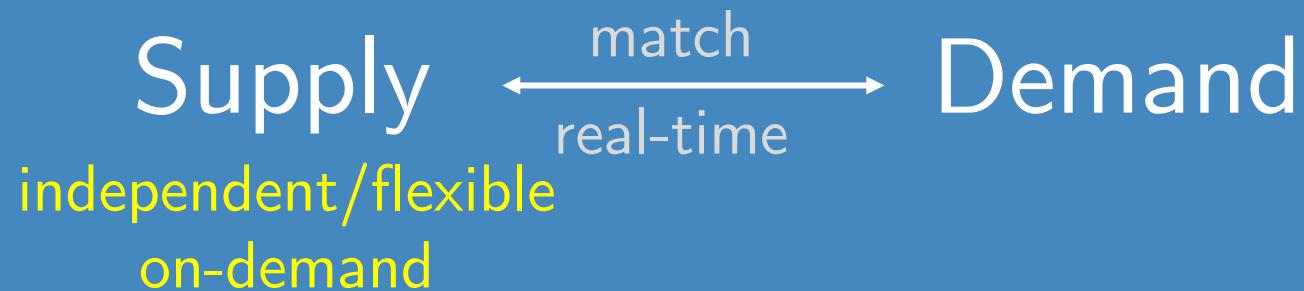
Gig Economy



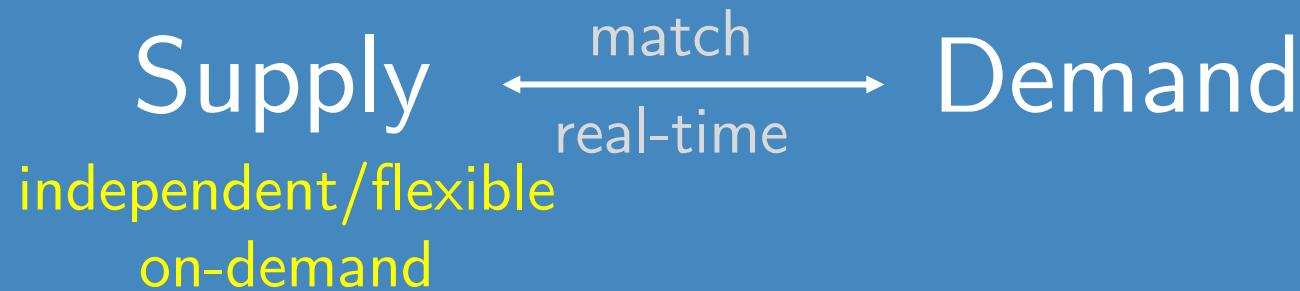
caviar



Gig Economy



Gig Economy



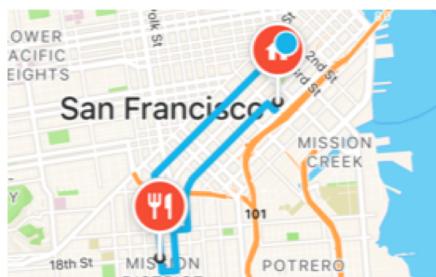
Capacity planning is challenging

In Practice

Real-time
“surge pricing”

Deliver by 6:15pm

Decline



Mission Chinese Food

\$22.78 subtotal (2 items)

BUSY PAY: +\$1.50

4.1 miles total

Accept Order

In Practice

Real-time
“surge pricing”

Deliver by 6:15pm Decline

Mission Chinese Food
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Accept Order

Scheduled bonus

5:00 PM–6:00 PM

+10% (5:00pm - 5:30pm)
+30% (5:30pm - 6:00pm)

6:00 PM–7:00 PM

+30% (6:00pm - 6:30pm)
+40% (6:30pm - 7:00pm)

In Practice

Real-time “surge pricing”

Deliver by 6:15pm Decline

Mission Chinese Food
\$22.78 subtotal (2 items)

BUSY PAY: +\$1.50

4.1 miles total

Accept Order

Scheduled bonus

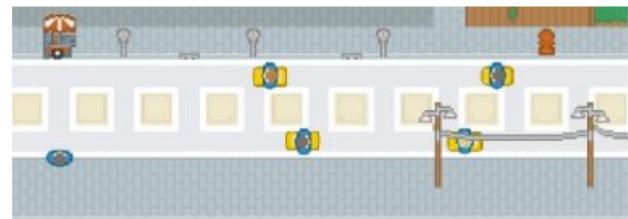
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+30% (5:30pm - 6:00pm)

6:00 PM–7:00 PM

+30% (6:00pm - 6:30pm)
+40% (6:30pm - 7:00pm)

“You’re so close to
your precious target”

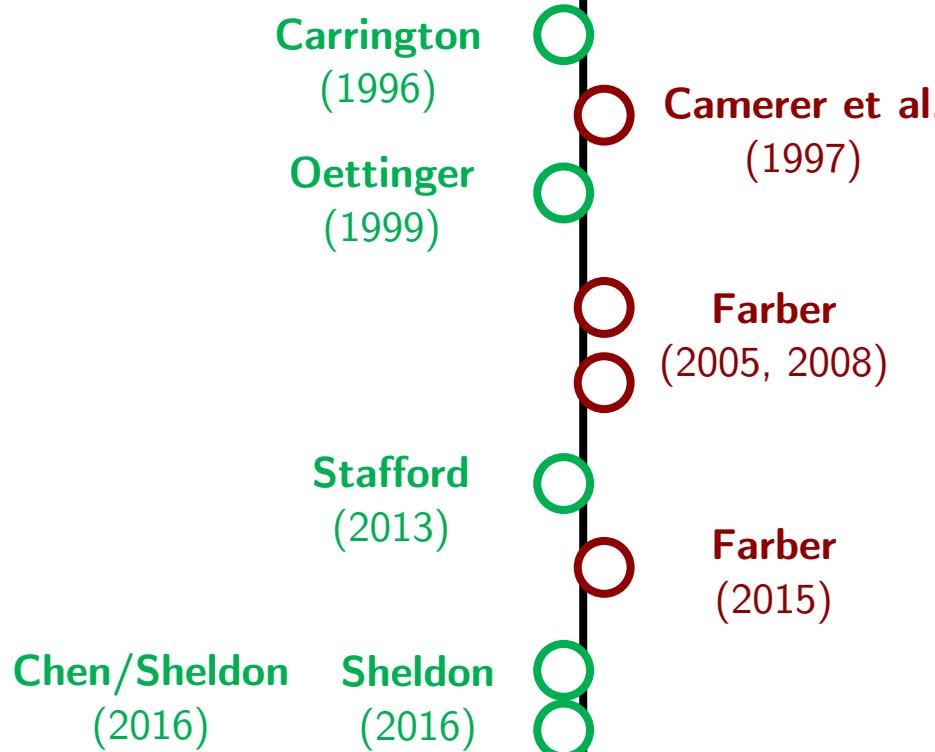


How Uber Uses
Psychological Tricks to
Push Its Drivers’ Buttons

Theories of Labor Supply

Neoclassical

- Maximize lifetime utility
- **Positive** income elasticities



Behavioral

- Reference-dependence, targets
- **Negative** income elasticities

Research Questions

How do gig economy workers
make labor decisions?

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How do gig economy workers
make labor decisions?

How can the platform influence
their decisions?

Outline

Our data
Endogeneity
Selection

Empirical
Strategy
Heckman + IV

Results
 $P(\text{work})/\text{Hours}$
*Time-dependent
Within-day/
Across-days
Income Targeting
Inertia*

Implications
Optimize
Incentives

Data

NYC ride-hailing firm

Drivers are guaranteed an hourly base rate.

Data

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Drivers are guaranteed an hourly base rate.



Shift-level financial incentives and driving activity *for all*

Data

NYC ride-hailing firm

Drivers are guaranteed an hourly base rate.



Shift-level financial incentives and driving activity *for all*

5.5M

Observations

358

Days

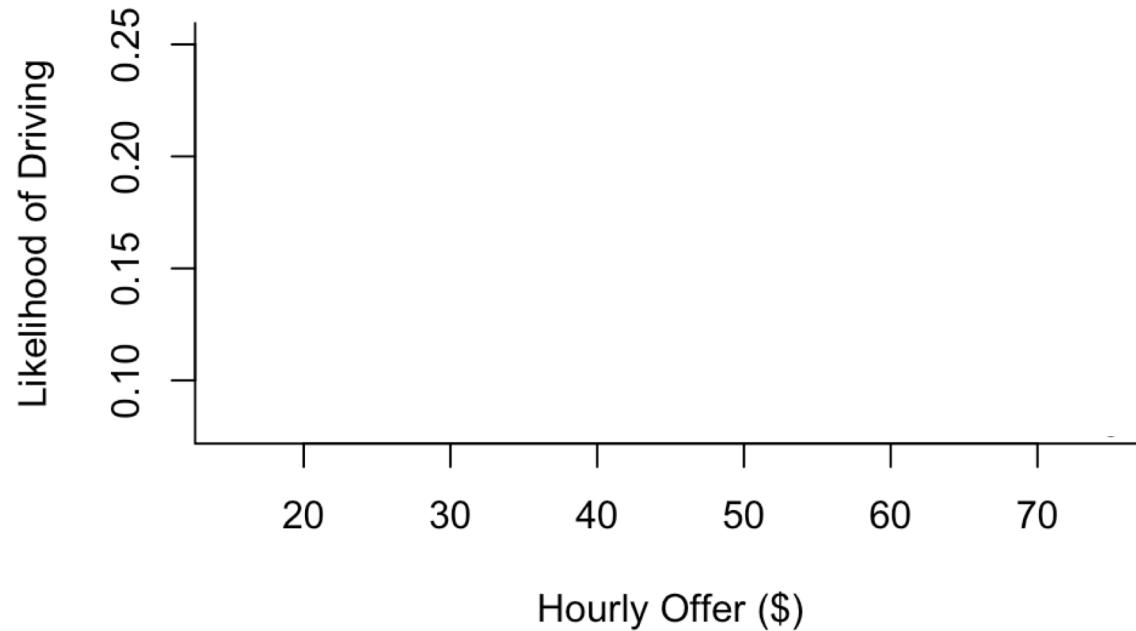
Oct 2016 – Sep 2017

7,826

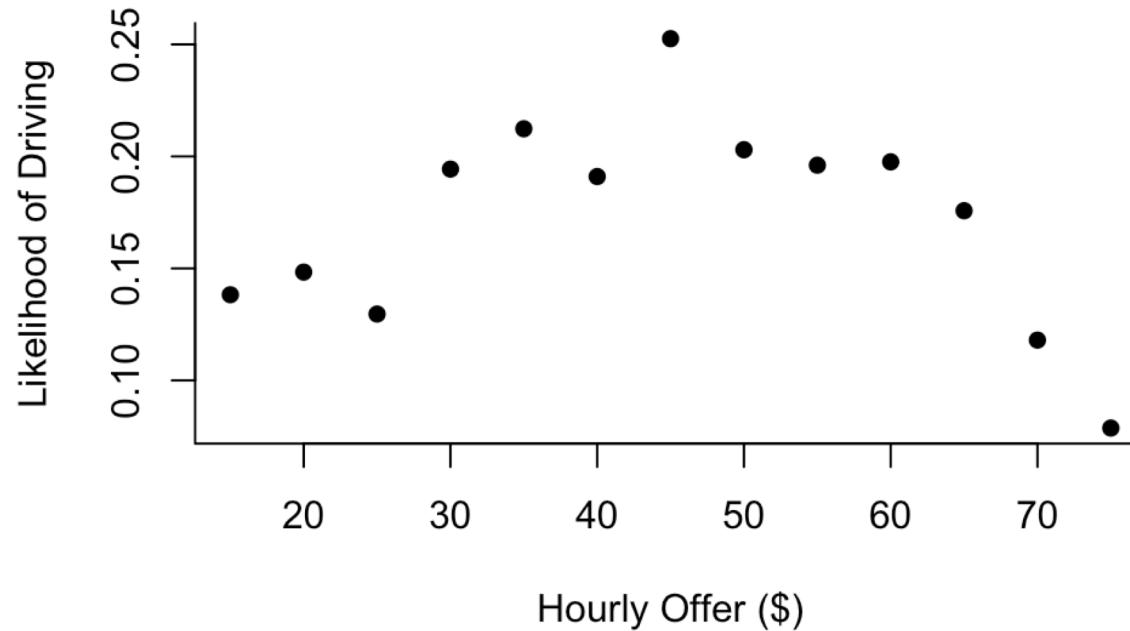
Unique drivers

- SUV (64.54%)
- Sedan (21.77%)
- Van (13.69%)

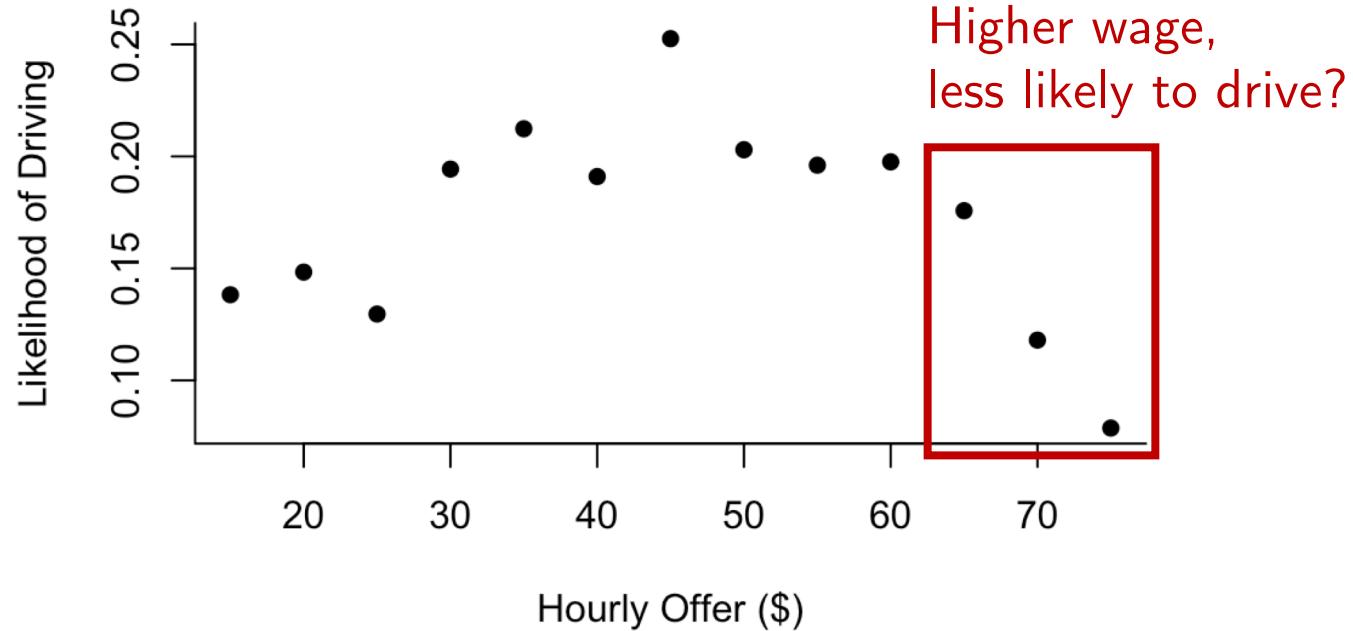
Drive ~ Wage?



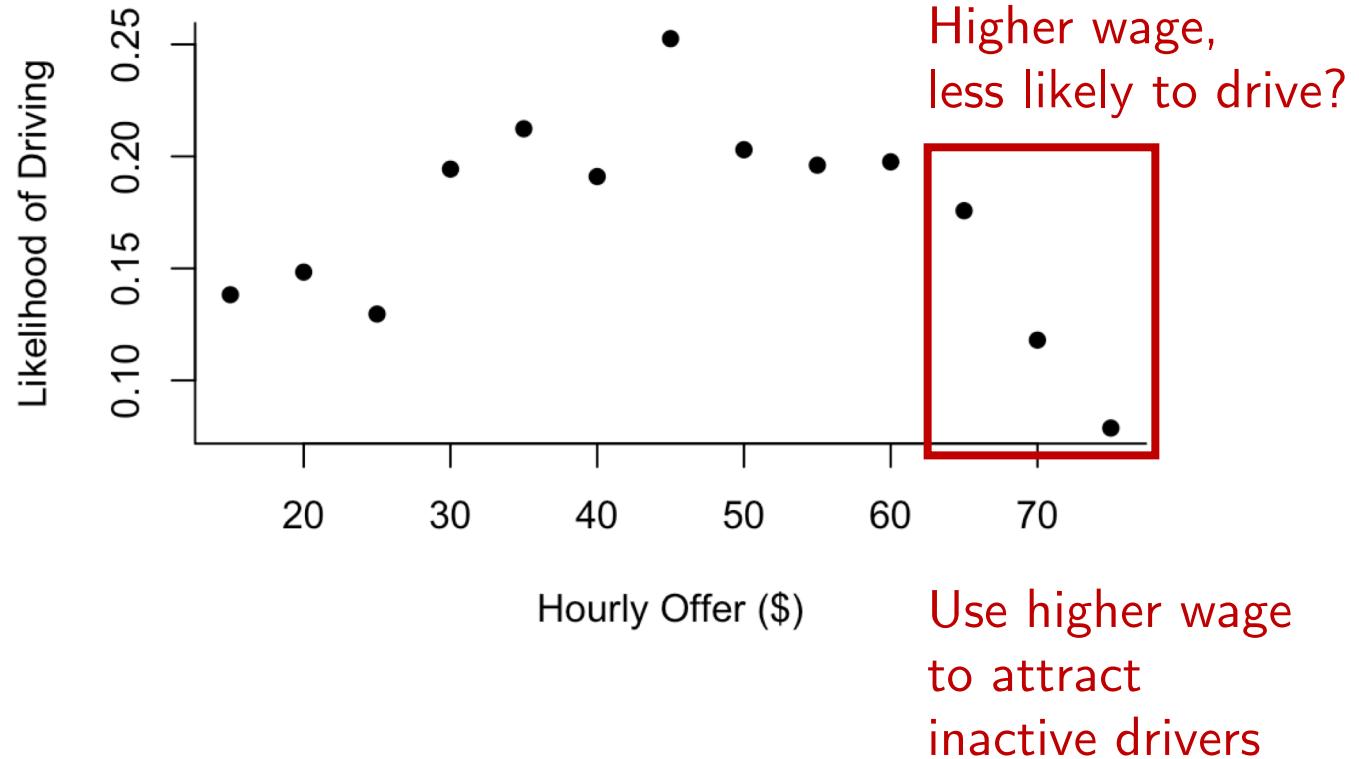
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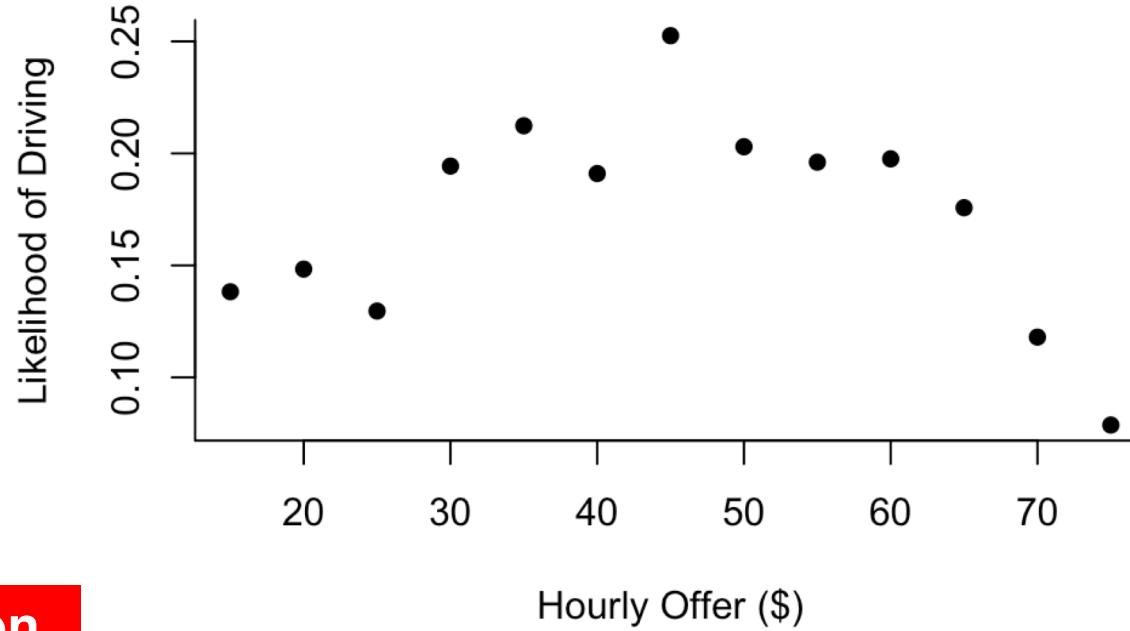
Drive ~ Wage?



Simultaneity



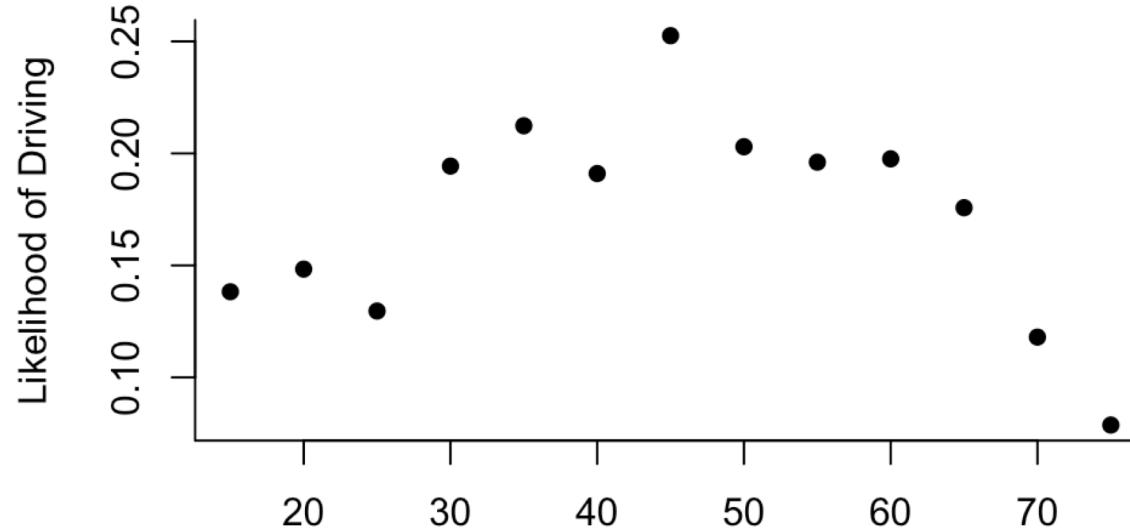
Simultaneity



Solution

Instrumental
Variables

Simultaneity

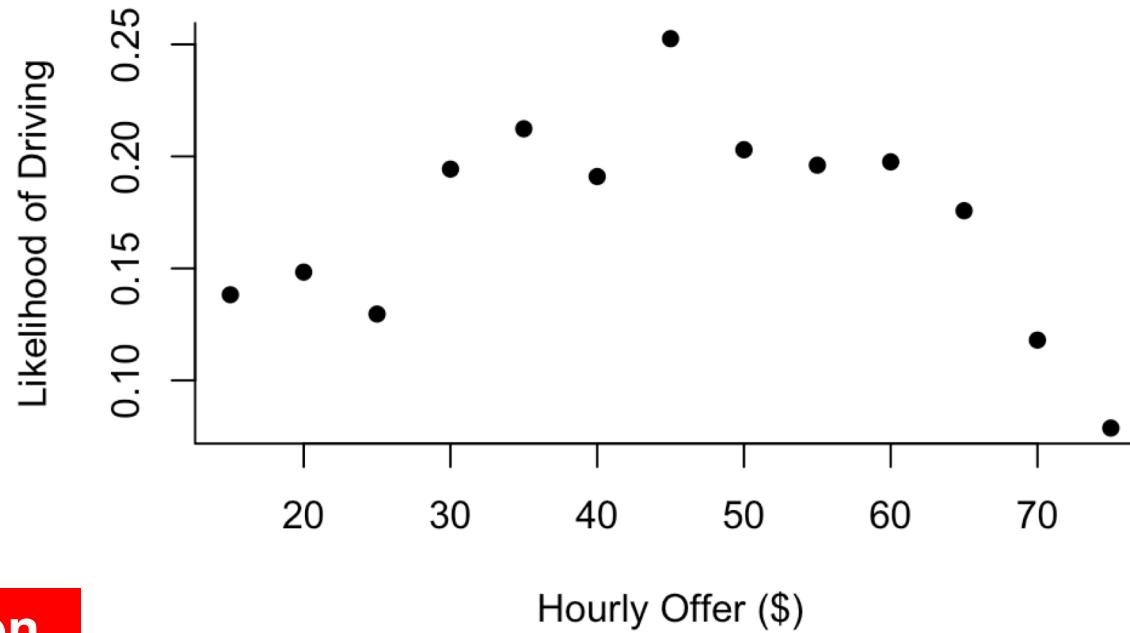


Solution

Instrumental Variables

- **Offer:** Average of other drivers' offers
(Camerer et al. 1997, Sheldon 2016)

Simultaneity



Solution

Instrumental Variables

- **Offer:** Average of other drivers' offers
(Camerer et al. 1997, Sheldon 2016)
- **Promo** (binary): Lagged value from the same shift in the previous week
(Villas-Boas & Winer 2001, Yang et al 2003)

Hours ~ Wage?



Hours ~ Wage?

$$\text{Log(Hours)} \leftarrow \text{Log(Wage)}$$



Hours ~ Wage?

$$\text{Log(Hours)} \leftarrow \text{Log(Wage)}$$



Decision to work is not random



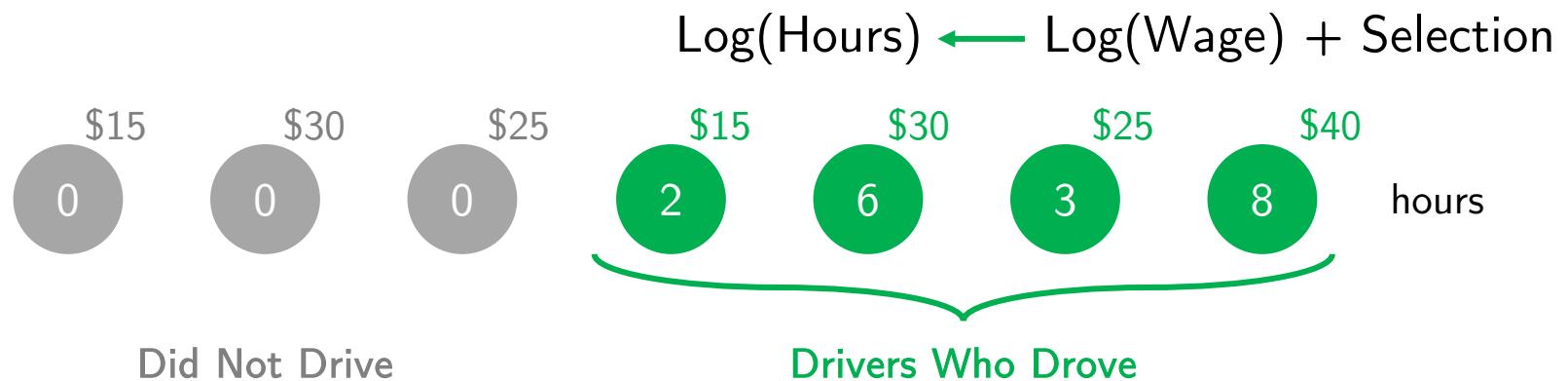
Selection Bias

Decision to work is **not random**



Selection Bias

Decision to work is **not random**



Solution

Heckman Two-Stage Estimation

("Heckit" - Heckman 1979)

Empirical Strategy

1 Work or not?

Control Function Probit:

$P(\text{drive}) \text{ on Offer} + \text{Promo} + \text{ISF} + \text{HSF} + \text{Controls}$

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Income So Far
= intensity of work

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Income So Far
= intensity of work

Hours So Far
= amount of available time

Empirical Strategy

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Income So Far
= intensity of work

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= amount of available time

Conditional
on working

2 How long to work?

2SLS with Fixed Effects

$$\# \text{ Hours} \text{ on Earning} + \text{ISF} + \text{HSF} + \text{IMR} + \text{Controls}$$

Empirical Strategy

1 Work or not?

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Conditional
on working

2 How long to work?

2SLS with Fixed Effects

$$\# \text{ Hours on Earning} + \text{ISF} + \text{HSF} + \text{IMR} + \text{Controls}$$

Inverse Mills Ratio
= correct for selection

Results

Compare:

1
2 vs. 1
2 + ISF + HSF
“Targets”



Within-Day

Midday



Late Night

Across-Days

Tuesday



Sunday

Late Night

1

| | Work or not? | |
|---------------------------|--------------|------------|
| | Base | + Targets |
| Hourly offer/ earnings | | |
| Promo | | |
| Income so far | | |
| Hours so far | | |
| | | |
| AIC | 95,856.010 | 72,887.620 |

N = 166,766

Late Night

1

| | Work or not? | |
|---------------------------|---------------------|---------------------|
| | Base | + Targets |
| Hourly offer/ earnings | 0.008*** (0.001) | 0.012*** (0.001) |
| Promo | 0.229*** (0.038) | 0.285*** (0.046) |
| Income so far | | |
| Hours so far | | |
| AIC | 95,856.010 | 72,887.620 |

Financial incentives and
getting a “deal”
encourage working

N = 166,766

Late Night

1

| | Work or not? | |
|---------------------------|---------------------|-----------------------|
| | Base | + Targets |
| Hourly offer/ earnings | 0.008*** (0.001) | 0.012*** (0.001) |
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| Income so far | | -0.002*** (0.0002) |
| Hours so far | | |
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| Income so far | Income Target | -0.002*** (0.0002) |
| Hours so far | | |
| AIC | 95,856.010 | 72,887.620 |

N = 166,766

For average driver,
\$10 additional income so far,
P(drive) decreases by 0.25%

The more you've earned,
the less likely you're going to
continue working.

Late Night

1

| | Work or not? | |
|---------------------------|---------------------|-----------------------|
| | Base | + Targets |
| Hourly offer/ earnings | 0.008*** (0.001) | 0.012*** (0.001) |
| Promo | 0.229*** (0.038) | 0.285*** (0.046) |
| Income so far | Income Target | -0.002*** (0.0002) |
| Hours so far | | 0.361*** (0.007) |
| | | |
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Late Night

1

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| Promo | 0.229*** (0.038) | 0.285*** (0.046) |
| Income so far | Income Target | -0.002*** (0.0002) |
| Hours so far | Inertia | 0.361*** (0.007) |
| AIC | 95,856.010 | 72,887.620 |

N = 166,766

For average driver,
1 additional hour so far,
P(drive) increases by 4.1%

The longer you've been active,
the more likely you'll continue
working

Late Night

1

2

| | Work or not? | | # Hours | | |
|---------------------------|---------------------|-----------------------|---------|------|-----------|
| | Base | + Targets | Naive | Base | + Targets |
| Hourly offer/ earnings | 0.008*** (0.001) | 0.012*** (0.001) | | | |
| Promo | 0.229*** (0.038) | 0.285*** (0.046) | | | |
| Income so far | Income Target | -0.002*** (0.0002) | | | |
| Hours so far | Inertia | 0.361*** (0.007) | | | |
| IMR | | | | | |
| AIC/R ² | 95,856.010 | 72,887.620 | | | |

N = 166,766

Late Night

1

2

| | Work or not? | | # Hours | | |
|---------------------------|---------------------|-----------------------|----------------------|-------------------|----------------------|
| | Base | + Targets | Naive | Base | + Targets |
| Hourly offer/ earnings | 0.008*** (0.001) | 0.012*** (0.001) | -0.010*** (0.001) | -0.001 (0.001) | 0.001*** (0.0002) |
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| Income so far | Income Target | -0.002*** (0.0002) | | | |
| Hours so far | Inertia | 0.361*** (0.007) | | | |
| IMR | | | | *** | *** |
| AIC/R ² | 95,856.010 | 72,887.620 | 0.313 | 0.324 | 0.957 |

N = 166,766

N = 18,941

Late Night

1

2

| | Work or not? | | # Hours | | |
|---------------------------|---------------------|-----------------------|----------------------|-------------------|-------------------------|
| | Base | + Targets | Naive | Base | + Targets |
| Hourly offer/ earnings | 0.008*** (0.001) | 0.012*** (0.001) | -0.010*** (0.001) | -0.001 (0.001) | 0.001*** (0.0002) |
| Promo | 0.229*** (0.038) | 0.285*** (0.046) | | | |
| Income so far | Income Target | -0.002*** (0.0002) | | | -0.0002*** (0.00002) |
| Hours so far | Inertia | 0.361*** (0.007) | | | 0.187*** (0.001) |
| IMR | | | | *** | *** |
| AIC/R ² | 95,856.010 | 72,887.620 | 0.313 | 0.324 | 0.957 |

N = 166,766

N = 18,941

Late Night

1

2

| | Work or not? | | # Hours | | |
|---------------------------|--|-----------------------|--|-------------------|-------------------------|
| | Base | + Targets | Naive | Base | + Targets |
| Hourly offer/ earnings | 0.008*** (0.001) | 0.012*** (0.001) | -0.010*** (0.001) | -0.001 (0.001) | 0.001*** (0.0002) |
| Promo | 0.229*** (0.038) | | The more you've earned, you'll drive shorter hours. | | |
| Income so far | Income Target | -0.002*** (0.0002) | | Income Target | -0.0002*** (0.00002) |
| Hours so far | Inertia | 0.361*** (0.007) | | Inertia | 0.187*** (0.001) |
| IMR | The longer you've been active, you'll drive longer hours. | | | | |
| AIC/R ² | 95,856.010 | 72,887.620 | 0.313 | 0.324 | 0.957 |

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Late Night

1

2

| | Work or not? | | # Hours | | |
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| | Work or not? | | | # Hours | | |
|------------|--------------|-----|-----|---------|-----|-----|
| | Offer | ISF | HSF | Earning | ISF | HSF |
| Late night | + | - | + | + | - | + |

Results Across Shifts

1

Work or not?

| | Offer | ISF | HSF |
|------------|-------|-----|-----|
| Midday | + | + | + |
| PM peak | + | - | + |
| PM off | + | - | + |
| Late night | + | - | + |

Income Target Inertia

Income targeting effect kicks in later in the day.

Results Across Shifts

| | Work or not? | | | # Hours | | |
|------------|--------------|-----|-----|---------|-----|-----|
| | Offer | ISF | HSF | Earning | ISF | HSF |
| Midday | + | + | + | - | + | + |
| PM peak | + | - | + | + | - | + |
| PM off | + | - | + | + | - | + |
| Late night | + | - | + | + | - | + |

Income Inertia Income Inertia

Target Target

Income targeting effect
kicks in later in the day.

Results Across Days

1

Work or not?

| | Offer | ISF | HSF |
|-----------|-------|-----|-----|
| Tuesday | + | + | + |
| Wednesday | + | + | + |
| Thursday | + | - | + |
| Friday | + | - | + |
| Saturday | + | - | + |
| Sunday | + | - | + |

Income
Target Inertia

Income targeting effect
kicks in later in the week.

Results Across Days

| | 1 Work or not? | | | 2 # Hours | | |
|-----------|-------------------|-----|-----|--------------|-----|-----|
| | Offer | ISF | HSF | Earning | ISF | HSF |
| Tuesday | + | + | + | + | + | + |
| Wednesday | + | + | + | + | - | + |
| Thursday | + | - | + | + | - | + |
| Friday | + | - | + | + | - | + |
| Saturday | + | - | + | + | - | + |
| Sunday | + | - | + | + | - | + |

Income Target Inertia Income Target Inertia

Financial incentives and income target effect are not significant for weekdays.

Optimizing Incentives

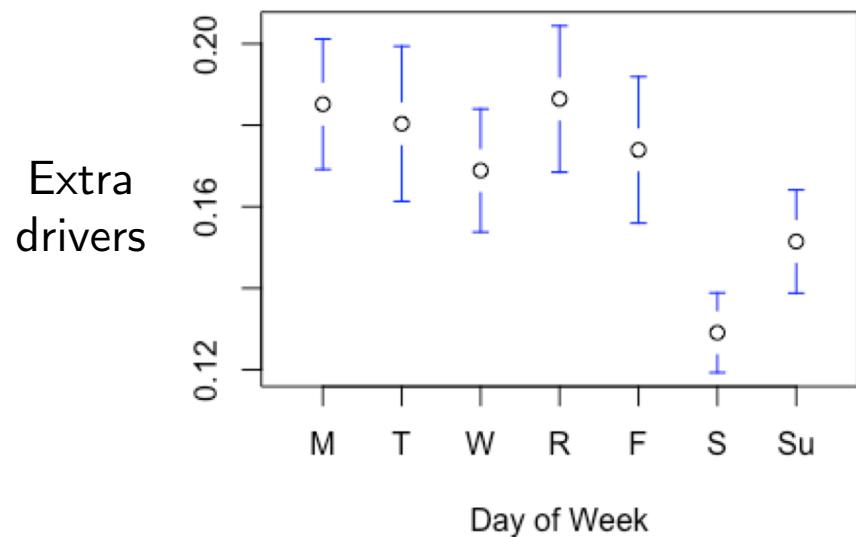
Using the insights we obtain, we propose algorithm for optimal allocation of financial incentives:

Ranking each driver by her
minimum driving-inducing incentive
 $=$ how much to trigger working decision

Optimizing Incentives

Compared to company's current practice, our algorithm...

Given the same budget



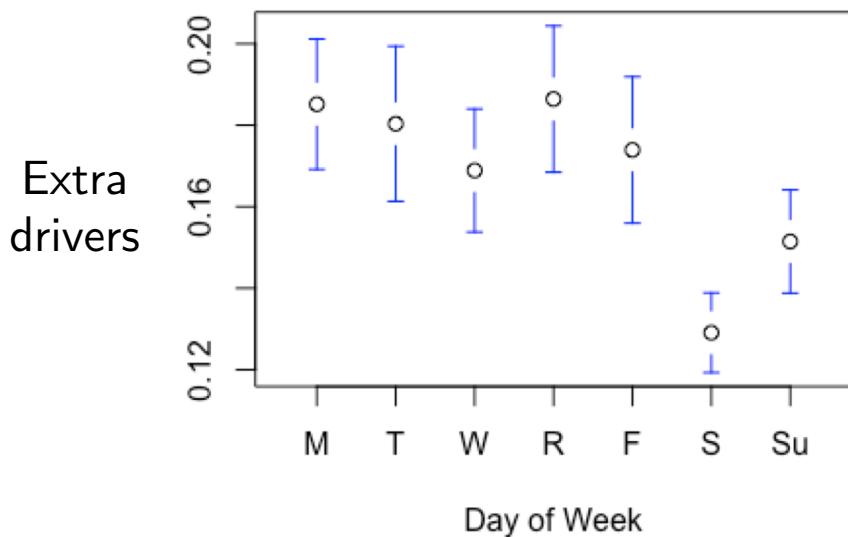
Can recruit **17% more drivers**

Average promo: 1.61x

Optimizing Incentives

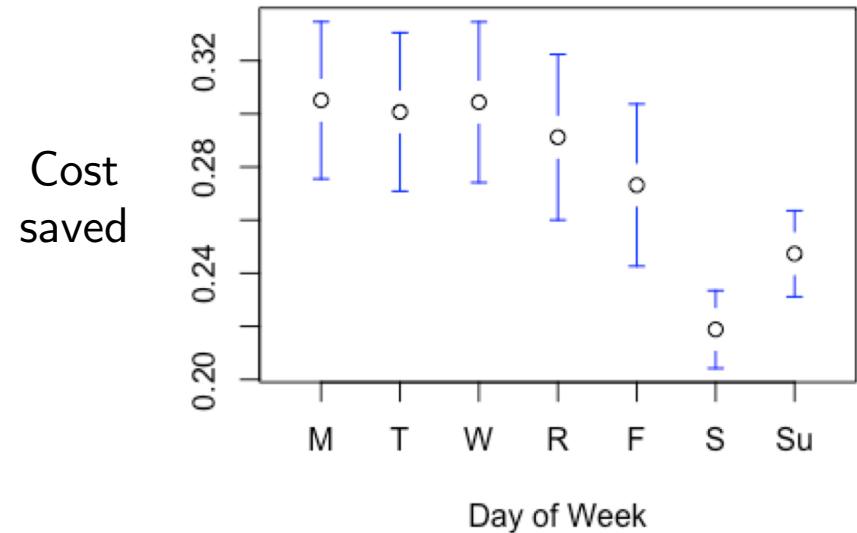
Compared to company's current practice, our algorithm...

Given the same budget



Can recruit **17% more drivers**
Average promo: 1.61x

Given the same capacity



Costs 28% less to maintain capacity

Summary

How do gig economy workers make labor decisions?

Approach

- Shift-level data from ride-hailing company
- Modified two-stage Heckman estimation w/ IVs and fixed effects



Summary

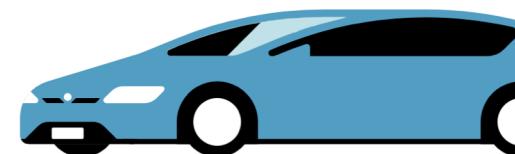
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Findings

- Decisions depend on driver type and time



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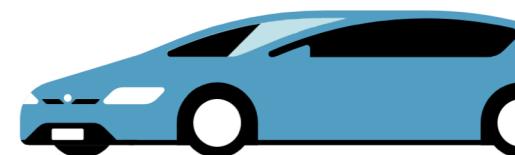
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- Income targeting affects how long they will work, from positively early on to negatively later in the day or week



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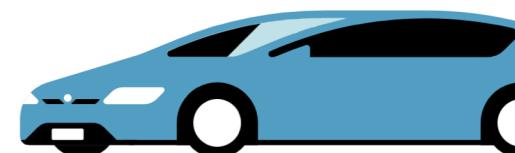
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Findings

- Decisions depend on driver type and time
- Offer and inertia can increase work activity
- Income targeting affects how long they will work, from positively early on to negatively later in the day or week
- Compared to the company's current practice, our approach can improve service capacity by 17% at the same cost or maintain the same capacity at 28% less cost



Heckit with IVs

1. Choice Equation “Drive or not?”

CF: Regress hourly offer/promo on IVs. Keep residuals

Probit: Estimate $P(\text{drive})$

$$P(\text{Drive}_{i,t} = 1 | \mathbf{X}_{i,t}) = \Phi(\alpha_{0,t} + \alpha_w w_{i,t} + \alpha_\psi \psi_{i,t} + \boldsymbol{\alpha} \mathbf{X}_{i,t} + \alpha_e \hat{e}_{i,t})$$

C

Inverse Mills Ratio (IMR)

$$\lambda(c_z) = \frac{\phi(c_z)}{1 - \Phi(c_z)}$$

Conditional on driving

2. Level Equation “How long?”

IV: Estimate hourly earning from IVs

OLS: Estimate hours

$$f(\text{Hour}_{i,t}) = \beta_{0,i} + \beta_w w_{i,t} + \boldsymbol{\beta} \mathbf{Z}_{i,t} + \theta \lambda_{i,t} + u_{i,t}$$

L