



# The Impact of Behavioral and Economic Drivers on Gig Economy Workers

BDRM 2018



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# Gig Economy



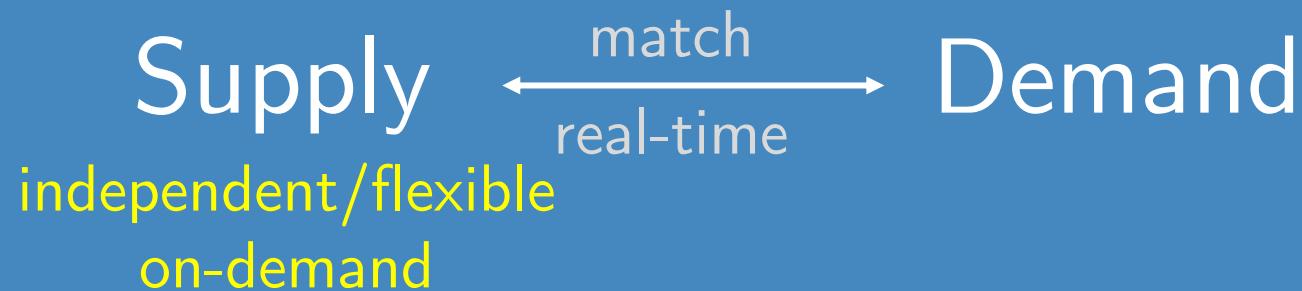
caviar



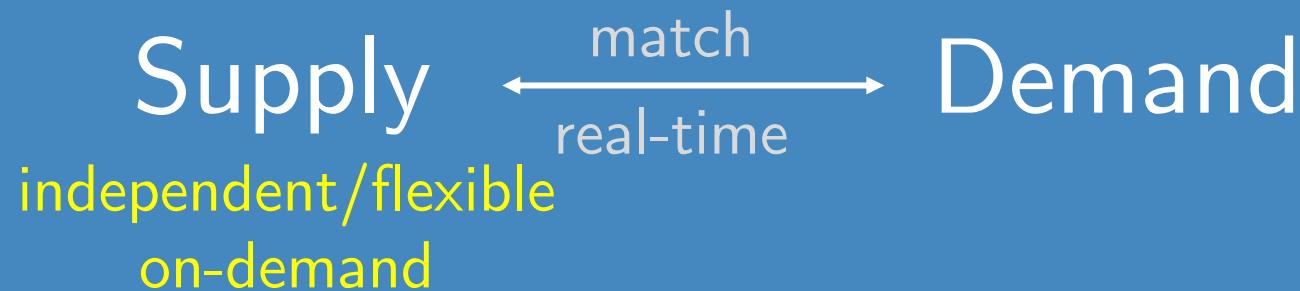
POSTMATES



# Gig Economy



# Gig Economy

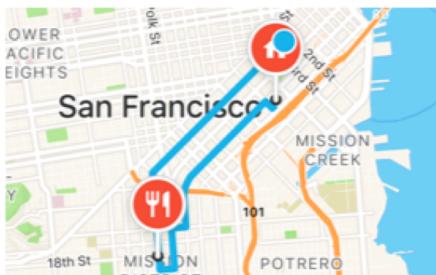


## Capacity planning is challenging

# 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

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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

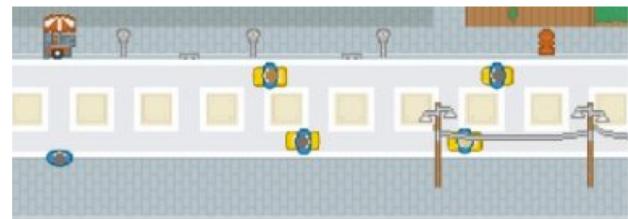
5:00 PM–6:00 PM

+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)

## “You’re so close to your precious target”

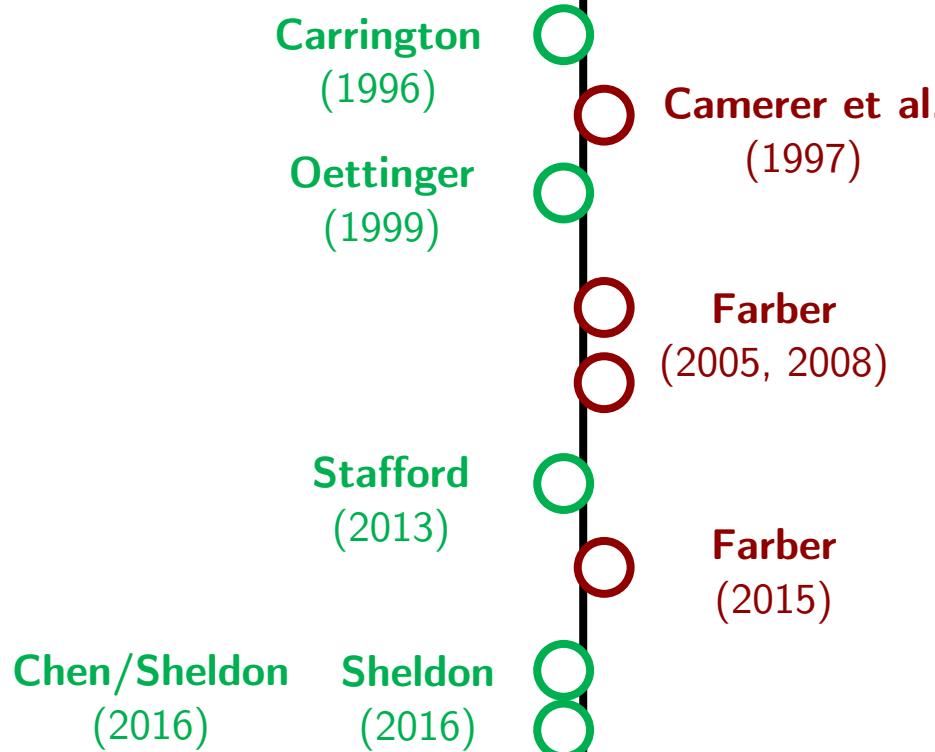


How Uber Uses Psychological Tricks to Push Its Drivers’ Buttons

# 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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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.

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

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## 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

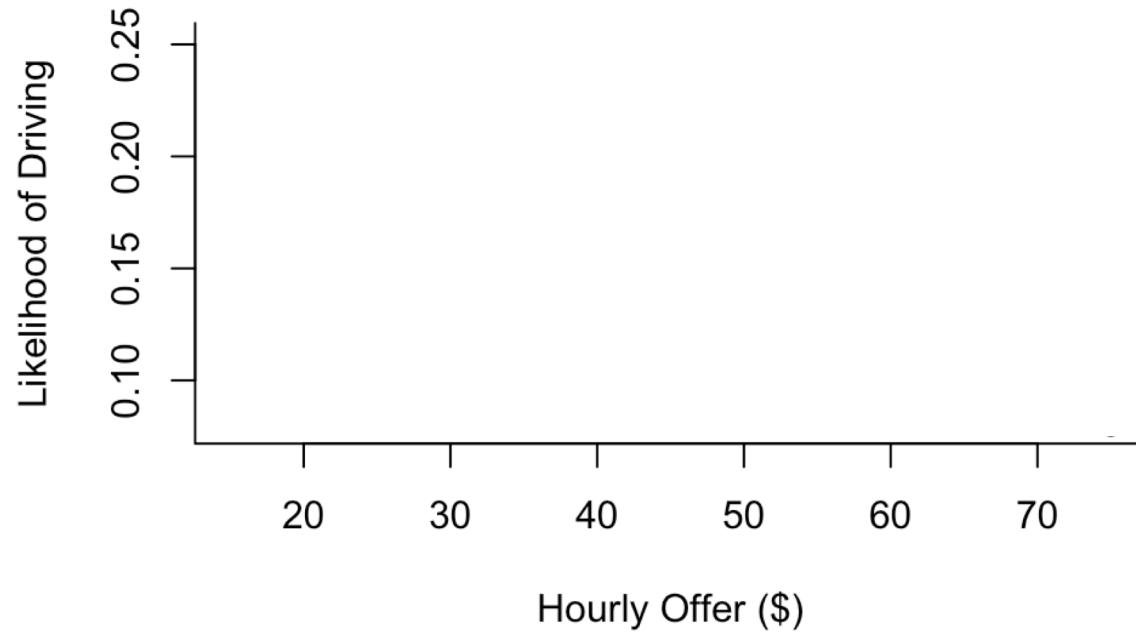
*Oct 2016 – Sep 2017*

**7,826**

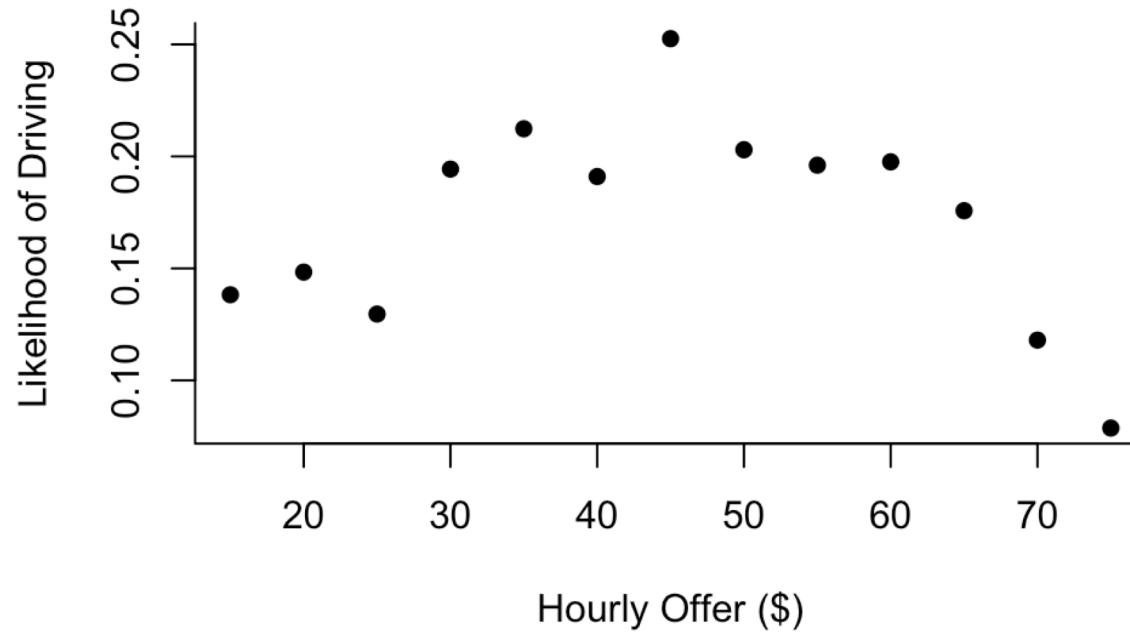
Unique drivers

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

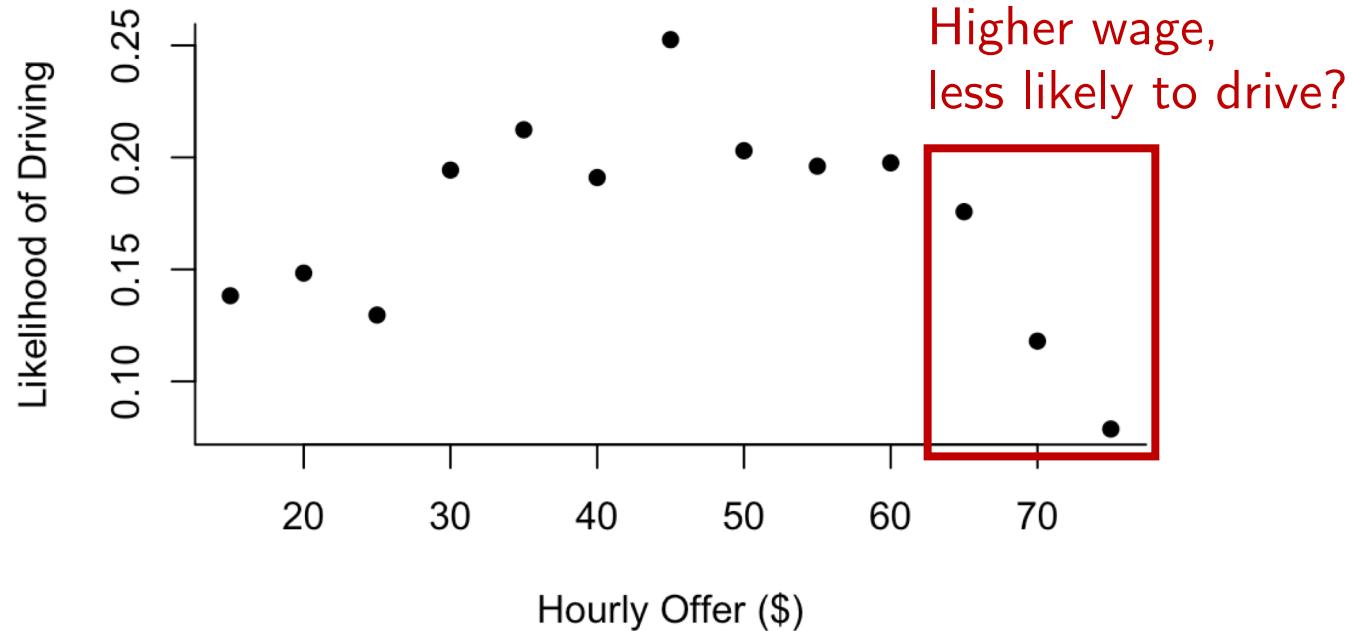
# Drive ~ Wage?



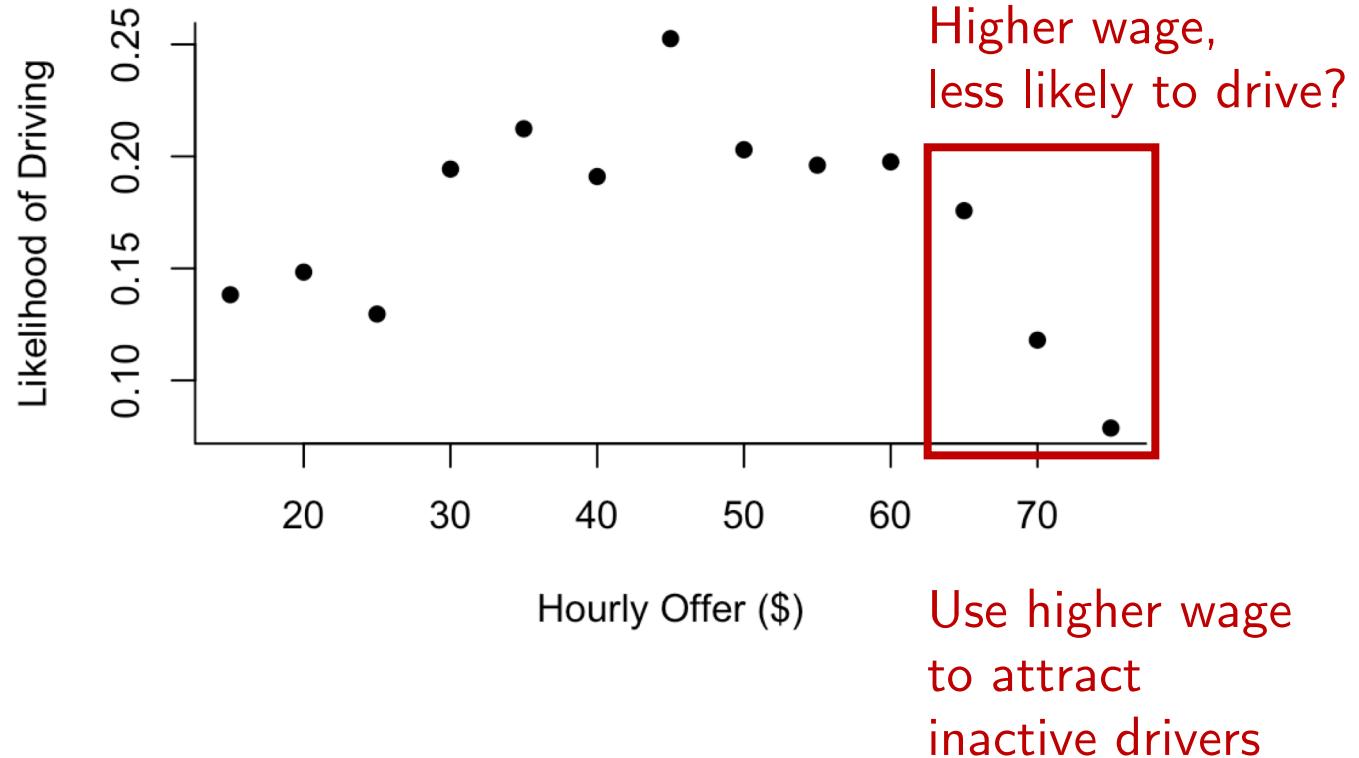
# Drive ~ Wage?



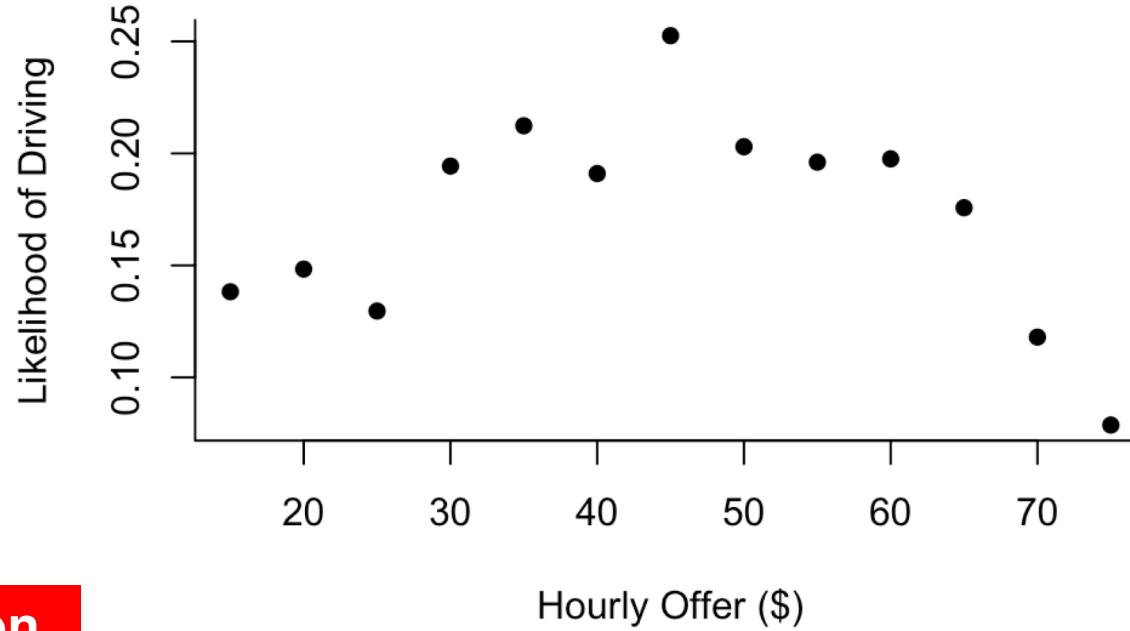
# Drive ~ Wage?



# Simultaneity



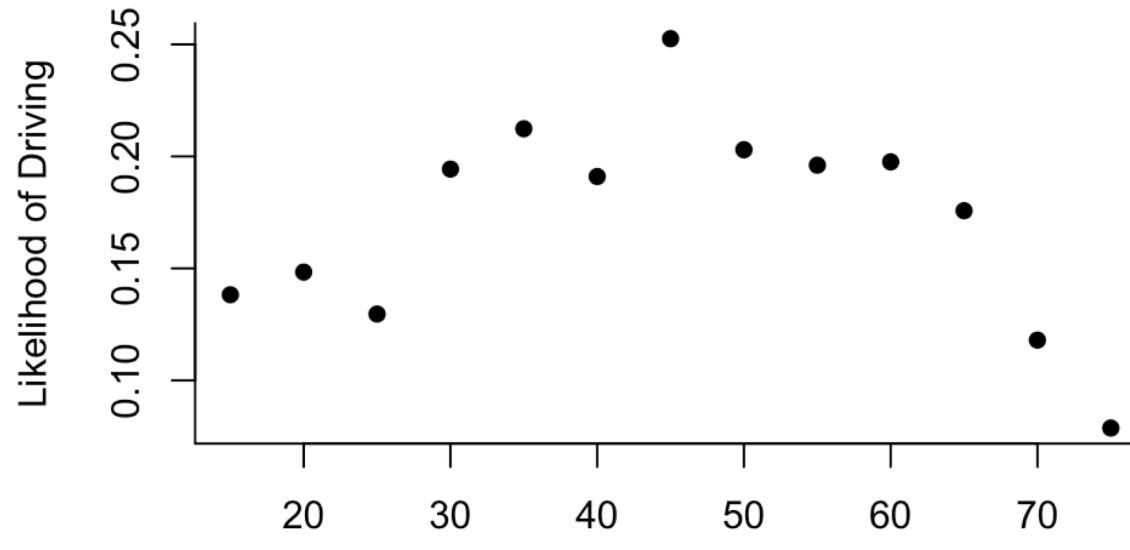
# Simultaneity



**Solution**

Instrumental  
Variables

# Simultaneity

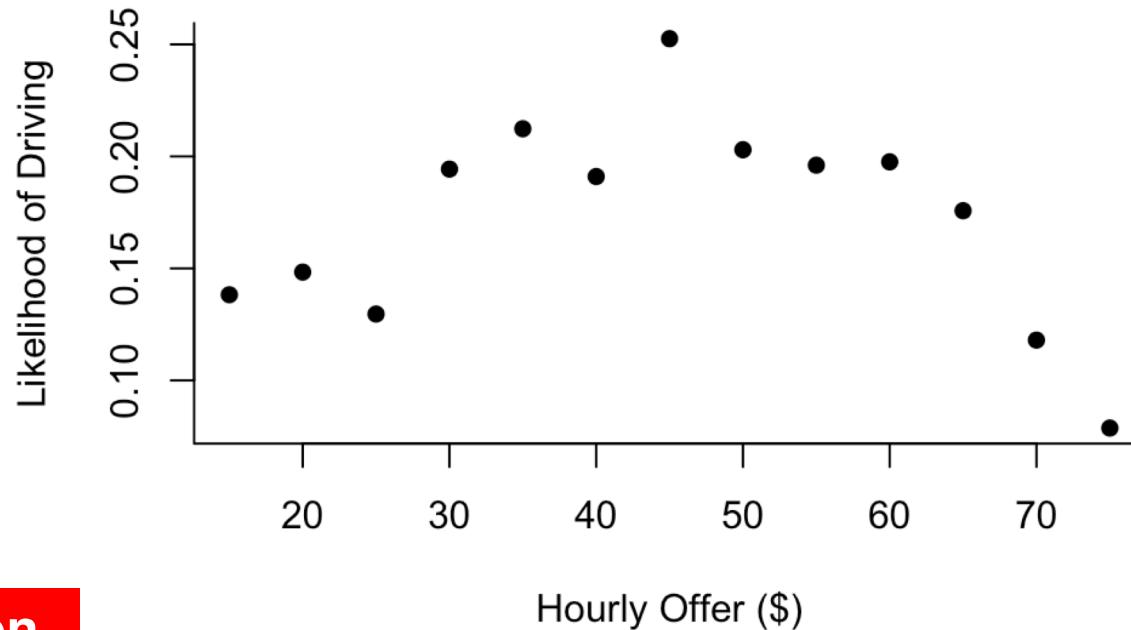


## Solution

## Instrumental Variables

- **Offer:** Average of other drivers' offers  
(Hausman 1996, Sheldon 2016, Xu et al 2017)

# Simultaneity



## Solution

## Instrumental Variables

- **Offer:** Average of other drivers' offers  
(Hausman 1996, Sheldon 2016, Xu et al 2017)
- **Promo** (binary): Lagged value from the same shift in the previous week  
(Villas-Boas & Winer 1999, Yang et al 2003, Archak et al 2011, Ghose et al 2012)

# Hours ~ Wage?



# Hours ~ Wage?



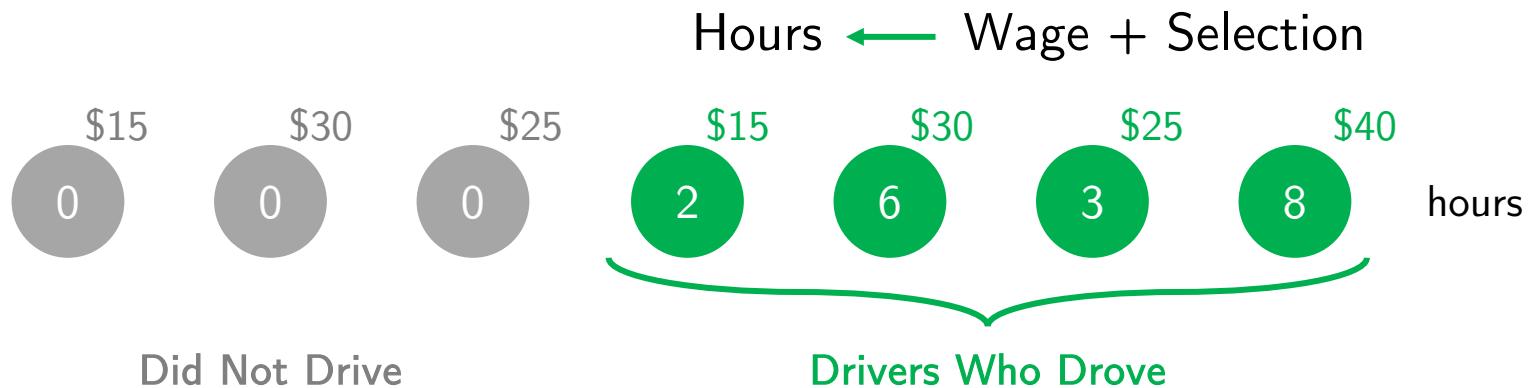
# Selection Bias

Decision to work is **not random**



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Decision to work is **not random**



## Solution

## Heckman Two-Stage Estimation

("Heckit" - Heckman 1979)

# Empirical Strategy

## 1 Work or not?

Control Function Probit:

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

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Control Function Probit:

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Income So Far  
= intensity of work

# Empirical Strategy

## 1 Work or not?

Control Function Probit:

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

|  
Income So Far  
= intensity of work

|  
Hours So Far  
= amount of available time

# Empirical Strategy

## 1 Work or not?

Control Function Probit:

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

Income So Far  
= intensity of work

Hours So Far  
= amount of available time

Conditional  
on working

## 2 How long to work?

2SLS with Fixed Effects

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

# Empirical Strategy

## 1 Work or not?

Control Function Probit:

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Income So Far  
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= amount of available time

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

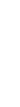
Midday



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

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	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		
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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)
AIC	95,856.010	72,887.620

N = 166,766

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	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	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 <sup>2</sup>	95,856.010	72,887.620			

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	Work or not?		# Hours		
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Promo	0.229*** (0.038)	0.285*** (0.046)			
Income so far	Income Target	-0.002*** (0.0002)			
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AIC/R <sup>2</sup>	95,856.010	72,887.620	0.313	0.324	0.657

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 <sup>2</sup>	95,856.010	72,887.620	0.313	0.324	0.657

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)		<b>The more you've earned, you'll drive shorter hours.</b>		
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	<b>The longer you've been active, you'll drive longer hours.</b>				
AIC/R <sup>2</sup>	95,856.010	72,887.620	0.313	0.324	0.657

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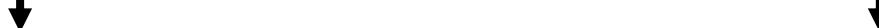
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# Late Night

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	Work or not?		# Hours		
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Income so far		-0.002*** (0.0002)			-0.0002*** (0.00002)
Hours so far		0.361*** (0.007)			0.187*** (0.001)



	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

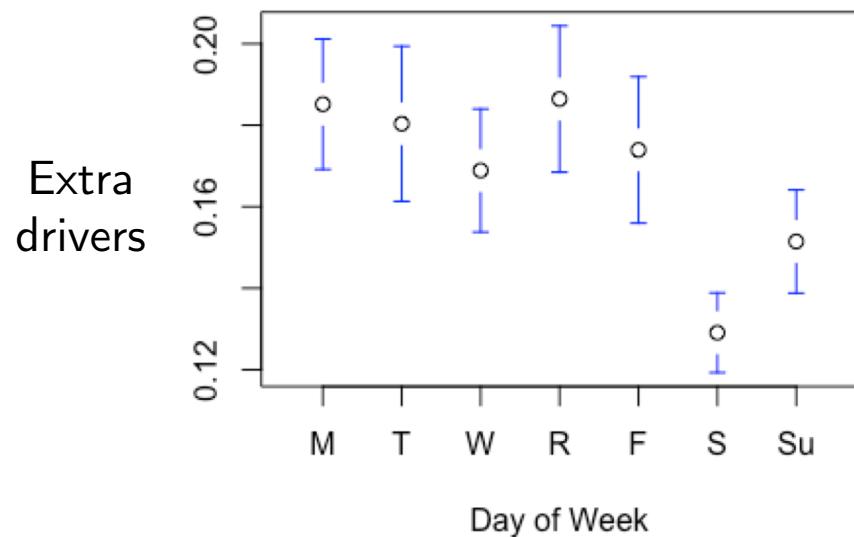
Using the insights we obtain, we propose algorithm for optimal allocation of financial incentives:

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



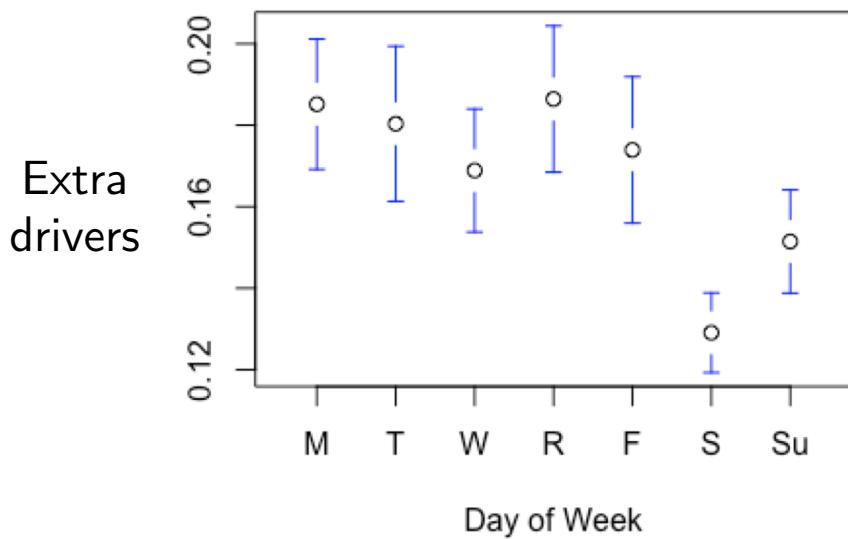
Can recruit **17% more drivers**

Average promo: 1.61x

# Optimizing Incentives

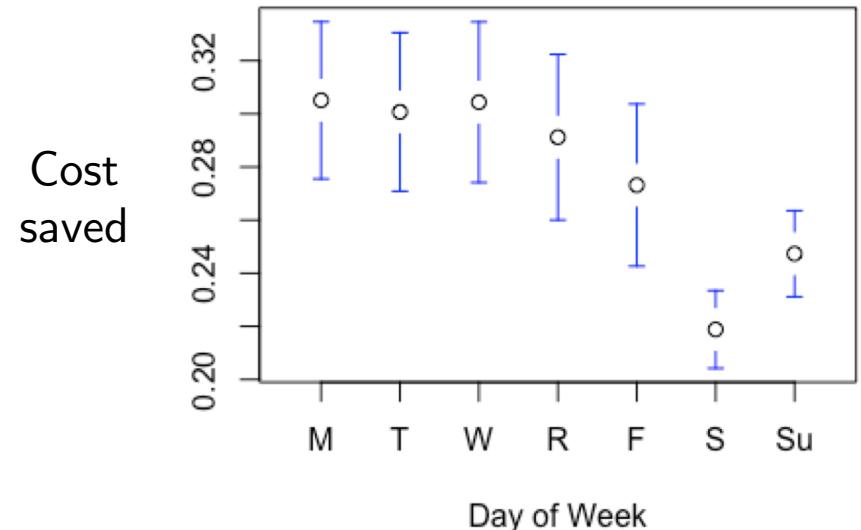
Compared to company's current practice, our algorithm...

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

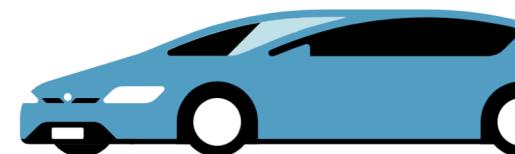
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## Findings

- Decisions depend on driver type and time



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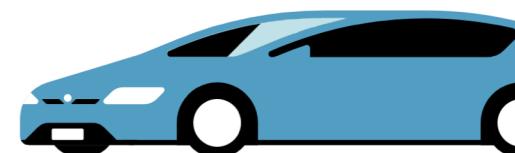
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- Income targeting has a positive effect early on and then switches to a negative effect later in the day or week



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## Findings

- Decisions depend on driver type and time
- Offer and inertia can increase work activity
- Income targeting has a positive effect early on and then switches to a negative effect 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