



The Impact of Behavioral and Economic Drivers on Gig Economy Workers

BDRM 2018



Park Sinchaisri (Wharton OID)
Gad Allon (Wharton), Maxime Cohen (NYU)

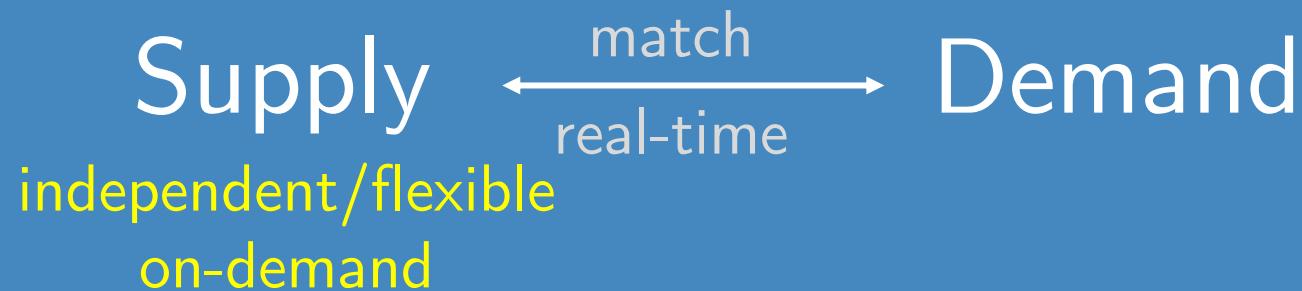
Gig Economy



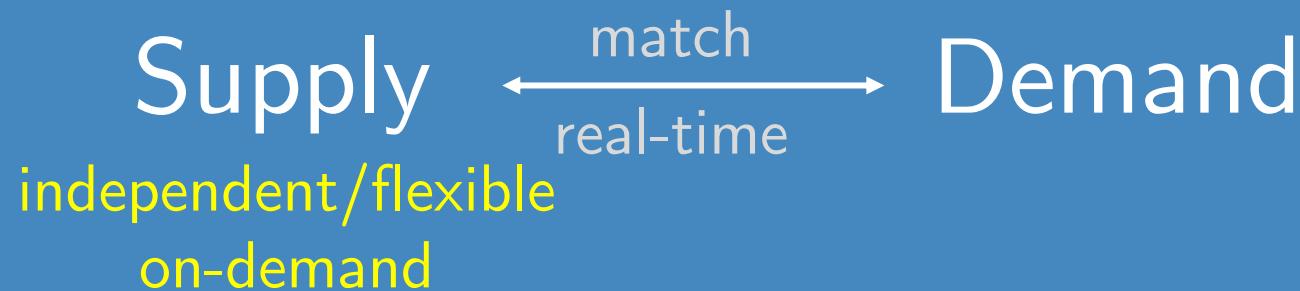
caviar



Gig Economy



Gig Economy

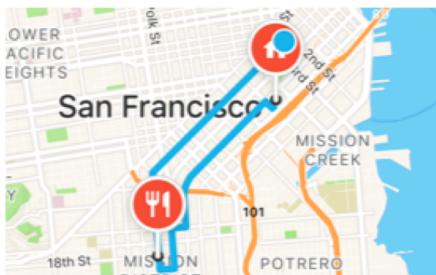


Capacity planning is challenging

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

San Francisco

Mission Chinese Food

\$22.78 subtotal (2 items)

BUSY PAY: +\$1.50

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

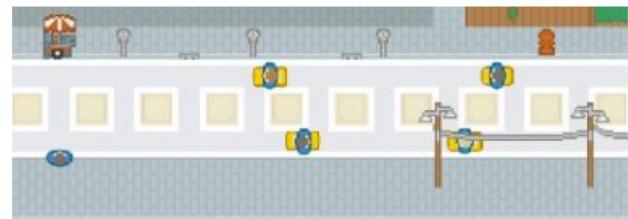
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+10% (5:00pm - 5:30pm)
+30% (5:30pm - 6:00pm)

6:00 PM–7:00 PM

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

“You’re so close to your precious target”

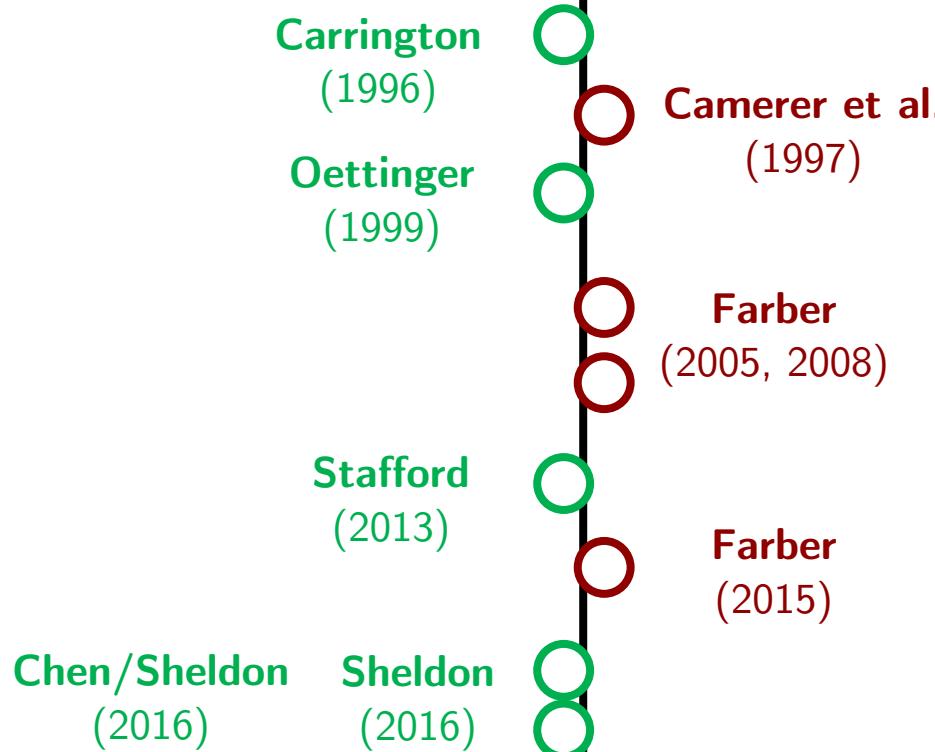


How Uber Uses Psychological Tricks to Push Its Drivers’ Buttons

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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How do gig economy workers
make labor decisions?

How can the platform influence
their decisions?

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

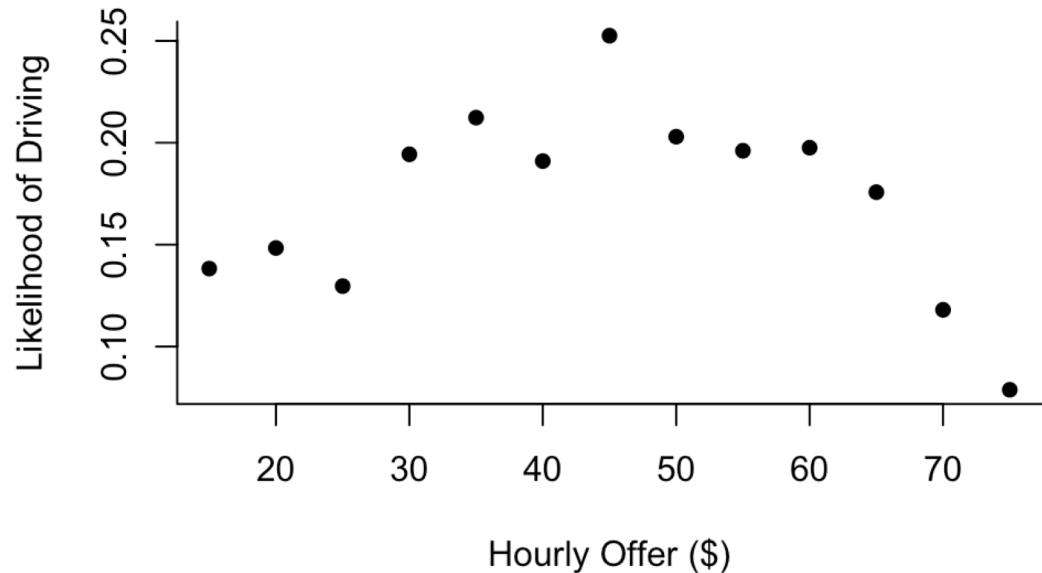
Oct 2016 – Sep 2017

7,826

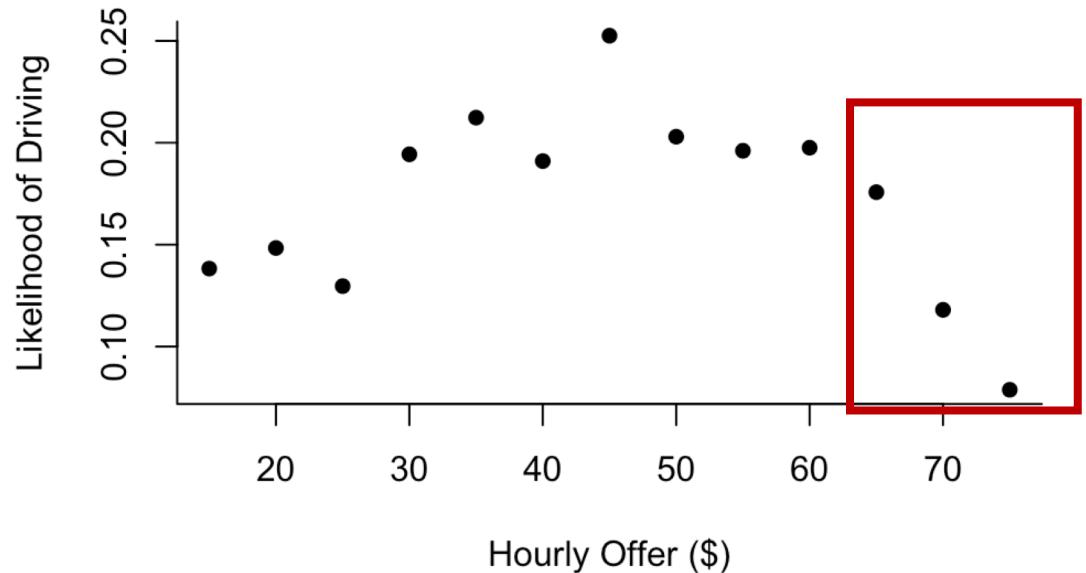
Unique drivers

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

Challenges

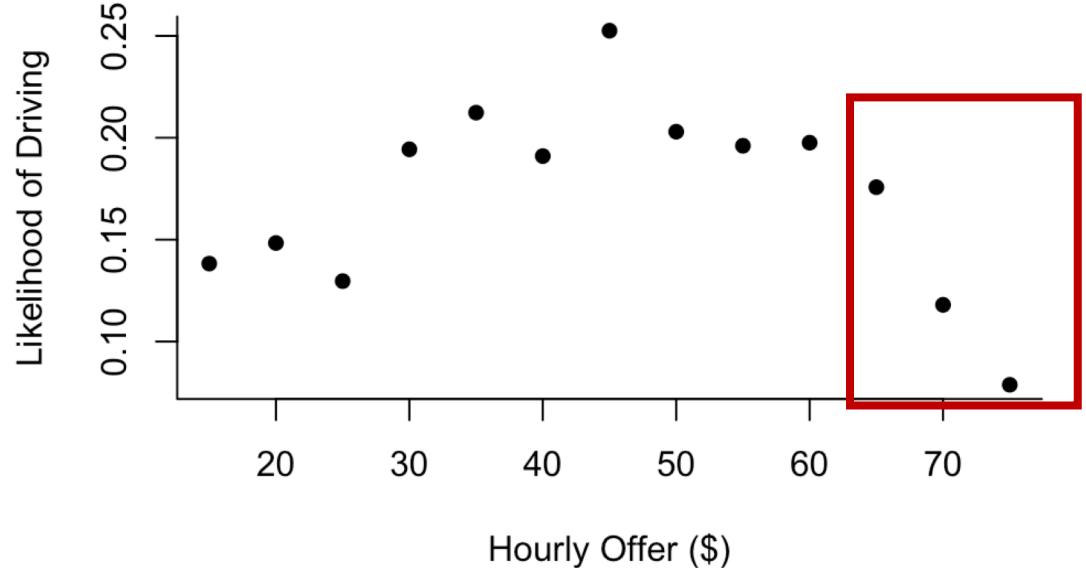


Challenges



Higher wage, less likely to drive?

Challenges

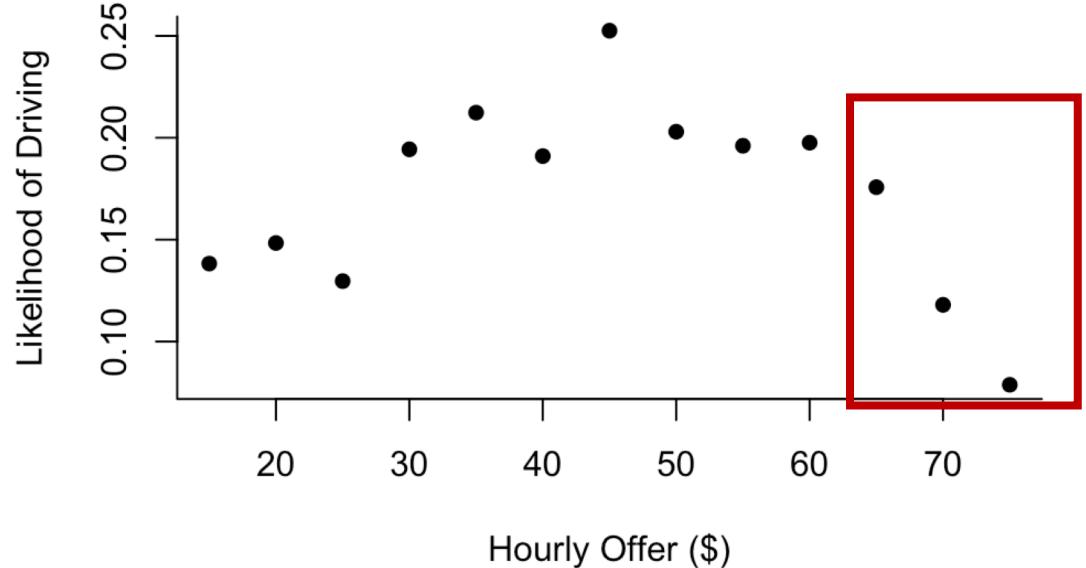


Higher wage, less likely to drive?

Use higher wage to attract inactive drivers

Challenges

Simultaneity



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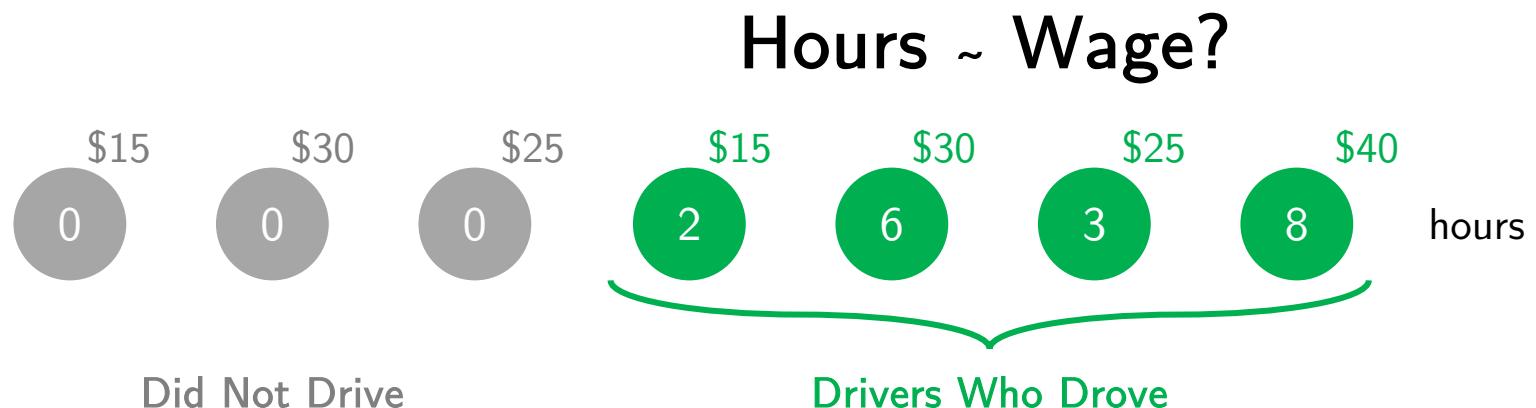
Solution: Instrumental Variables

- **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)

Challenges

Simultaneity

Solution: Instrumental Variables

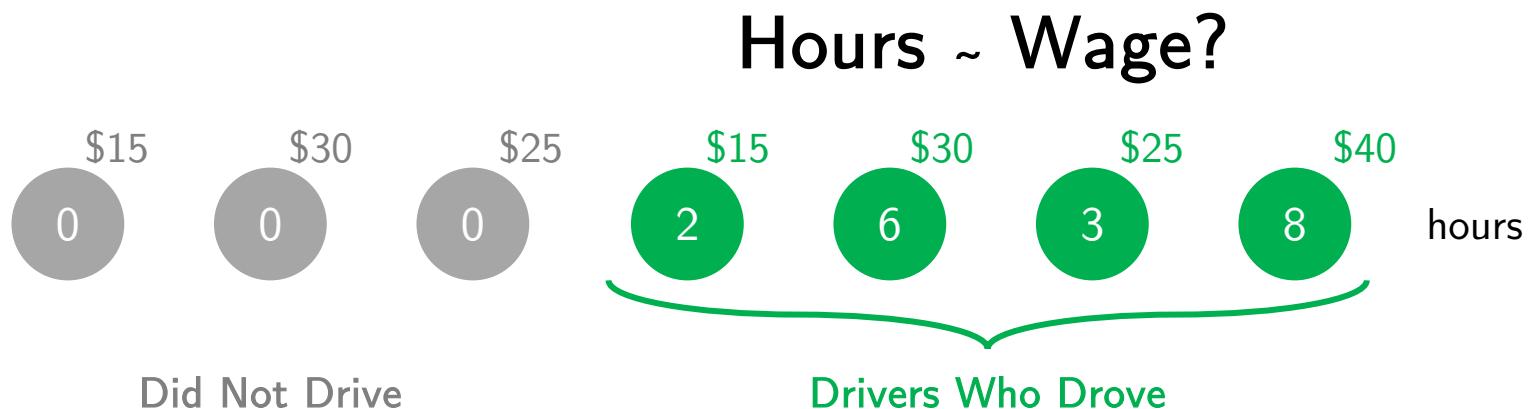


Challenges

Simultaneity

Solution: Instrumental Variables

Decision to work is **not random**



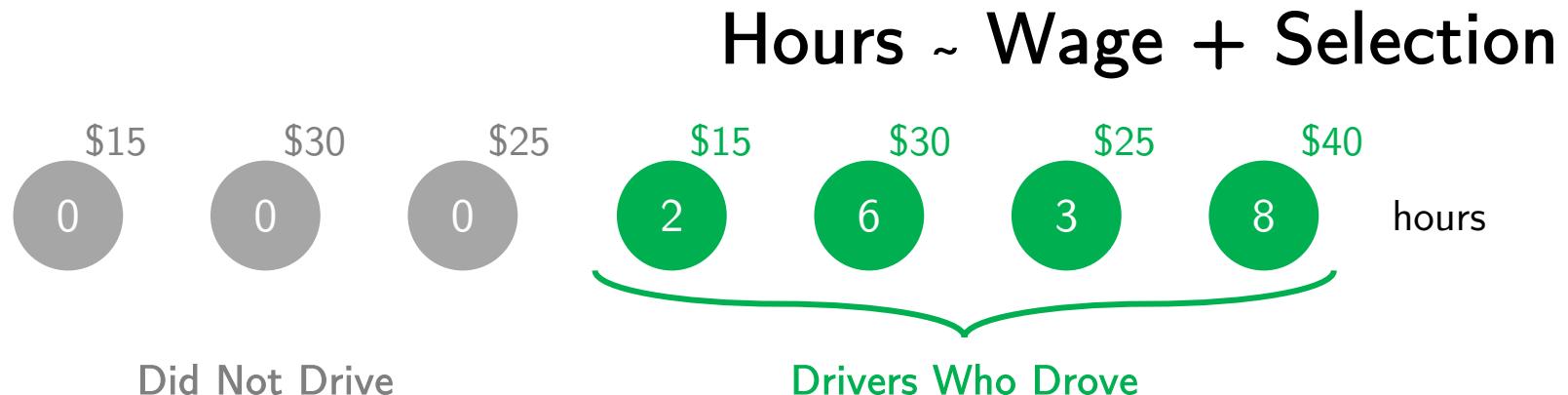
Challenges

Simultaneity

Solution: Instrumental Variables

Selection Bias

Solution: Heckman Two-Stage Method
("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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$P(\text{drive}) \text{ on Offer} + \text{Promo} + \text{ISF} + \text{Controls}$

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?

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Conditional
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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

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		
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)
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	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)
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	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 ²	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)		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	0.657

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		-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

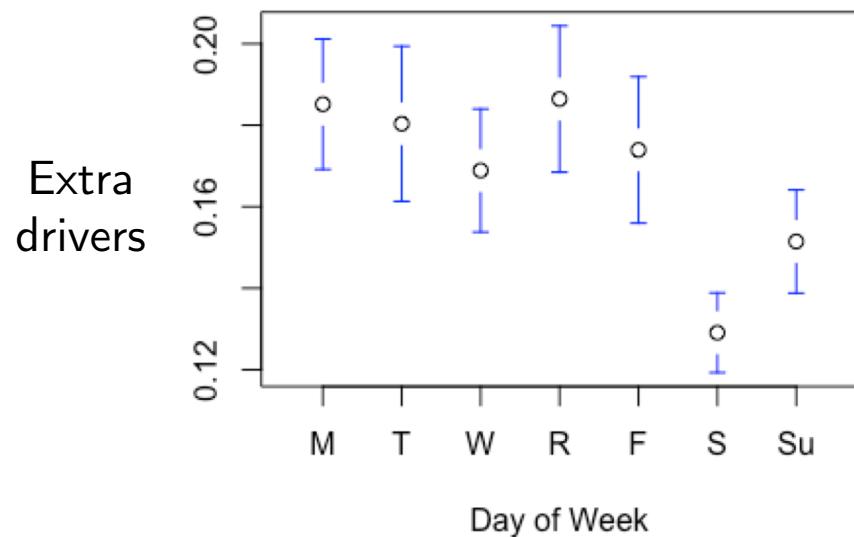
Using the insights we obtain, we propose algorithm for optimal allocation of financial incentives:

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



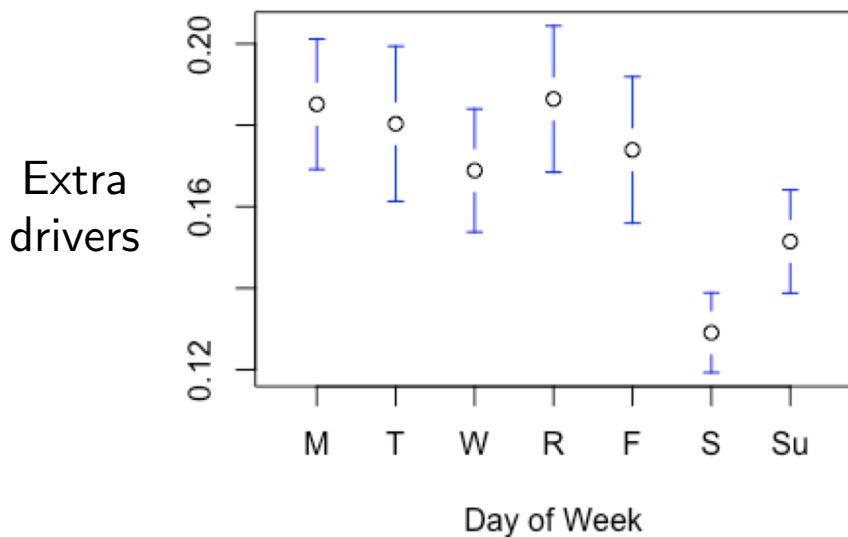
Can recruit **17% more drivers**

Average promo: 1.61x

Optimizing Incentives

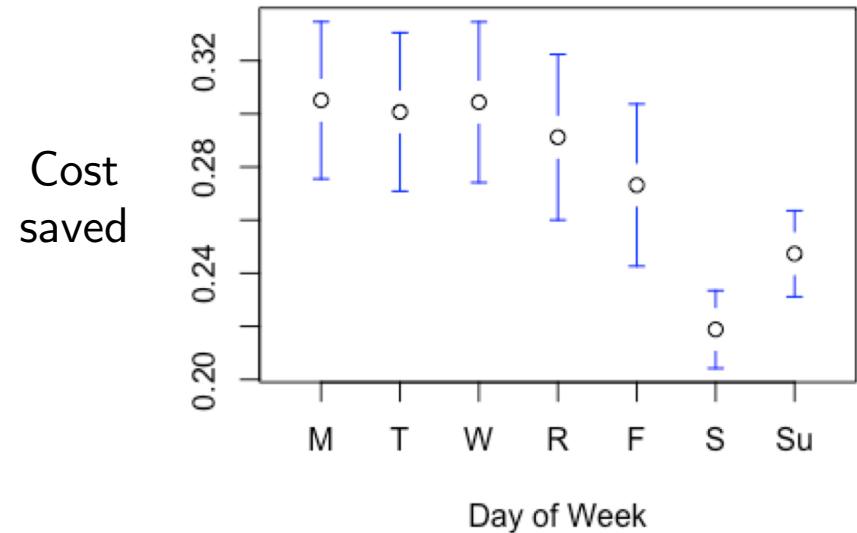
Compared to company's current practice, our algorithm...

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



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Findings

- Decisions depend on driver type and time



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Findings

- Decisions depend on driver type and time
- Offer and inertia can increase work activity



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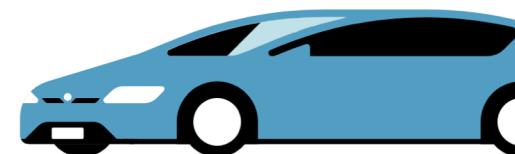
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- Decisions depend on driver type and time
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- Income targeting has a positive effect early on and then switches to a negative effect later in the day or week



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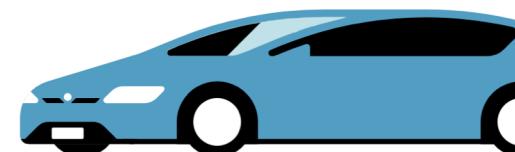
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Approach

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

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