



The Impact of Behavioral and Economic Drivers on Gig Economy Workers

MSOM 2018



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Gad Allon, Maxime Cohen

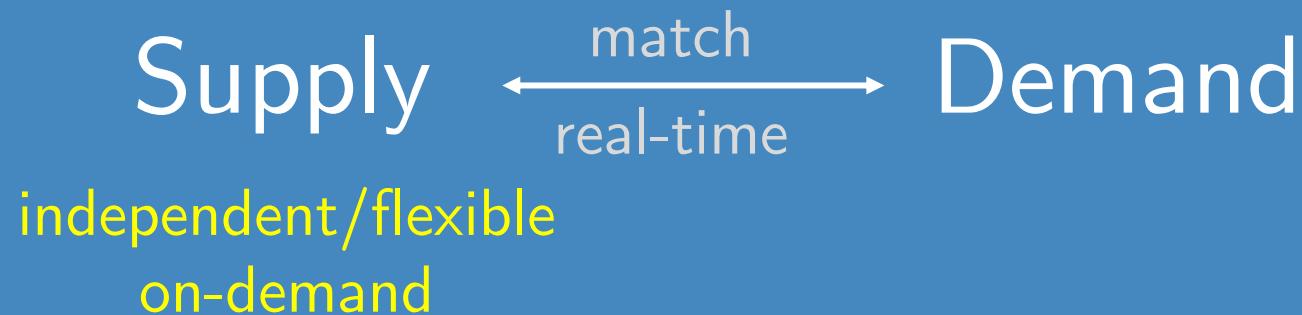
Gig Economy



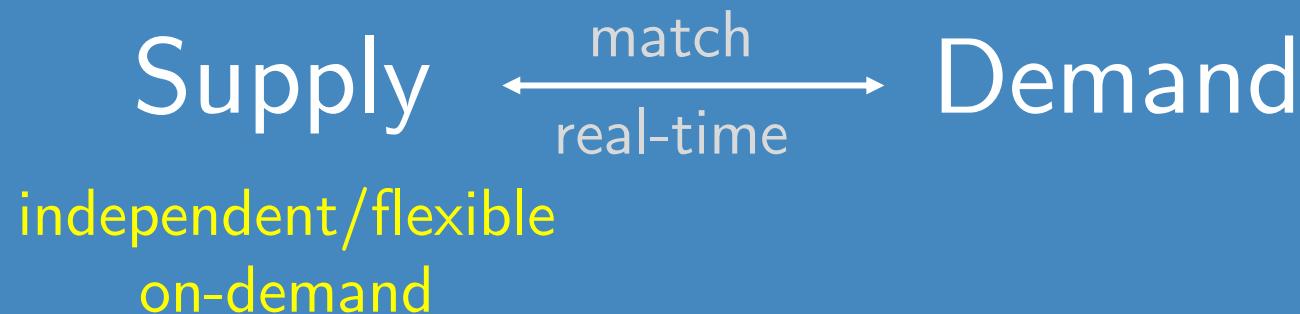
caviar



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)

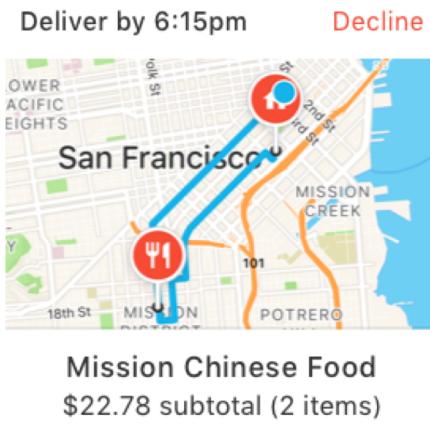
BUSY PAY: +\$1.50

4.1 miles total

Accept Order

In Practice

Real-time “surge pricing”



Pre-announced bonus



5:00 PM–6:00 PM

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



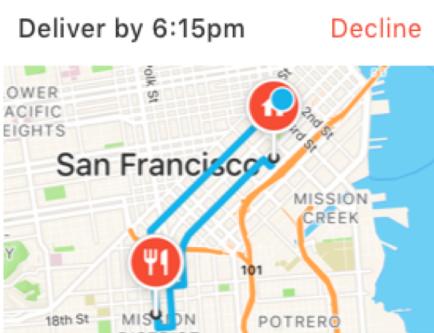
6:00 PM–7:00 PM

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

caviar

In Practice

Real-time “surge pricing”



\$22.78 subtotal (2 items)

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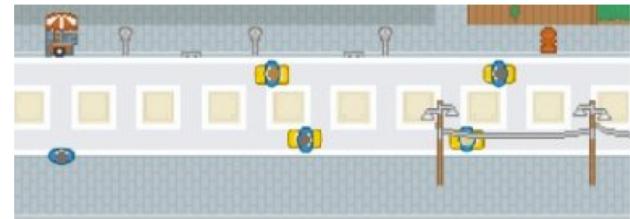


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caviar

“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

Theories of Labor Supply

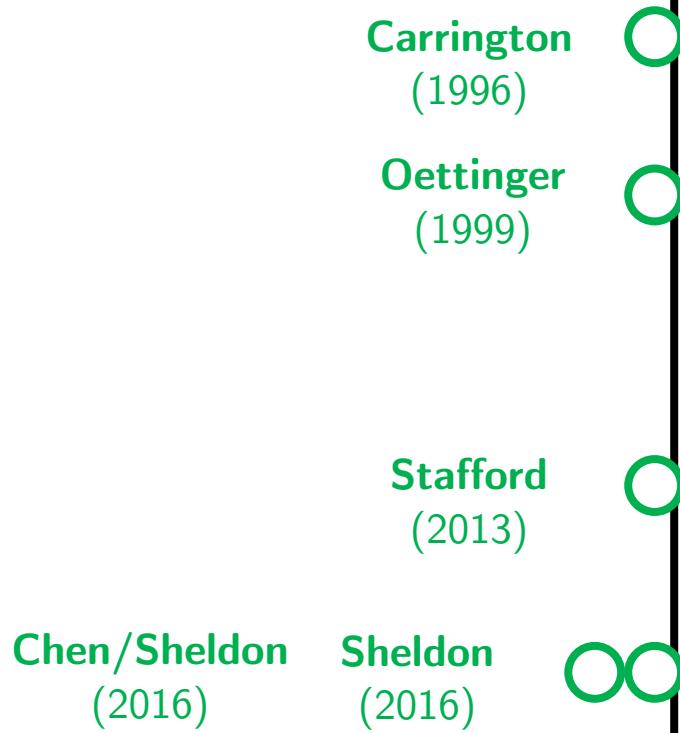
Neoclassical

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

Theories of Labor Supply

Neoclassical

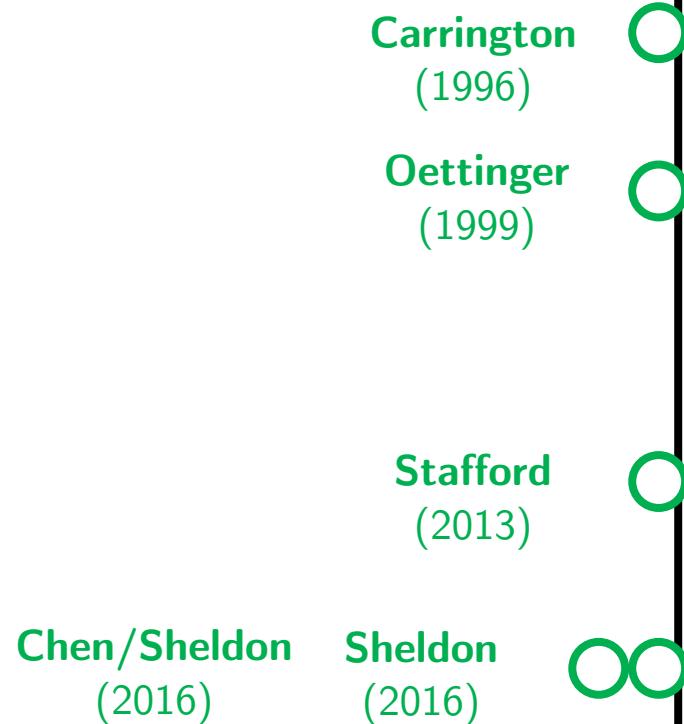
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Theories of Labor Supply

Neoclassical

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



Behavioral

- Reference-dependence, targets

Theories of Labor Supply

Neoclassical

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

Carrington
(1996)

Oettinger
(1999)

Stafford
(2013)

Chen/Sheldon
(2016)

Sheldon
(2016)

Behavioral

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



Theories of Labor Supply

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(2016)

Behavioral

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

Camerer et al.
(1997)

Farber
(2005, 2008)

Farber
(2015)

Thakral & To
(2017)

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.

Data

NYC ride-hailing firm

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

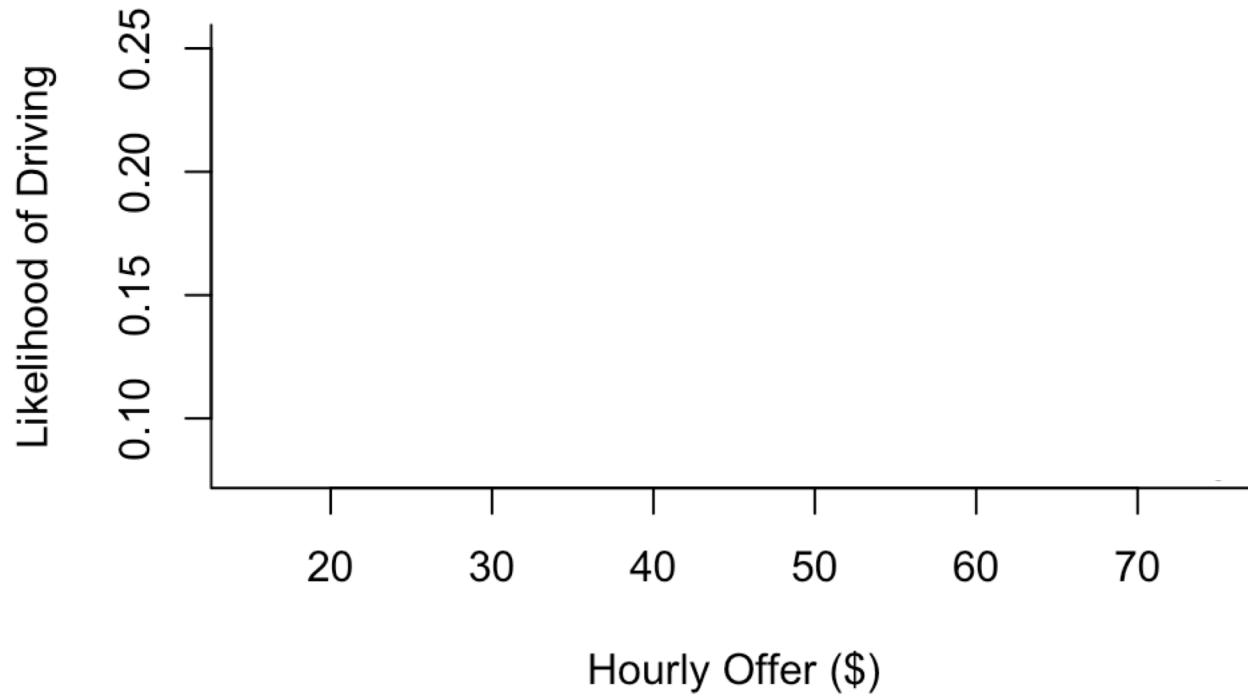
Oct 2016 – Sep 2017

7,826

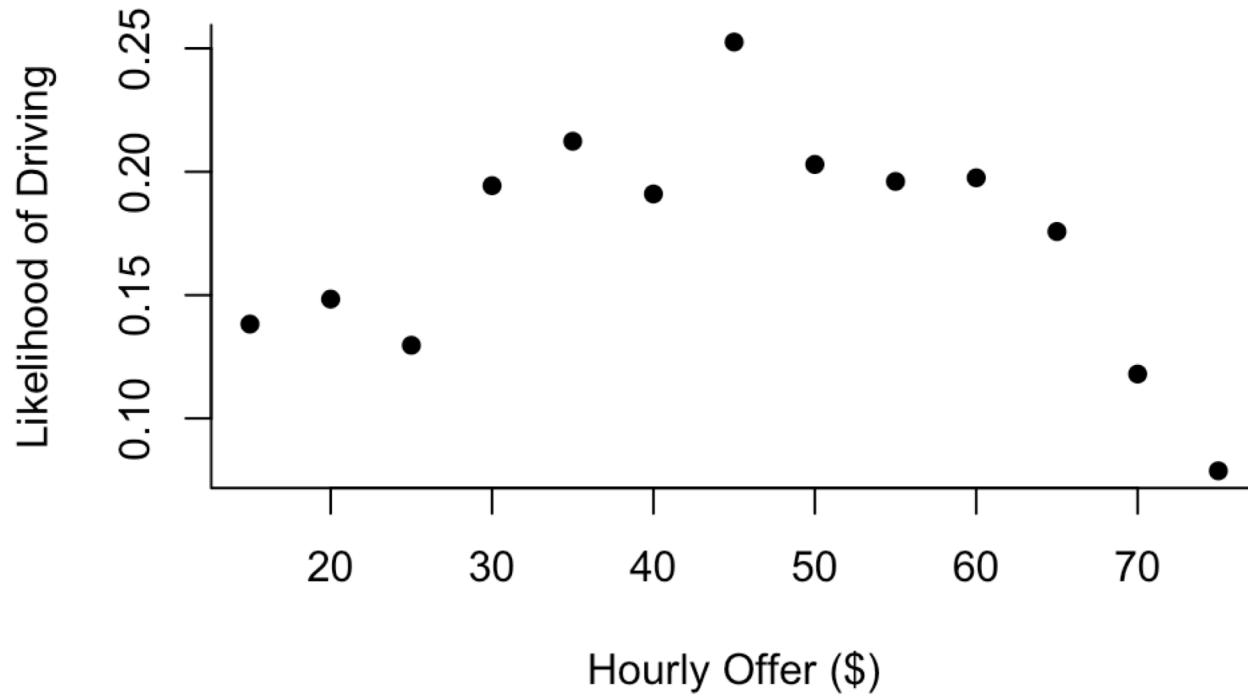
Unique drivers

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

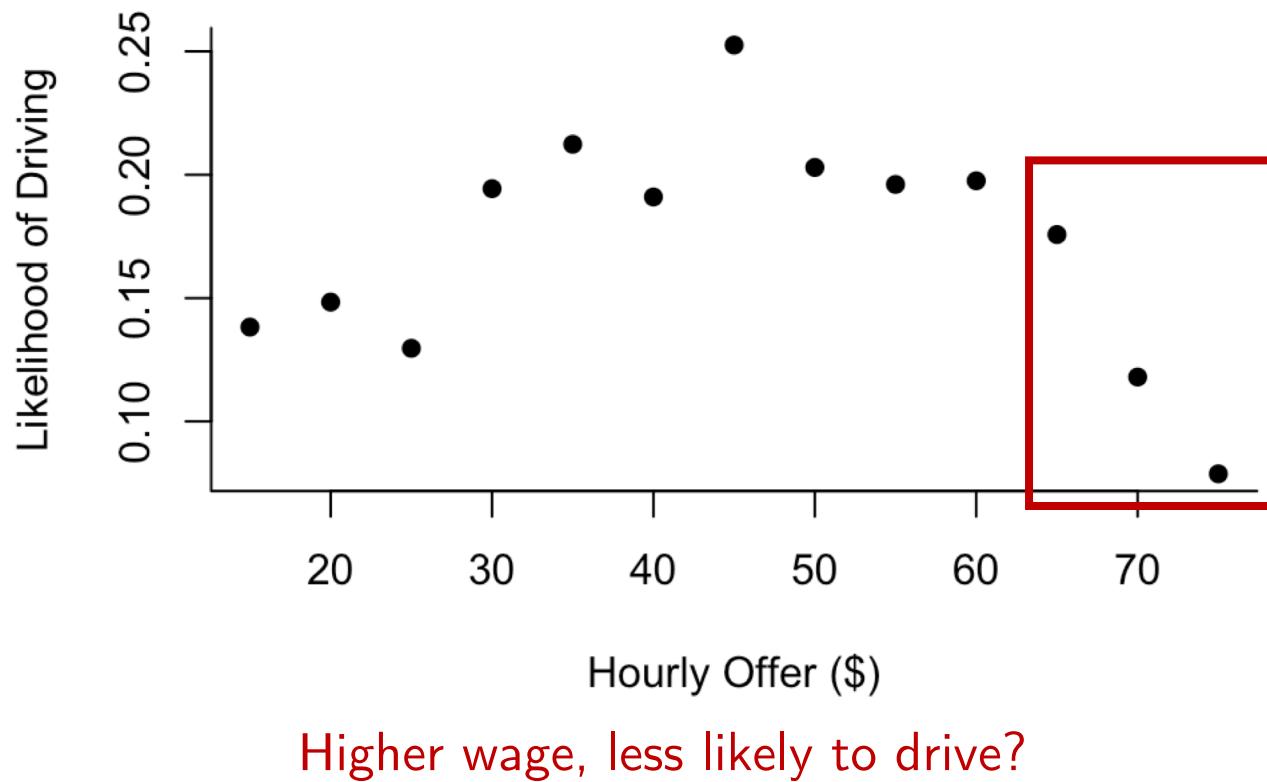
Challenges



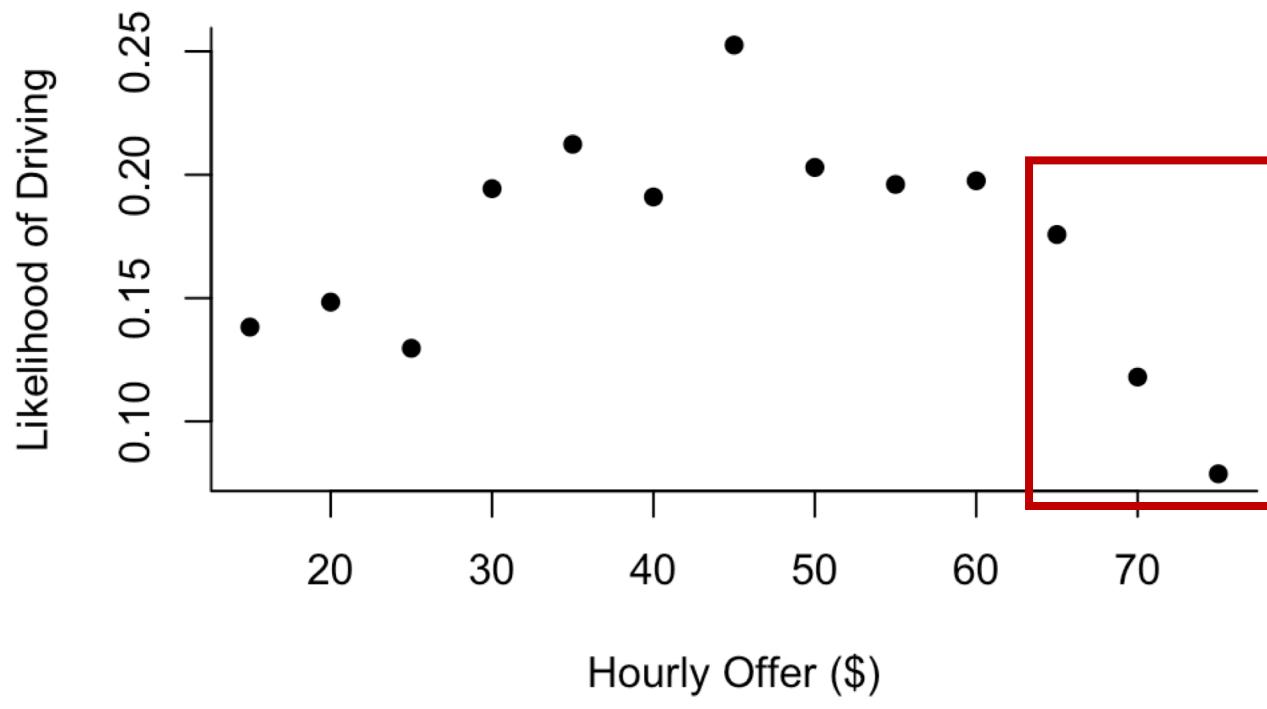
Challenges



Challenges



Challenges

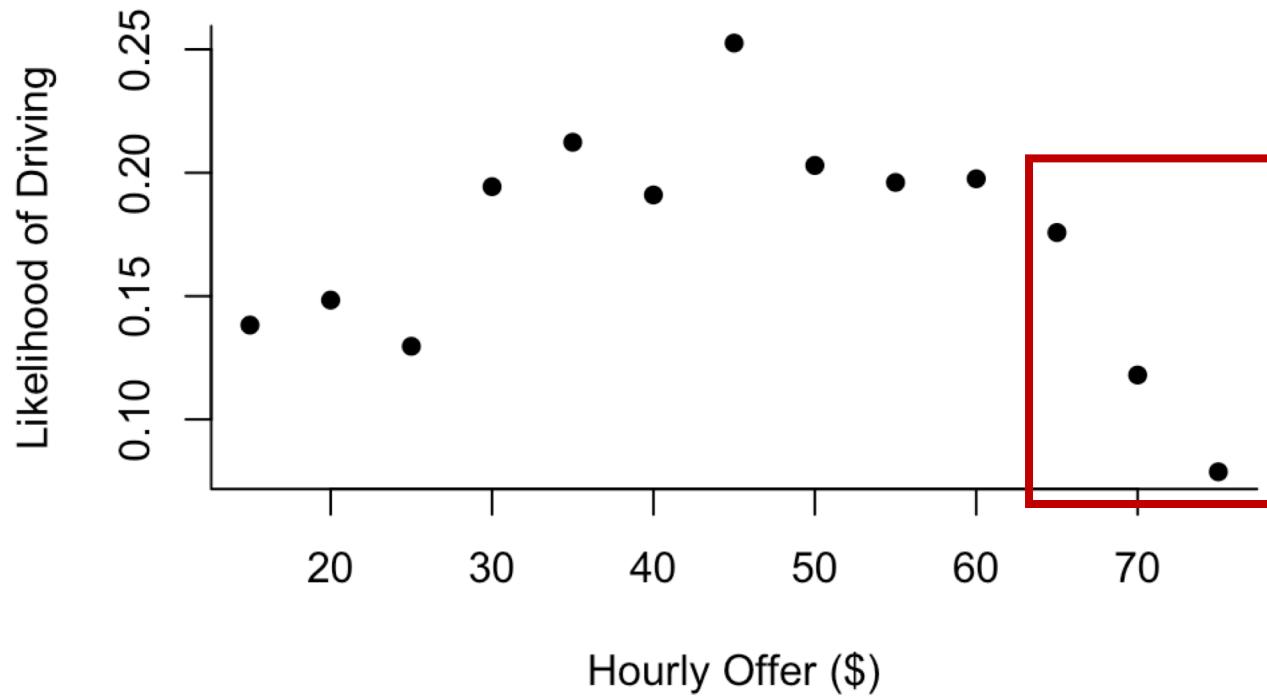


Higher wage, less likely to drive?

Use higher wage to attract inactive drivers

Challenges

Simultaneity



Higher wage, less likely to drive?

Use higher wage to attract inactive drivers

Challenges

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)

Challenges

Simultaneity

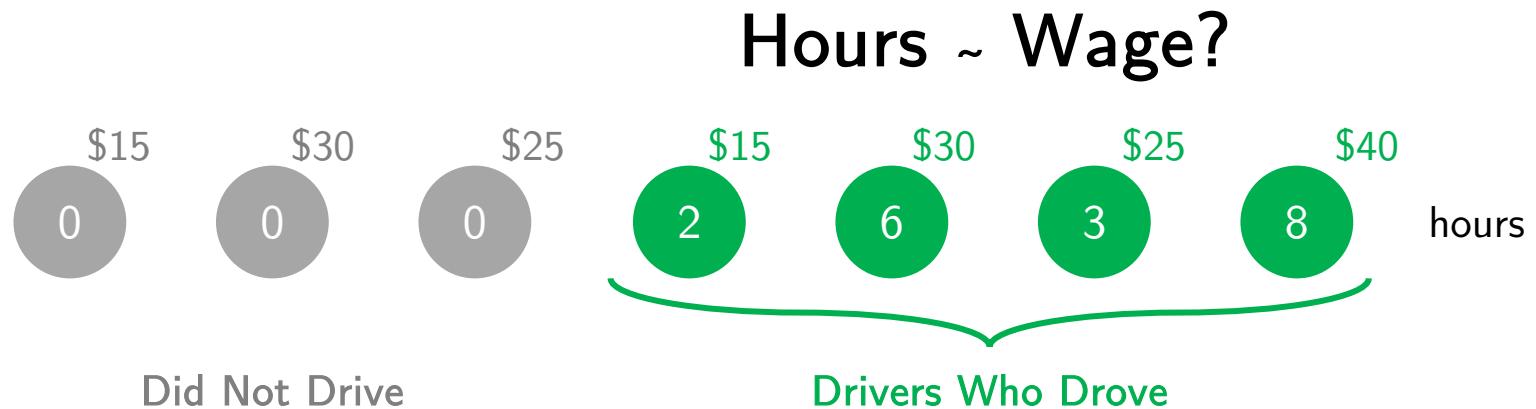
Solution: Instrumental Variables



Challenges

Simultaneity

Solution: Instrumental Variables



Challenges

Simultaneity

Solution: Instrumental Variables

Decision to work is **not random**

Hours ~ Wage?



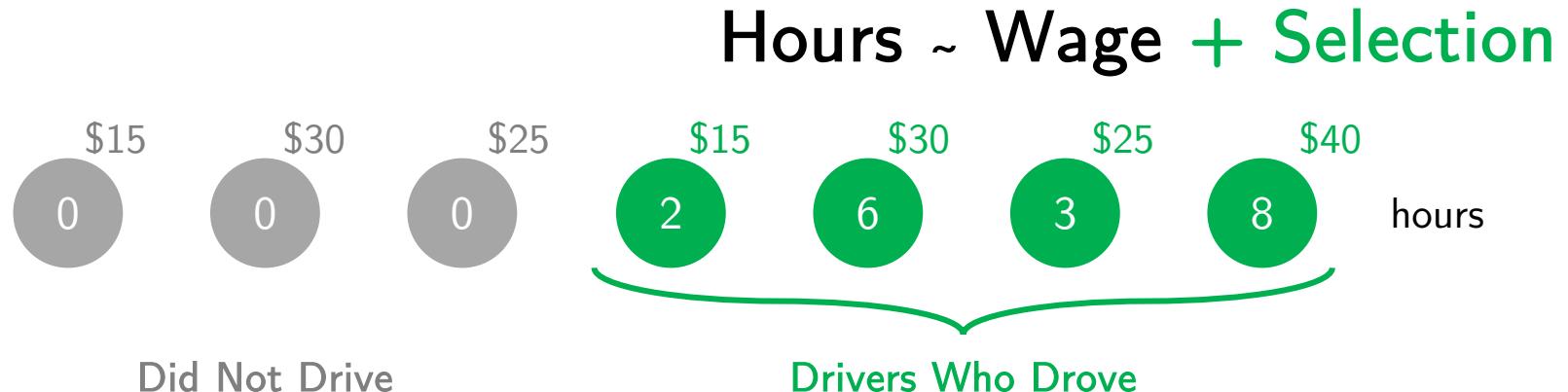
Challenges

Simultaneity

Solution: Instrumental Variables

Selection Bias

Solution: Heckman Two-Stage Method
("Heckit" - Heckman 1979)



Empirical Strategy

Modified Heckman Two-Stage Method
with IVs and FEs

Empirical Strategy

1 Work or not?

Control Function Probit:
 $P(\text{drive}) \text{ on Offer + Promo}$

+ Controls

Empirical Strategy

1 Work or not?

Control Function Probit:

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

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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

1
2 vs. 1
2 + ISF + HSF
“Targets”



Within-Day

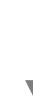
Midday



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

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Hours so far		
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N = 166,766

For average driver,
\$100 additional income so far,
 $P(\text{drive})$ decreases by 2.5%

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

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Late Night

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	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

The longer you've been active,
the more likely you'll 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	Inertia	0.361*** (0.007)
AIC	95,856.010	72,887.620

For average driver,
1 additional hour so far,
 $P(\text{drive})$ increases by 4.1%

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

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)			
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

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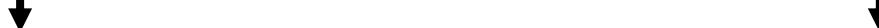
	Work or not?			# Hours		
	Offer	ISF	HSF	Earning	ISF	HSF
Late night	+	-	+	+	-	+

Late Night

1

2

	Work or not?		# Hours		
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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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	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

Results Across Shifts

1

Work or not?

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

Income Target Inertia

The negative impact of income targeting 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

The negative impact of income targeting kicks in later in the day for both stages.

Results Across Days

1

Work or not?

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

Income Target Inertia

The negative impact of income targeting 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

For # hours, earnings and weekly income target effect are not significant during weekdays.

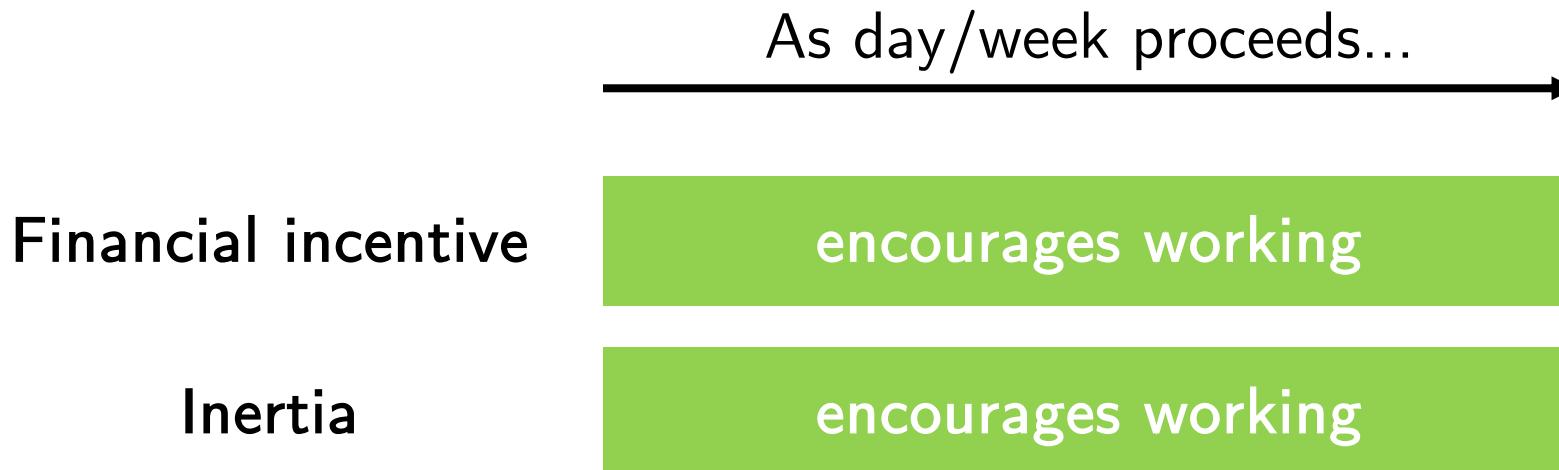
Results Summary

Financial incentive

As day/week proceeds...

encourages working

Results Summary



Results Summary

As day/week proceeds...

Financial incentive

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Inertia

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discourages working later on

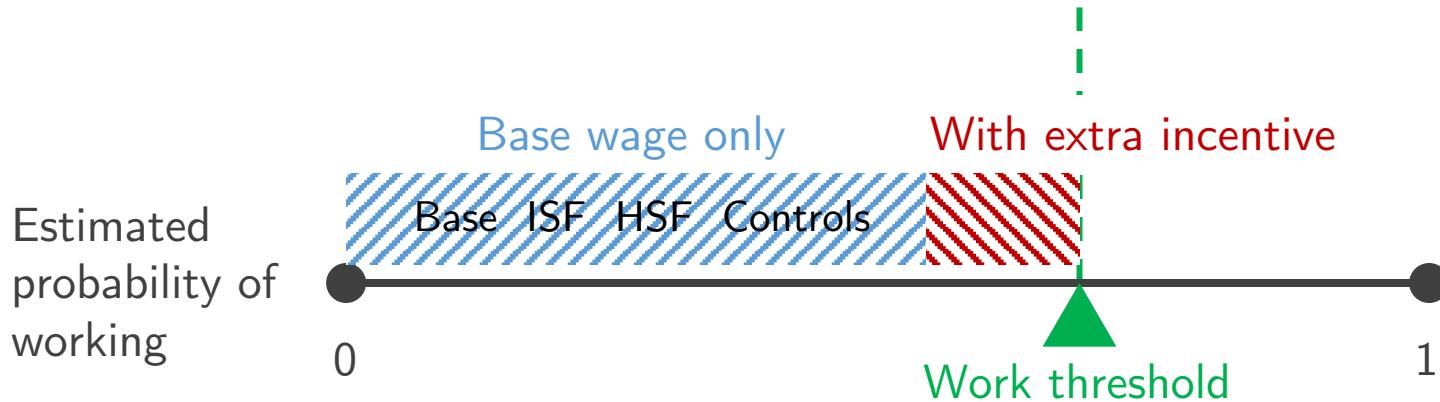
Who Should Get Bonuses?

Who Should Get Bonuses?



Who Should Get Bonuses?

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



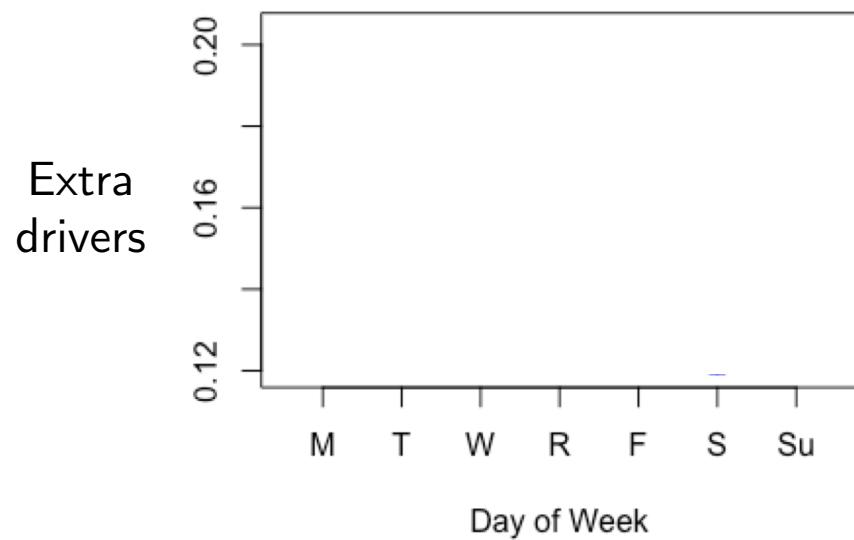
Optimizing Incentives

Compared to current practice from January to September 2017

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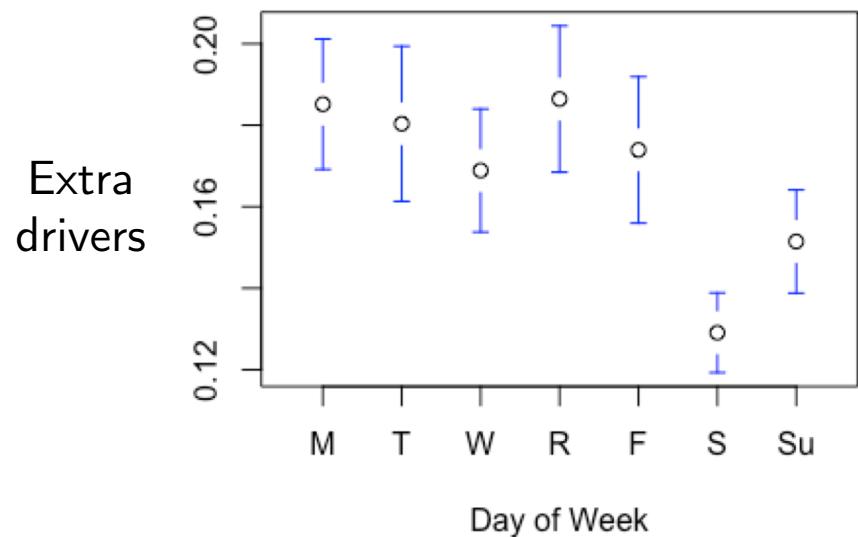
Given the same budget



Optimizing Incentives

Compared to current practice from January to September 2017

Given the same budget



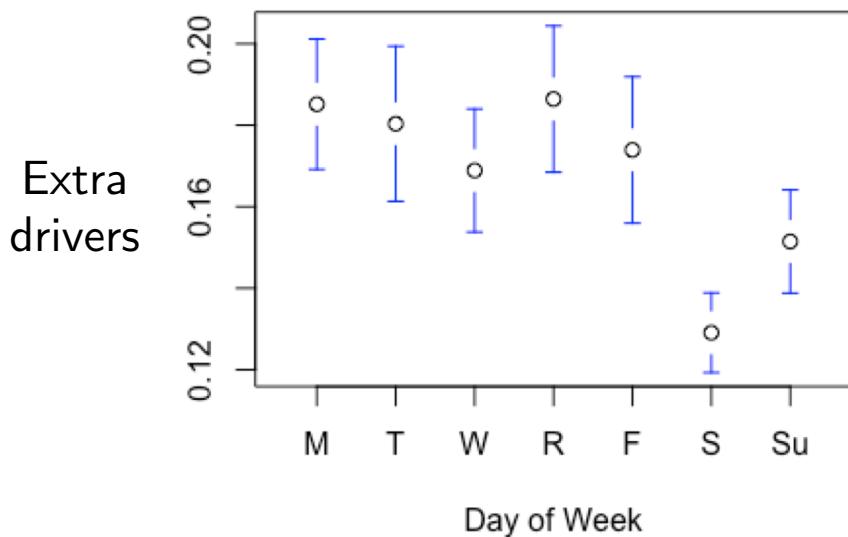
Can recruit **17% more drivers**

Average promo: 1.61x

Optimizing Incentives

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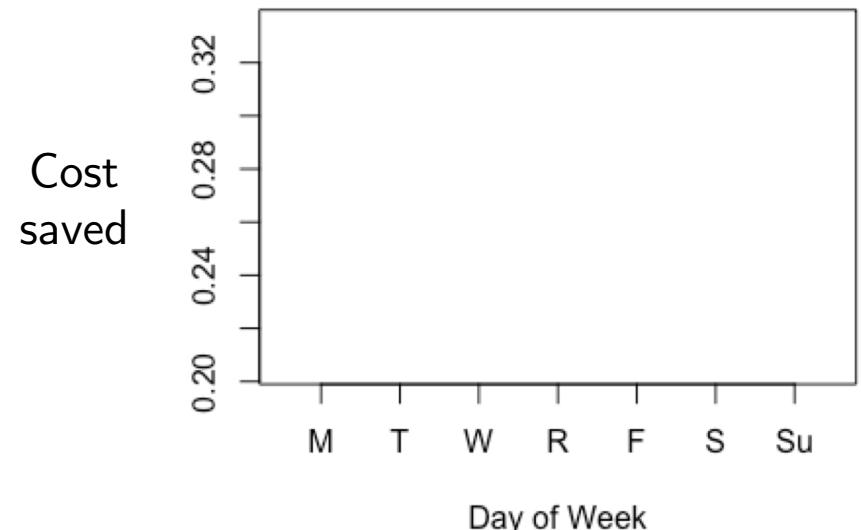
Given the same budget



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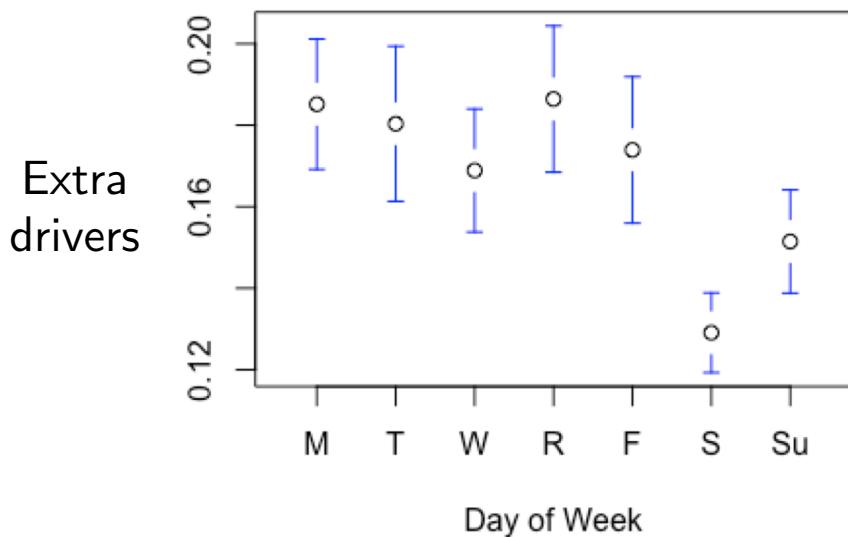
Given the same capacity



Optimizing Incentives

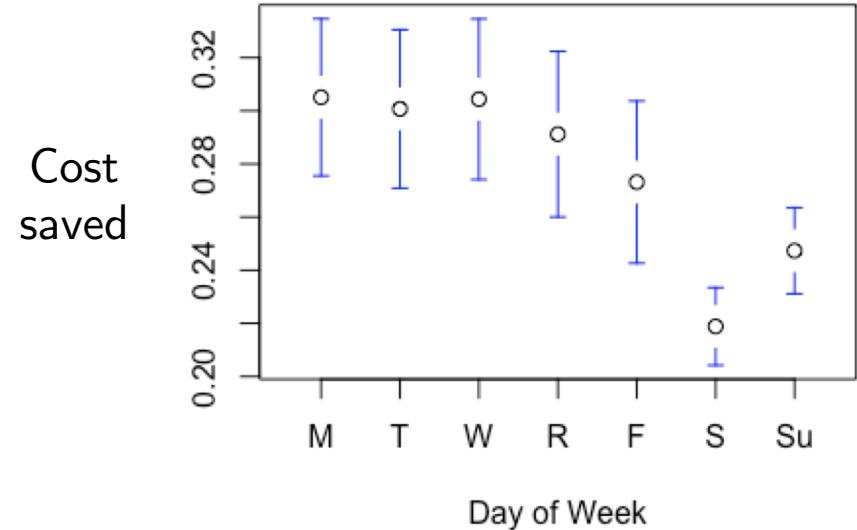
Compared to current practice from January to September 2017

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 Heckman estimation w/ IVs and fixed effects

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Findings

Financial incentive

As day/week proceeds...

encourages working

Inertia

encourages working

Income Target

discourages working later on

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How do gig economy workers make labor decisions?

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encourages working

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encourages working

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discourages working later on

Implications

- Compared to current practice, our approach can improve service capacity without incurring extra cost or maintain the same capacity with 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