



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

MSOM 2018



Park Sinchaisri  
Gad Allon, Maxime Cohen

# Gig Economy



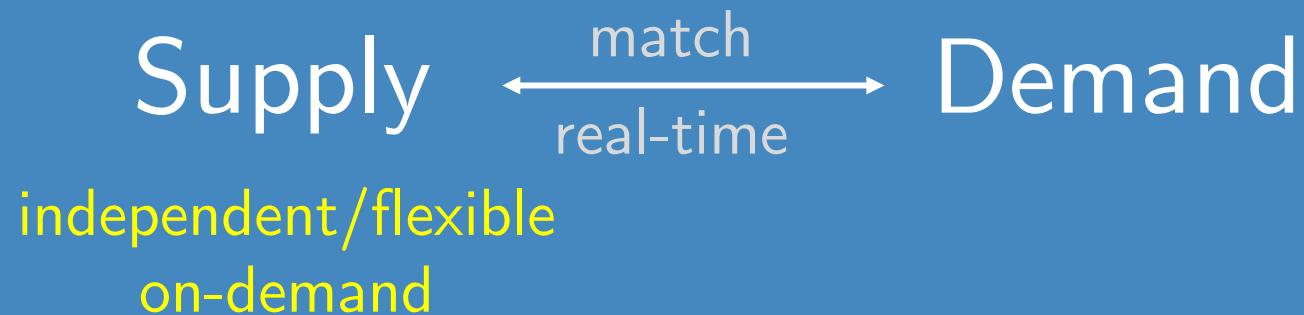
caviar



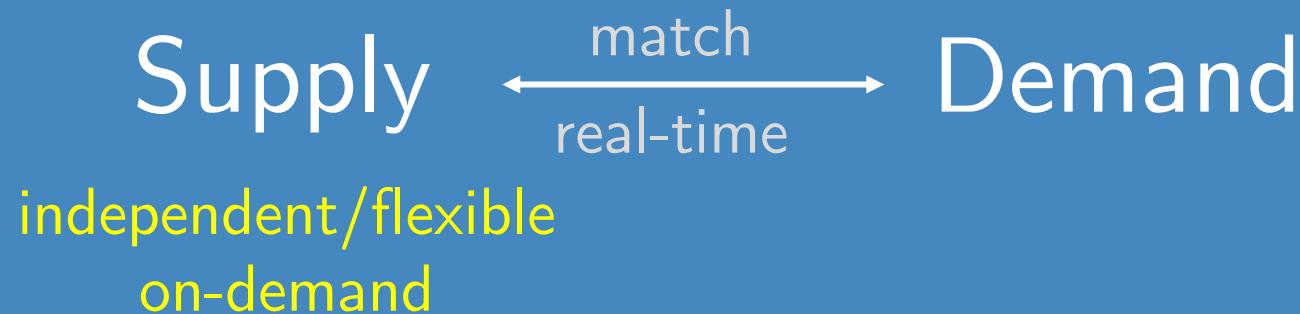
POSTMATES



# Gig Economy



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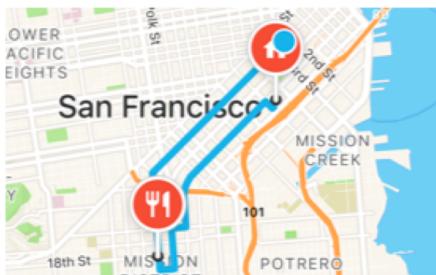


## Capacity planning is challenging

# In Practice

## Real-time “surge pricing”

Deliver by 6:15pm      Decline



Mission Chinese Food  
\$22.78 subtotal (2 items)

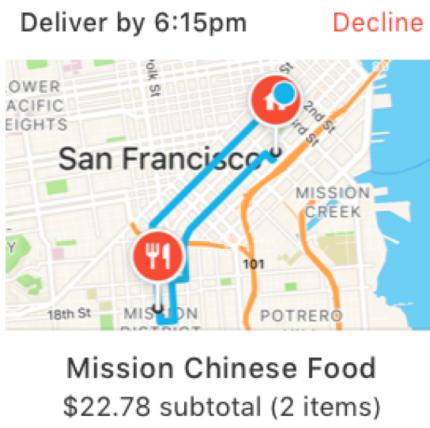
BUSY PAY: +\$1.50

4.1 miles total

Accept Order

# In Practice

## Real-time “surge pricing”



4.1 miles total

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## Pre-announced bonus



5:00 PM–6:00 PM

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



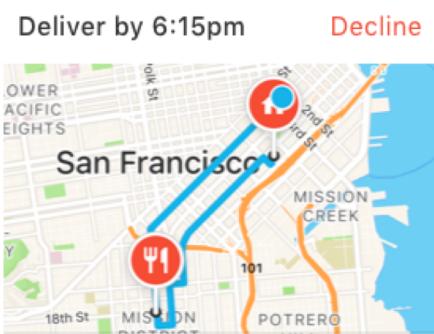
6:00 PM–7:00 PM

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

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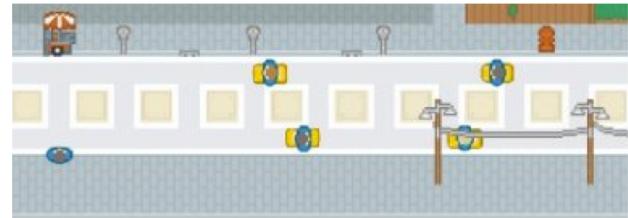


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caviar

“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

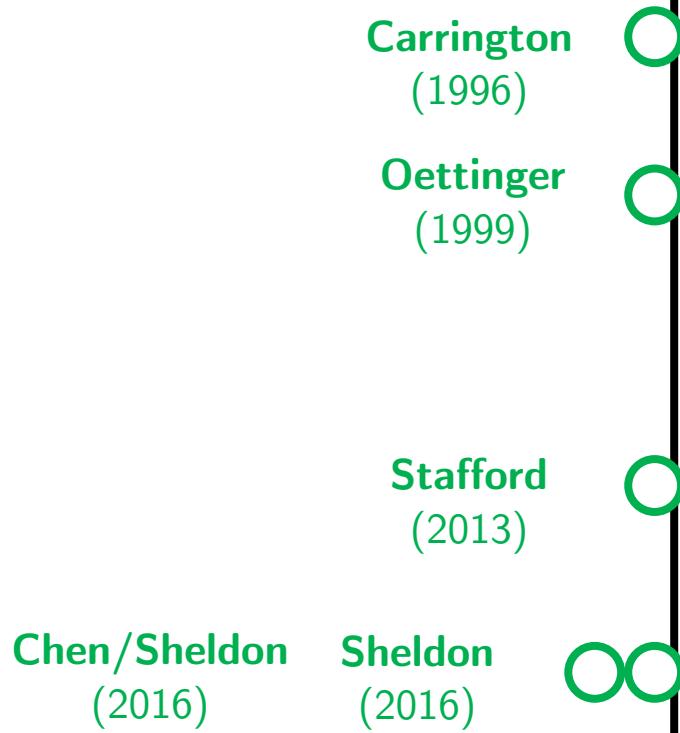
## Neoclassical

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

# Theories of Labor Supply

## Neoclassical

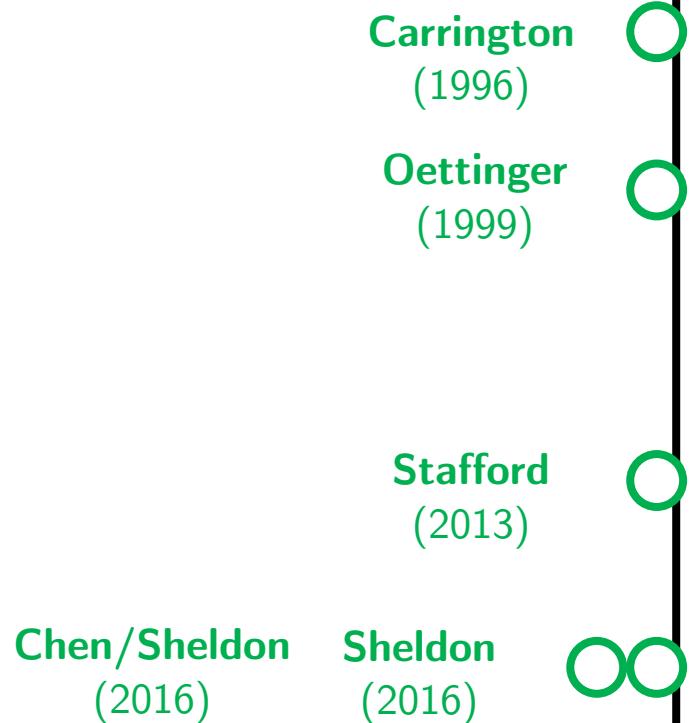
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# Theories of Labor Supply

## 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



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Sheldon  
(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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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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Drivers are guaranteed an hourly base rate.



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

**5.5M**

Observations

**358**

Days

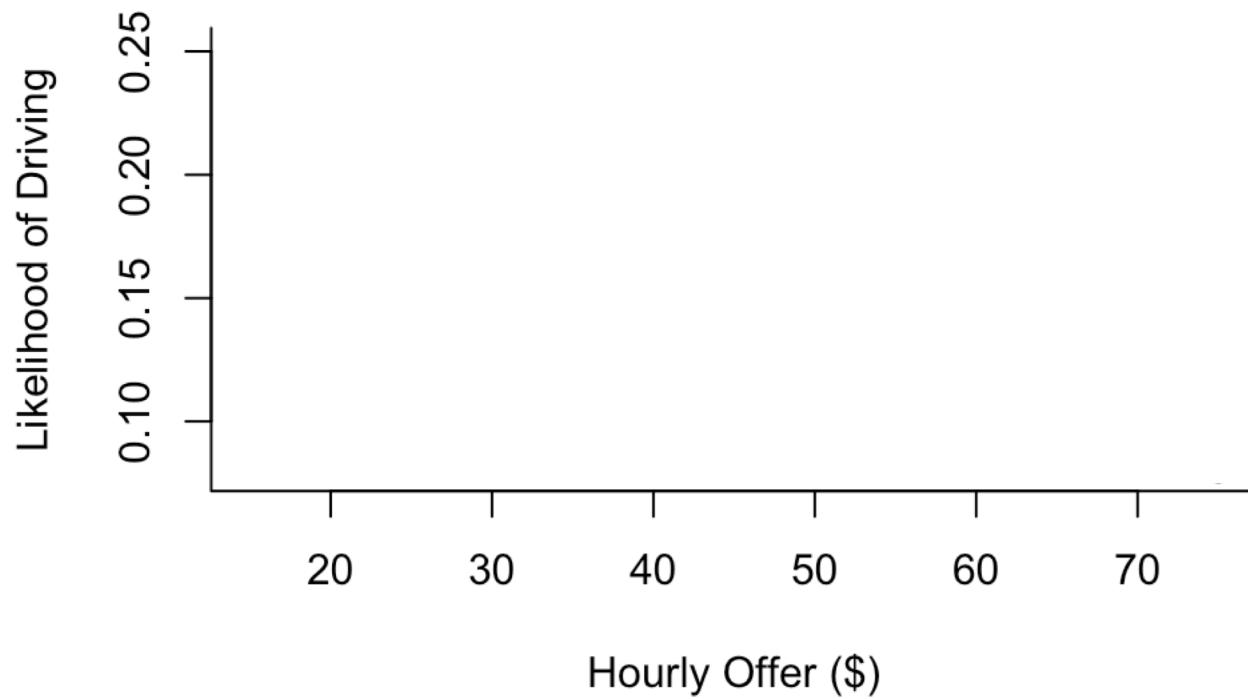
*Oct 2016 – Sep 2017*

**7,826**

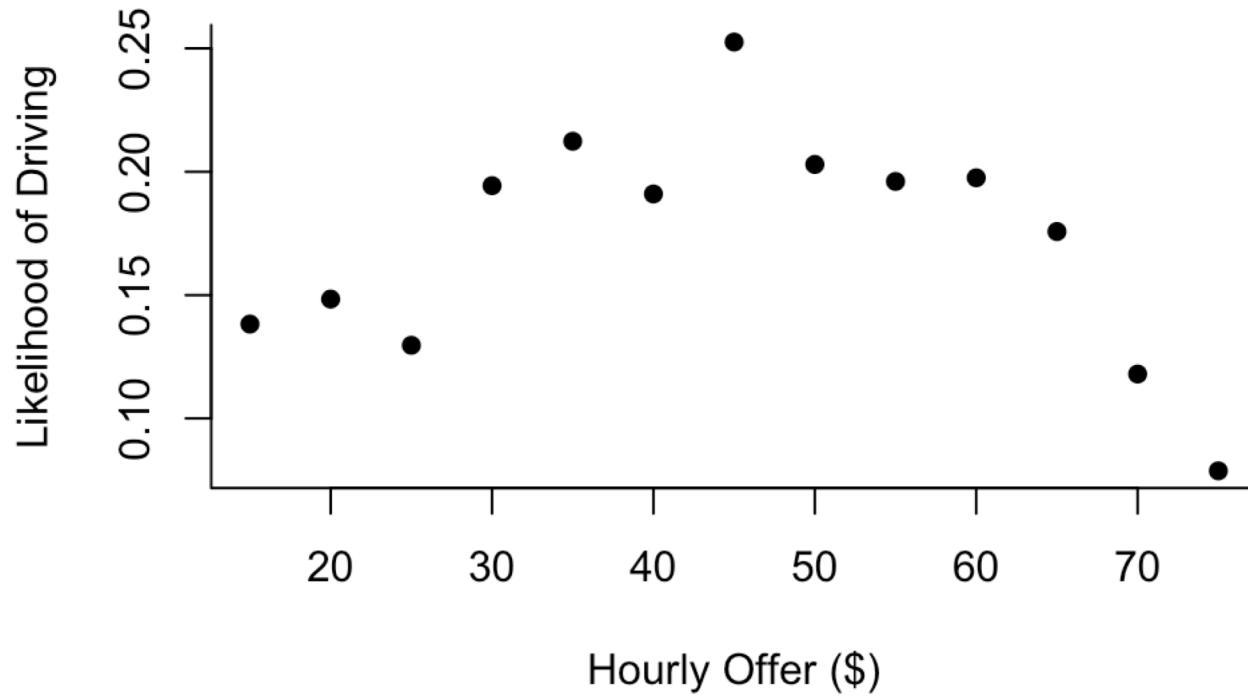
Unique drivers

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

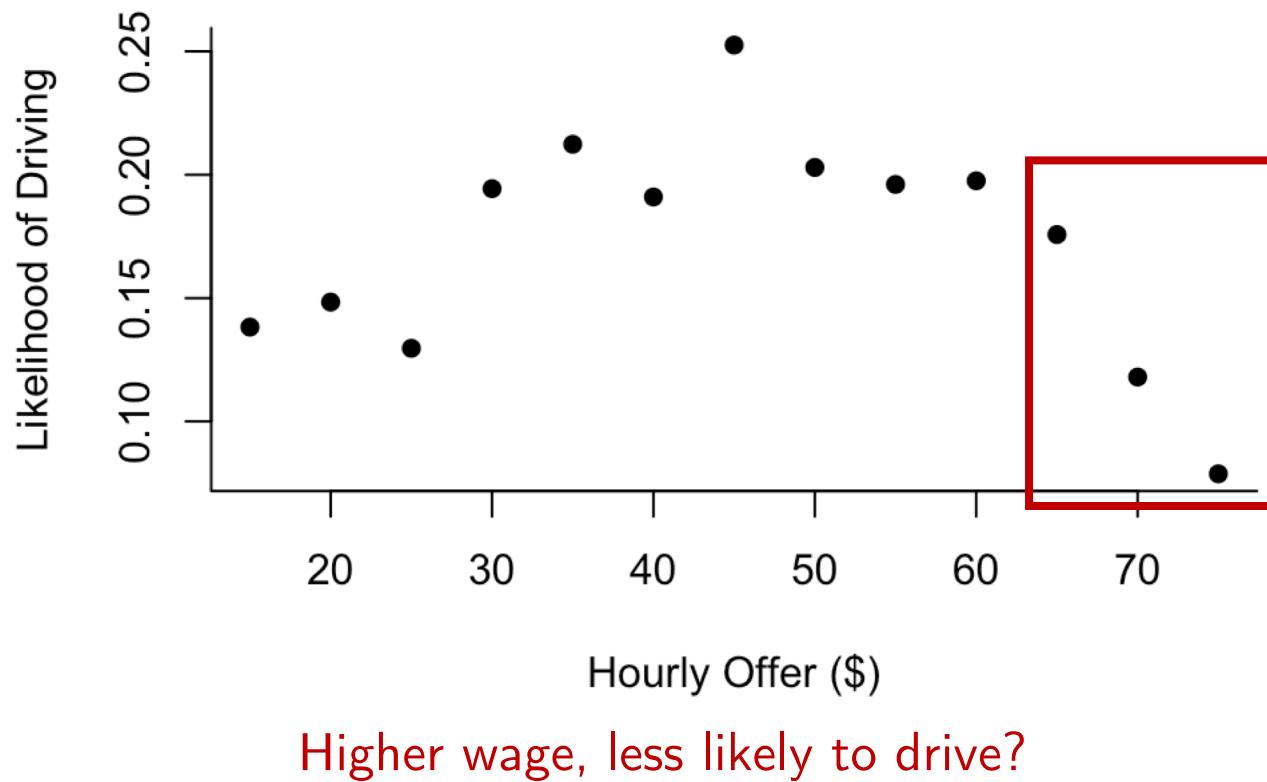
# Challenges



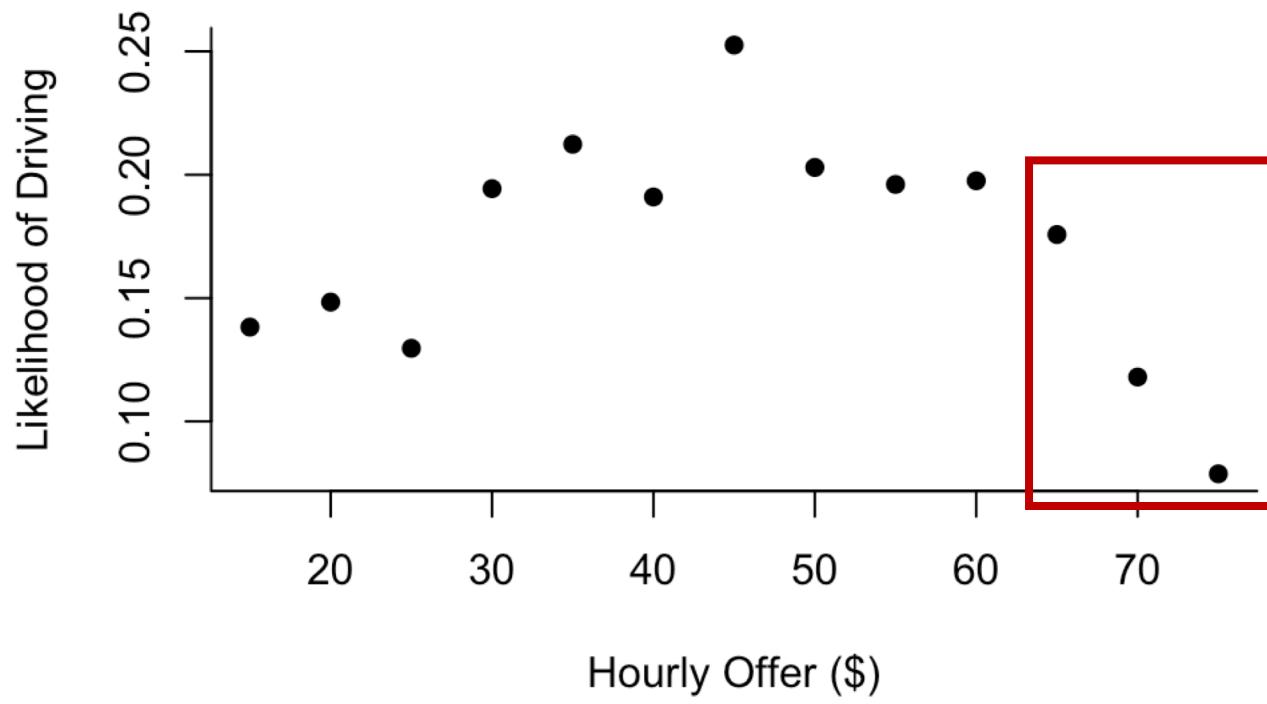
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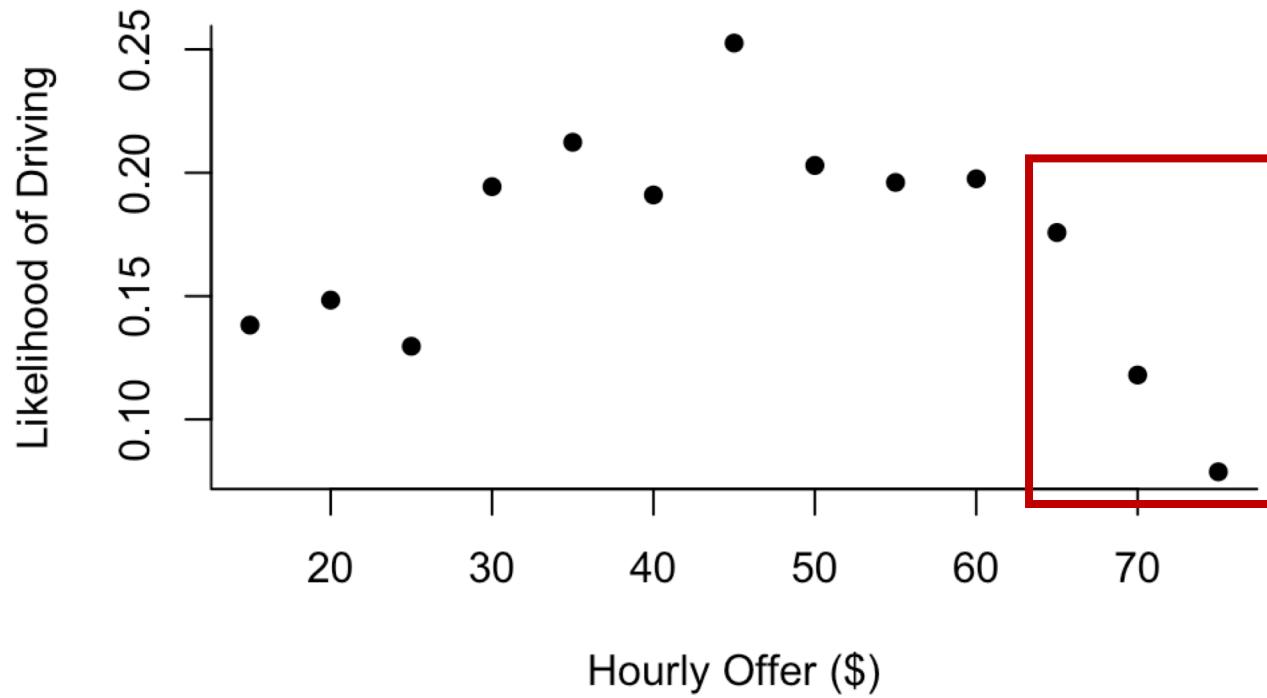


Higher wage, less likely to drive?

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

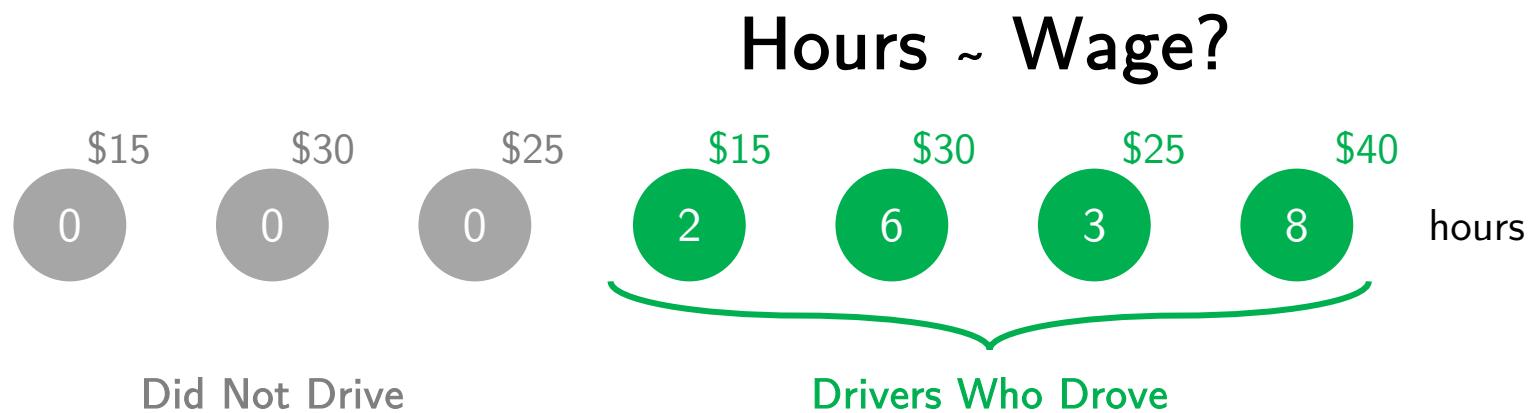
Solution: Instrumental Variables



# Challenges

Simultaneity

Solution: Instrumental Variables



# Challenges

Simultaneity

Solution: Instrumental Variables

Decision to work is **not random**

Hours ~ Wage?



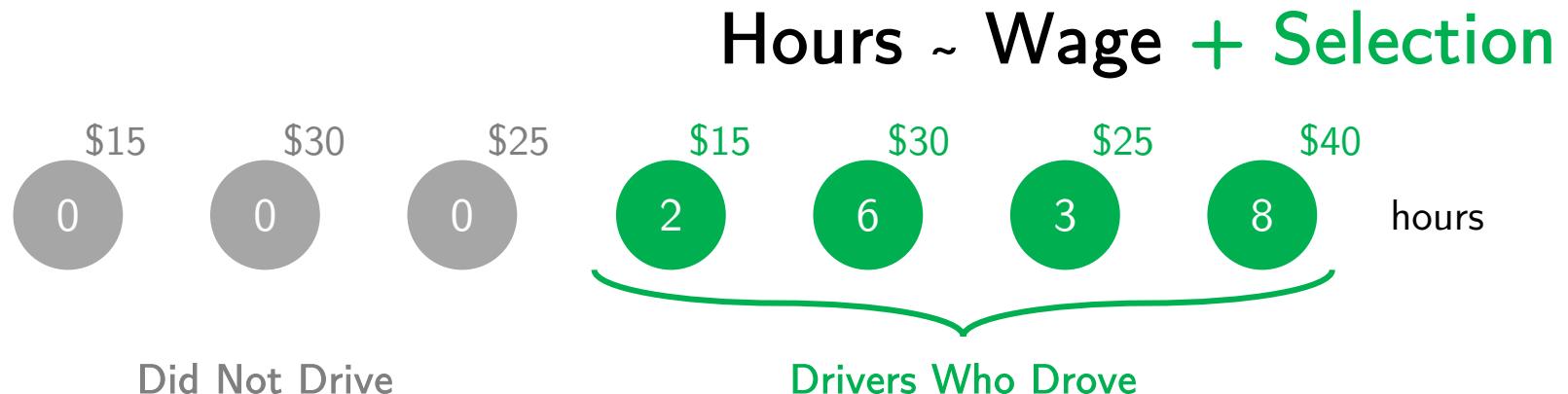
# Challenges

## 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

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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  
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Control Function Probit:

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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

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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

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

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	Work or not?	
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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)
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The more you've earned,  
the less likely you're going to  
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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  
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	Base	+ Targets
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Promo	0.229*** (0.038)	0.285*** (0.046)
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Hours so far		0.361*** (0.007)
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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

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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

# 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)			
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IMR					
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AIC/R <sup>2</sup>	95,856.010	72,887.620	0.313	0.324	0.957

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N = 18,941

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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	0.957

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Work or not?



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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

# 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

	1			2		
	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.

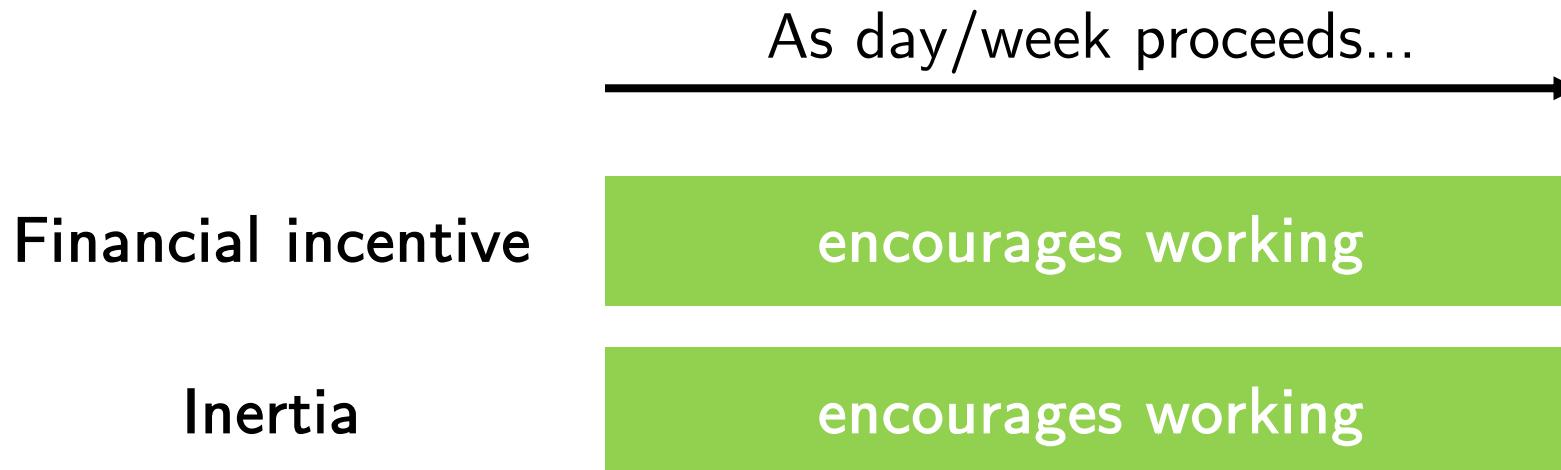
# Results Summary

Financial incentive

As day/week proceeds...

encourages working

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# Results Summary

As day/week proceeds...

Financial incentive

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Inertia

encourages working

Income Target

discourages working later on

# Who Should Get Bonuses?

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# Who Should Get Bonuses?

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



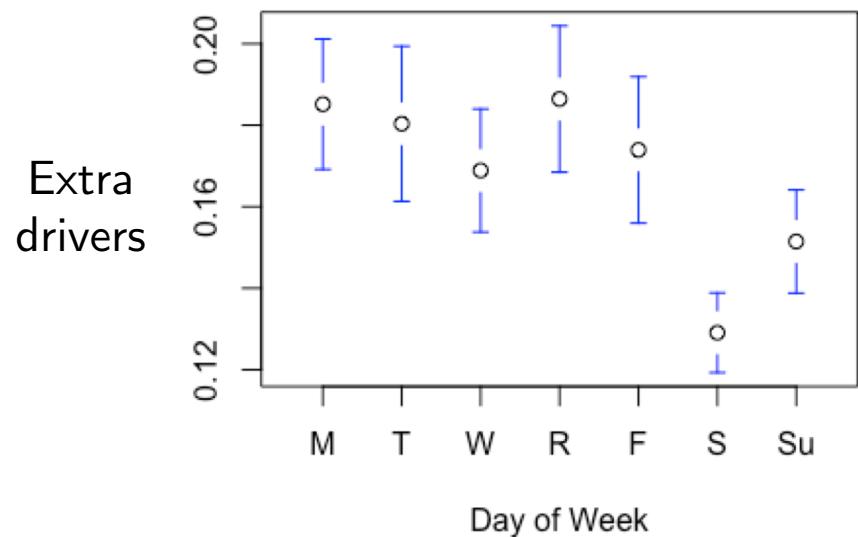
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Compared to current practice from January to September 2017

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Compared to current practice from January to September 2017

Given the same budget



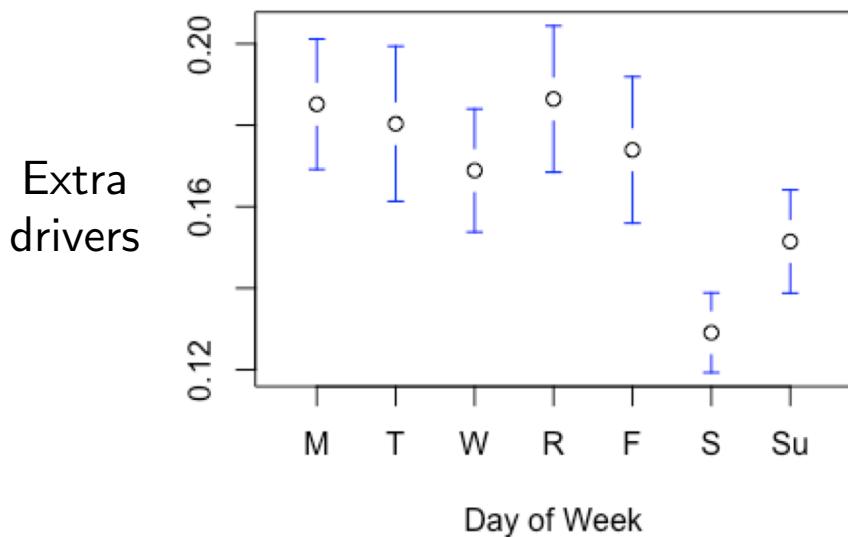
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Average promo: 1.61x

# Optimizing Incentives

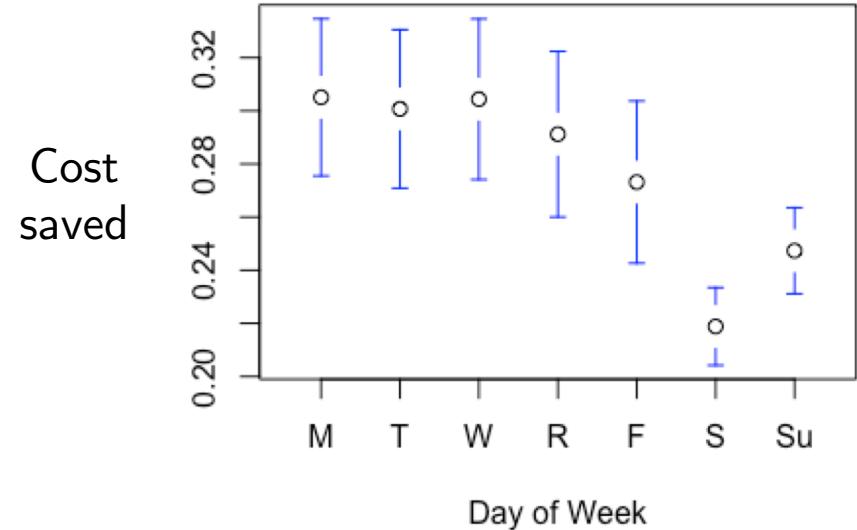
Compared to current practice from January to September 2017

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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Financial incentive

As day/week proceeds...

encourages working

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discourages working later on

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How do gig economy workers make labor decisions?

## Approach

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

## Findings

Financial incentive

As day/week proceeds...

encourages working

Inertia

encourages working

Income Target

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