Regulating Transportation Network Companies:

Should Uber and Lyft Set Their Own Rules?

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Rise of the TNCs

- Rapid growth of Transportation Network Companies (TNC)
  - Uber founded in 2009, San Francisco
  - Estimated value of Uber in 2019: $80B
  - Lyft founded in 2012, San Francisco, IPO valuation in 2019 $24B
  - 45,000 TNC drivers in SF, 487,000 SF labor force
  - Competitors: DiDi (China, Latin America), Ola (India), Grab (Singapore) …
- TNCs have disrupted urban transportation:
  - Aug 2018 in NYC, 558K TNC trips vs 275K taxi trips per day [1]
  - 97K registered TNC vehicles vs 16K yellow cabs in NYC [1]
  - 3 million active Uber drivers globally, 750K in US [1]
  - 15M Uber rides daily in 2017 [1]
  - Average NYC business trip cost $24.22 + $4.03 tip
  - Uber generated US consumer surplus estimated at $6.8B in 2015 [2].

[1] Iqbal, Mansoor, Uber Revenue and Usage Statistics (2018).
[2] Cohen, Peter, et al. *Using big data to estimate consumer surplus: The case of uber*. No. w22627. National Bureau of Economic Research, 2016.

Criticisms and Regulation

- TNC criticisms
  - Taxi drivers are hurt by TNC competition
  - TNC drivers paid sub-minimum wage:
    - after expenses, drivers earn $14.25/hour in NYC [3] (minimum wage $15/hour) while facing most of the business risk
  - Public transit loses passengers
  - Private car owners are unhappy
    - TNCs caused 50% of increase in congestion in SF during 2010-2016 [4].
- Cities starting to regulate TNC
  - In Dec 2018, New York became the first US city to
    - freeze new TNC vehicle registrations for one year
    - set minimum wage for TNC drivers at $17.22/hour
  - London court ruled TNC drivers as employees; under appeal
  - CA supreme court ABC test for gig workers
  - Seattle considering similar rules to raise driver pay

[3] Parrott and Reich, An earning standard for new york city's app based drivers: economic analysis and policy assessment, 2018
[4] SF transportation authority, *TNC&Congestion*, 2018
[5] Schaller Consulting, *Empty seats, full streets*, 2017

Lyft Financials for 2018

- Bookings = \$8.1B, Drivers get \$5.9B (72%), Revenues = \$2.2B. Driver net wages = 62% of gross = \$3.7B
- Total rides in 2018 = 619M

	Total	Per ride
Bookings (Fares collected)	\$8.1B	\$13.00
Drivers gross (net)	\$5.9B (\$3.7B)	\$9.50 (\$5.90)
Revenues	\$2.2B	\$3.50
Cost of revenues	\$1.24B	\$2.00
Loss	\$0.91B	\$1.47
Total cost = Rev + Loss	\$3.06B	\$4.97

Cost of revenue = insurance costs required under TNC and city regulations for ridesharing + payment processing charges, including merchant fees and chargebacks (returns), + hosting and platform related technology costs (AWS). Driver + Cost of revenues = minimum cost of service = 88% of bookings. So gross margin is 12%. To make this 50% need to raise fares by 77%

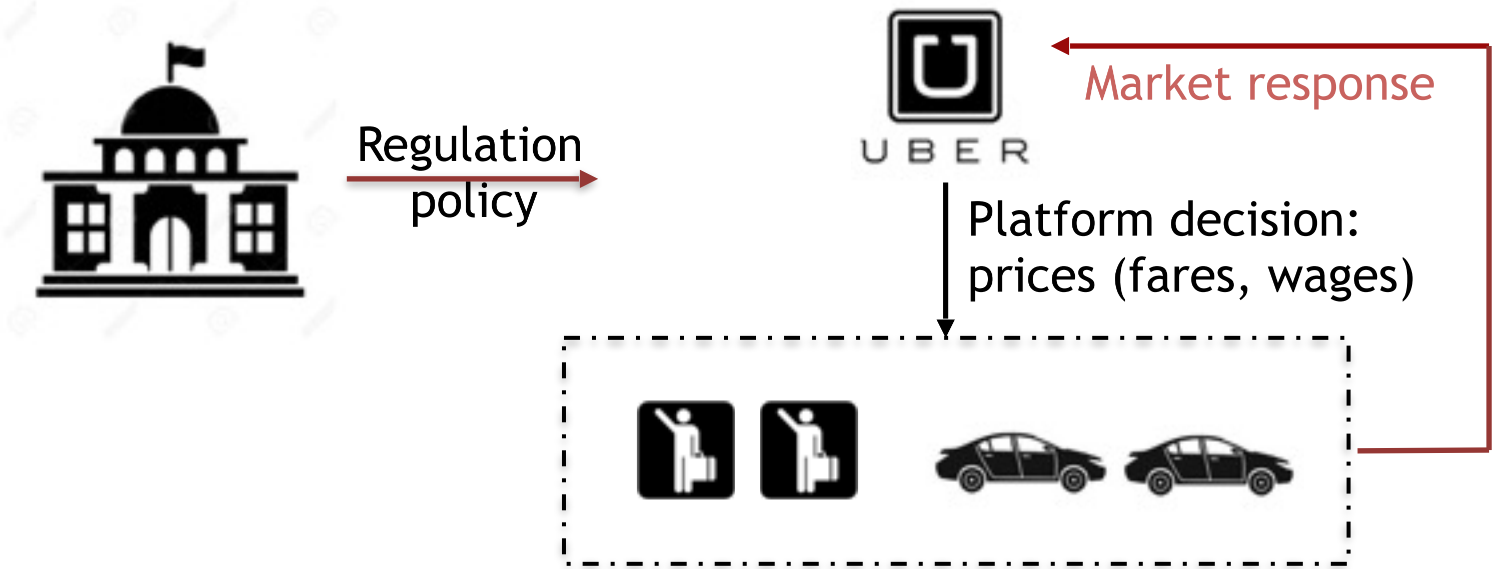
Scope of this Talk

- This talk will:
  - explain how regulations affect the TNC marketplace (platforms, drivers, passengers, etc)
    - Earning of drivers
    - Cost to passengers
    - Profit of platform

- Focus on three regulations:
  - Cap on number of TNC vehicles
  - Minimum wage of TNC drivers
  - Congestion surcharge on TNC rides

Big Picture

- The big picture



- Goal:
  - predict the decisions of platform, passengers, drivers
  - calculate how decisions are affected by exogenous regulation
- Focus:
  - platform pricing
  - market response

Market Response-Demand Model

- Passenger model:
  - Each passenger faces a trip cost = value of pickup time + trip price [6]

    $$c = \alpha t + \beta p_1$$

    - t is pickup waiting time
    - p_1 is the per-mile price
  - Each passenger has a reservation cost
    - captures the cost of alternatives (public transit, walking, etc)
    - CDF function: $F_p(c)$

- Demand function:

$$\text{arrival rate of TNC passengers} = \text{arrival rate of all potential passengers} \times \text{proportion of passengers who take } TNC$$

[6] Mohring, H. Optimization and Scale Economies in Urban Bus Transportation, *American Economic Review*, 62 (4) (1972), pp. 591-604

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    - CDF function: $F_p(c)$
- Demand function (new passengers per minute) β includes average trip length:

  $$\lambda = \lambda_0\left(1 - F_p(\alpha t + \beta p_1)\right)$$

Market Response-Supply Model

- Driver model:
  - The hourly earning (wage rate) of each driver is:

    $$r = p_2\lambda/N$$

    - p_2: per-mile payment to drivers
    - N: total number of TNC drivers
  - Each driver has a reservation wage
    - CDF function: $F_d(r)$

- Supply function

  $$N = N_0 F_d(p_2\lambda/N)$$

- Market equilibrium equation

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- Proposition: the pickup time satisfies $t = \frac{c}{\sqrt{N-\lambda/u}}$

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- Proposition: the pickup time satisfies $t = \frac{C}{\sqrt{N-\lambda/u}}$

Numerical Solutions

$$\max_{p_1, p_2} \quad \lambda(p_1 - p_2)$$

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$$N = N_0 F_d(p_2 \lambda / N)$$

- solve under different λ_0
- F_p and F_d uniform distributions
- Parameters tuned to match realistic data of SF city

Real Data of San Francisco City [1]

- Number of passenger / minute: $\lambda = 141$
- Average number of drivers: $N = 3200$
- Ride price: 11.4 $/ trip
- Driver pay: 6.9$/ trip
- Driver hourly wage: 18.3$/hour

[1] TNCS today: A profile of San Francisco Transportation Network Company Activities, 2017

Numerical Solutions (unregulated case)

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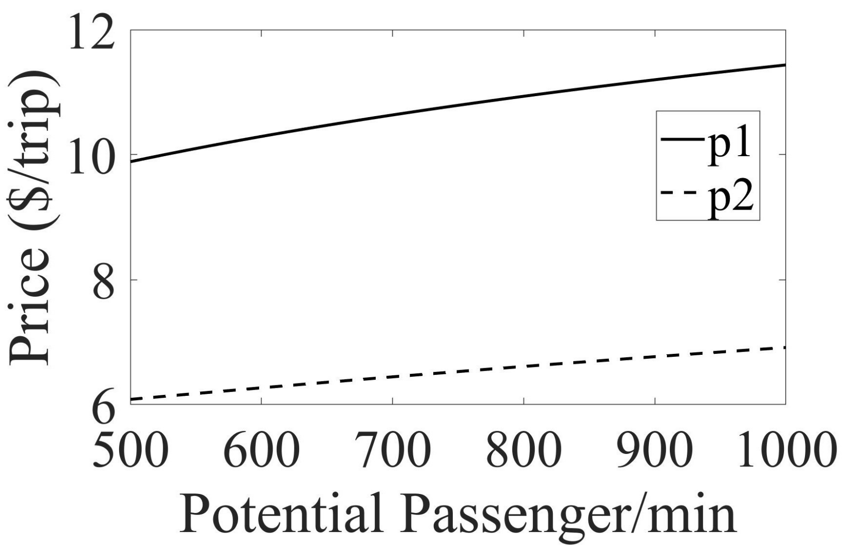

(In SF, potential passenger 989/min)

As potential passengers double

- Cost per ride p_1 increases by 15% from $9.9 to $11.4
- Driver payment p_2 increases 13% from $6.1 to $6.9 per ride

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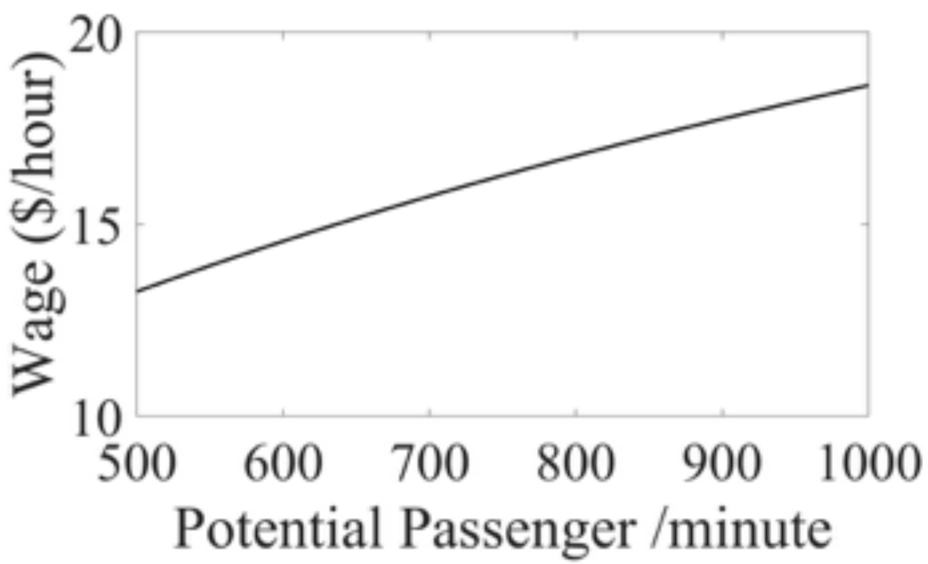

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As potential passengers double

- Driver wage increases by 41% from \$13.2 to \$18.6 per hour

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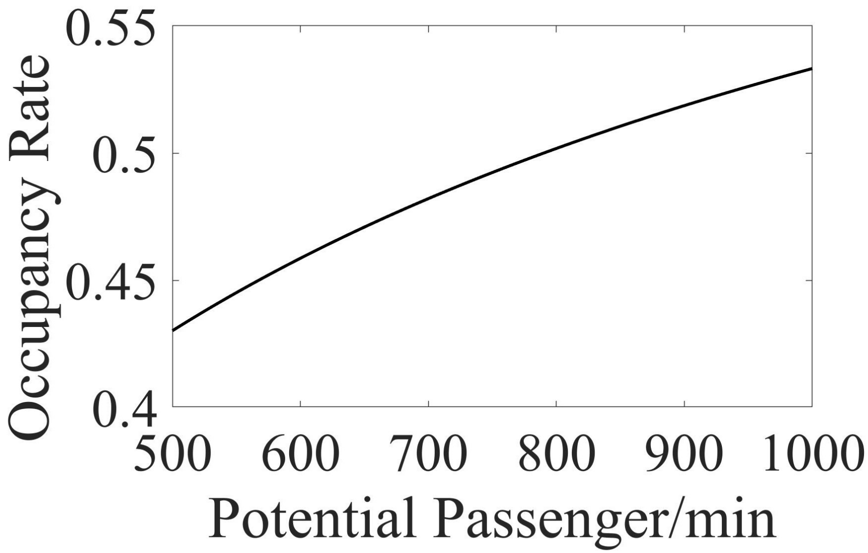

As potential passengers double

- Occupancy increases 23% from 43% to 53%

TNC scale economies (NYC, unregulated)

- As number of potential passengers doubles from 500 to 1,000 rides per minute, the cost per ride increases by 11 percent from $2.4 to $2.7 per mile, driver payment increases by 6.6 percent from $1.4 to $1.5 per mile, platform share increases 20 percent from $1 to $1.2 per mile

- Driver wages increase 29 percent from $17 to $24 per hour because driver utilization increases by 25 percent from 0.4 to 0.5

- By the same token, in the absence of a wage floor, a driver's hourly wage declines by 29 percent from peak to off-peak hours. Further, platform share increases 20% from $1 to $1.2 per mile

Profit-Maximizing TNC (Cap Constraint)

- Platform profit:

$$R_p = \lambda(p_1 - p_2)$$

- Platform decision:
  - Maximize profit subject to market equilibrium equations and cap constraint

$$\max_{p_1, p_2} \quad \lambda(p_1 - p_2)$$

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- Theorem:
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- Results under cap constraints

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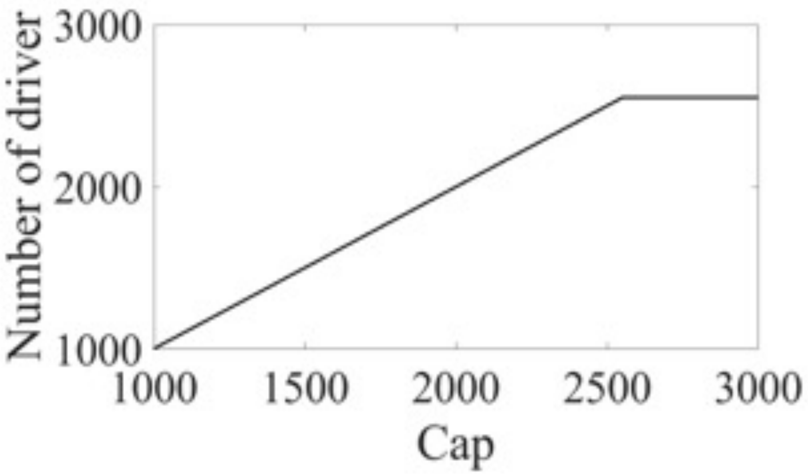

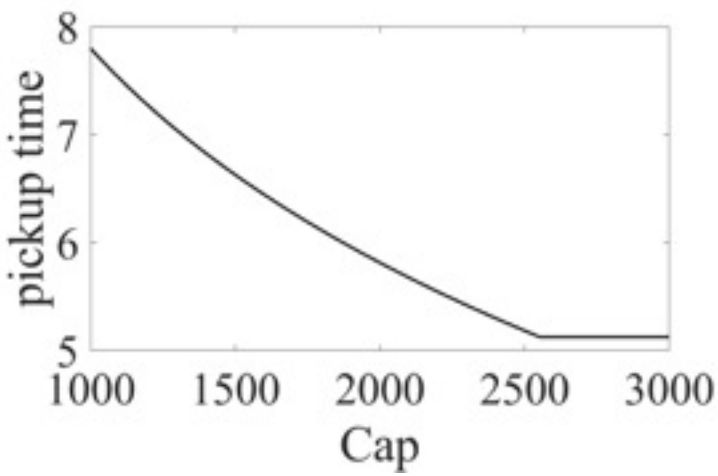

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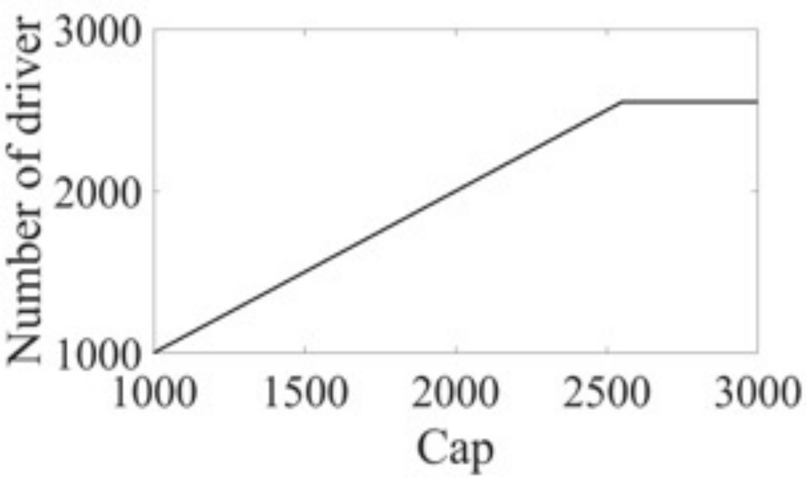

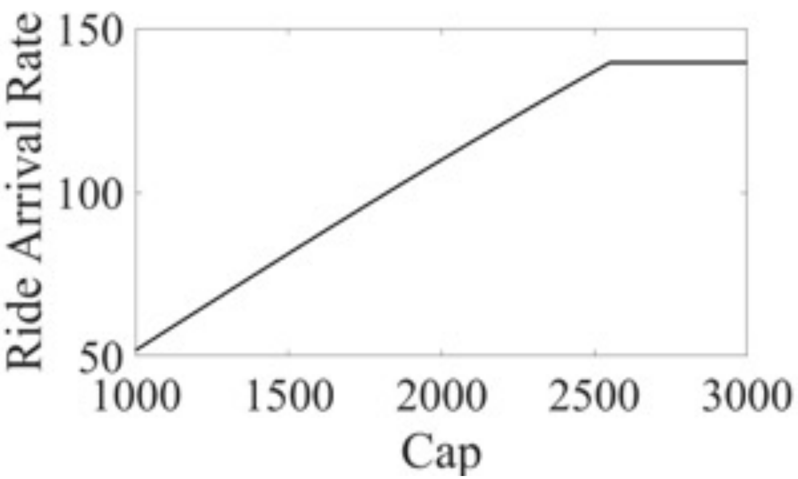

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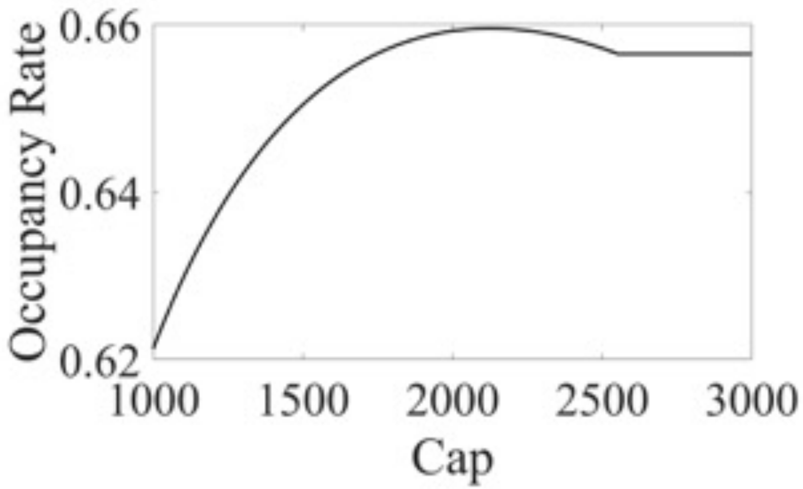

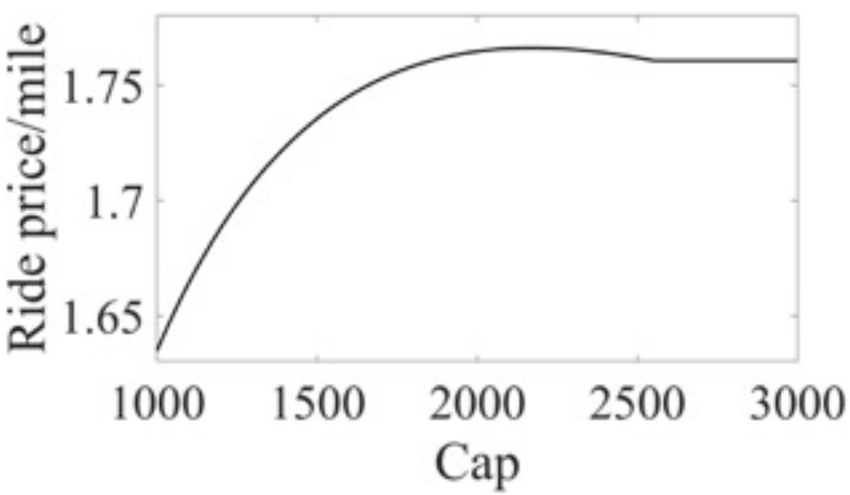

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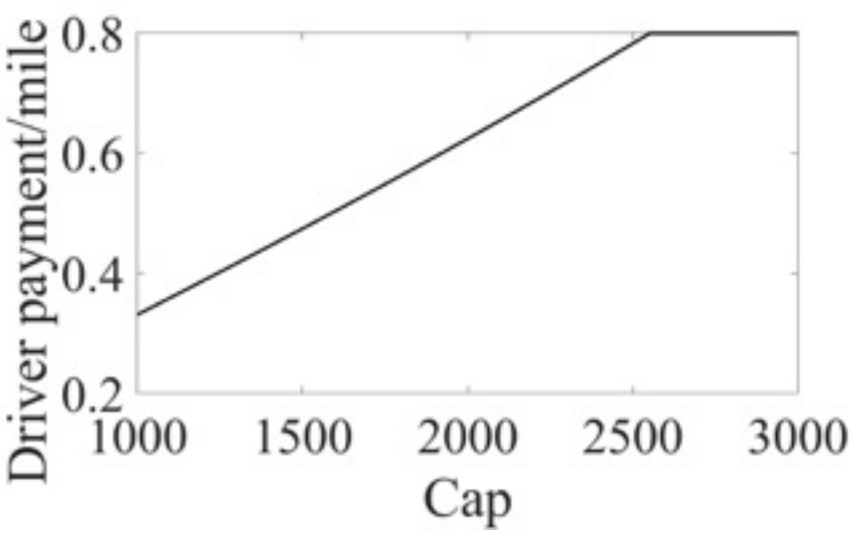

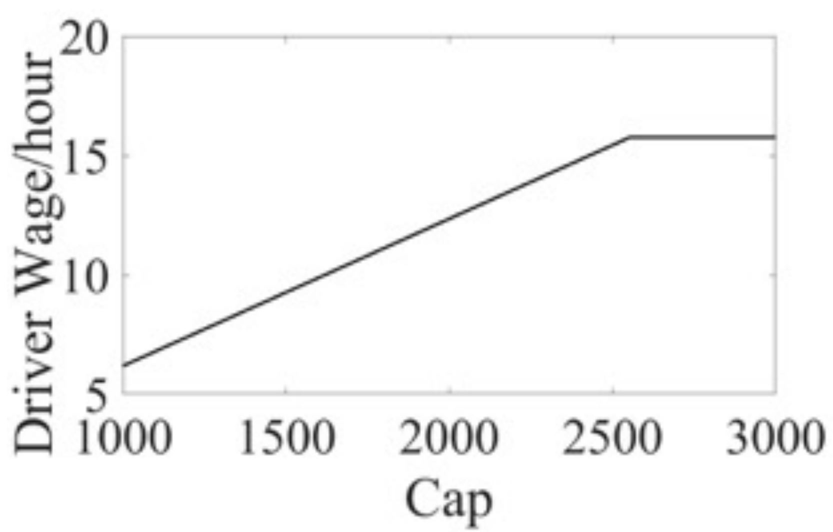

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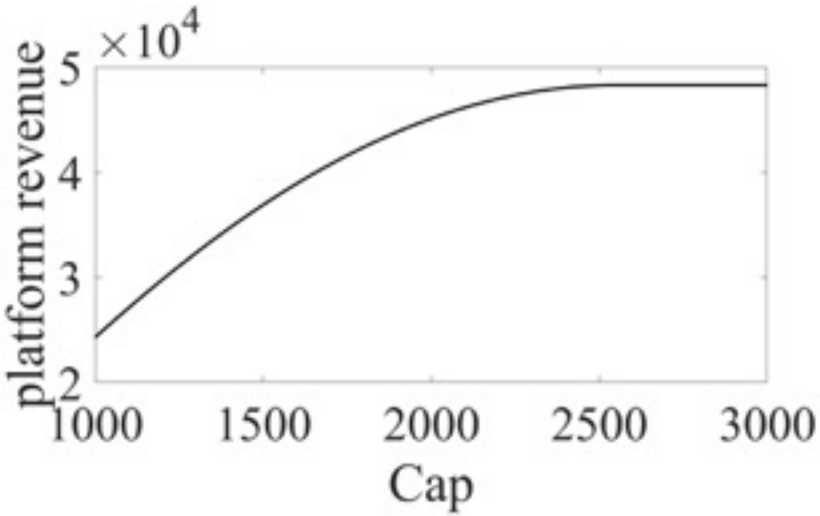

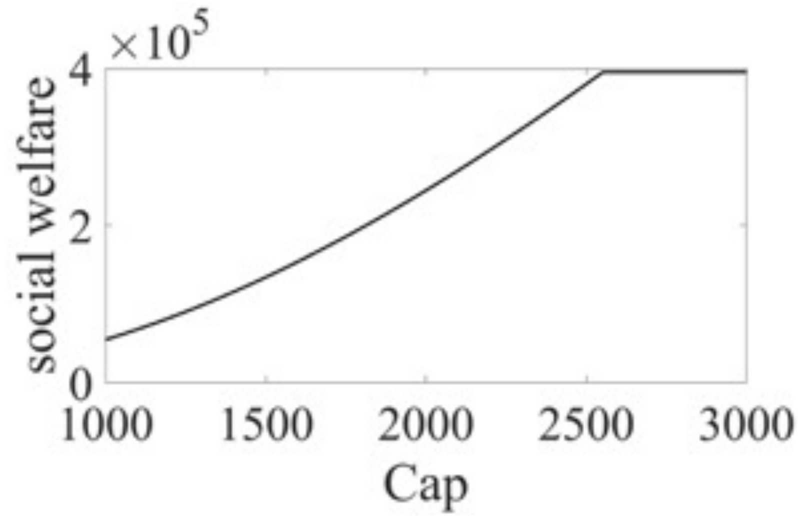

Profit-Maximizing TNC (wage floor)

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- Results under wage floor

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- solve under different wage floors
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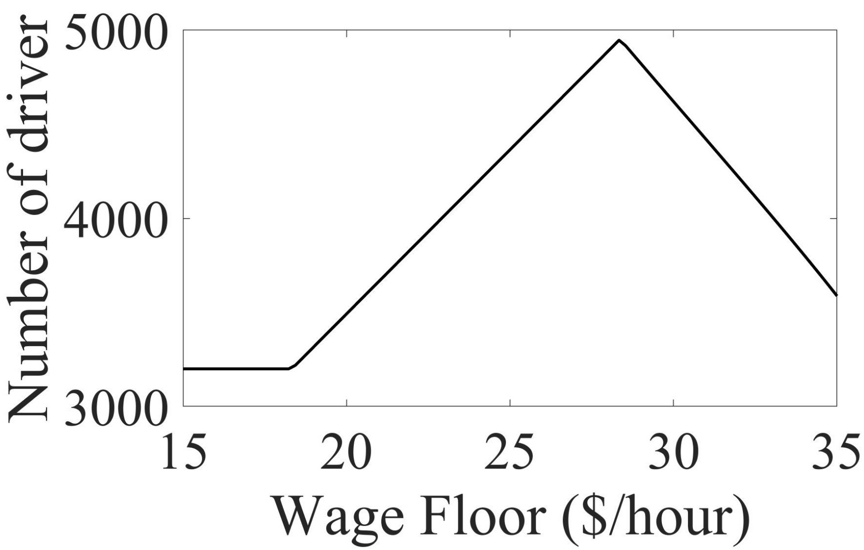

Figure 1

Figure 2

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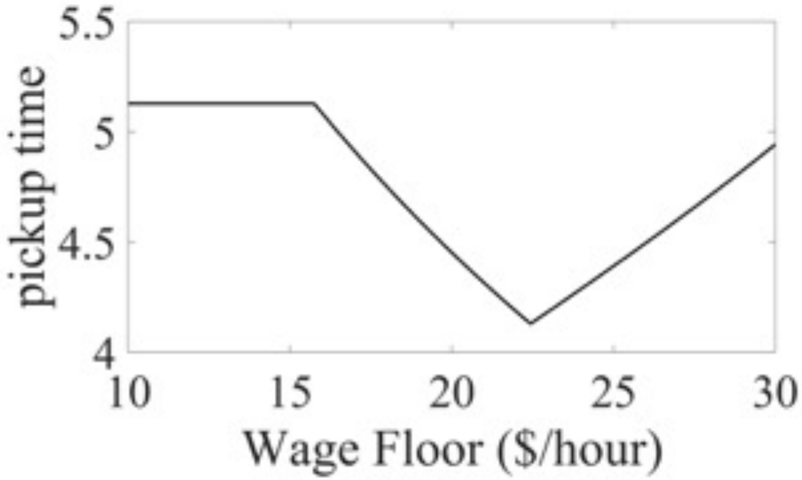

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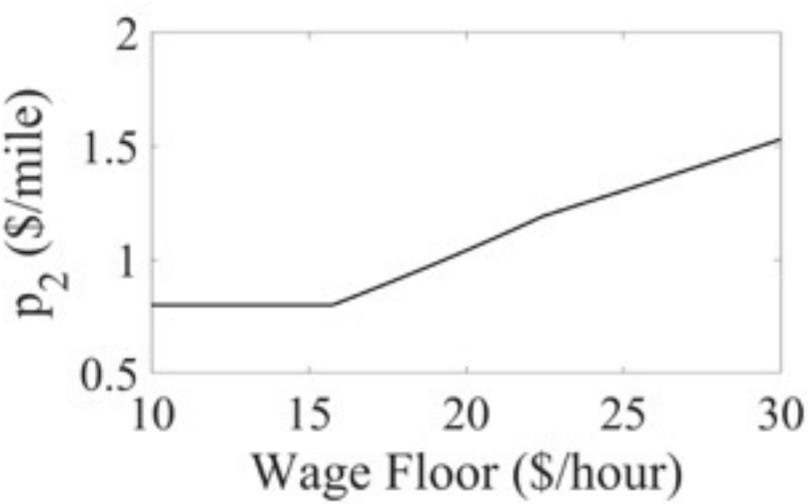

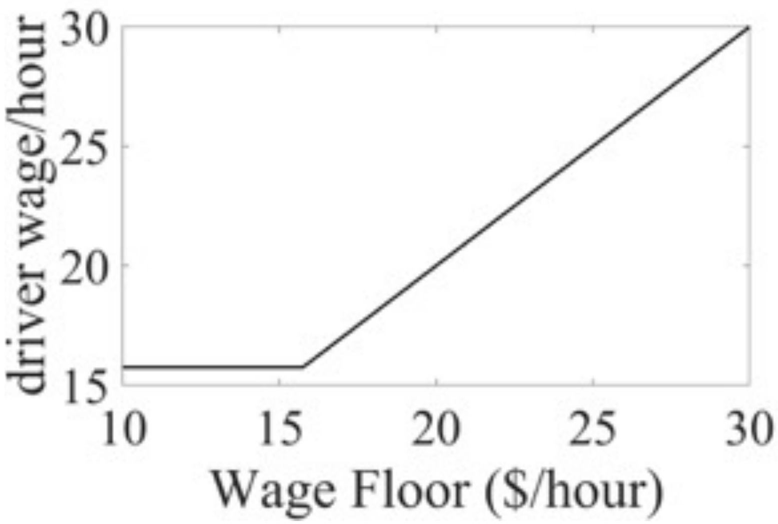

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Numerical Solutions (congestion surcharge)

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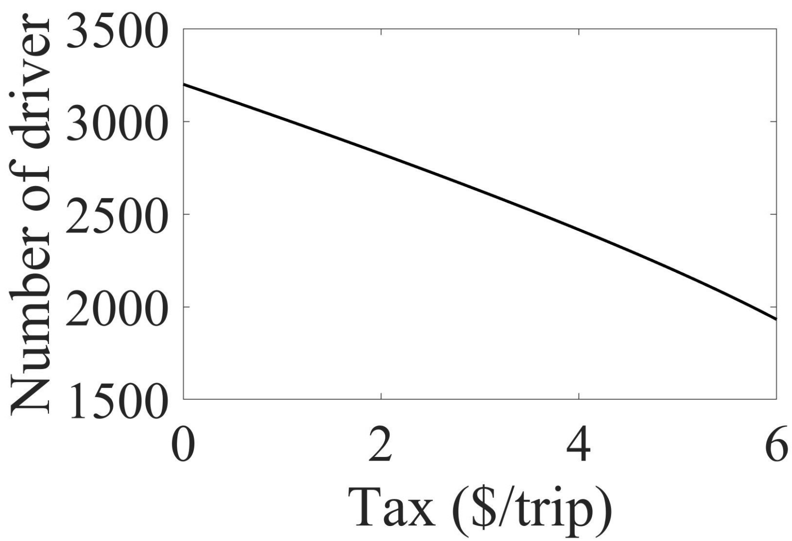
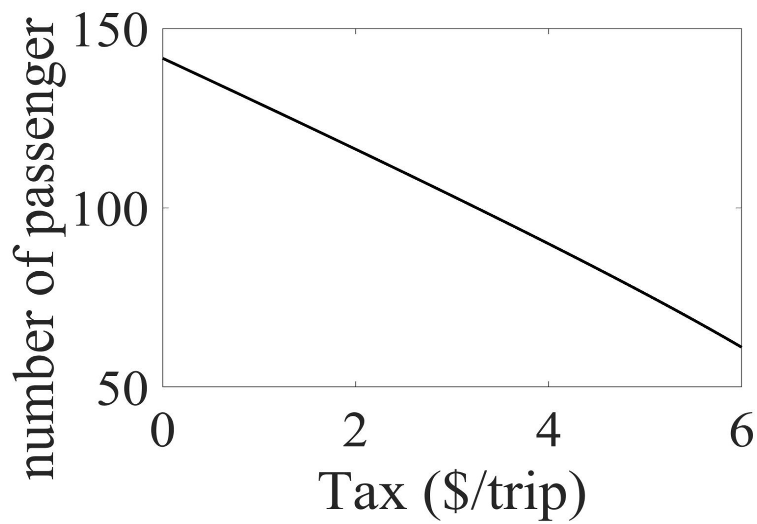
$$\text{s.t. } \lambda = \lambda_0\left(1 - F_p\left(\alpha\frac{c}{\sqrt{N-\lambda/u}} + \beta p_1 + p_3\right)\right)$$

$$N = N_0 F_d(p_2\lambda/N)$$

- Solve this problem for different values of congestion surcharge
- Tune parameter to match SF data





Numerical Solutions (wage floor + surcharge)

- Results under congestion surcharge **and** wage floor

$$\max_{p_1, p_2, N} \quad \lambda(p_1 - p_2)$$

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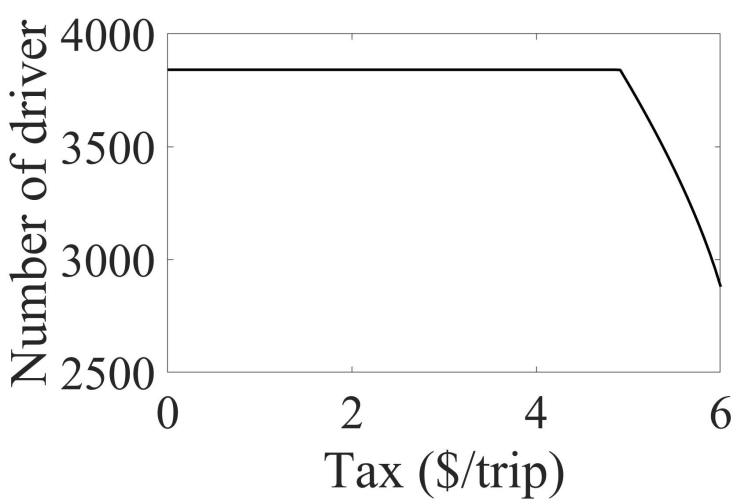
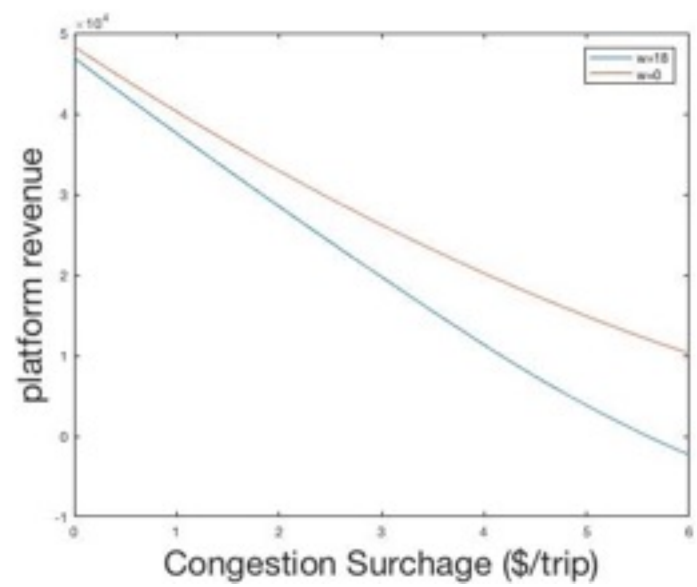
$$N \leq N_0 F_d(p_2 \lambda / N)$$

$$w \leq p_2 \lambda / N$$

- Fix wage floor w=17.2$/hour
- Solve this problem for different values of tax





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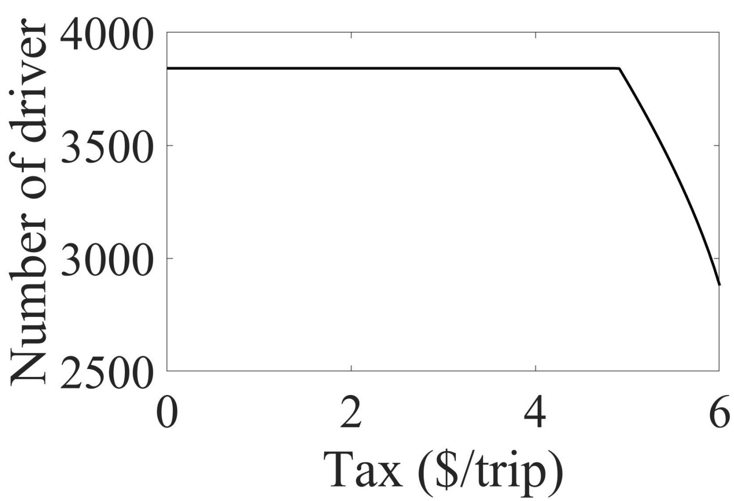
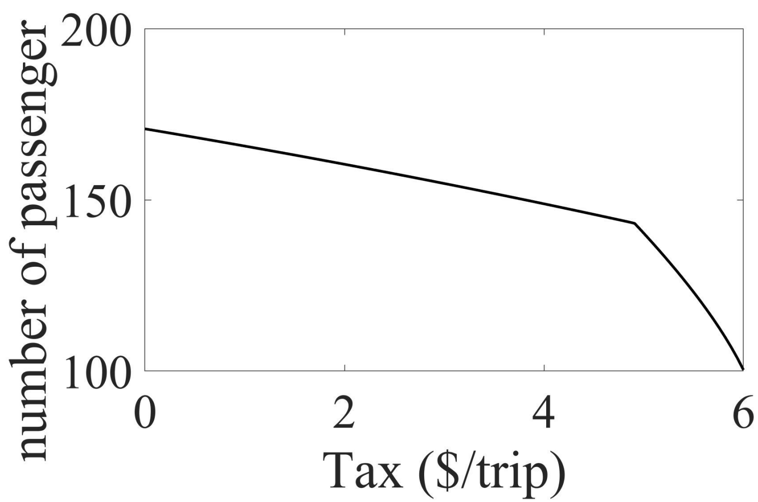




Numerical Solutions (wage floor + surcharge)

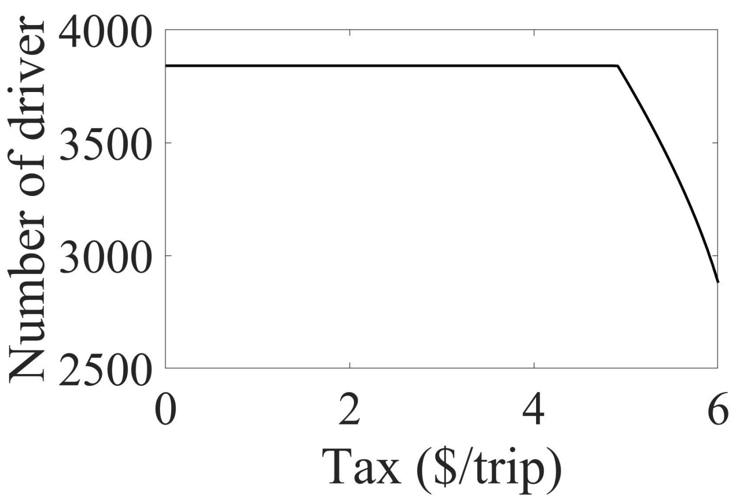
- With surcharge

$$\max_{p_1,p_2,N} \quad \lambda(p_1 - p_2)$$

$$\text{s.t. } \lambda = \lambda_0\left(1 - F_p\left(\alpha\frac{c}{\sqrt{N-\lambda/u}} + \beta p_1 + p_3\right)\right)$$

$$N \le N_0 F_d(p_2\lambda/N)$$

$$w \le p_2\lambda/N$$



- Without surcharge

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$$\text{s.t. } \lambda = \lambda_0\left(1 - F_p\left(\alpha\frac{c}{\sqrt{N-\lambda/u}} + \beta p_1\right)\right)$$

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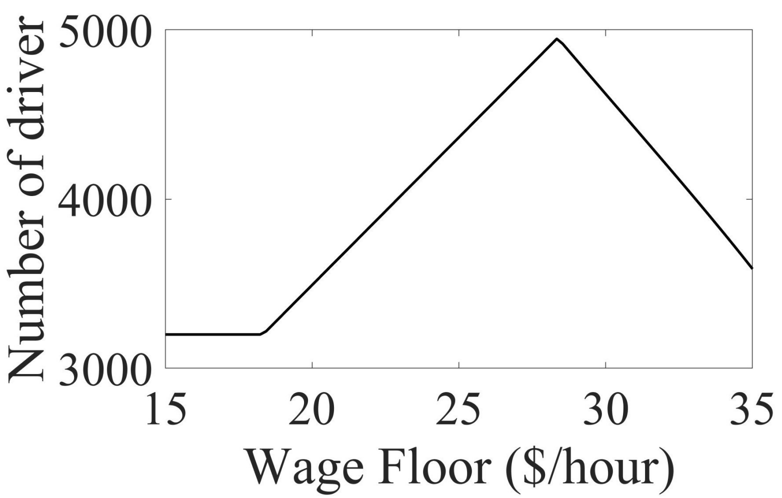

Extensions of the Model

- Platform subsidy
  - Objective is to maximize market share for fixed subsidy or loss, decrease p_1 or/and increase p_2
  - Subsidize passengers more than drivers
- Platform competition
  - More than one platform
  - Need behavior model
- Autonomous vehicles
  - Cost of AV today much higher than driver cost
  - AV today not safe enough

Conclusion

- TNC business model requires market power and unorganized driver pool
- Higher minimum wage (up to a limit) increases number of drivers and passengers, and reduces platform rents
- Cap on number of drivers hurts drivers, passengers and platform
- Congestion charge reduces number and wage of drivers
- But with minimum wage congestion charge does not reduce number of drivers

Thank you!