Flattening the Curve? On-Demand Delivery Platforms and Demand Dispersion

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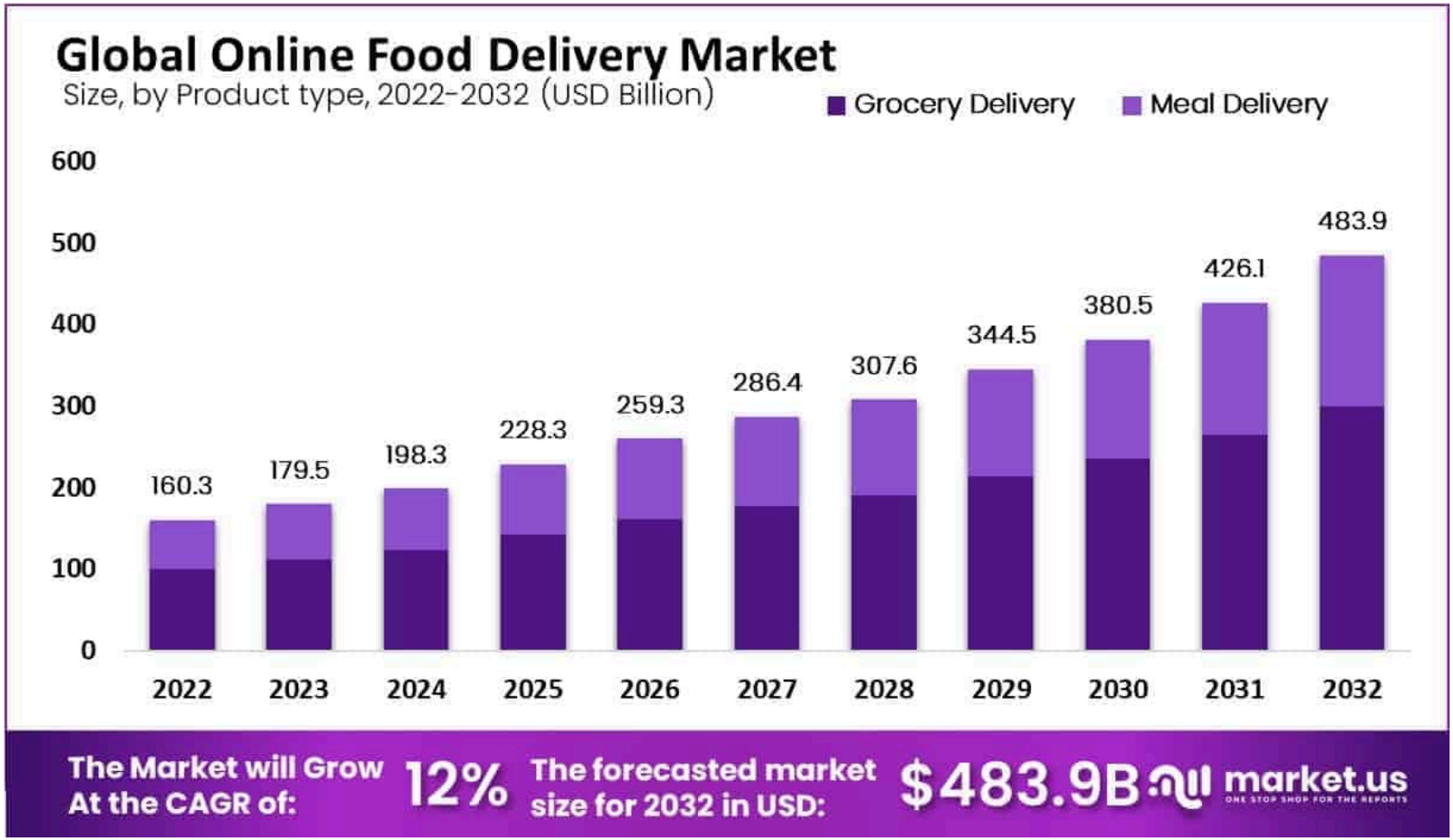
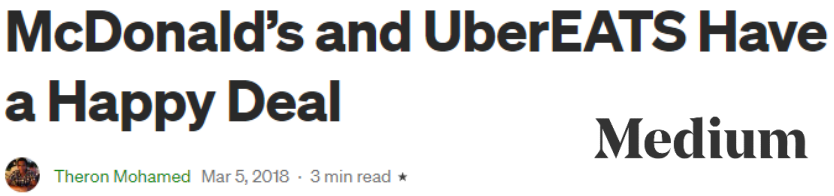

Global Online Food Delivery Market
Size, by Product type, 2022-2032 (USD Billion)
Grocery Delivery
Meal Delivery
600
500
400
300
200
100
0
160.3
179.5
198.3
228.3
259.3
286.4
307.6
344.5
380.5
426.1
483.9
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
The Market will Grow At the CAGR of:
12%
The forecasted market size for 2032 in USD:
$483.9B
market.us
ONE STOP SHOP FOR THE REPORTS

Do on-demand delivery platforms benefit restaurants?



Benefits:

- Flexible access to delivery service
- An internet channel to serve customers

Costs:

- Cannibalizing restaurants' own channels (takeout/dine-in)
- Extra costs (delivery/commission fees)

Li and Wang (2024), *ISR*
Li and Wang (2024), *MS*
Mayya and Li (2024), *ISR*

Bucciferro Family McDonald's

3.5 ★★★½☆ (854) · $1–10

Fast food restaurant ·

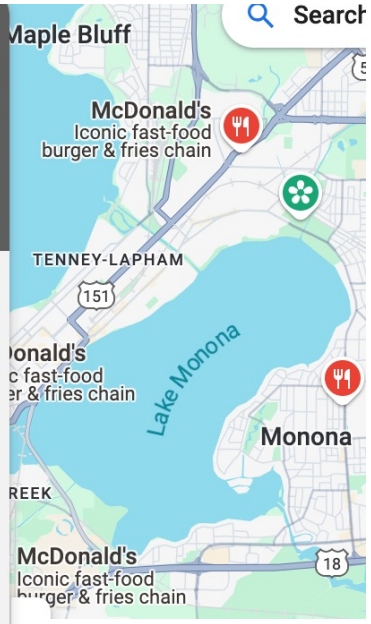
Overview Reviews About

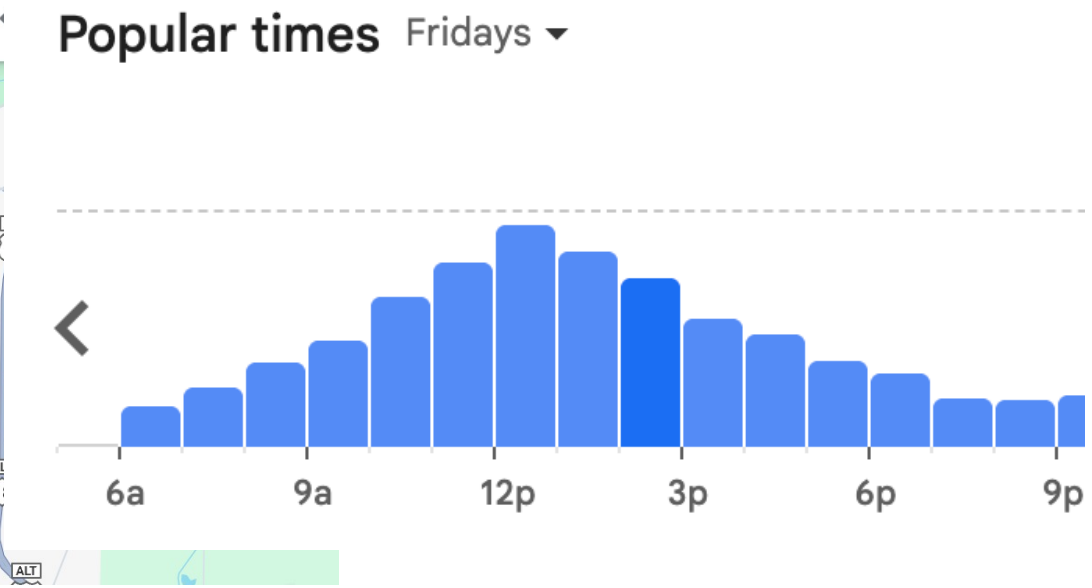
Directions Save Nearby Send to phone Share

ORDER ONLINE

✓ Dine-in · ✓ Drive-through
✓ Delivery

4500 University Ave, Madison, WI 53705

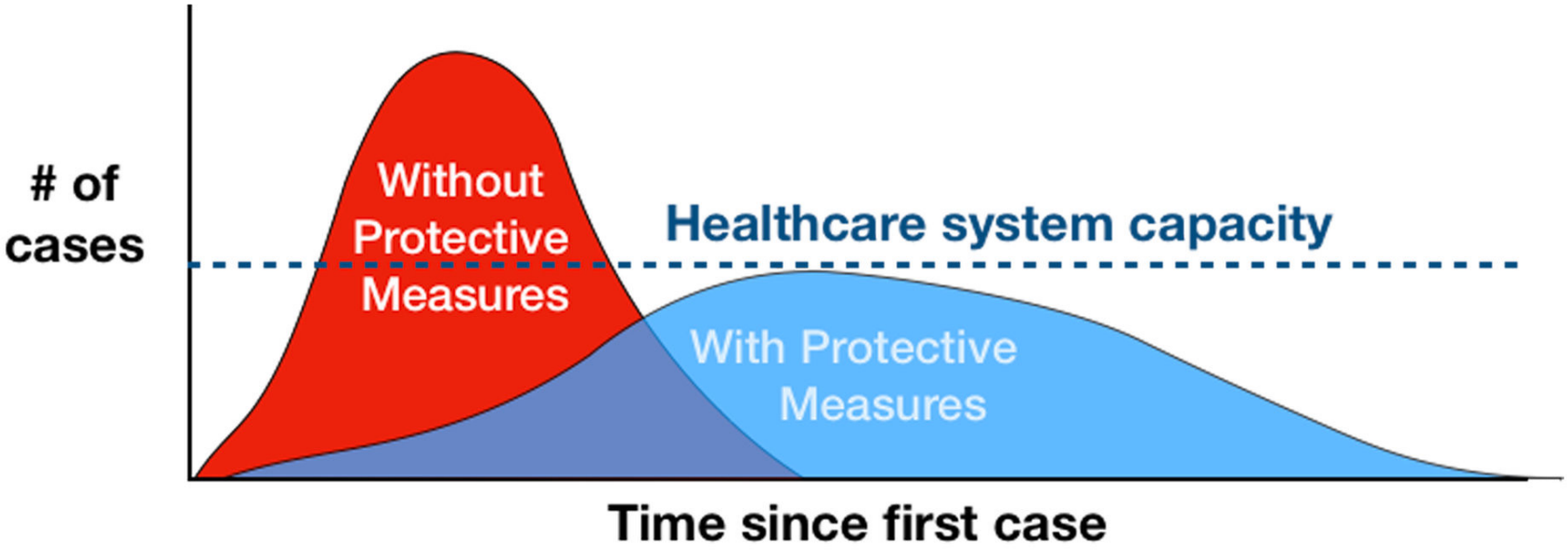




Demand varies over the day

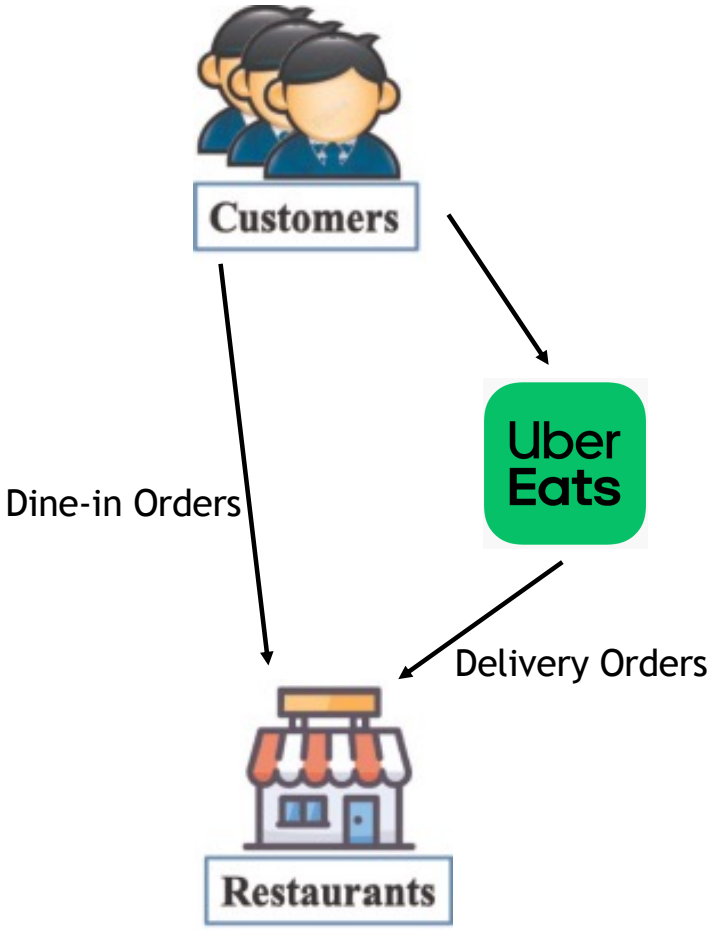
- Lunch hours: long waiting time
- Least busy hours: few visitors

"Flattening the curve" as a public health strategy



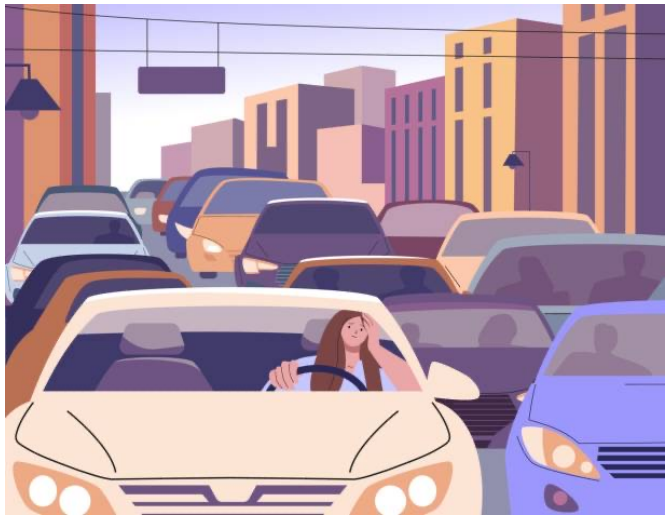
Questions

- How does adding an on-demand delivery option shape customer arrival patterns?
  - Flattening the curve, or the opposite?
  - Under what conditions?



A Bottleneck Model

Arnott et al. (1988)



Base Model

Total market size of M homogenous customers

Two channels $j \in \{I, O\}$

- Channel I : dine in
- Channel O : ordering delivery

Assumptions:

- All customers have the same desired dining time t^*
- First-come, first-served. No discrimination based on arrival channels

Customer Cost Function

Total cost for a customer joining the queue at time t via channel $j \in \{I, O\}$ is

$$C_j(t) = \alpha_j W(t) + \beta |deviation\ from\ t^*| + \gamma_j$$

Delivery less sensitive to waiting

$$\boxed{\alpha_I \geq \alpha_O}$$

- $W(t)$: Waiting time in queue $W(t) = Q(t)/s$, i.e., queue length divided by capacity
- γ_I: fixed cost associated with dine in (e.g., cost to get to the restaurant)
- γ_O: fixed cost associated with delivery (e.g., delivery fee)

Decision variables:

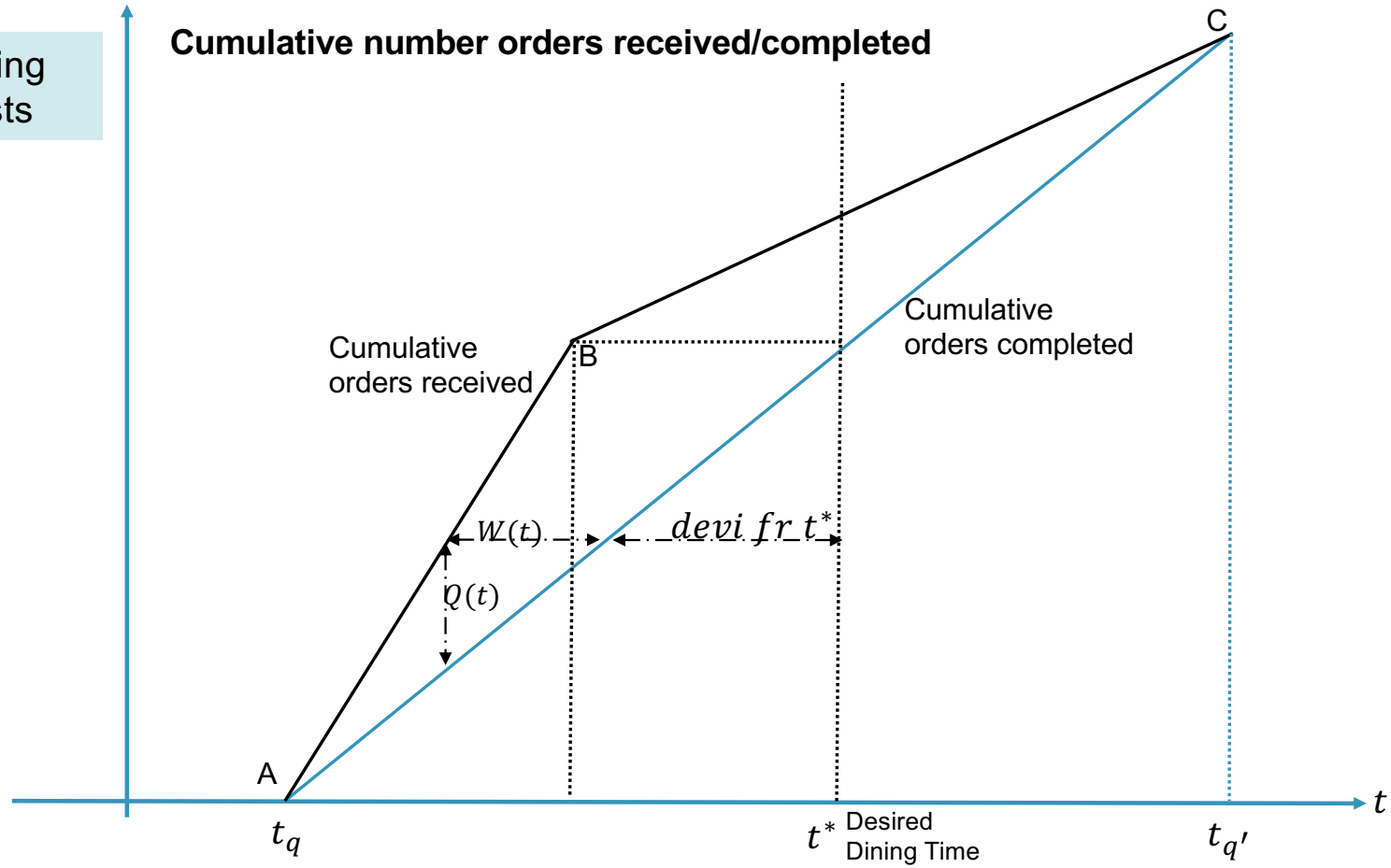
- $j \in \{I, O\}$: dine in or delivery
- t : time to join the queue. For dine in, time of arriving at the restaurant; For delivery, time of placing the order

Case I: Dine-In Only

$$C_I(t) = \alpha_I\, W(t) + \beta|deviation\ from\ t^*| + \gamma_I$$

$$W(t) = Q(t)/s$$

Trade-off between waiting costs and deviation costs



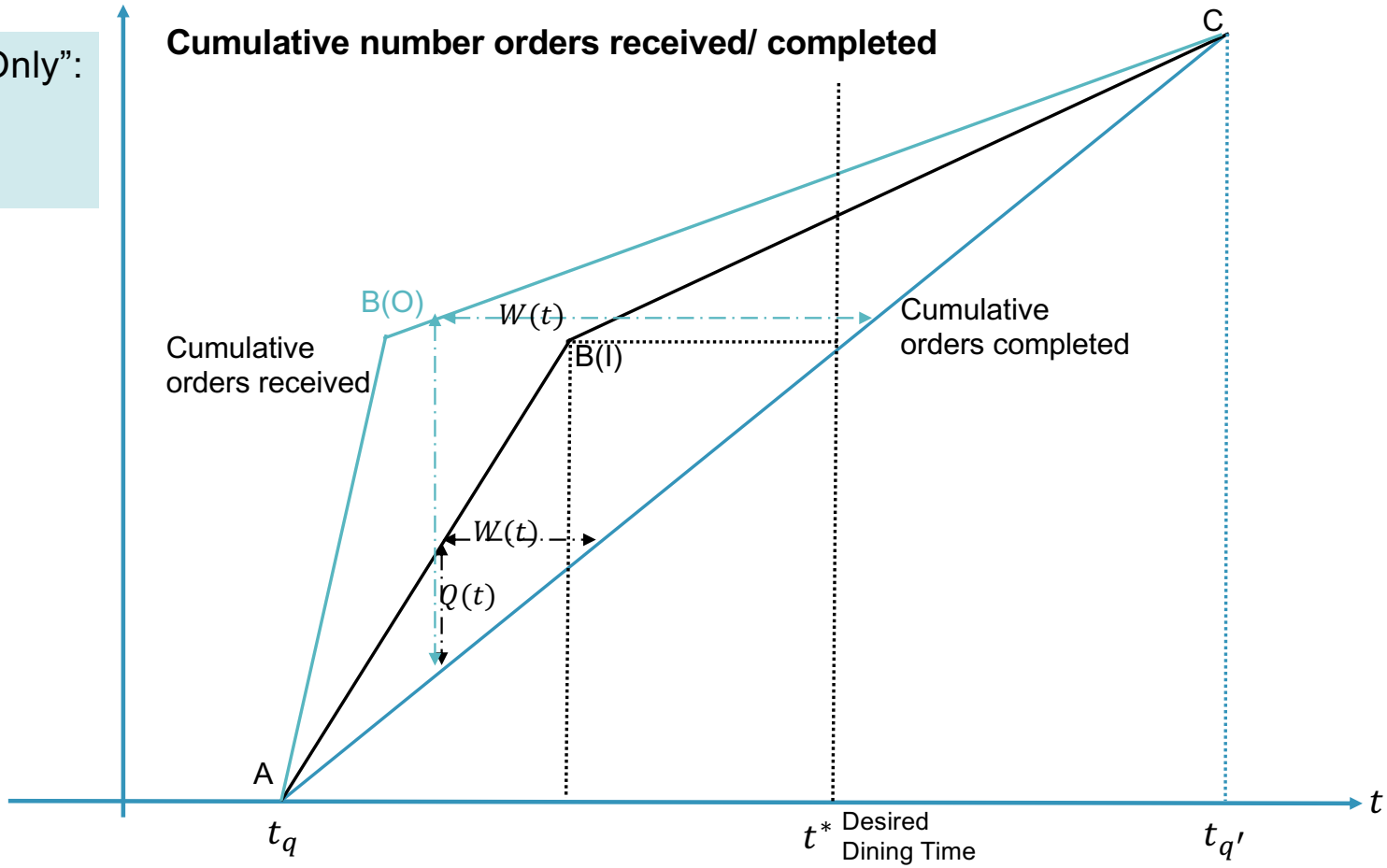
Case O: Delivery Only

$$C_j(t) = \alpha_j W(t) + \beta|deviation\ from\ t^*| + \gamma_j$$

$$W(t) = Q(t)/s \qquad \alpha_I > \alpha_O$$

Compared to "Dine-In Only":

1. More orders arrive earlier



Empirical Analysis

Panel Data

30,565 restaurants in California from Jan 2018 to Dec 2019

Restaurant characteristics from Yelp

- Price level, rating, cuisines, location, etc.

Restaurant partnership with major food delivery platforms

- DoorDash, Grubhub & Uber Eats, combined mkt share >95%

Restaurant visits from a mobile tracking company

- 35+ million unique devices, good representative of US population
- # hourly visits to each restaurant location
- Duration of stay
  - 0~20 minutes
  - 20~120 minutes
  - > 4 hours

Category	Number of Restaurants	Number (Percentage) on Platforms	Average Price Level (0-4)	Average Rating
Full-Service	15,164	6,893 (45.5%)	1.76	4.04
Limited-Service	12,104	6,000 (49.6%)	1.22	3.95
Snack & Nonalcoholic Beverage Bars	3,297	888 (26.9%)	1.02	3.90

Empirical Measures of Dispersion

- For a restaurant on day d, the density of order arrivals at time h is

$$p_{d,h} \triangleq \frac{N_{d,h}}{\sum_{h=\underline{T}}^{\overline{T}} N_{d,h}}$$

- Shannon index of dispersion is

$$ShannonIndex_d = -\sum_{h=\underline{T}}^{\overline{T}} p_{d,h} \ln(p_{d,h})$$

- Larger $ShannonIndex$ means a more dispersed (i.e., flatter) distribution

More Empirical Measures of Demand Dispersion

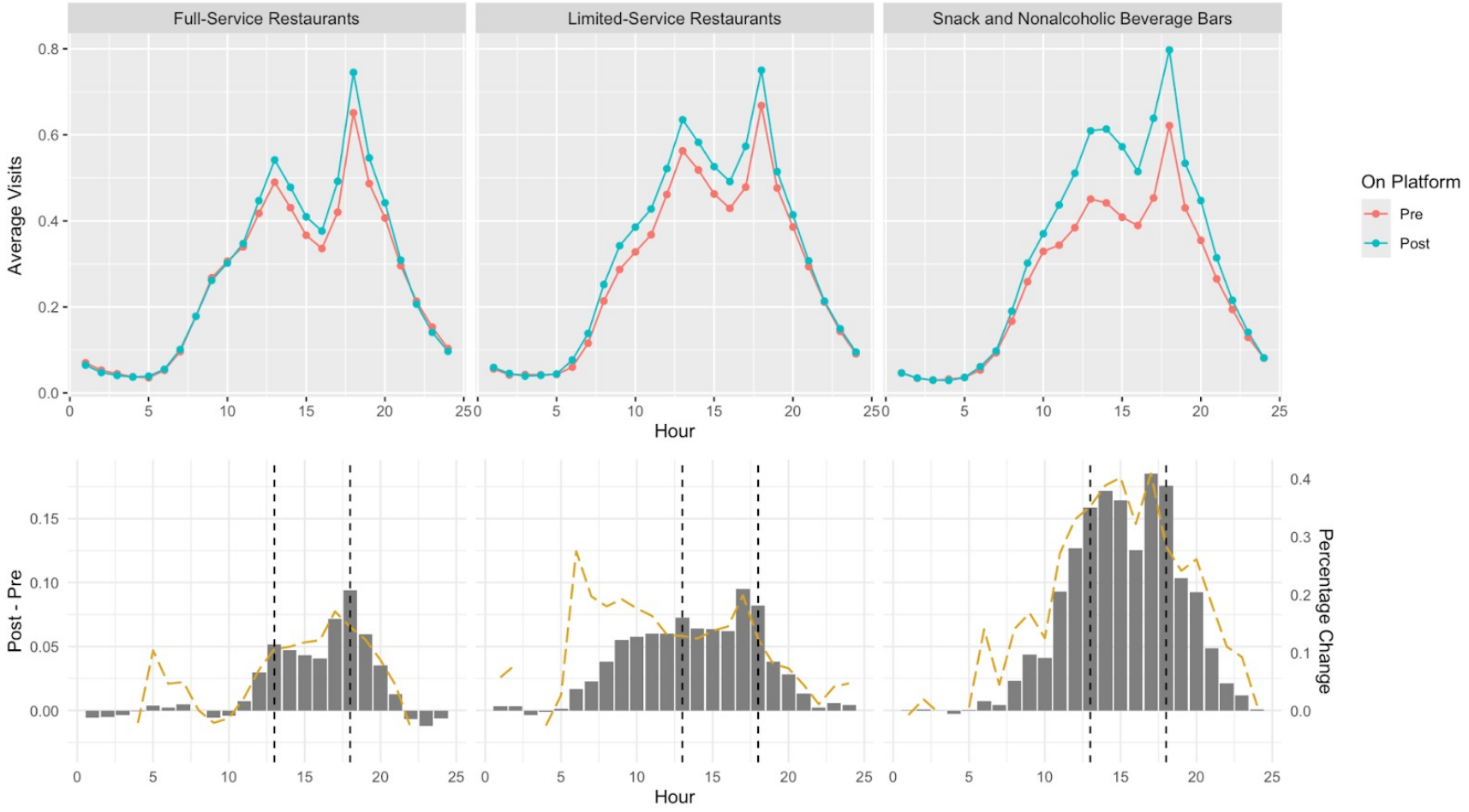
- Simpson's index of dispersion (Herfindahl-Hirschman Index)

$$SimpsonIndex_d = 1 - \sum_{h=\underline{T}}^{\overline{T}} p_{d,h}^2$$

Larger $SimpsonIndex$ means a more dispersed (i.e., flatter) distribution

- Ripley's K and L functions
  - Detect whether points have a random, dispersed or clustered distribution pattern
  - Take into account the temporal sequence of customer orders
  - KS statistics on Ripley's K function

Model-Free Evidence



Overall Effects on Dispersion and Total Demand

	Dispersion			Total Demand
	ShannonIndex	*SimpsonIndex*	*KSRipley*	*Visits*
OnPlatform	0.025*** (0.0021)	0.0043*** (0.00057)	-0.0073*** (0.00053)	0.018*** (0.0021)
Restaurant Fixed Effects	Yes	Yes	Yes	Yes
Week Fixed Effects	Yes	Yes	Yes	Yes
N	2,485,960	2,485,960	2,485,960	2,485,960
adj. R-sq	0.894	0.592	0.899	0.637

Impact on Different Types of Restaurants

	ShannonIndex
OnPlatform	0.012*** (0.0033)
OnPlatform × *Limited-ServiceRestaurants*	0.025*** (0.0042)
OnPlatform × *SnackNonalcoholicBeverageBars*	0.0066 (0.0090)
Restaurant Fixed Effects	Yes
Week Fixed Effects	Yes
N	2,485,960
adj. R-sq	0.894

Moderating Role of Residential and Job Density

- The increase in visits is weaker in higher-density areas. Similarly, the effect of flattening the demand curve is also less predominant for restaurants operating in denser areas.

	Total Demand		*ShannonIndex*		*KSRipley*	
OnPlatform	0.017***	0.018***	0.024***	0.024***	-0.0069***	-0.0069***
	(0.0021)	(0.0022)	(0.0021)	(0.0021)	(0.00052)	(0.00053)
OnPlatform × *RAC*	-0.020***		-0.033***		0.0092***	
	(0.0018)		(0.0030)		(0.00077)	
OnPlatform × *WAC*		-0.015***		-0.030***		0.0077***
		(0.0033)		(0.0042)		(0.0011)
Restaurant Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Week Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	2,485,650	2,485,650	2,485,650	2,485,650	2,485,650	2,485,650
adj. R-sq	0.638	0.638	0.894	0.894	0.899	0.899

Changes in Employee Count

- Platform-driven demand smoothing occurs primarily through the utilization of existing spare capacity rather than through expansion of capacity.

	$Workers^{120\sim240}$	$Workers^{>240}$
OnPlatform	-0.0022 (0.031)	0.069 (0.050)
Restaurant Fixed Effects	Yes	Yes
Week Fixed Effects	Yes	Yes
N	2,290,234	2,290,234
adj. R-sq	0.697	0.500

Summary

- Flatten the curve
- Theoretical lens: bottleneck model
- Empirical evidence:
  - the demand curves at limited-service restaurants are more evened
  - the effect of flattening the demand curve is also less predominant for restaurants operating in denser areas
  - no change in employee count

Thank you

Q&A