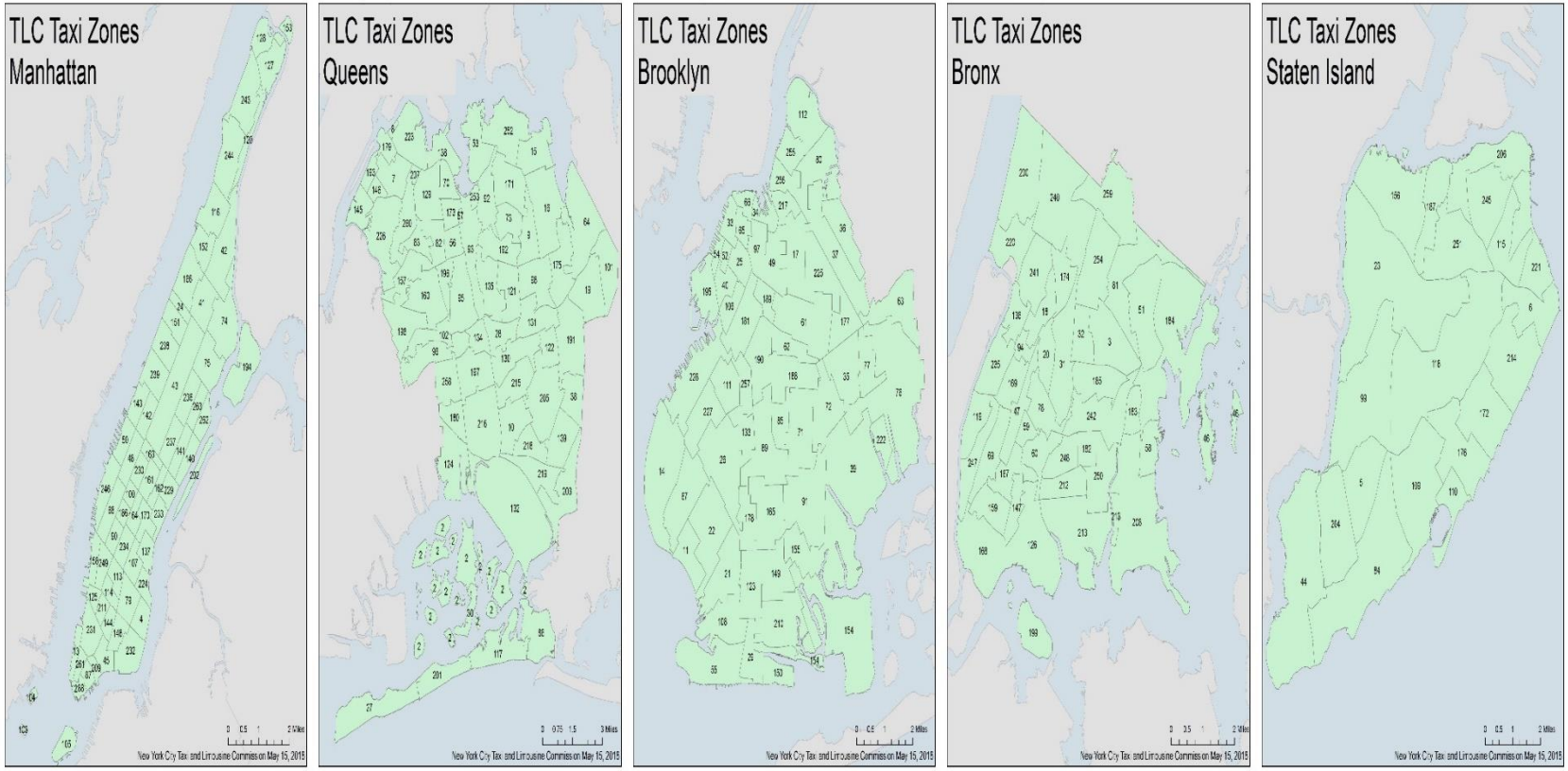
Online Appendix

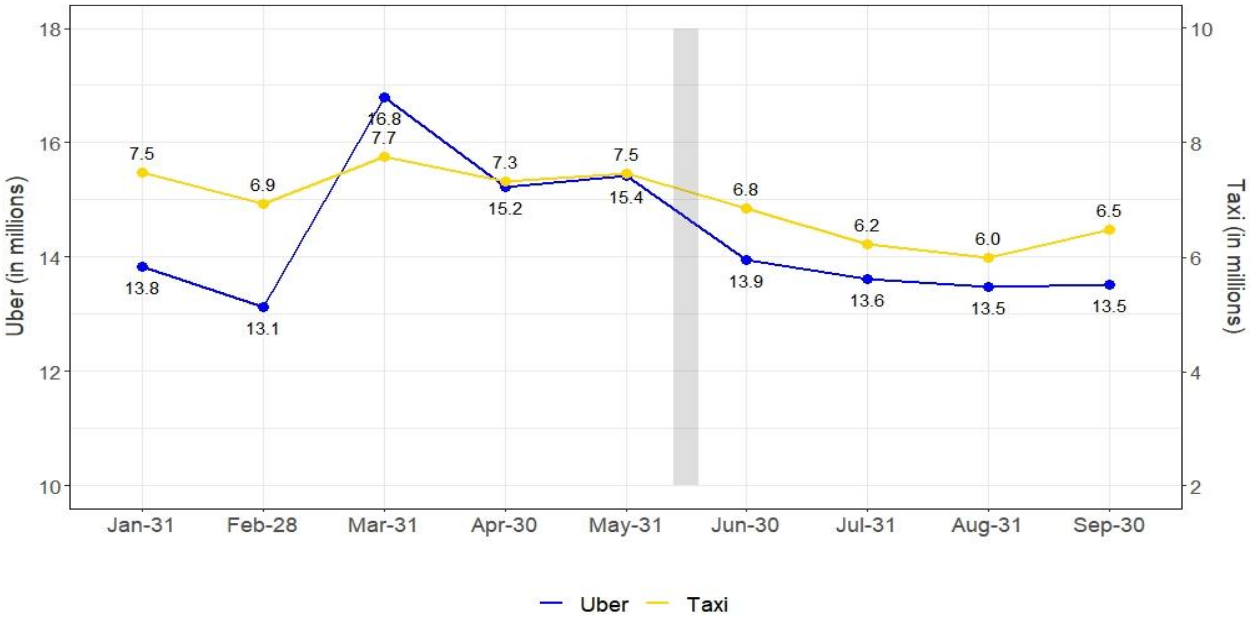
Figure A1. New York City taxi zone map



New York City is divided into five boroughs (Manhattan, Bronx, Staten Island, Brooklyn, and Queens), which are further segmented into 263 taxi zones.

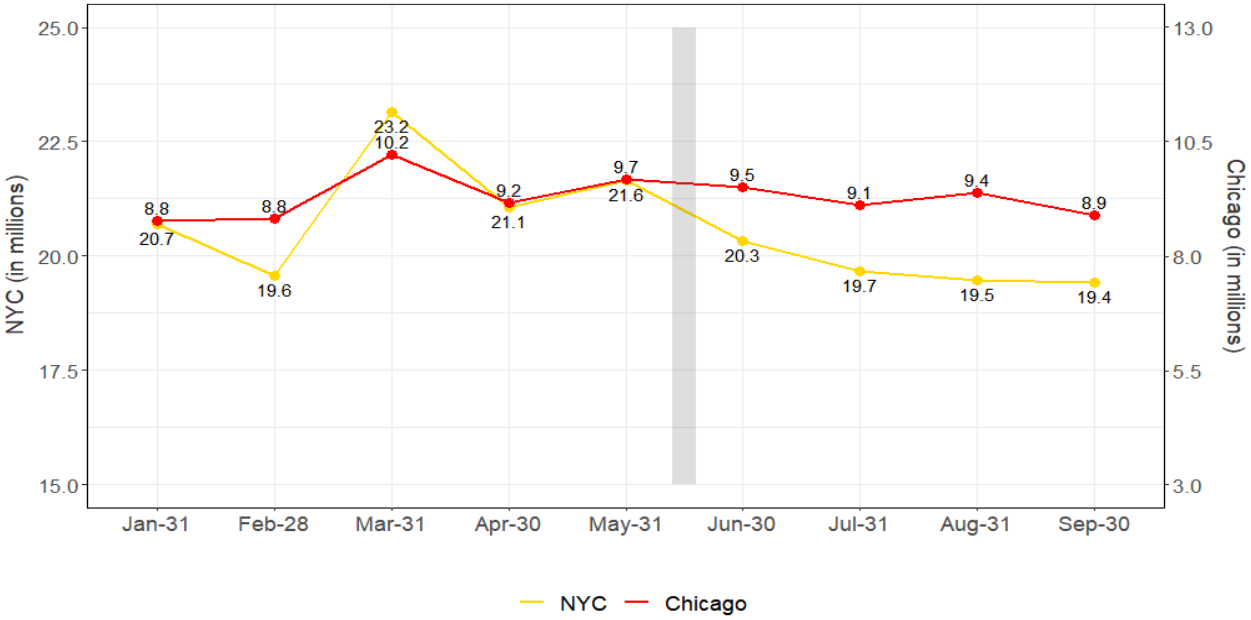
Source: *TLC Trip Record Data (https://www1.nyc.gov/site/tlc/about/tlc-trip-record-data.page)*

Figure A2. Monthly trip volume of Uber (left) and taxi (right) during 2019



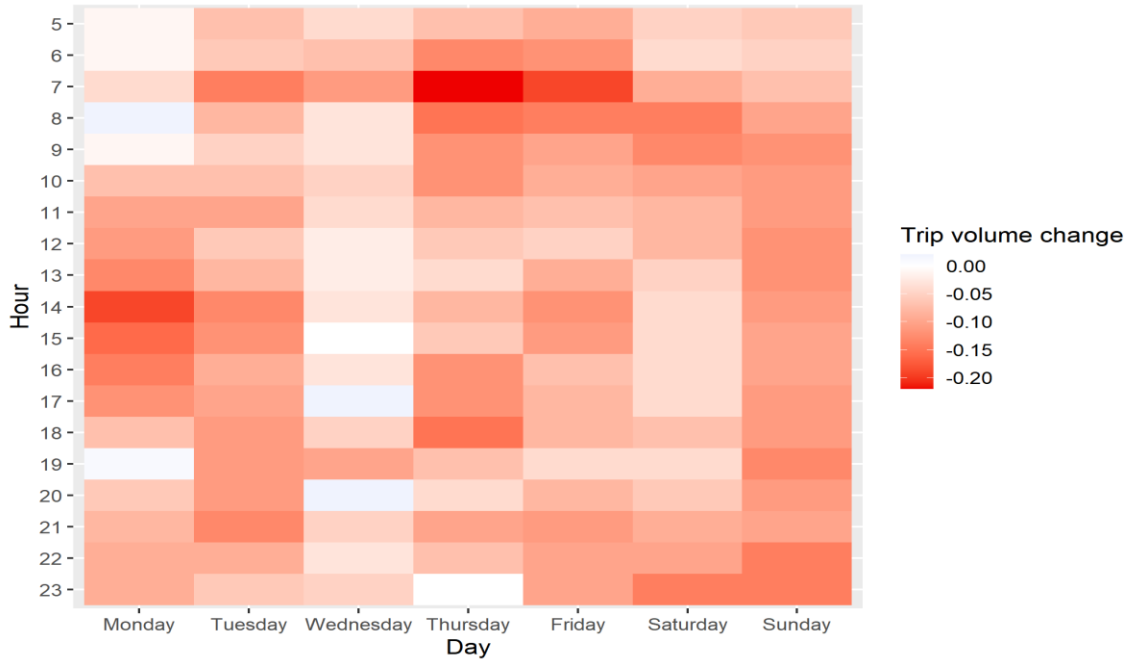
The grey line indicates the date for Lyft's access restriction (June 27th, 2019).

Figure A3. Monthly rideshare trip volume of NYC (left) and Chicago (right) during 2019



The grey line indicates the date for Lyft's access restriction (June 27th, 2019).

Figure A4. Differences in Uber trip volume before and after Lyft's access restriction (May 30th–July 24th, 2019)



Red color (blue color) is used for day-hour segments that experienced a decrease (increase) in Uber trip volume after Lyft's access restriction (June 27th, 2019).

Table A1. Rideshare business in New York City and Chicago

	Platform	New York City	Chicago
Service launch time	Uber	2011. 05	2011. 09
	Lyft	2014. 07	2013. 05
	Via	2014. 07	2015. 11
	Juno	2013. 08	-
Market share in 2019	Uber	70%	72%
	Lyft	22%	27%
	Via	5%	1%
	Juno	3%	-

Table A2. Summary statistics of rideshare and taxi trips in New York City and Chicago

		New York City	Chicago
Rideshare business	Avg. fare amount	$18.36	$15.15
	Avg. trip duration	18.44 minutes	18.15 minutes
	Avg. trip distance	2.91 miles	6.06 miles
	Avg. monthly volume	20,879,622 trips	9,390,156 trips
Taxi business	Avg. fare amount	$18.30	$18.06
	Avg. trip duration	14.18 minutes	14.63 minutes
	Avg. trip distance	3.06 miles	3.68 miles
	Avg. monthly volume	7,297,361 trips	1,420,676 trips

Summary statistics are calculated based on rideshare and taxi trips completed between January–June 2019 (before Lyft's access restriction).

Table A3. The effect of Lyft's access restriction on Lyft trip numbers across different time segments: DID estimations using NYC taxis and Chicago rideshare trips as counterfactuals

	NYC taxi trips as a counterfactual			Chicago rideshare trips as a counterfactual		
(log) Trip #	**(1)** Full sample	**(2)** Restricted segments	**(3)** Unrestricted segments	**(4)** Full sample	**(5)** Restricted segments	**(6)** Unrestricted segments
Lyft's Access Restriction × Lyft (1: Lyft, 0: Taxi)	-0.0892*** (0.0124)	-0.0763*** (0.0129)	-0.119*** (0.0157)	-	-	-
Lyft's Access Restriction × NYC (1: NYC, 0: Chicago)	-	-	-	-0.0865*** (0.0088)	-0.0900*** (0.0098)	-0.0766*** (0.0104)
(log) Trip # in 2018	0.265*** (0.0126)	0.272*** (0.0132)	0.168*** (0.0115)	-	-	-
(log) Taxi Trip #	-	-		0.0920*** (0.0092)	0.0959*** (0.0105)	0.0685*** (0.0064)
Zone FEs	Yes	Yes	Yes	Yes	Yes	Yes
Week FEs	Yes	Yes	Yes	Yes	Yes	Yes
Day-of-the-week FEs	Yes	Yes	Yes	Yes	Yes	Yes
Hour FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	504,960	378,720	126,240	326,400	244,800	81,600
Adjusted R^2	0.893	0.889	0.906	0.869	0.860	0.900

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A4. The effect of Lyft's access restriction on Uber trip numbers with different time windows before and after Lyft's access restriction

(log) Uber Trip #	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks
Lyft's Access Restriction	-0.0244***	-0.0343***	-0.0366***	-0.0435***	-0.0408***	-0.0690***	-0.0782***	-0.0862***
	(0.0070)	(0.0069)	(0.0057)	(0.0049)	(0.0050)	(0.0051)	(0.0052)	(0.0054)
(log) Uber Trip # in 2018	0.293***	0.325***	0.337***	0.340***	0.353***	0.353***	0.355***	0.358***
	(0.0259)	(0.0262)	(0.0254)	(0.0251)	(0.0253)	(0.0250)	(0.0249)	(0.0251)
(log) Taxi Trip #	0.0591***	0.0730***	0.0693***	0.0676***	0.0674***	0.0676***	0.0663***	0.0648***
	(0.0081)	(0.0079)	(0.0078)	(0.0076)	(0.0074)	(0.0076)	(0.0077)	(0.0075)
Zone FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day-of-the-week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hour FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	63,120	126,240	189,360	252,480	315,600	378,720	441,840	504,960
Adjusted R^2	0.927	0.920	0.924	0.925	0.925	0.918	0.920	0.921

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A5. The effect of Lyft's access restriction on Uber trip numbers with different time windows before and after Lyft's access restriction: DID estimations using NYC taxis as counterfactuals

(log) Trip #	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks
Lyft's Access Restriction × Uber (1: Uber, 0: Taxi)	-0.0679***	-0.0638***	-0.0797***	-0.0896***	-0.0951***	-0.113***	-0.118***	-0.122***
	(0.0128)	(0.0136)	(0.0125)	(0.0119)	(0.0115)	(0.0115)	(0.0114)	(0.0115)
(log) Trip # in 2018	0.290***	0.305***	0.310***	0.311***	0.317***	0.320***	0.320***	0.321***
	(0.0150)	(0.0153)	(0.0150)	(0.0148)	(0.0149)	(0.0148)	(0.0148)	(0.0148)
Zone FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day-of-the-week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hour FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	126,240	252,480	378,720	504,960	631,200	757,440	883,680	1,009,920
Adjusted R^2	0.927	0.925	0.926	0.926	0.927	0.925	0.926	0.926

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A6. The effect of Lyft's access restriction on Uber trip numbers with different time windows before and after Lyft's access restriction: DID estimations using NYC taxis as counterfactuals (Outer boroughs subsample)

(log) Trip #	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks
Lyft's Access Restriction × Uber (1: Uber, 0: Taxi)	-0.0783*** (0.0163)	-0.0785*** (0.0164)	-0.0978*** (0.0154)	-0.113*** (0.0150)	-0.120*** (0.0146)	-0.139*** (0.0147)	-0.145*** (0.0144)	-0.152*** (0.0145)
(log) Trip # in 2018	0.226*** (0.0153)	0.232*** (0.0154)	0.238*** (0.0151)	0.237*** (0.0147)	0.242*** (0.0147)	0.245*** (0.0148)	0.246*** (0.0148)	0.247*** (0.0148)
Zone FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day-of-the-week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hour FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	93,120	186,240	279,360	372,480	465,600	558,720	651,840	744,960
Adjusted R^2	0.908	0.906	0.907	0.907	0.907	0.906	0.906	0.907

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A7. The effect of Lyft's access restriction on Uber trip numbers with different time windows before and after Lyft's access restriction: DID estimations using Chicago rideshare trips as counterfactuals

(log) Trip #	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks
Lyft's Access Restriction × NYC (1: NYC, 0: Chicago)	-0.0453*** (0.0129)	-0.0493*** (0.0124)	-0.0534*** (0.0098)	-0.0683*** (0.0086)	-0.0660*** (0.0083)	-0.0892*** (0.0086)	-0.0908*** (0.0089)	-0.0947*** (0.0091)
(log) Taxi Trip #	0.0799*** (0.0094)	0.0934*** (0.0098)	0.0908*** (0.0097)	0.0891*** (0.0095)	0.0903*** (0.0095)	0.0905*** (0.0096)	0.0897*** (0.0096)	0.0890*** (0.0095)
Zone FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day-of-the-week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hour FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	81,600	163,200	244,800	326,400	408,000	489,600	571,200	652,800
Adjusted R^2	0.915	0.907	0.909	0.910	0.909	0.904	0.906	0.907

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A8. The effect of Lyft's access restriction on Uber trip numbers using individual week dummies

(log) Uber Trip #	**(1)** Full sample	**(2)** Restricted segment	**(3)** Unrestricted segment
Week 1 Dummy	-0.0125	0.00487	-0.0589***
	(0.0066)	(0.0078)	(0.0060)
Week 2 Dummy	-0.0807***	-0.0352***	-0.218***
	(0.0076)	(0.0081)	(0.0085)
Week 3 Dummy	-0.0454***	-0.0369***	-0.0667***
	(0.0051)	(0.0056)	(0.0065)
Week 4 Dummy	-0.0351***	-0.0435***	-0.00537
	(0.0047)	(0.0054)	(0.0064)
(log) Uber Trip # in 2018	0.339***	0.315***	0.352***
	(0.0251)	(0.0247)	(0.0356)
(log) Taxi Trip #	0.0673***	0.0702***	0.0516***
	(0.0076)	(0.0090)	(0.0050)
Zone fixed effect	Yes	Yes	Yes
Day-of-the-week FEs	Yes	Yes	Yes
Hour fixed effect	Yes	Yes	Yes
Observations	252,480	189,360	63,120
Adjusted R^2	0.925	0.920	0.942

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A9. The effect of Lyft's access restriction on the trip numbers of Juno and Via

: Juno does not provide location information before 2019, which disables us to control for its 2018 trip trend.

	(1) (log) Juno Trip #	**(2)** (log) Via Trip #
Lyft's Access Restriction	-0.0353***	-0.0757***
	(0.0068)	(0.0078)
(log) Via Trip # in 2018	-	0.167***
		(0.0062)
(log) Taxi Trip #	0.127***	0.165***
	(0.0124)	(0.0153)
Zone FEs	Yes	Yes
Day-of-the-week FEs	Yes	Yes
Hour FEs	Yes	Yes
Observations	252,480	252,480
Adjusted R^2	0.677	0.822

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A10. The effect of Lyft's access restriction on Uber trip numbers (Manhattan subsample)

	(1) Full sample	(2) Restricted segments	(3) Unrestricted segments
Lyft's Access Restriction	-0.0435***	-0.0277***	-0.0874***
	(0.0049)	(0.0054)	(0.0052)
(log) Uber Trip # in 2018	0.340***	0.315***	0.358***
	(0.0251)	(0.0247)	(0.0356)
(log) Taxi Trip #	0.0676***	0.0704***	0.0545***
	(0.0076)	(0.0090)	(0.0051)
Zone FEs	Yes	Yes	Yes
Day-of-the-week FEs	Yes	Yes	Yes
Hour FEs	Yes	Yes	Yes
Observations	252,480	189,360	63,120
Adjusted R^2	0.925	0.919	0.941

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A11. The effect of Lyft's access restriction on Uber trip numbers during weekends

: Based on the heat map (Figure 2), we assume late-night periods (Sat 9 pm–Sun 3 am) as unrestricted time segments and other periods as restricted time segments.

(log) Uber Trip #	**(1)** Full sample	**(2)** Restricted segment	**(3)** Unrestricted segment
Lyft Access Restriction	-0.0651***	-0.0553***	-0.126***
	(0.0044)	(0.0046)	(0.0078)
(log) Uber trip # in 2018	0.413***	0.399***	0.286***
	(0.0310)	(0.0325)	(0.0446)
(log) Taxi Trip #	0.0701***	0.0676***	0.0647***
	(0.0082)	(0.0082)	(0.0112)
Zone FEs	Yes	Yes	Yes
Day-of-the-week FEs	Yes	Yes	Yes
Hour FEs	Yes	Yes	Yes
Observations	100,992	88,368	12,624
Adjusted R^2	0.930	0.929	0.941

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A12. The effect of Lyft's access restriction on Uber trip numbers: Breakdown by hours (Baseline: 7 pm–8 pm)

(log) Uber Trips	**(1)**	
Lyft's Access Restriction	0.0110	(0.0093)
Lyft's Access Restriction × (12 am–1 am)	0.0050	(0.0129)
Lyft's Access Restriction × (1 am–2 am)	0.0455***	(0.0134)
Lyft's Access Restriction × (2 am–3 am)	0.0515**	(0.0160)
Lyft's Access Restriction × (3 am–4 am)	0.0591***	(0.0152)
Lyft's Access Restriction × (4 am–5 am)	-0.0134	(0.0141)
Lyft's Access Restriction × (5 am–6 am)	-0.0494**	(0.0153)
Lyft's Access Restriction × (6 am–7 am)	-0.120***	(0.0127)
Lyft's Access Restriction × (7 am–8 am)	-0.192***	(0.0106)
Lyft's Access Restriction × (8 am–9 am)	-0.158***	(0.0124)
Lyft's Access Restriction × (9 am–10 am)	-0.103***	(0.0101)
Lyft's Access Restriction × (10 am–11 am)	-0.114***	(0.0127)
Lyft's Access Restriction × (11 am–12 pm)	-0.0906***	(0.0107)
Lyft's Access Restriction × (12 pm–1 pm)	-0.0875***	(0.0091)
Lyft's Access Restriction × (1 pm–2 pm)	-0.0689***	(0.0114)
Lyft's Access Restriction × (2 pm–3 pm)	-0.0944***	(0.0100)
Lyft's Access Restriction × (3 pm–4 pm)	-0.0858***	(0.0107)
Lyft's Access Restriction × (4 pm–5 pm)	-0.0571***	(0.0099)
Lyft's Access Restriction × (5 pm–6 pm)	-0.0584***	(0.0082)
Lyft's Access Restriction × (6 pm–7 pm)	-0.0743***	(0.0077)
Lyft's Access Restriction × (8 pm–9 pm)	-0.00259	(0.0098)
Lyft's Access Restriction × (9 pm–10 pm)	-0.0304***	(0.0089)
Lyft's Access Restriction × (10 pm–11 pm)	-0.0292**	(0.0095)
Lyft's Access Restriction × (11 pm–12 am)	-0.0394***	(0.0112)
(log) Uber Trips in 2018	0.338***	(0.0252)
(log) Taxi Trip #	0.0675***	(0.0076)
Zone FEs	Yes	
Day-of-the-week FEs	Yes	
Hour FEs	Yes	
Observations	252,480	
Adjusted R^2	0.925	

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table A13. The effect of Lyft's access restriction on the trip duration of Lyft and Uber

Prior studies have used driver detours to measure Uber and taxi drivers' fraud and treated longer trip duration (for the same route) as lower service quality (Balafoutas et al. 2013, Liu et al. 2019, 2021). Aligned with these studies, news media reported that Uber drivers often employ a practice known as longhauling[1] – taking an unnecessarily long route to a destination to drive up a fare (Bensinger 2018, Dorsey 2018). Thus, we use trip duration (controlling for trip distance and the total number of taxi and rideshare trips in the zone and hour) to capture service quality. We use the following equation.

$$\log(Y_{piht}) = \beta_0 + \beta_1 A_t + X_{piht} B + \alpha_i + \delta_h + \gamma_t + \varepsilon_{piht} \quad (1)$$

where Y_{piht} is the average trip duration (in minutes) of trips reported on platform p (Lyft or Uber), in zone i, during the h^{th} hour of day t, A_t is a binary variable that equals one for dates after Lyft restricted access to its app (June 27th, 2019), and zero otherwise, and X_{piht} includes average trip distance and the total number of private transportation trips in zone i during the h^{th} hour of day t. α_i, δ_h, and γ_t are zone, hour, and day-of-the-week fixed effects, respectively.

One caveat is that trip duration may be endogenous to the number of vehicles on the road. Even though we controlled for trip distance and the total trip number of rideshare services and taxis during the hour, we do not have data on public transportation or privately owned vehicles to account for the impact of reduced congestion. To mitigate the bias from reduced road congestion, we employ a DID estimation using taxi trip duration as a counterfactual. Taxi trips were also subject to reduced congestion after Lyft's access restriction, which enables us to control for the time trend in road congestion. Our results generally hold.

However, the DID estimation is not without problems. First, taxi drivers might not be an appropriate control group. For example, Uber drivers tend to engage less in detours than taxi drivers due to real-time monitoring and rating systems (Liu et al. 2021). Second, the demand for taxi trips could have increased after rideshare trips decreased. This could improve the service quality of taxis as taxi drivers tend to detour less when the demand is high (Liu et al. 2019). Because of these limitations, we leave it for future studies to investigate the effect of access restriction on quality using a more direct measure of service quality (e.g., driver ratings).

(log) Trip Duration (in minutes)	**(1)** Lyft trip duration	**(2)** Uber trip duration
Lyft's Access Restriction	-0.0244***	-0.0300***
	(0.0010)	(0.0008)
Trip Distance	0.157***	0.159***
	(0.0022)	(0.0026)
(log) Total Trip #	0.101***	0.0817***
	(0.0040)	(0.0037)
Zone FEs	Yes	Yes
Day-of-the-week FEs	Yes	Yes
Hour FEs	Yes	Yes
Observations	228,338	240,014
Adjusted R^2	0.710	0.746

Observations are at the hour-day-zone level.
Robust standard errors clustered at the zone level are in parentheses.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

[1]While passengers pay the fixed upfront price, drivers' pay is determined by the actual trip's mileage and time.

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