The impact of segregated cyling lanes on London's road users

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October 17th, 2022

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Section 1

Introduction

Why look at segregated cycling lanes?

- According to Transport for London (2020), 20% of the trips done in Central London could be done by foot or cycling (active travel)
- Still active travel is not studied as much as other urban transportation modes
- Segregated cycling lanes have been built extensively in large cities such as London, Paris, and New York to reduce motorised traffic, bring health benefits by encouraging active travel mode and reduce pressure on public transport
- However, benefits are conditional on these infrastructures creating a new increase in cycling flows and not merely displacing cycling and other road users' traffic

Overview

- This analysis uses the roll-out of the Cycle Superhighways (CSHs) programme to disentangle pre-existing cycling trends from the impact of segregated lanes
- It pays attention to displacement effects on cyclists and other car users
- It finds that contrary to studies looking at the first generations of lanes (non-segregated), the second phase of the programme was successful at reducing cycling accidents

Background: the London Cycle Superhighways programme

- In 2008, Mayor Ken Livingstone announced the London Cycle Superhighways scheme
- It was aimed at commuters and more experienced cyclists, providing faster and more direct radial routes between outer and central London
- In 2010, the first lanes were built[1], but they were perceived as unsafe by bike users
- In response to the first criticism, the safety standards were increased, leading to delays in the roll-out of the programme
- In 2012, the first segregated cycle lanes were built and construction continued over the decade
- In this project, I focus my analysis on the roll-out second generation of segregated cycling lanes

[1] CS3, CS7 in 2010 and CS2, CS8 in 2011

Super Cycle Highway Network

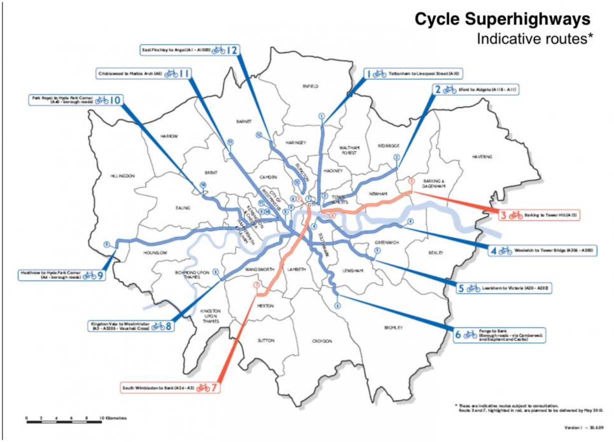


Figure 1: Original cycle superhighways network map

Literature review

- The first generation of the CSHs did not have an impact on road accidents (Li, Graham, and Liu 2017)
- Transport studies have shown that segregated lanes are safer than non-segregated lanes (Cohen 2013; Mulvaney et al. 2015; Reynolds et al. 2009) leading to a review of the design
- Safer infrastructure is also more inclusive: surveys show that women, young people or the elderly are more likely to cycle when cycling routes are separated from car traffic in London (Aldred et al, 2017)
- Bhuyan et al. (2021) use a propensity score to evaluate the impact of the cycle superhighways on congestion

Section 2

Empirical strategy

Empirical strategy

- Simple OLS estimations of traffic flows on CSHs lanes versus other roads in London over-estimates the impact of the segregated lanes as they had more cycling traffic even before construction
- However, I can compare cycling traffic on the lanes before and after construction as long as the different CSHs were on the same growth path and the timing of construction was not related to the cycling growth potential
- The lanes were built to be radial roads connecting outer Boroughs to Central London; the different lanes are not substitutable
- Differences in timing were driven by safety standards and not growth potential, allowing me to use the late treated lanes as a control group for the early-treated lanes
- I can also use lanes treated in 2020 as a control group even though I do not observe their flows after opening

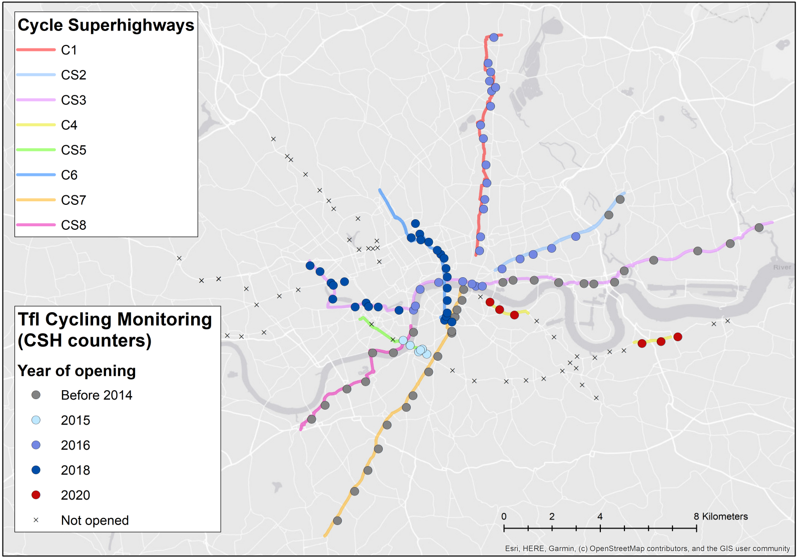
Cycle Superhighway 8 - Opened in 2011 - Painted lane

Cycle Superhighway 5 - Opened in 2015 - Segregated lane

Data

Data	Type	Source	Date	Unit
CSHs monitoring	Survey	TfL	2014-2019	Counting sites
London Cycle	Survey	TfL	2014-2019	Counting sites
Cycle Hire data	All journeys	TfL	2012-today	O/D stations
Road Traffic Counts	Survey	DfT	2002-today	Counting sites
Road Safety Data	Accidents	DfT	2004-2021	Lat/Lon

Map of the CSH counting sites

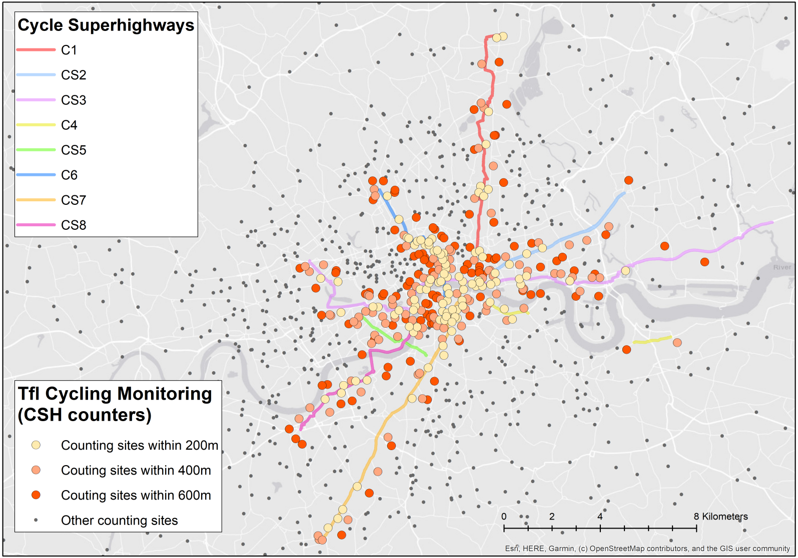


- 320 count sites over 11 planned routes[2] [3]
- Counts are done on a representative day and adjusted for seasonal variations and represent annual averages
- 2014/2019 but not all sites are surveyed every year: I have a balanced panel, pre and post-treatment counts for C1, CS2, CS3, CS5 and C6, which corresponds to 84 counting sites in the treatment

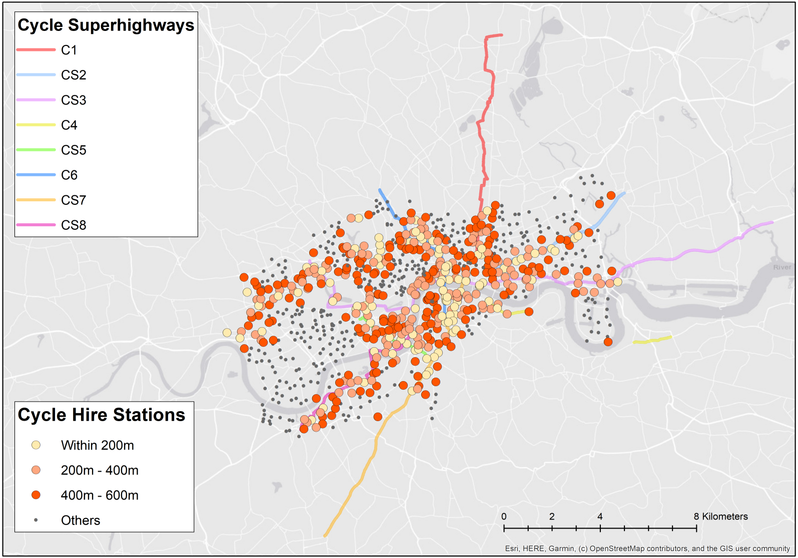
[2] I assign the route reference to counting sites based on the planned network map

[3] Each count site is observed in all directions

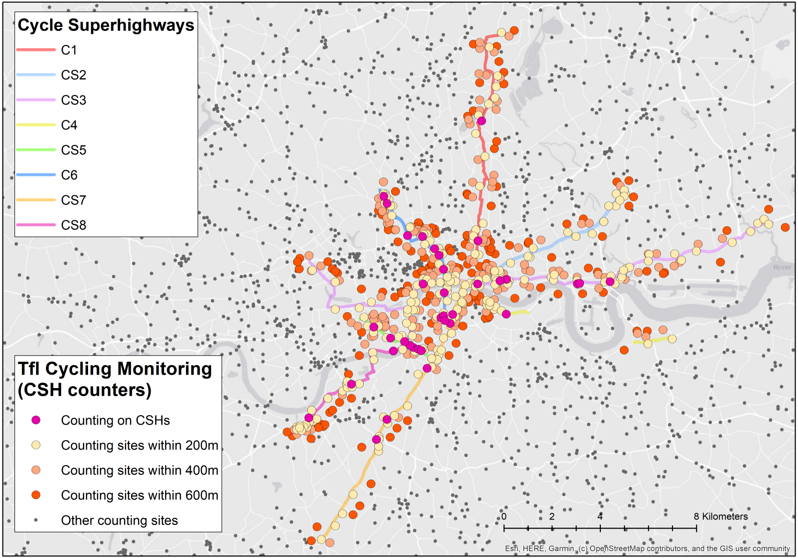
Map of the cycling monitoring programme counting sites



Map of cycle hire stations



Map of Road Traffic Counters



Map of traffic accidents involving bikes (2009-2019)

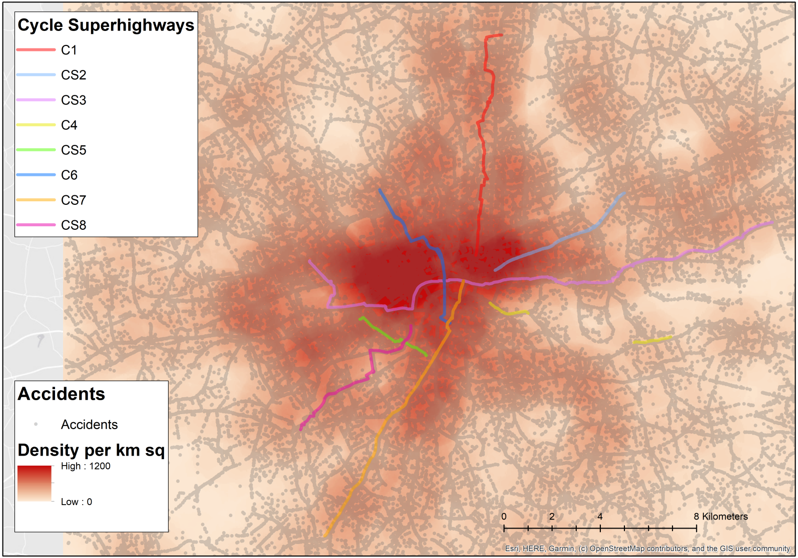


Table 1: Summary statistics 2011 census (early versus late treated)

	2015	2016	2018
Household size	1.9	2.22	1.95
	(0.2)	(0.58)	(0.28)
Population	268.2	360.47	336.94
	(34.62)	(75.42)	(89.59)
Age	39.71	33.02	35.57
	(6.03)	(3.5)	(3.79)
Median age	37.98	29.49	32.11
	(6.65)	(4.98)	(4.92)
Share highly educated	56.61	48.41	52.31
	(2.31)	(18.34)	(14.17)
Bike to work (per 1000)	40.08	35.34	29.94
	(30.47)	(28.16)	(10.5)
Distance to work	8.71	8.75	7.9
	(2.21)	(2.52)	(1.68)
Total cycles	2047.36	1425.74	1603.28
	(830.95)	(1136.6)	(1019.97)
Counting sites #	N= 2	N= 20	N= 20

Event study deseign

$$\ln(TotalCycles_{it}) = \sum_{j=-4}^{J} \theta^j Treat_{it}^j + \gamma_i + \delta_t + \eta_{it}$$

- $ln(TotalCycles)_{it}$ the average daily flow recorded in counter i and year t
- $Treat_{it}^j = \mathbb{1}\{j = t - Opening_i\}$ is a categorical variable for years since opening $Opening_i$ $j = \{-3, -2, ..., 4\}$
- The base level is $j = -1$, the year before opening
- θ_j for $j \geq 0$ captures dynamic effects of j years relative the cycle superhighway opening
- γ_i and δ_t site and year fixed effects
- All the standard errors are clustered at the counting site and year level

Section 3

Results

Cycling flows near CSHs

- The analysis uses the CSHs monitoring programme surveys
- Counts are done on a representative day and adjusted for seasonal variations and represent annual averages
- 2014/2019 but not all sites are surveyed every year: I have a balanced panel, pre and post-treatment counts for 84 counting sites in the treatment
- The first column includes all CSHs constructed between 2015-2018
- The second column also includes CSHs opened in 2020

	Treated	Treated + Control
j<=-4	-0.309	-0.299
	(0.174)	(0.212)
j=-3	-0.118	-0.126
	(0.0767)	(0.149)
j=-2	-0.166***	-0.135**
	(0.0322)	(0.0447)
j=0	0.215***	0.260***
	(0.0397)	(0.0315)
j=1	0.345***	0.400***
	(0.0208)	(0.0283)
j=2	0.494***	0.562***
	(0.0416)	(0.104)
j>=3	0.595***	0.696***
	(0.0185)	(0.105)
N	504	528
Rsquared	0.949	0.949
Year FE	Yes	Yes
Site FE	Yes	Yes

SD clustered at year and cycle superhighway route level

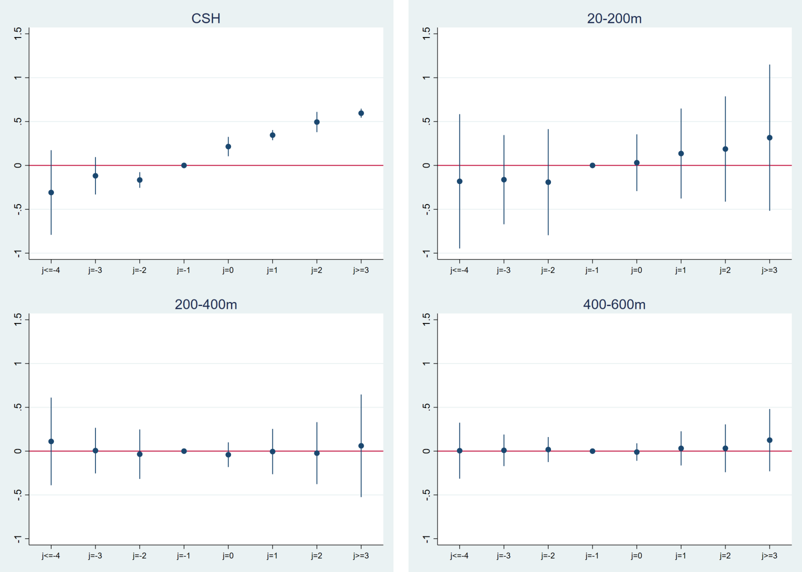
* $p < .1$, ** $p < .05$, *** $p < .01$

- The event study analysis uses the Central/Inner/Outer London Cycle Monitoring datasets
- It starts in 2014 and ends in 2019. Each counting site is monitored quarterly and observed in all directions.
- For each site, I calculate the distance to the CSHs and group them by distance bands

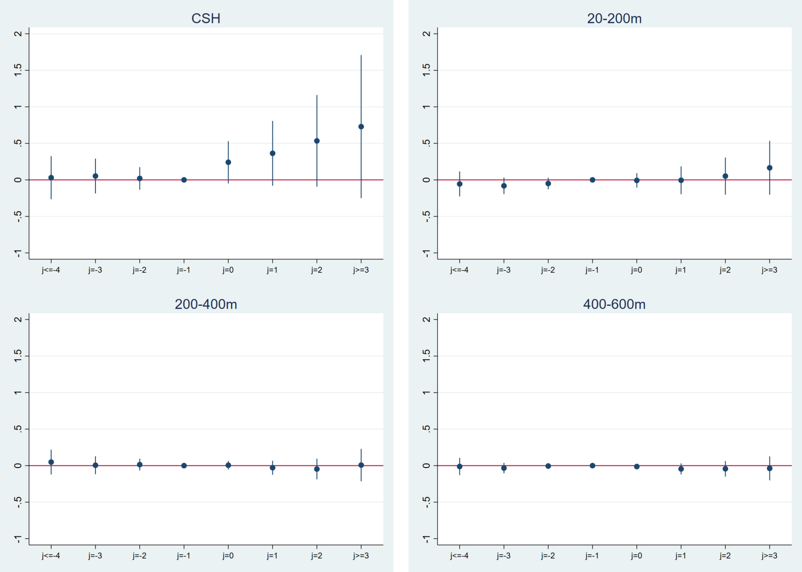
	20-200m	200-400m	400-600m
j<=-4	-0.181	0.111	0.00487
	(0.178)	(0.157)	(0.115)
j=-3	-0.163	0.00582	0.00909
	(0.118)	(0.0818)	(0.0649)
j=-2	-0.191	-0.0350	0.0180
	(0.141)	(0.0888)	(0.0514)
j=0	0.0308	-0.0408	-0.0105
	(0.0752)	(0.0443)	(0.0360)
j=1	0.135	-0.00498	0.0316
	(0.119)	(0.0813)	(0.0703)
j=2	0.187	-0.0230	0.0323
	(0.139)	(0.111)	(0.0984)
j>=3	0.316	0.0608	0.125
	(0.194)	(0.184)	(0.128)
N	1426	2415	3151
Rsquared	0.898	0.909	0.932
Quarter FE	Yes	Yes	Yes
Site FE	Yes	Yes	Yes

SD clustered at year and cycle superhighway route level

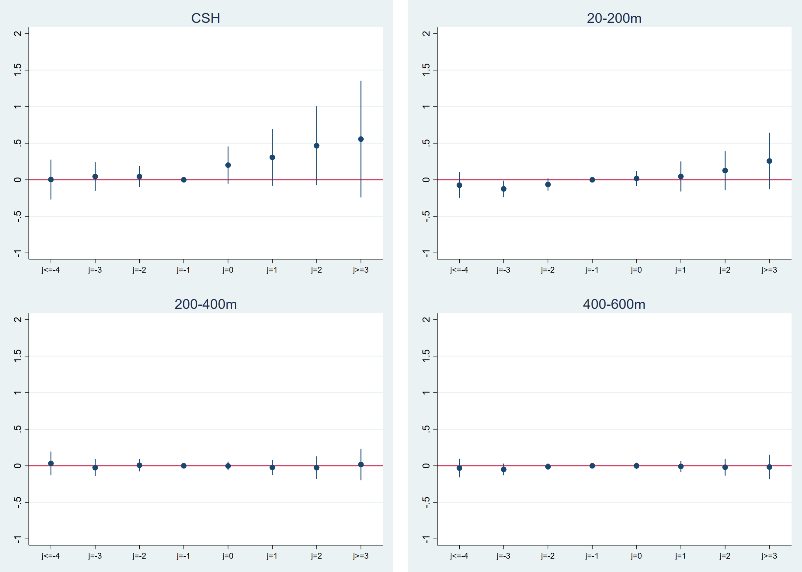
* $p < .1$, ** $p < .05$, *** $p < .01$


CSH
20-200m
200-400m
400-600m
1.5
1
.5
0
-.5
-1
j<=-4
j=-3
j=-2
j=-1
j=0
j=1
j=2
j>=3

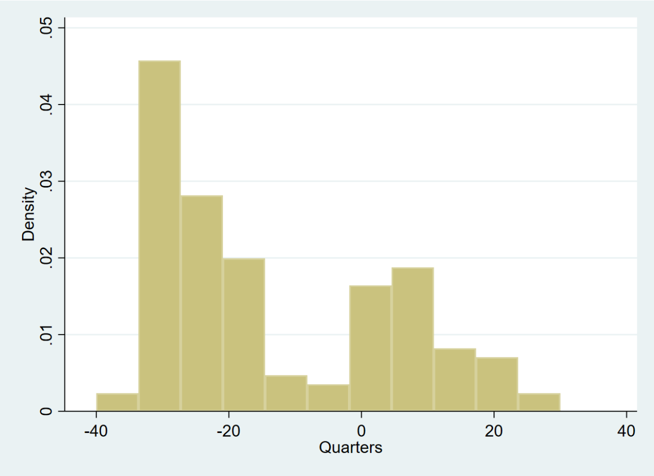
Cycle hire journeys starting near CSHs



Cycle hire journeys ending near CSHs



Co-location of cycle lanes and cycle hire stations?



Impact of a new cycle hire station

$$\ln(TotalCycles_{it}) = \beta NewStation + \gamma_i + \delta_t + \epsilon_{it}$$

NewStation a dummy for the opening of a new cycle hire station

	Ln Total Cycle
New cycle hire station	-0.0142
	(-0.33)
N	340
Rsquared	0.925
Year FE	Yes
Site FE	Yes

SD clustered at year and cycle superhighway route level

* $p < .1$, ** $p < .05$, *** $p < .01$

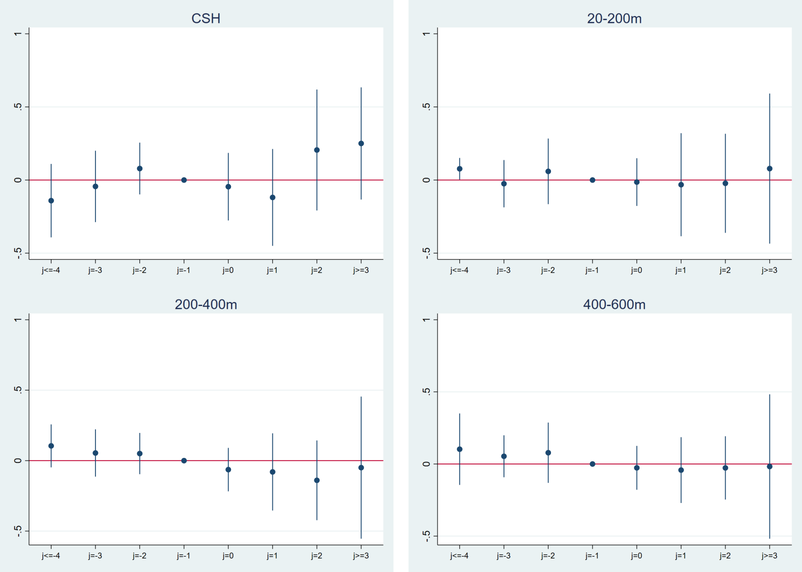
Car flows near CSHs

- The following event study analysis uses the DfT road traffic dataset
- The outcome is the logged number of total cars and taxis counted at each survey point
- For each site, I calculate the distance to the CSHs and group them by distance bands

	CSH	20-200m	200-400m	400-600m
j<=-4	-0.141	0.0770**	0.105	0.103
	(0.0905)	(0.0288)	(0.0593)	(0.0964)
j=-3	-0.0437	-0.0251	0.0543	0.0535
	(0.0879)	(0.0629)	(0.0653)	(0.0566)
j=-2	0.0787	0.0593	0.0501	0.0781
	(0.0638)	(0.0873)	(0.0569)	(0.0813)
j=0	-0.0456	-0.0139	-0.0637	-0.0266
	(0.0832)	(0.0634)	(0.0600)	(0.0592)
j=1	-0.119	-0.0319	-0.0800	-0.0422
	(0.119)	(0.137)	(0.107)	(0.0887)
j=2	0.205	-0.0224	-0.140	-0.0271
	(0.149)	(0.132)	(0.110)	(0.0854)
j>=3	0.250	0.0783	-0.0498	-0.0175
	(0.138)	(0.200)	(0.196)	(0.195)
N	212	510	782	988
Rsquared	0.974	0.967	0.968	0.983
Year FE	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes

SD clustered at year and cycle superhighway route level

* $p < .1$, ** $p < .05$, *** $p < .01$


CSH
20-200m
200-400m
400-600m
1
.5
0
-.5
j<=-4
j=-3
j=-2
j=-1
j=0
j=1
j=2
j>=3

Bus flows near CSHs

- The outcome is the logged number of total buses and coaches counted at each survey point
- For each site, I calculate the distance to the CSHs and group them by distance bands

	CSH	<200m	<400m	<600m
j<=-4	-0.182	-0.216	-0.238	-0.255
	(0.197)	(0.193)	(0.279)	(0.225)
j=-3	-0.0867	-0.0712	-0.0894	-0.120
	(0.0730)	(0.0764)	(0.116)	(0.0906)
j=-2	-0.0615	-0.0695	-0.0784	-0.0888
	(0.0539)	(0.0564)	(0.0910)	(0.0722)
j=0	-0.0448	0.0596	0.105	0.0679
	(0.0456)	(0.0630)	(0.0779)	(0.0378)
j=1	-0.0326	0.128	0.173	0.140
	(0.102)	(0.118)	(0.156)	(0.129)
j=2	-0.0248	0.175	0.215	0.171
	(0.146)	(0.159)	(0.189)	(0.128)
j>=3	-0.0504	0.238	0.286	0.273
	(0.161)	(0.206)	(0.273)	(0.224)
N	604	1488	2301	2876
Rsquared	0.882	0.909	0.885	0.896
Year FE	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes

SD clustered at year and cycle superhighway route level

* $p < .1$, ** $p < .05$, *** $p < .01$

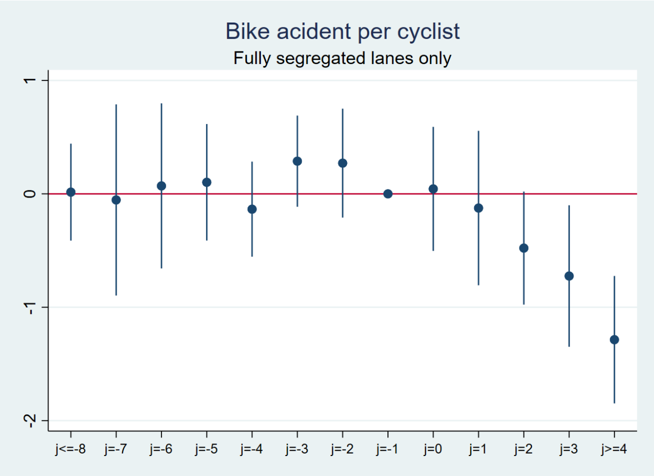
Accidents on CSHs

- I use the STATS 19 datasets that record the location of traffic accidents involving the police in England
- I do not observe all accidents involving bikes as many are not going to involve the police, however, I assume reporting does not change after CSHs openings
- The first column looks at all cycling accidents (1), then I add accidents over cycling flows (2), accidents over car flows (3), car accidents (4) and car accidents over car flows (5)

	Bike acc.	Bike acc. vs bike flow	Bike acc. vs car flow	Car acc.	Car acc. vs car flow
j<=-8	1.350	0.808	0.505	-0.613	-0.916
	(0.975)	(1.066)	(0.852)	(0.706)	(0.580)
j=-7	1.071	0.651	0.415	-0.653	-0.889*
	(0.710)	(0.838)	(0.699)	(0.480)	(0.390)
j=-6	0.834	0.460	0.260	-0.419	-0.619
	(0.542)	(0.483)	(0.307)	(0.422)	(0.336)
j=-5	0.611	0.286	0.125	-0.678*	-0.838**
	(0.418)	(0.540)	(0.452)	(0.253)	(0.190)
j=-4	0.504	0.209	0.0653	-0.364	-0.507
	(0.356)	(0.348)	(0.268)	(0.442)	(0.405)
j=-3	0.324	0.0360	-0.0611	-1.033*	-1.130**
	(0.177)	(0.257)	(0.244)	(0.401)	(0.366)
j=-2	0.264	0.128	0.124	-0.0817	-0.0863
	(0.160)	(0.188)	(0.202)	(0.161)	(0.166)
j=0	-0.268**	-0.280**	-0.146	-0.263	-0.129
	(0.0871)	(0.0965)	(0.0943)	(0.343)	(0.315)
j=1	-0.545	-0.380	-0.148	-0.108	0.123
	(0.356)	(0.444)	(0.508)	(0.365)	(0.326)
j=2	-0.995**	-0.789**	-0.497	-0.310	-0.0175
	(0.224)	(0.242)	(0.343)	(0.539)	(0.398)
j=3	-1.283**	-0.875*	-0.551	0.153	0.477
	(0.348)	(0.407)	(0.590)	(0.596)	(0.471)
j>=4	-1.978***	-1.401**	-1.227*	0.250	0.423
	(0.354)	(0.431)	(0.525)	(0.598)	(0.467)
N	209	209	209	209	209
Rsquared	0.751	0.715	0.723	0.609	0.617
Year FE	Yes	Yes	Yes	Yes	Yes
Site FE	Yes	Yes	Yes	Yes	Yes

SD clustered at year and cycle superhighway route level

* $p < .1$, ** $p < .05$, *** $p < .01$


Bike acident per cyclist
Fully segregated lanes only
1
0
-1
-2
j<=-8
j=-7
j=-6
j=-5
j=-4
j=-3
j=-2
j=-1
j=0
j=1
j=2
j=3
j>=4

Section 4

Conclusion

Conclusion

1. Results

- Segregated cycling lanes increase cycling flows at the opening and the years after
- There is no evidence of displacement of cyclists from the neighbouring roads - the increase contributes to the net overall increase of cycling in London
- There is also no evidence of a decrease in car flows where the road space has been reduced to accommodate the cycling lanes or in the neighbouring roads
- The increase in cycling flows is joined with a similar decrease in accidents involving bikes

2. Policy implications

- Cost benefit analysis should take into account medium-term growth when evaluating the impact of cycling infrastructure
- Hard segregation is effective at reducing bike-car accidents
- Building cycling lanes does not necessarily increase car traffic congestion