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A new perspective on traffic problems in towns

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The MFD and the built environment – A new perspective on traffic problems in towns

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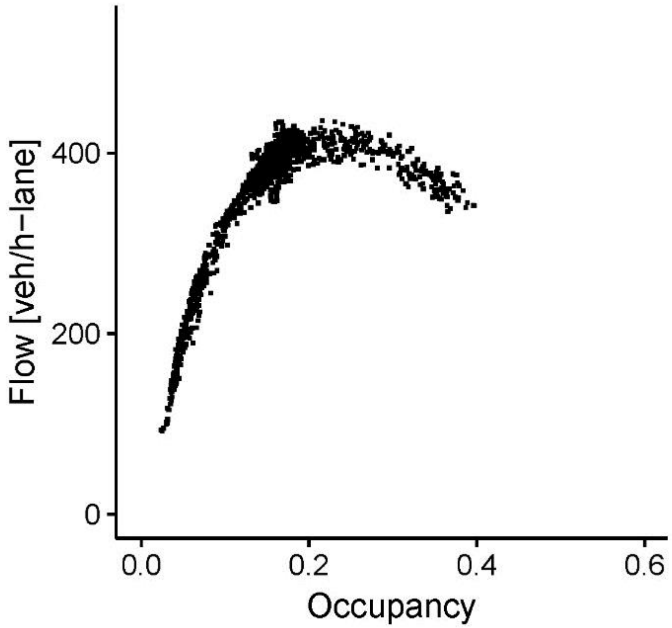
The macroscopic fundamental diagram (MFD)

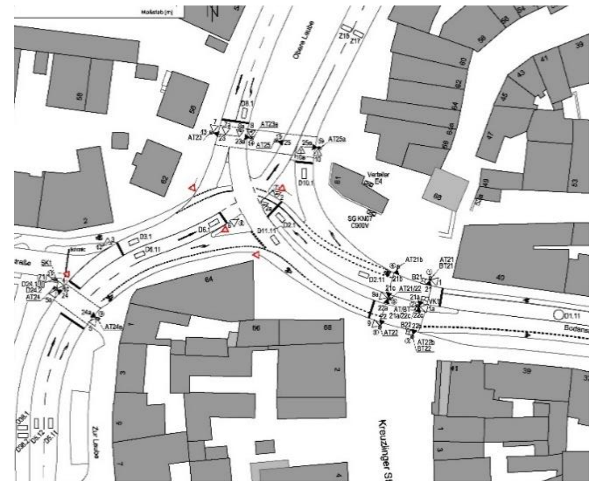


MFD estimated from loop detectors in Zurich (Loder et al., 2017)

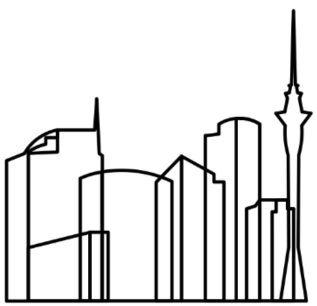
- Upper bound in the flow-density relationship
- Theory by Daganzo & Geroliminis (2008)
- Estimation methods as defined by Leclercq et al. (2014):
  - Analytical method
  - Loop detectors
  - Floating car data & loop detector data
- Empirical MFDs from Yokohama, Toulouse, Zurich, Shenzen

How does the built environment affect traffic?

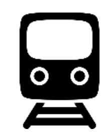
Construction drawing from and in courtesy of the city council of Bremen, Germany



Construction drawing from and in courtesy of the city council of Konstanz, Germany



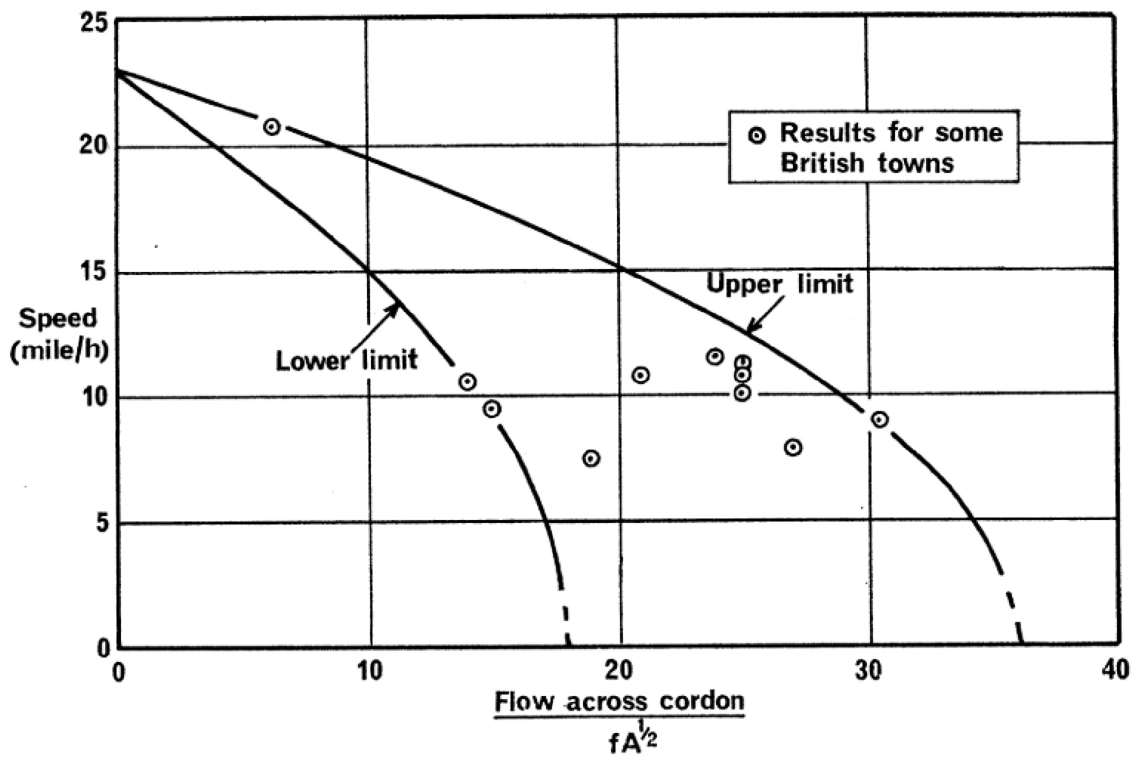
- Network capacity
- Likelihood of congestion



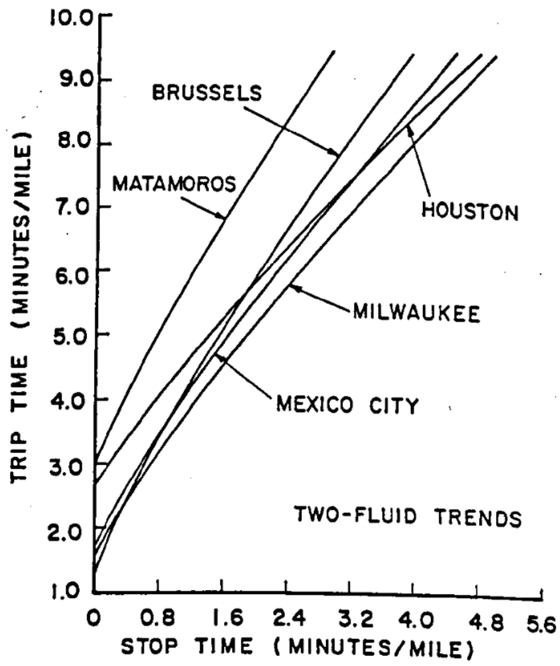
A supply side perspective instead of travel behavior perspective.

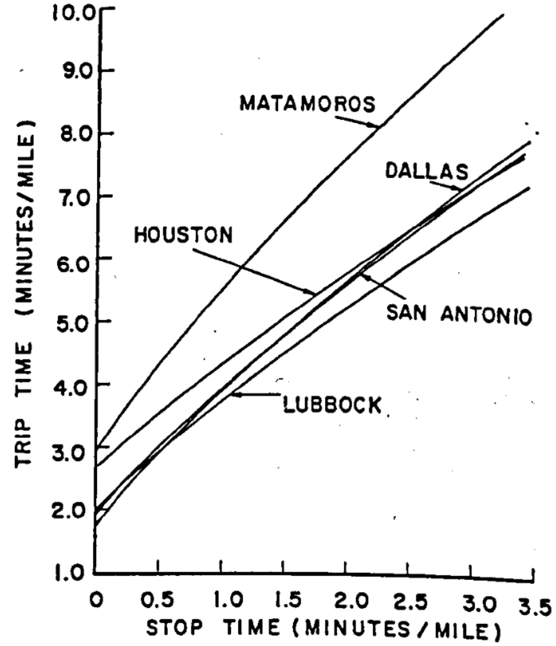
A look back I: Smeed (1968)

How many cars can enter downtown at given speed level?



A look back II: Herman & Prigogine (1979)





Ardekani & Herman (1985)

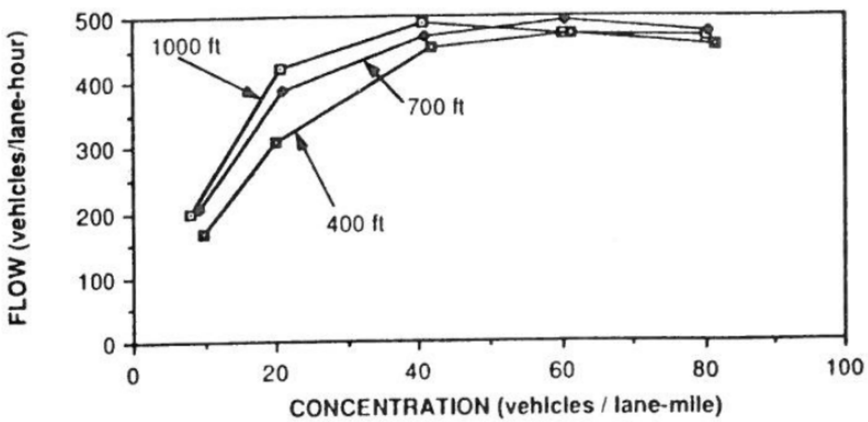
$$\log T_r = \frac{1}{1+n}\log T_m + \frac{n}{n+1}\log T$$

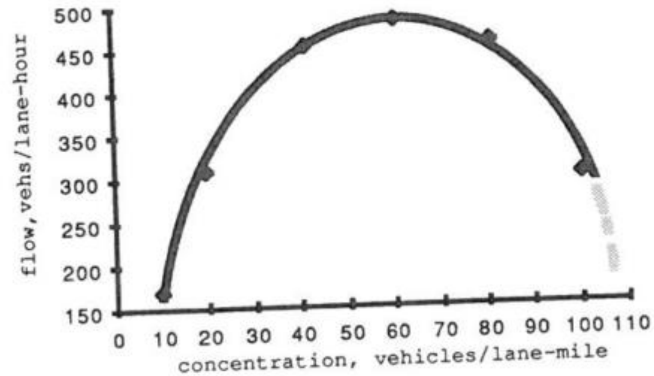
$$T_m = 3.93 + 0.004\, SignalDensity - 0.05\, SpeedLimit$$
$$-0.43\ \mathrm{ShareSignalProgression}$$

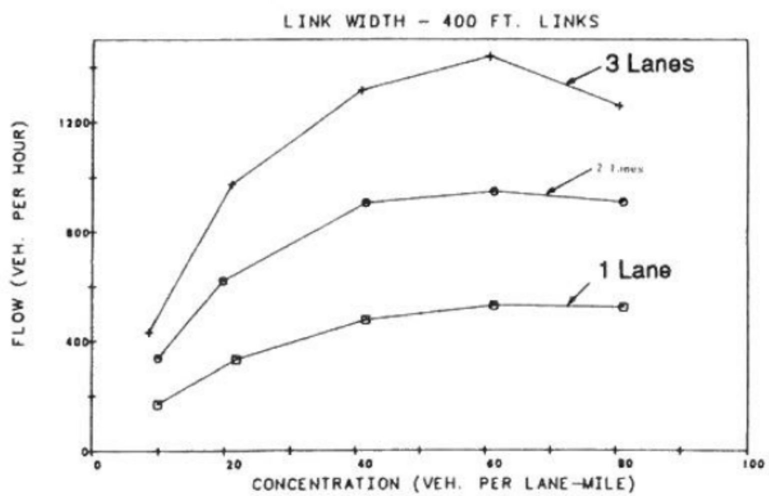
$$n = 1.73 + 1.12\, ShareOneWay\ - 0.18\, AvgLanes$$
$$-0.004\, SignalDensity - 0.27\, ShareActuated$$

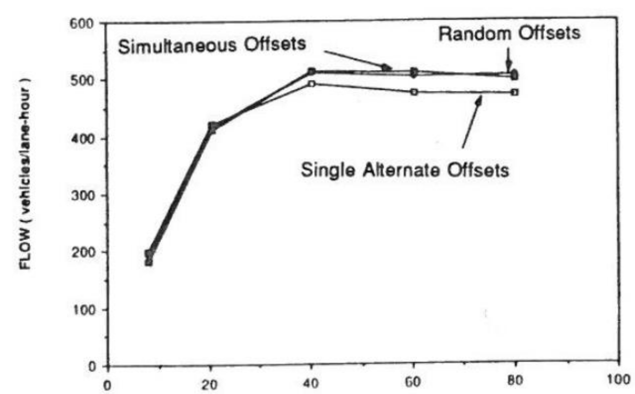
Ardekani et al. (1992)

A look back III: Mahmassani et al. (1987)









Research question

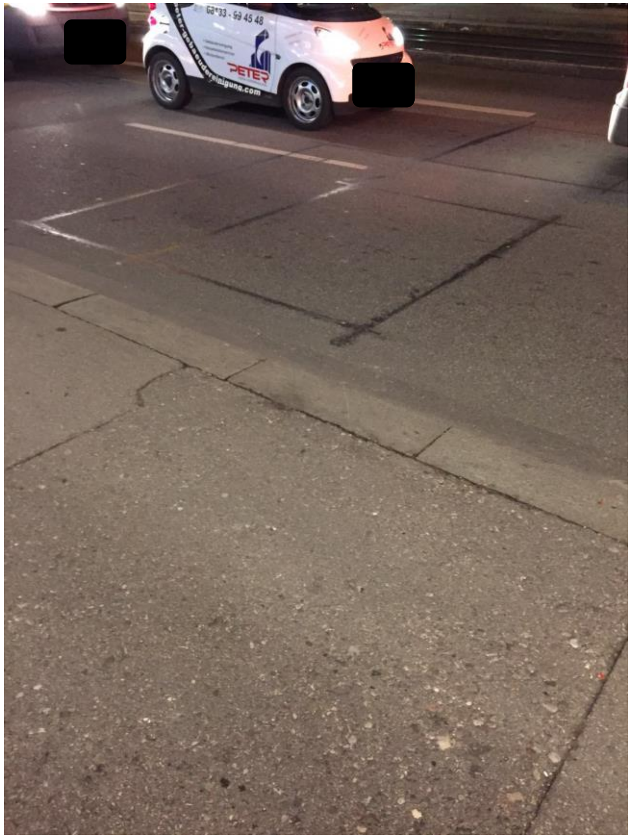
How do network features affect the capacity and the likelihood of congestion of road networks?

We address this questions by a cross comparison of MFDs estimated from empirical data.

Implications for how we build our cities.

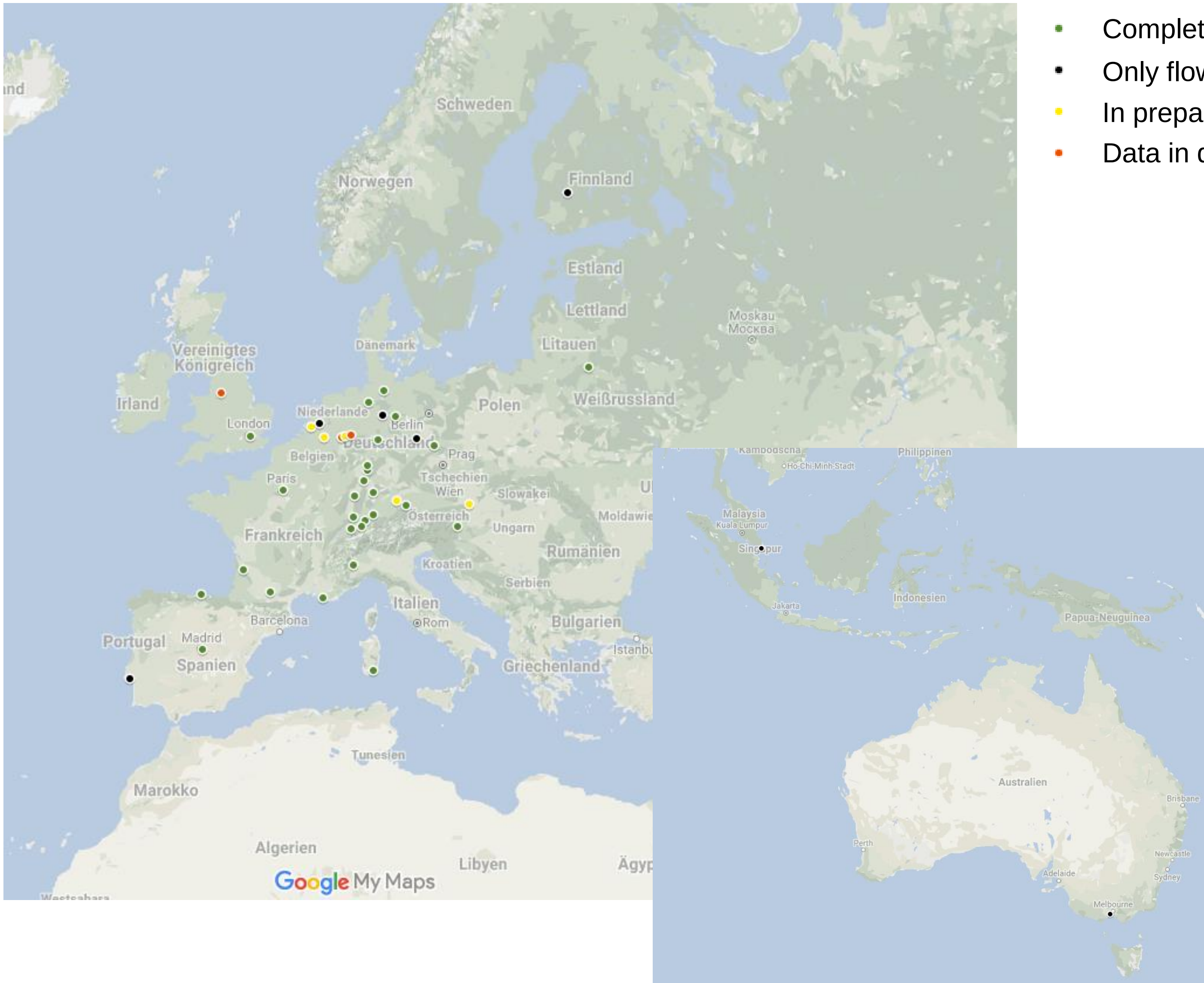
Data source: Stationary traffic detectors

- Most similar data sources to reduce bias's
- Always operate, compared to floating car data.
- Loop detectors measure flow and occupancy in a time interval *t*
- Occupancy is an indicator for traffic density
- Speed is available by double loops



Own photography, Munich, 2016.

Sample: Target is 30+ cities



- Completed (27)
- Only flows (7)
- In preparation (5)
- Data in delivery (3)

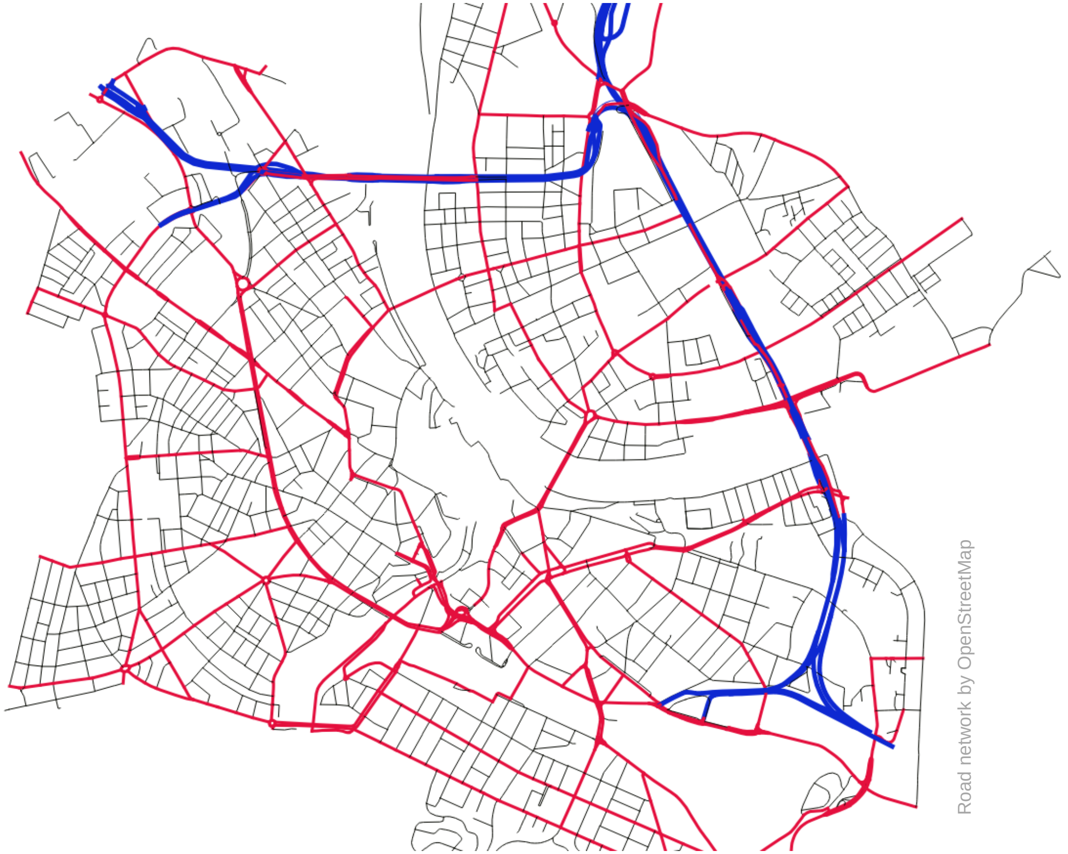
Data processing: Loop detectors

Aerial photography by google maps.

Mapping of detectors to the lanes of the road network to collect attributes

- Road class
- Lane length
- Driving direction
- Distance to traffic signal
- Identify multiple detectors per lane

Data processing: Road network



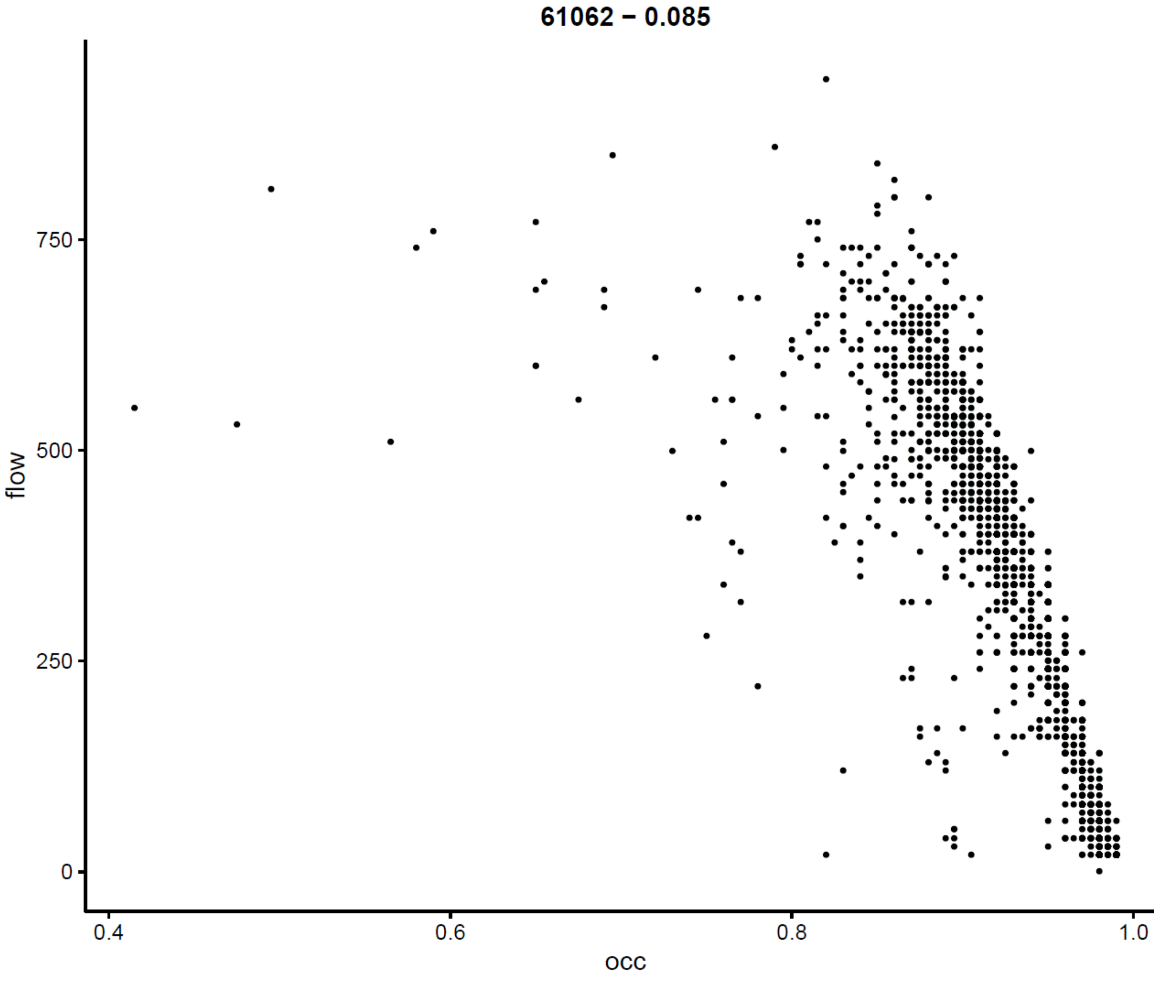
OpenStreetMap offers

- functional road class
- Number of lanes
- Speed limit

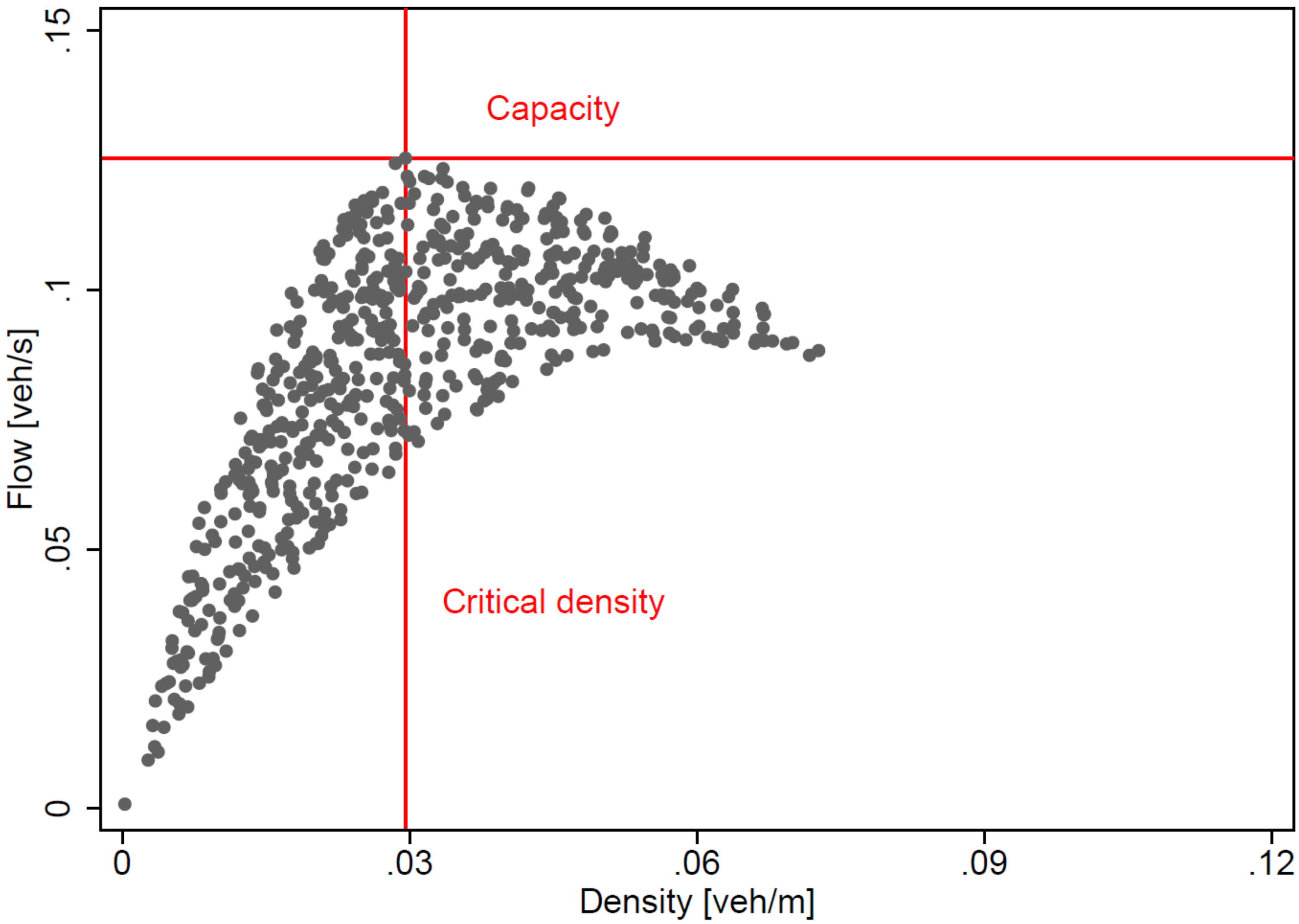
Adding missing attributes if necessary.

Create network with road segments from intersection to intersection

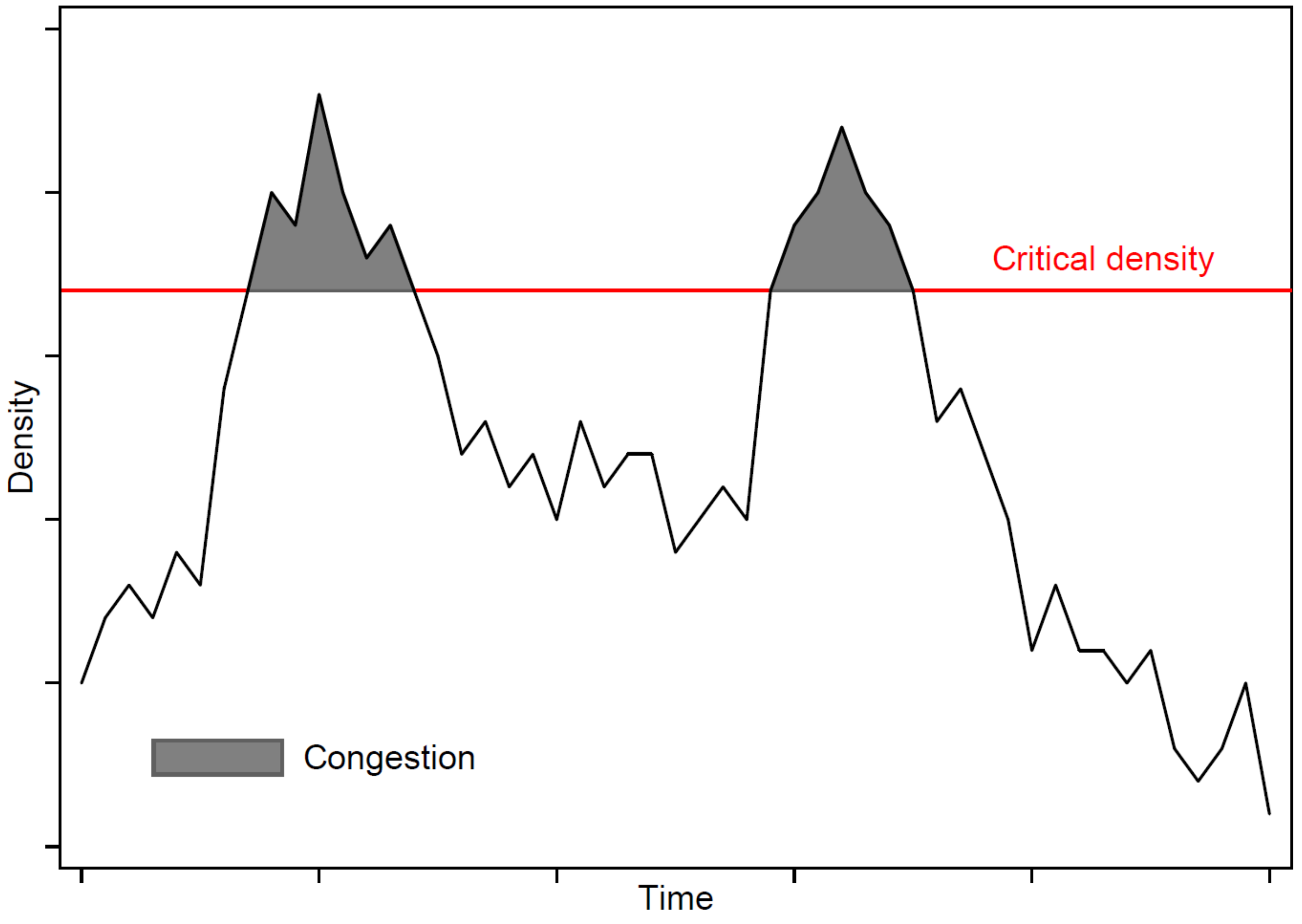
Data cleaning: It is a mess with empirical data



Parameters: Capacity



Indicators: Likelihood of congestion



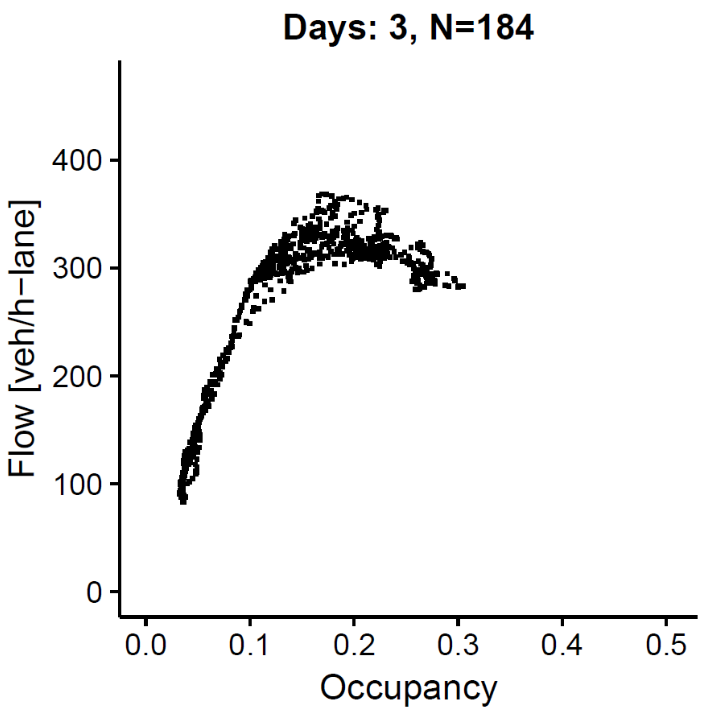
Network & built environment features

- Area of road network
- Average link length
- Average number of lanes
- Intersection density
- Network measures of centrality (routes)
- Public transport stops
- Public transport routes
- Population

Current status

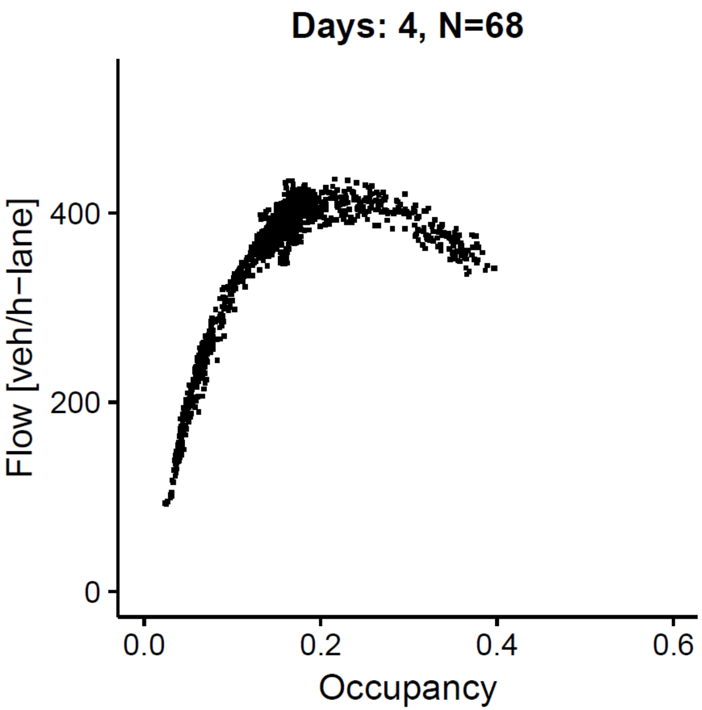
- Outlier detection in progress
- Some cities still need spatial data preparation
  - Harmonization of data formats
  - Digitalization of data

Some MFDs

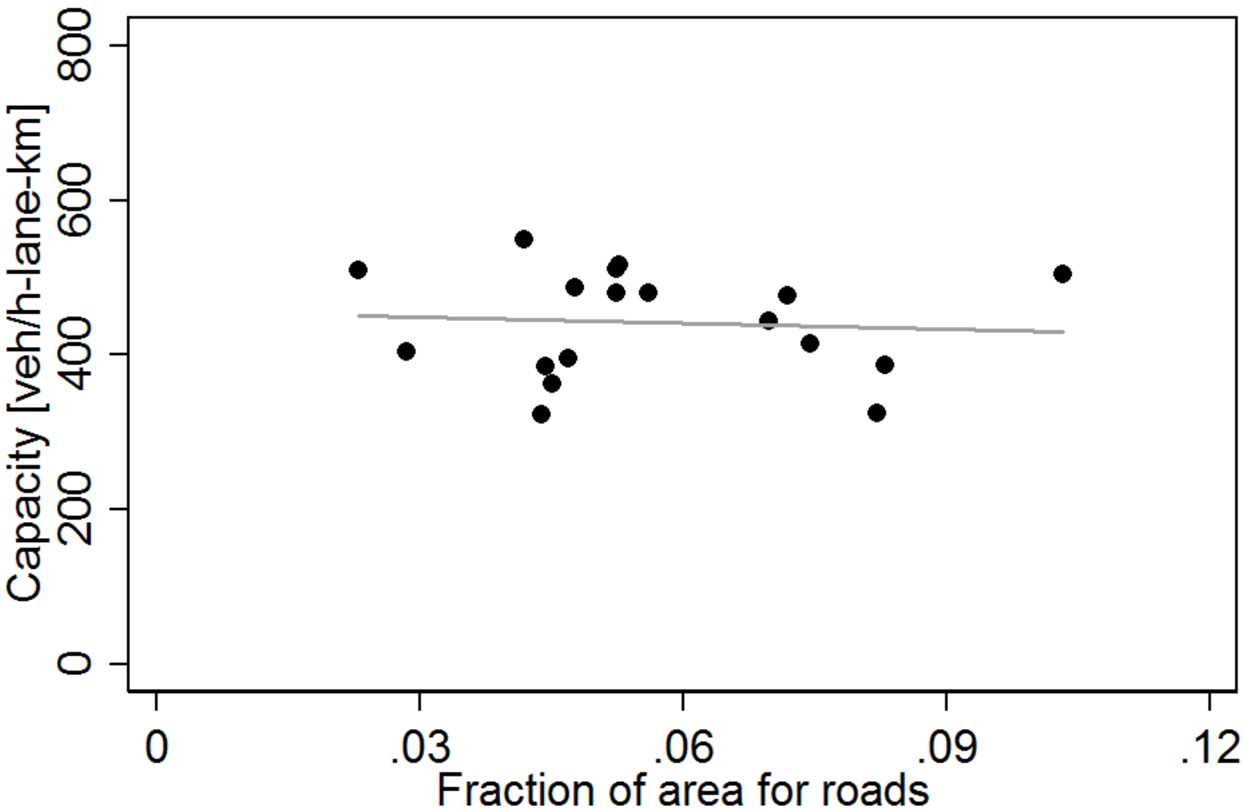


London

Zurich

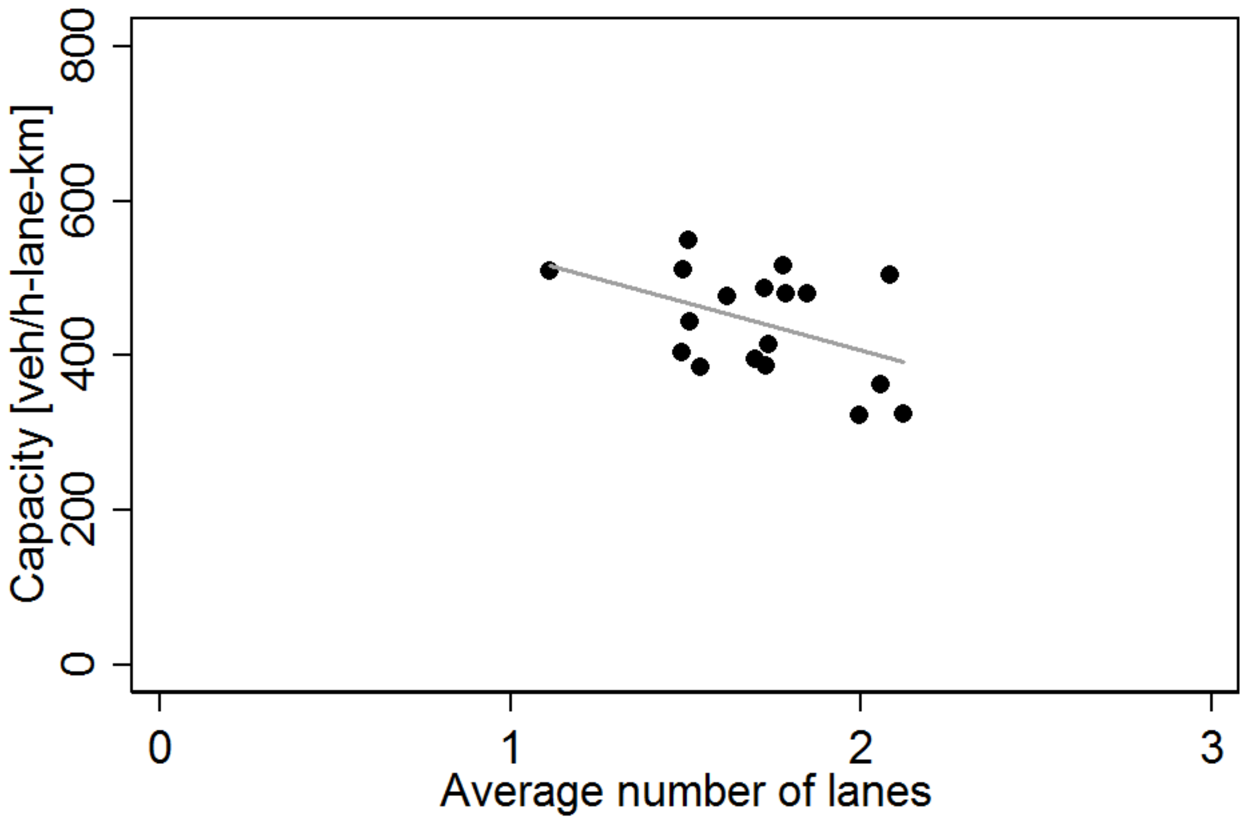


Area

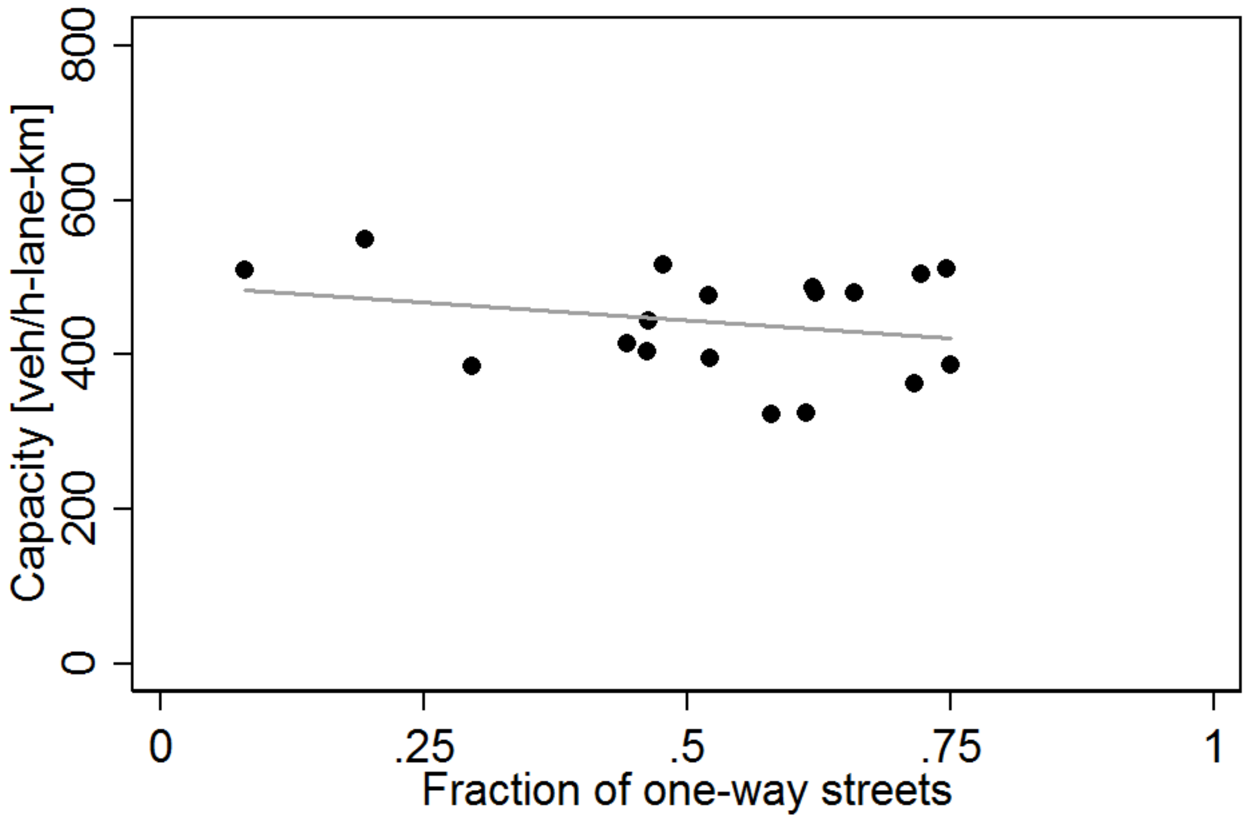


Capacity [veh/h-lane-km]
0
200
400
600
800
0
.03
.06
.09
.12
Fraction of area for roads

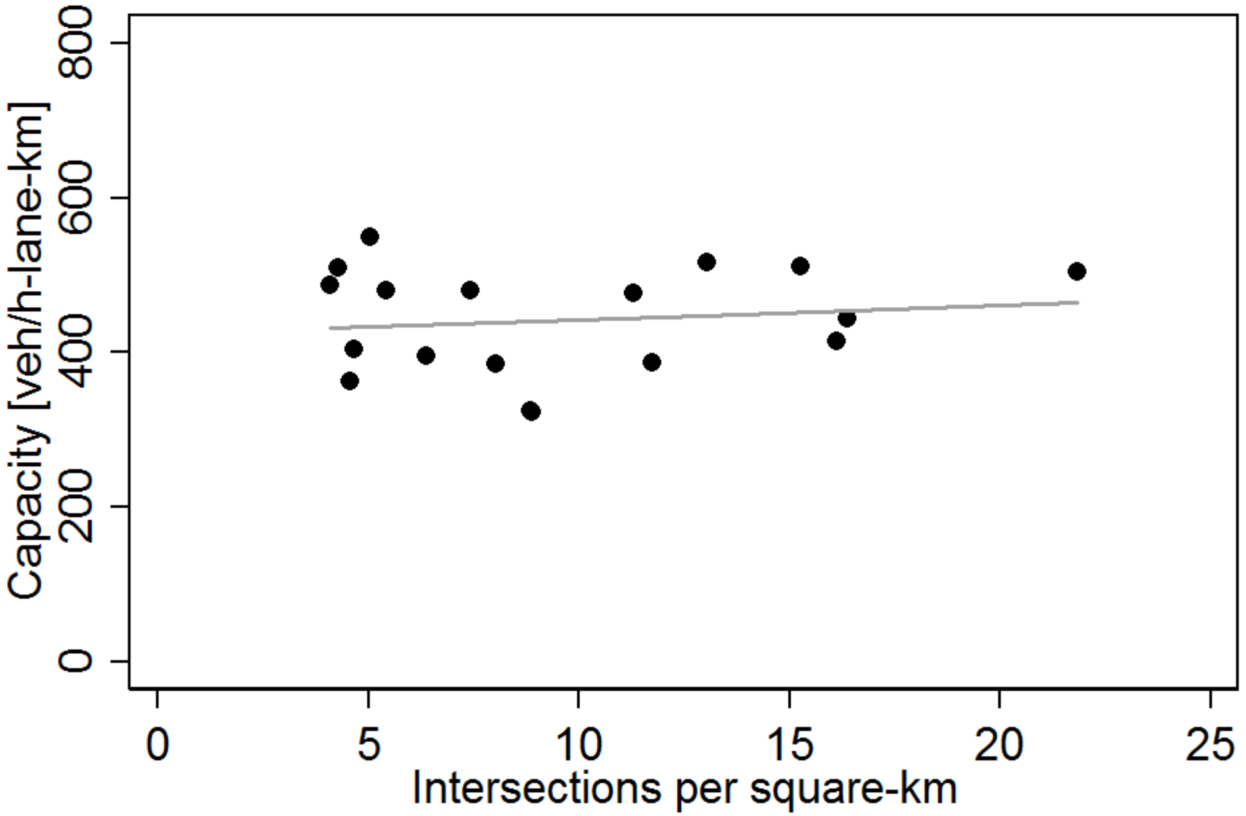
Average number of lanes



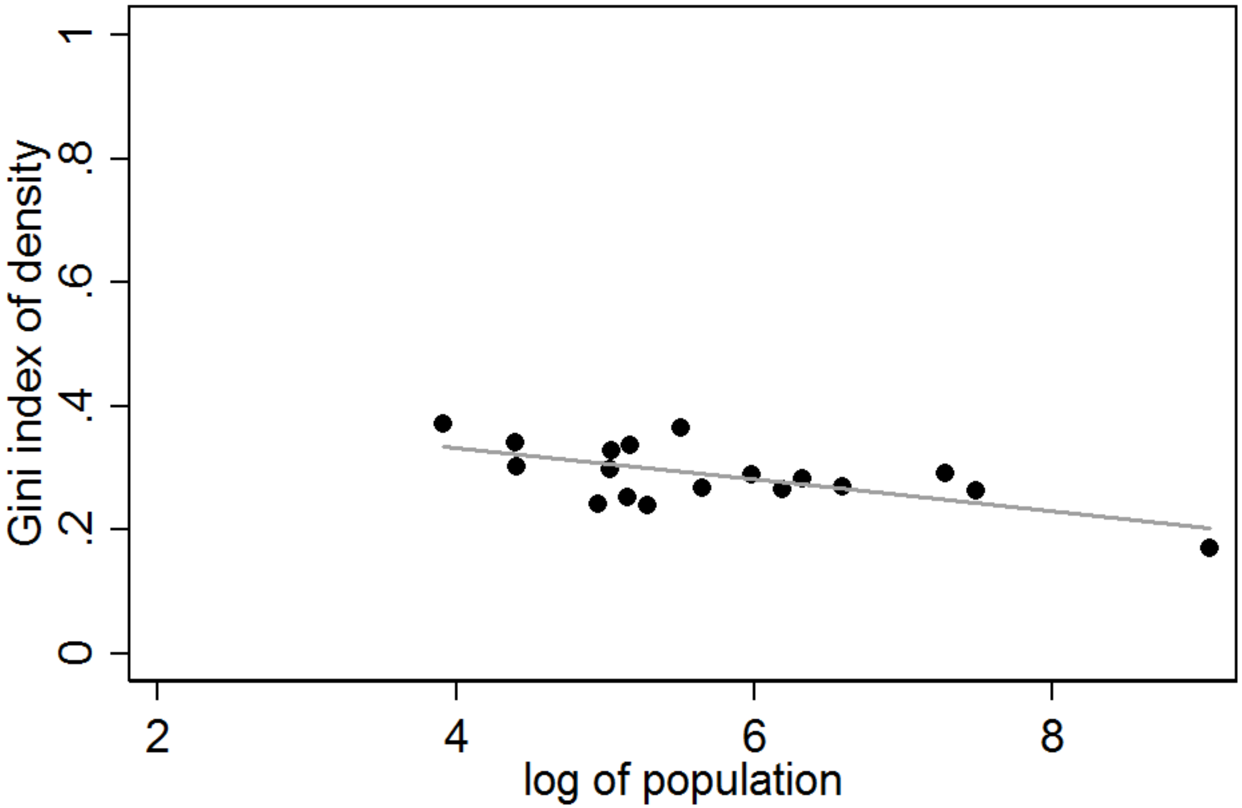
One-way streets



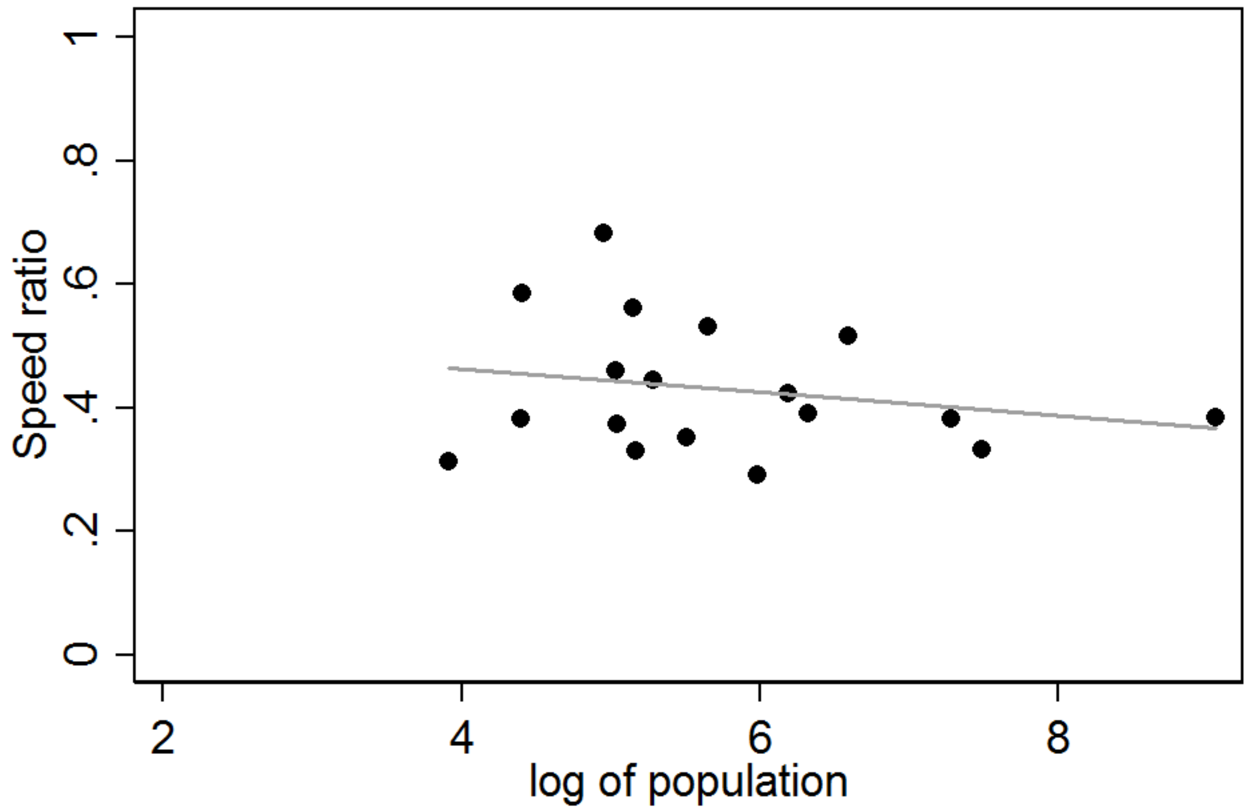
Intersections



Distribution of density



Speeds



Conclusions & Outlook

- We have variation in the data for the MFDs as well as in the network design parameters
- Robust MFD estimation and sensitivity analysis
- Apply econometric methods
- Work in progress, but expect first complete analysis for TRB 2018

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