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Explaining Urban network capacity – A first attempt

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- L Ambühl, ETH
- M Bliemer., University of Sydney
- M Menendez, NYU Abu Dhabi, earlier ETH

Hypotheses

- Urban networks have a stable fundamental diagram

- The extent of the network (parts) needs to be found

- The parameters of the MFD can be predicted with the urban form and public transport network

- Ideas based on early work e.g. Smeed, 1968, Godfrey (1969), Mahmassani,. Williams and Herman (1987)

Macroscopic (network) fundamental diagram

- Abstracting urban networks into a reservoir (Daganzo and Geroliminis, 2008)
- MFD quantifies reservoir outflow as a function of cars in the network.

- The parameter of the MFD are function of;
  - Networks
    - Intersection density
    - Lane miles
    - Interactions with road-based transit
  - Signal control
    - Cycle and lost times
    - Transit priority
    - Number of conflict points
  - Number of alternative routes
    - Potential bottlenecks

MFD by cuts
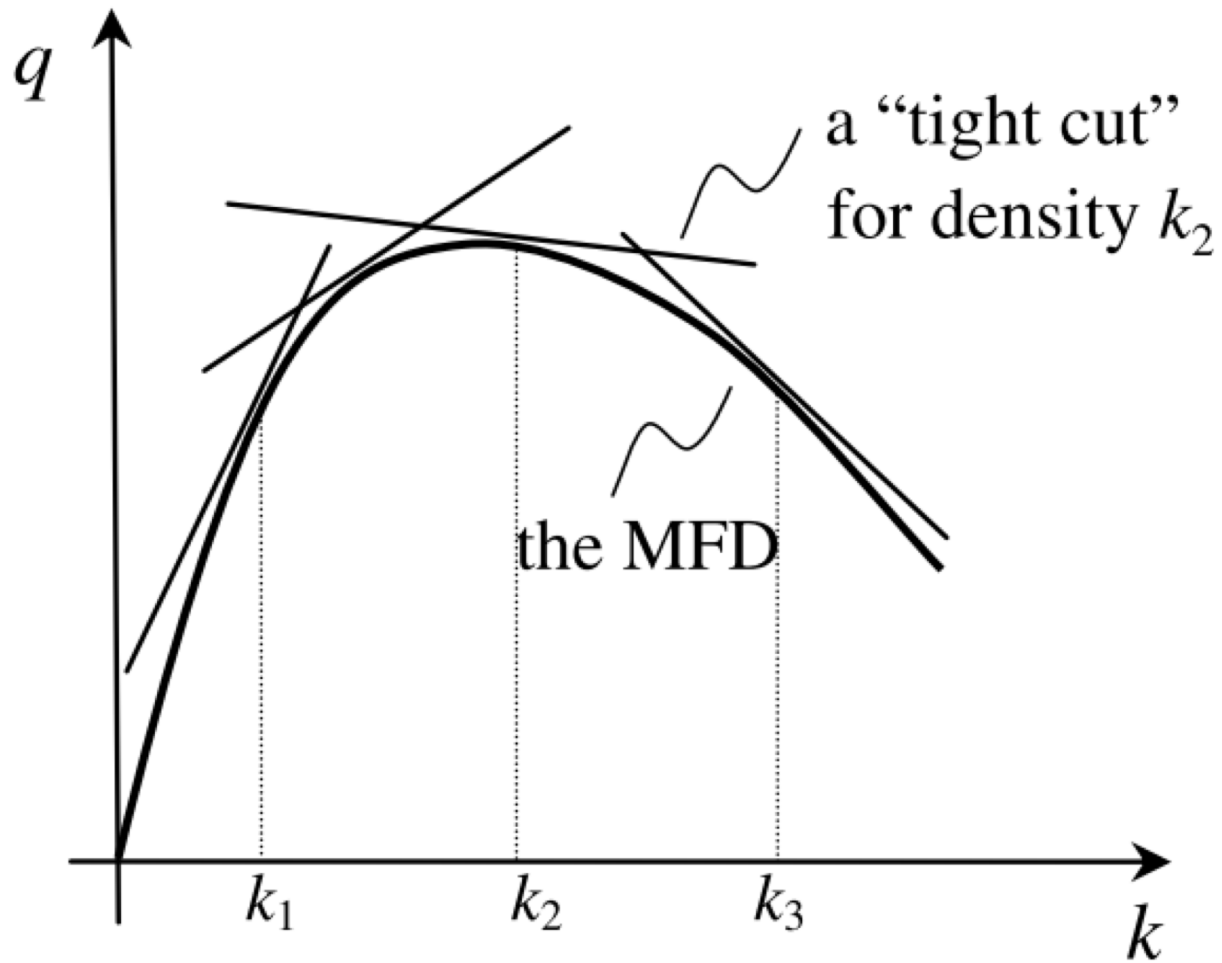
MFD Yokohama taxi data

HK 18
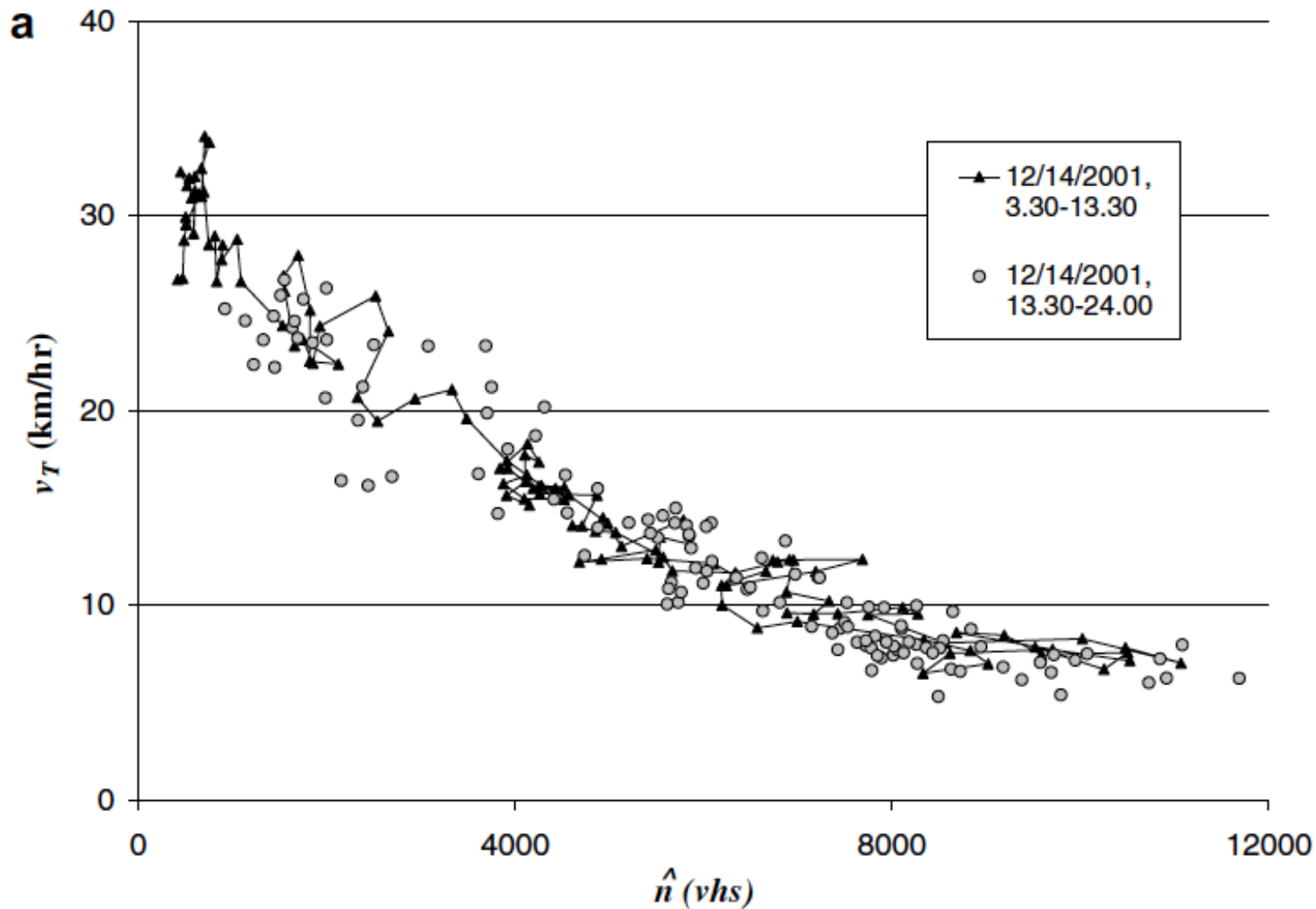
Data available at the IVT

- Traffic data from stationary sensors (loop detectors) (43 cities)

- Road and transit networks from OpenStreetMap

- Transit AVL data from Zurich and London
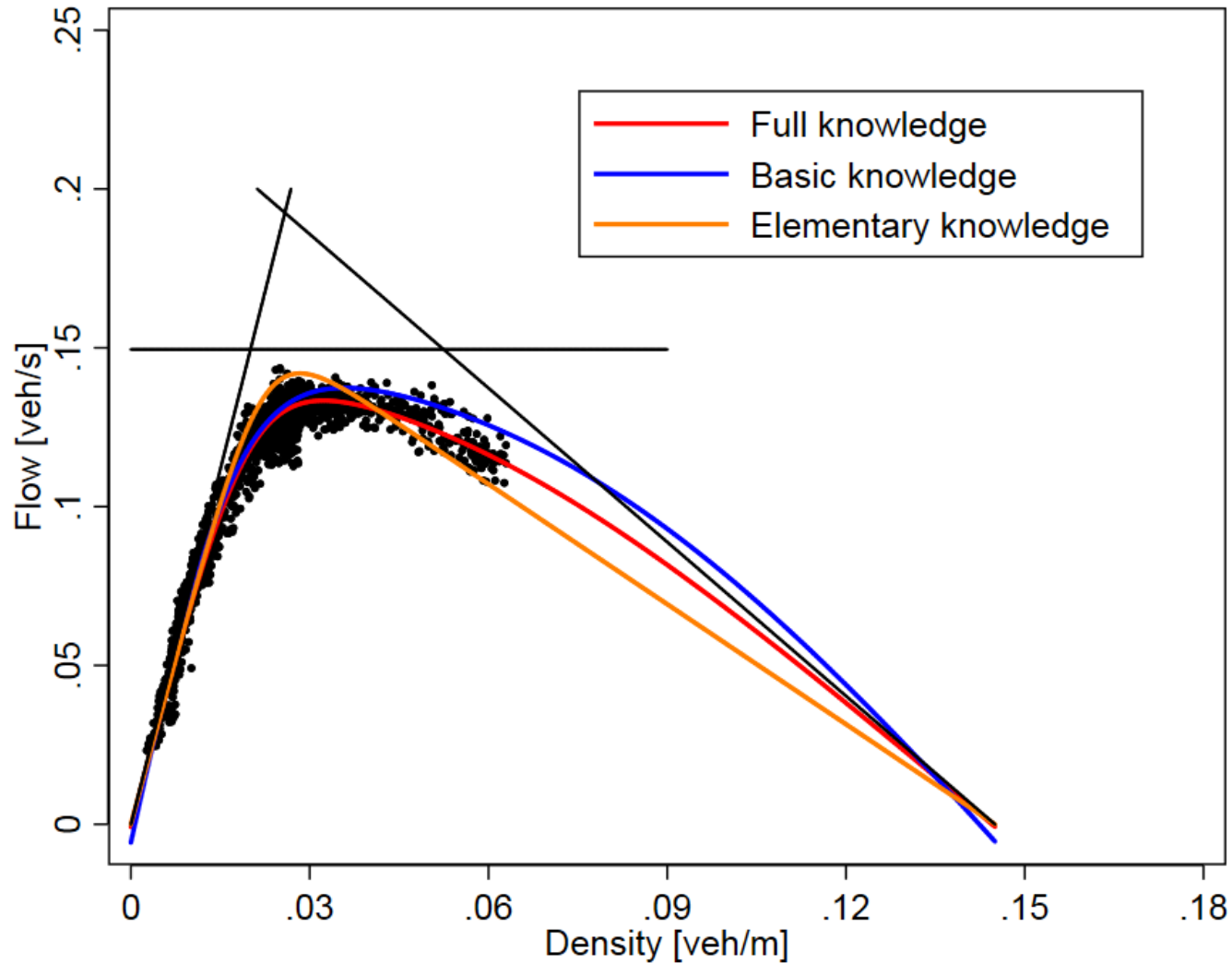
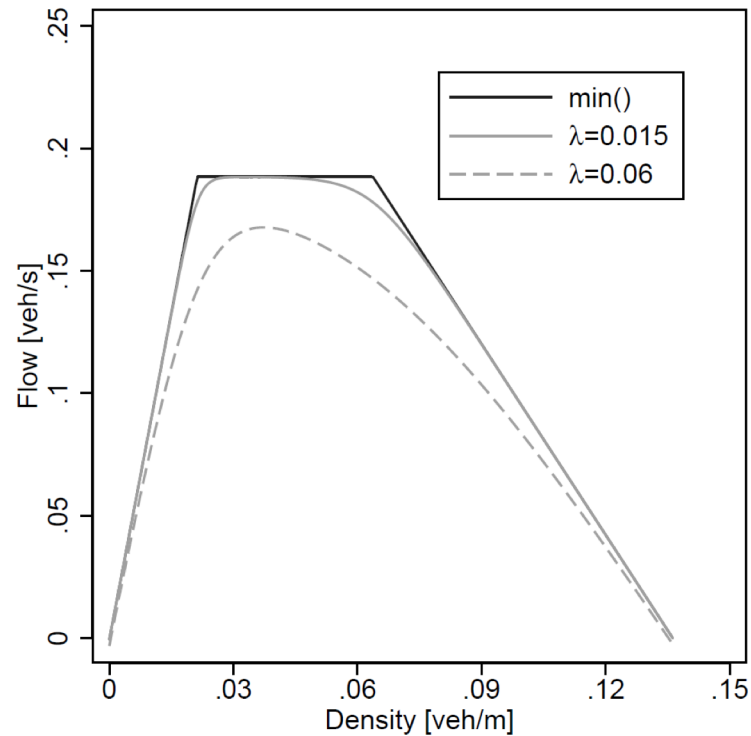- TomTom data for Zurich

MFDs as a probe of operational quality

A functional form for the MFD with partial knowledge

A functional form for the MFD

$$q(k) = \min\big(vk; Q; w(\kappa - k)\big)$$
$$\approx -\lambda \ln\left(\exp\left(-\tfrac{vk}{\lambda}\right) + \exp\left(-\tfrac{Q}{\lambda}\right)\exp\left(-\tfrac{w(\kappa-k)}{\lambda}\right)\right)$$
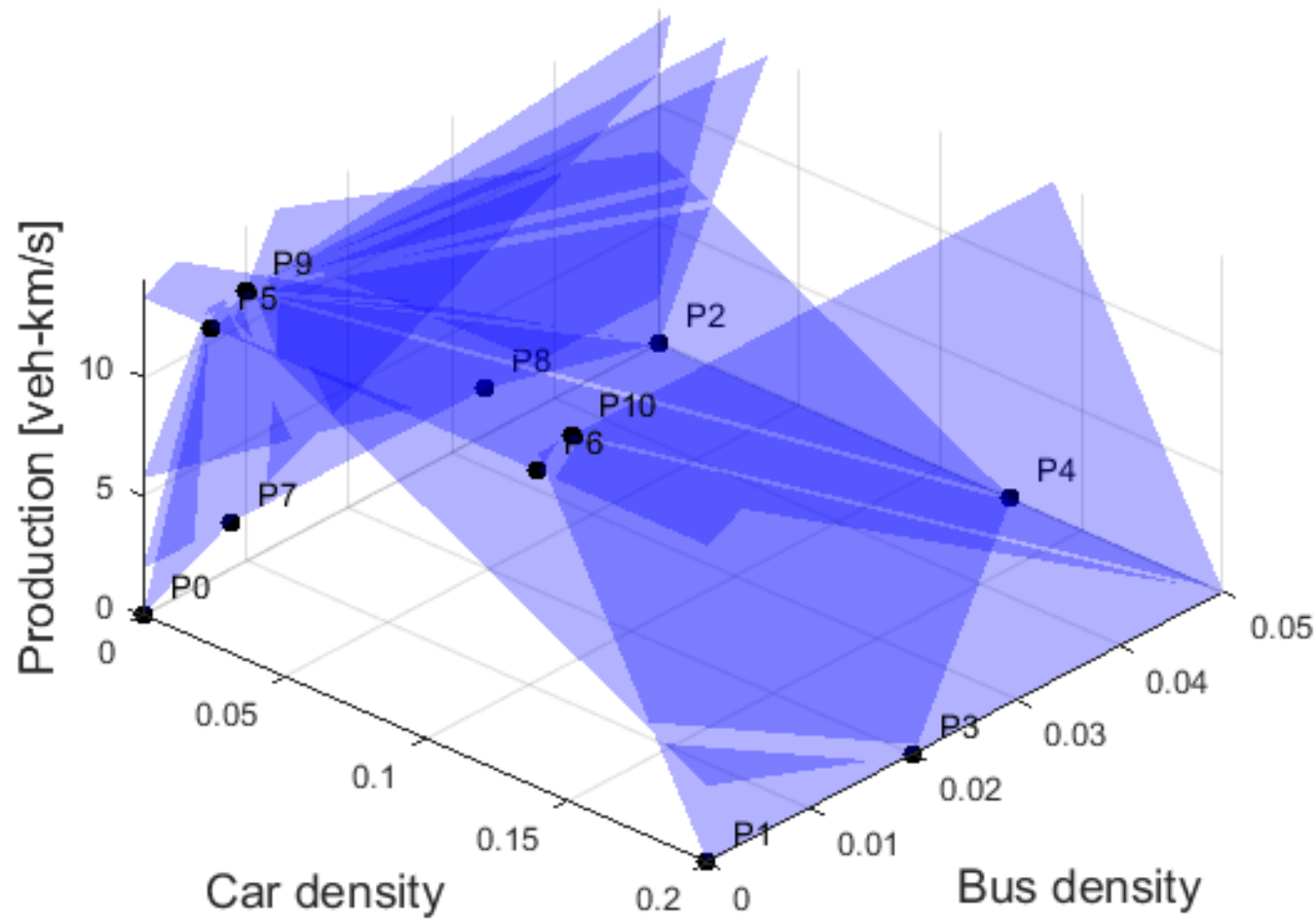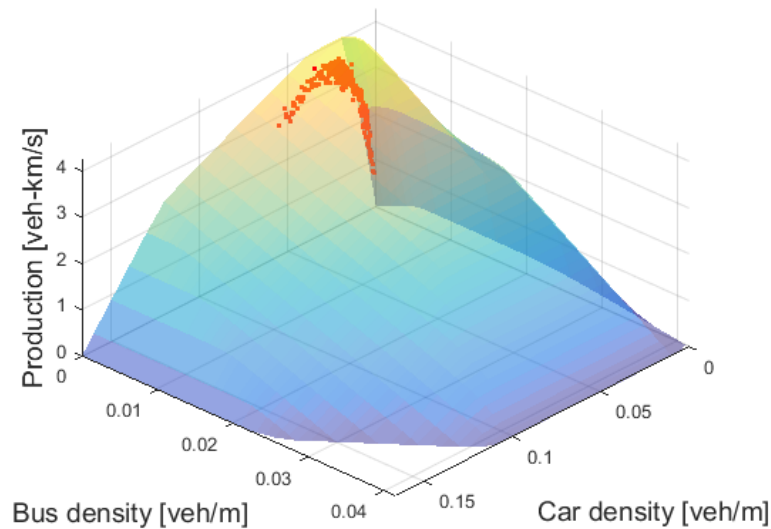
Extending the approach to 2 modes and 3D MFDs

Defining a functional form for the 3D MFDs

Create planes

First results using the cuts and functional form

Zurich
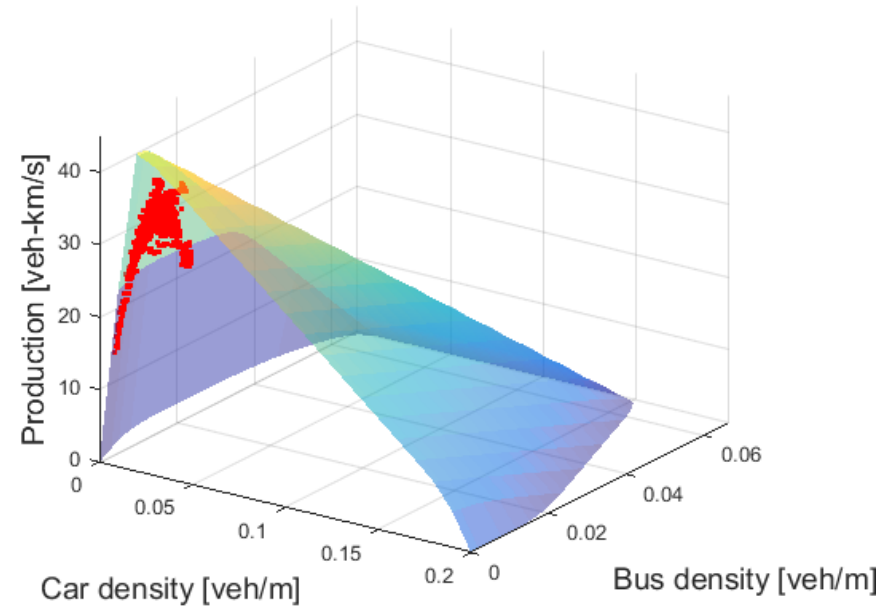
London

Modelling with 3D MFDs: Zürich

Finding the optimal modal split

Comparing MFDs

Three cases

How far are we?

What have we achieved?

- First large scale and comparative empirical analysis of MFDs

- Establish novel methods for MFD field work

- Methods to analyze productivity and efficiency of multi-modal urban networks

- Empirical MFD data will be shared among community after publication

What needs to be done?

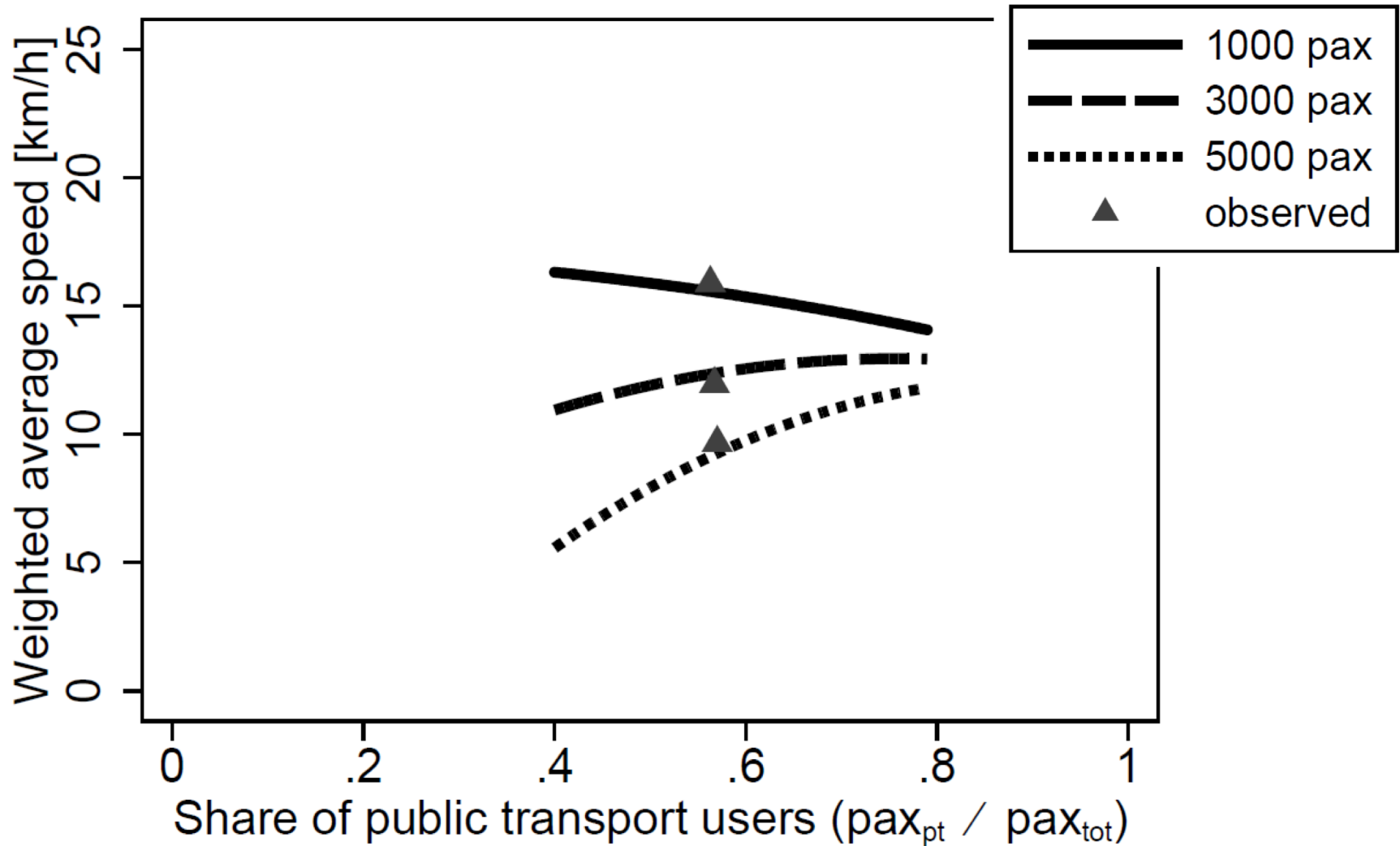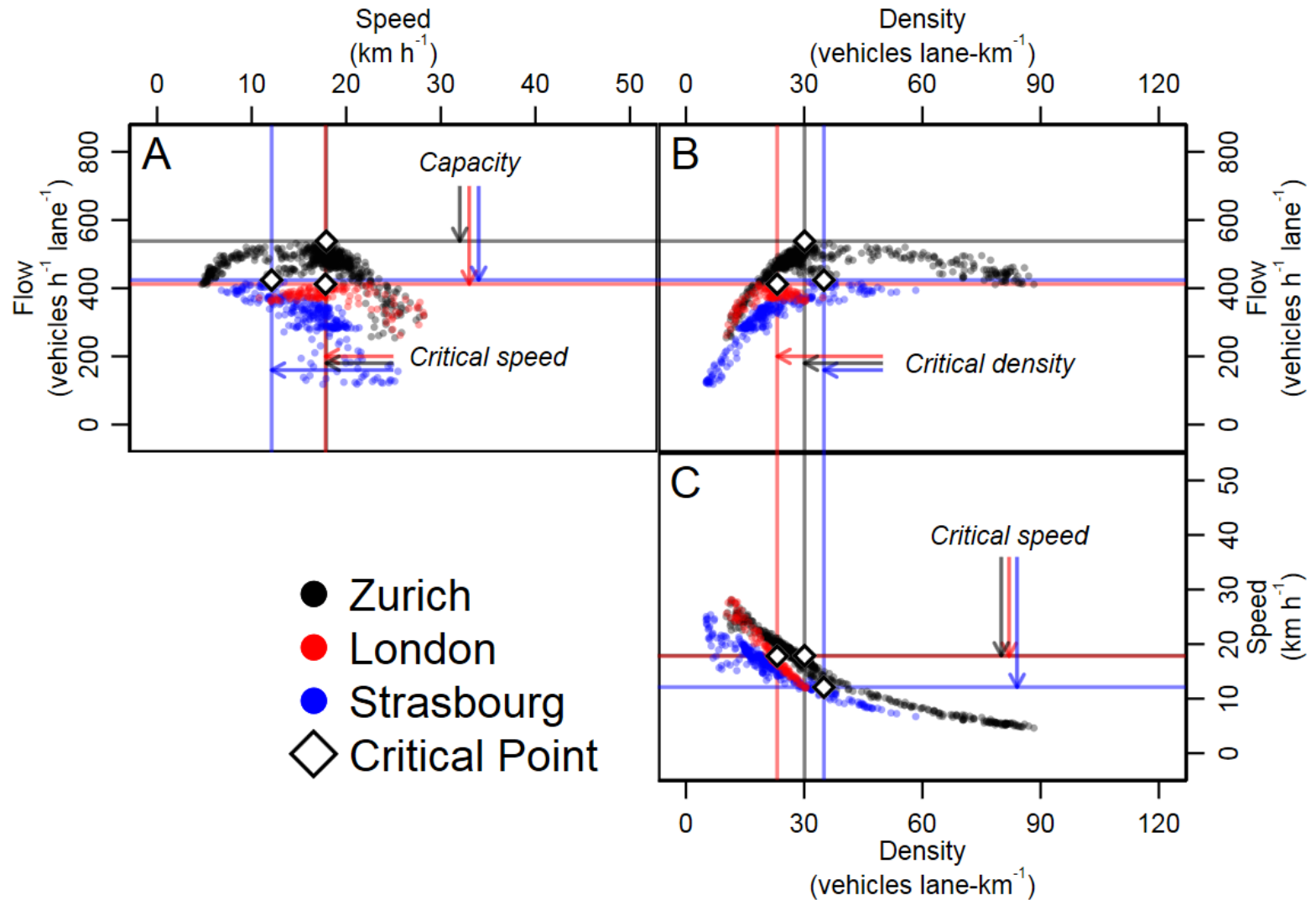- Analyzing congestion itself, its duration and intra- and inter-day patterns

- Productivity of multi-modal urban road networks in an AV age.

- Identification of the drivers of λ, can λ alone describe the shape of the MFD?

- Detailed analysis of effects of bus network design and operations on the 3D-MFD.

- Link between the 3D-MFD, pricing and human behavior to identify the realizable total productivity of multi-modal urban networks.

Questions?

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