Differentiation of Modal Preferences in Public Transportation

Anne-Valérie Preto Antonin Danalet Joschka Bischoff
Negar Rezvany Fabian Torres Michel Bierlaire

Transport and Mobility Laboratory
School of Architecture, Civil and Environmental Engineering
Ecole Polytechnique Fédérale de Lausanne
And Swiss Federal Railways SBB

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Outline

Challenges in Capturing Public Transport Demand

- MOBi **underpredicts tram** usage and **overpredicts** certain **bus** lines.
- Passenger counts suggest missing differentiation in modal preference.

Relative Difference	Base Model
Overall (Bus + Tram)	0.98%
Overall Bus	20.18%
Overall Tram	-24.87%
Over M1	-13.63%

Table: tl boarding data vs. MOBi base model (2023)

Literature Review

- **Preference-Based Models for Public Transport Modal Differentiation**
  - [Bunschoten et al., 2013]: SP surveys show higher ASC for tram. Preference disappears when adding comfort/info
  - [Axhausen et al., 2001]: Weak bonus; stronger for frequent users
  - [Ben-Akiva and Morikawa, 2002]: ASC = proxy for transfers; no true bonus
  - [Scherer, 2011]: Trams rated better; positive image for tram among frequent users
- **SP surveys in CH:** No PT mode differentiation since 2021 [Federal Office for Spatial Development, 2024]

Research Question

- SP: struggle to identify preference
- MOBi: challenges in capturing PT demand
- **Goal:** Capture tram preference (if any) using passenger count data
- Approach:
  - Use SBB's model, SIMBA.MOBi simulation outputs vs. TL passenger boarding counts
  - Calibrate alternative-specific constants (ASC) for tram/bus

Can observed ridership be used to isolate and quantify the tram bonus ?

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MOBi Model Overview

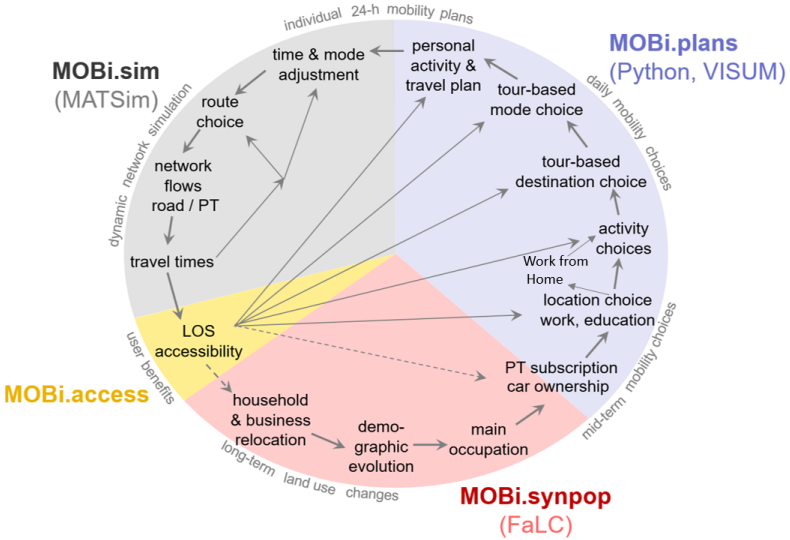


Figure: SIMBA MOBi pipeline

- **Agent-based model**, Switzerland-wide
- **Key modules:**
  - **MOBi.Plans:** activity planning
  - **MOBi.Sim:** route + mode choice
- **Multimodal:** walk, bike, PT, car
- Public transport modes distinguished:
  - Bus, Tram, Train (in simulation, not scoring)

Enhancing Student Behavior in MOBi.Plans

PT Subscriptions

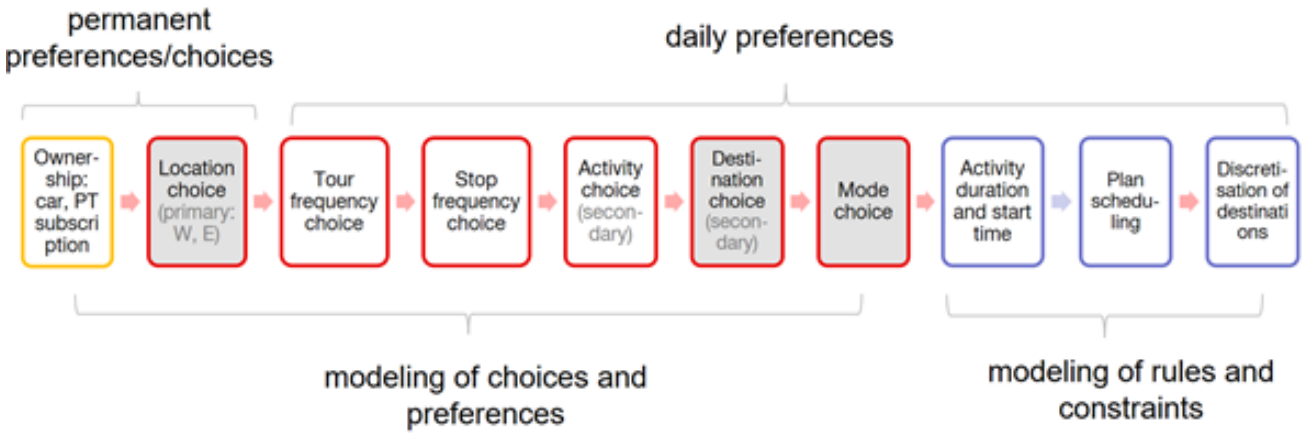
- Student rule
- Distance-based GA/VA

Car Availability

- DL model: no effect
- MTMC 2021 threshold

Campus Attractivity

- Boost business/leisure
- Weights $\times 5$ / $\times 10$



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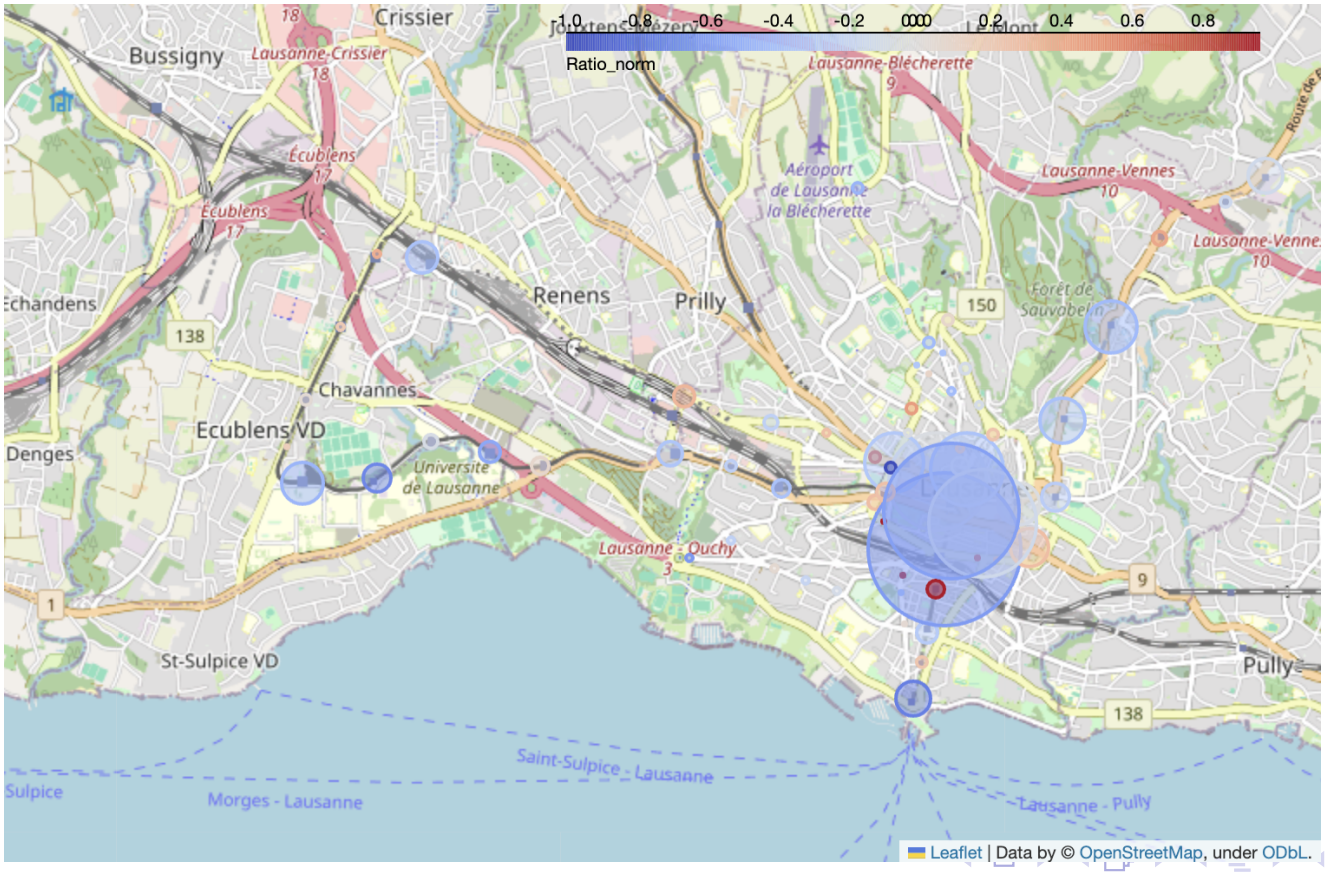
Scope of the Project

- Lausanne area, using the m1 line as a proxy for trams
- m2 line excluded since the slope is not modeled
- 10% of the population used in simulations
- Based on MATSim, with high computational cost



Trial-and-Error Calibration

Calibration Process

- Start from existing MOBi PT constants
- Increment tram constant to match tram boardings on m1
- Fine-tune the bus constant afterward
- Evaluate results using: relative difference, MAE, and MSE

Tram Constant: Sensitivity analysis

- Gradually increase tram constant to calibrate ridership on m1

Model	Global	Renens	Flon	Tram increase (%)
36e	-13.63	-12.80	-14.46	0.0
36f	-12.18	-11.49	-12.87	14.0
36g	-9.19	-8.36	-10.02	20.0
36h	-8.13	-7.19	-9.07	30.0
36i	-2.49	-1.89	-3.08	60.0
36j	-0.40	1.13	-1.92	75.0
36k	1.35	2.62	0.09	77.5
36l	1.24	3.36	-0.86	80.0
36m	1.14	2.48	-0.19	85.0

Table: Comparison of Relative Differences and Tram Constant Changes

Tram Calibration

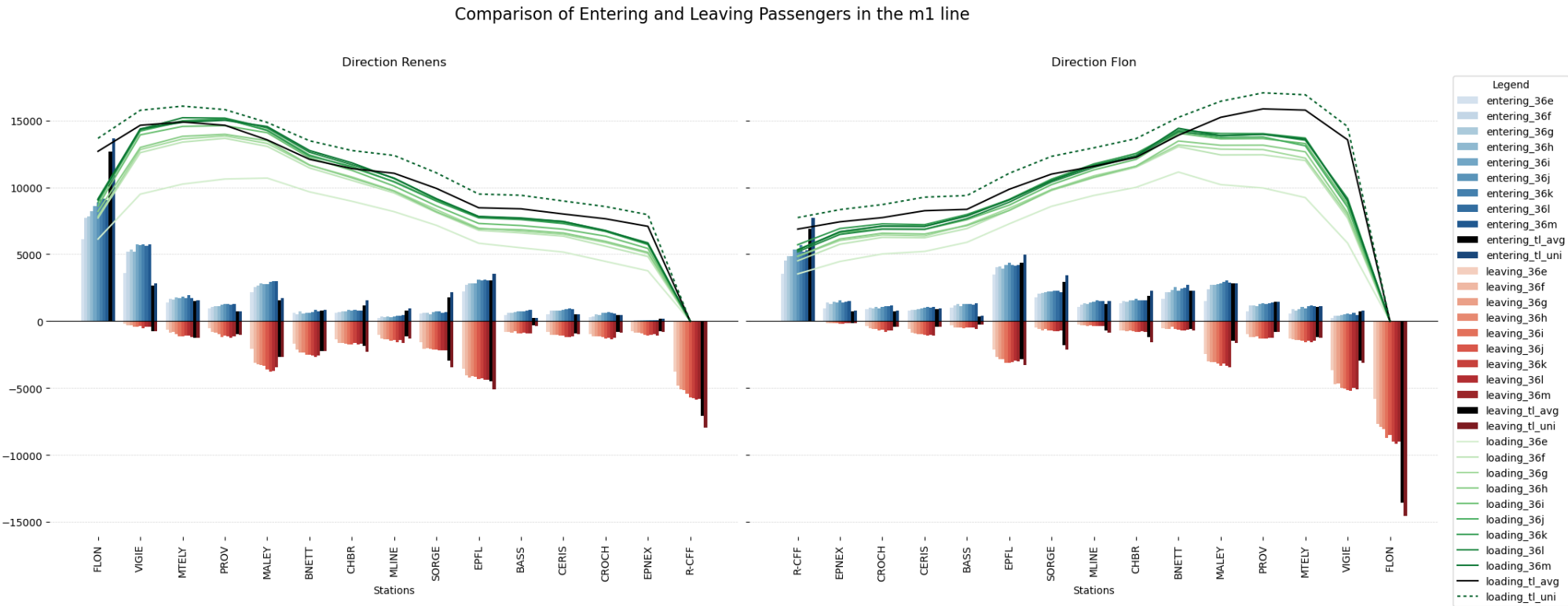


Figure: Comparison of boardings with tl data

Bus Constant: Sensitivity analysis

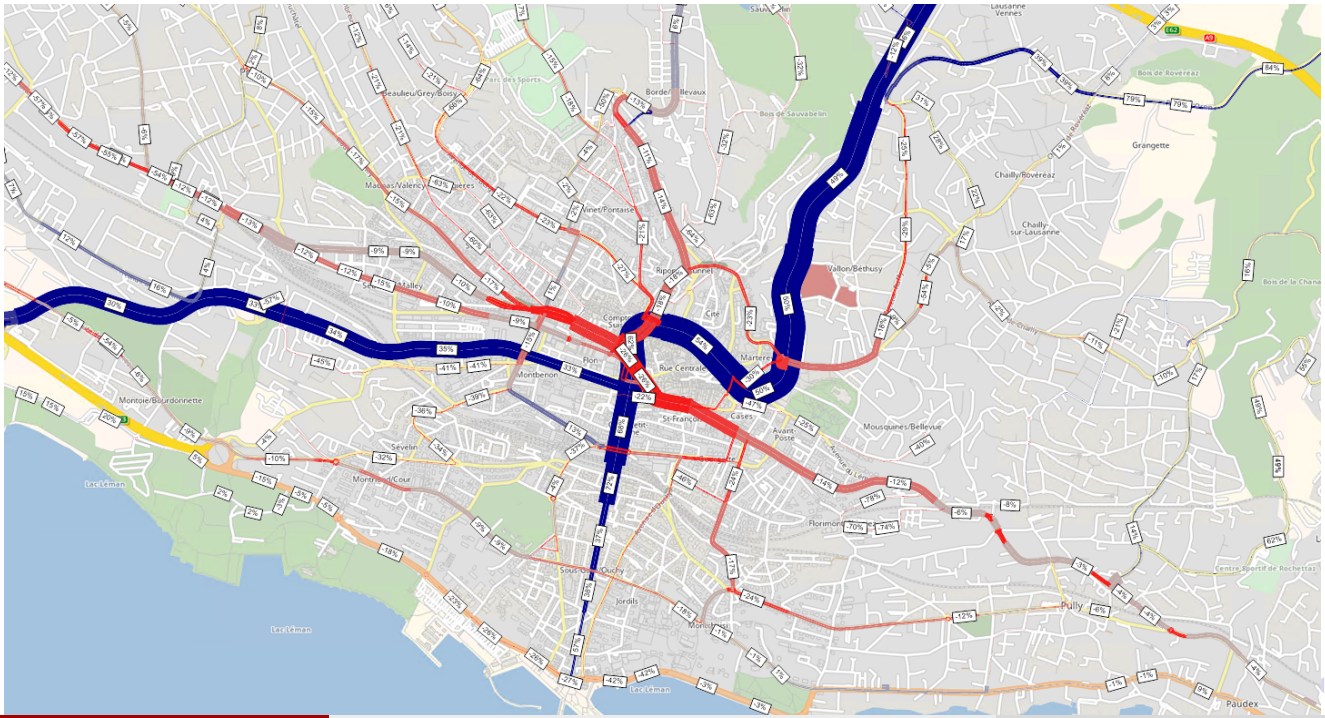
Model	Bus constant	Decrease	Rel. Diff. Bus	Rel. Diff.
36e	-0.21	0%	20.2%	2.0%
36j	-0.21	0%	23.3%	9.5%
36j1	-0.31	50%	2.6%	6.4%
36j2	-0.33	60%	-1.0%	-6.1%
36j3	-0.35	70%	-4.3%	-8.1%

Model	Bus constant	Decrease	Rel. Diff. Bus	Rel. Diff.
36e	-0.21	0%	20.2%	2.0%
36k	-0.21	0%	22.6%	9.3%
36k1	-0.2625	25%	13.2%	3.3%
36k2	-0.294	40%	7.2%	-0.3%
36k3	-0.315	50%	3.8%	-2.8%
36k4	-0.3675	75%	-7.2%	-9.8%

Tram vs. Bus: Geographical Interaction

Impact of ASC Calibration

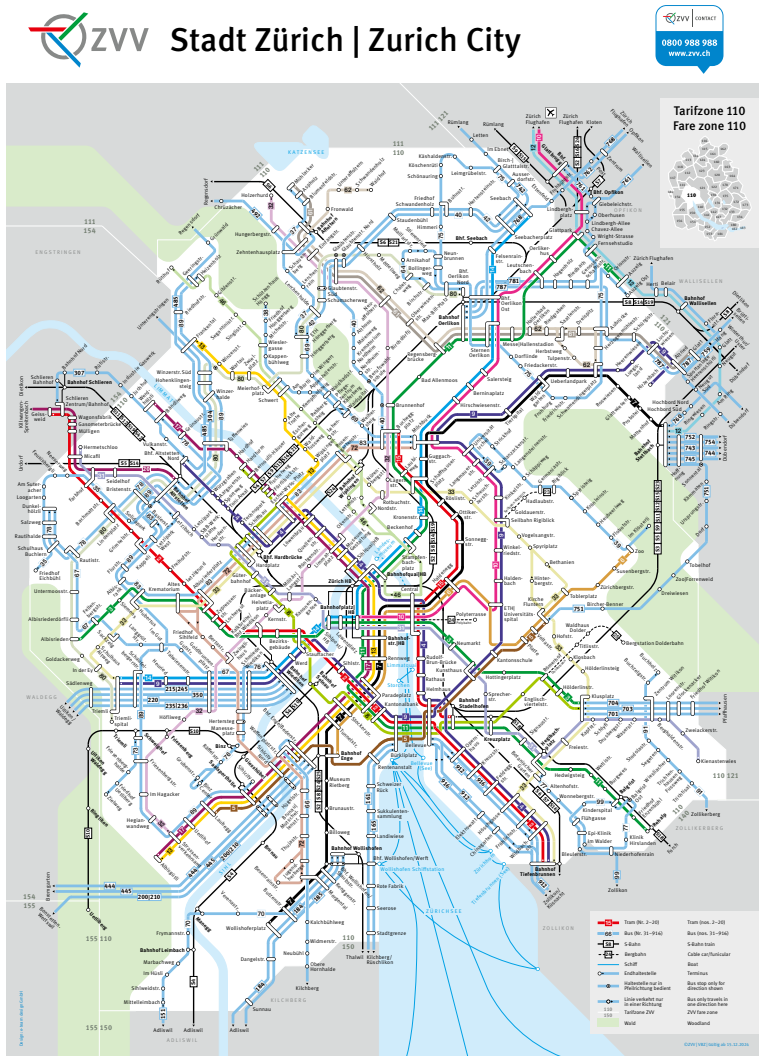
- More boardings on trams (blue), fewer on buses (red)
- Transfer effects observed (e.g., Sallaz)
- Competitive corridors shift mode (e.g., m1 vs. lines 17/18)



External Validation: Zürich

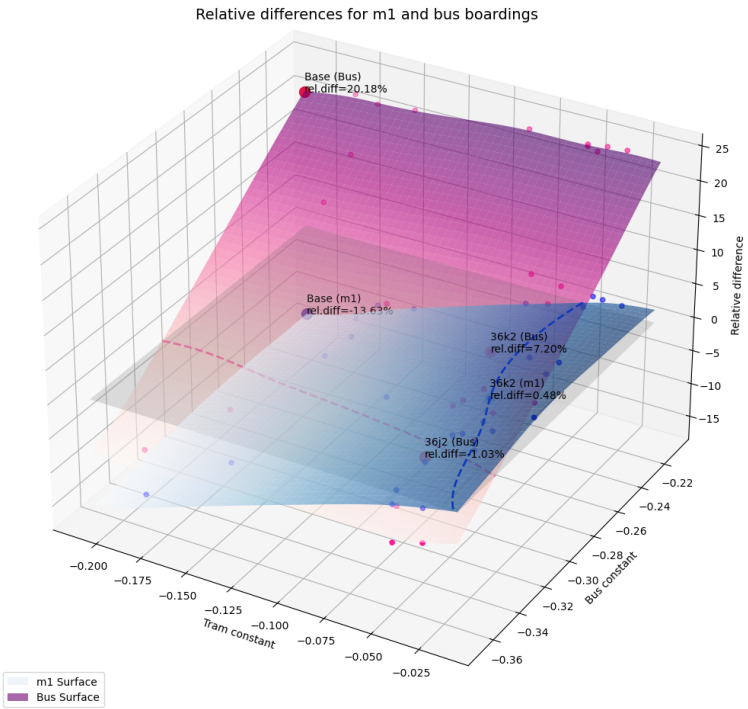
Relative Difference	Base	36j2	36k2
Tram Constant	-0.21	-0.0525	-0.04725
Bus Constant	-0.21	-0.336	-0.294
Tram Lines (13 lines)	-11.84%	3.53%	6.69%
Bus Lines (23 lines)	16.32%	8.79%	18.44%
Overall	-3.04%	5.18%	10.37%

Table: Model performance on Zürich TL data



Model 36j2 generalizes better; 36k2 overfits tram in Lausanne.

RBF Interpolation Across Models



Idea

- Tram/Bus constants **interact**
- Search for set of constants with min. error
- Results: **similar** bus constant than in the trial and error method, overfitted tram constant (m1 only)

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Results: Best Calibration Models

Relative Difference: TL vs. Simulated Ridership

Model	Tram cst	Bus cst	Rel. Diff. m1	Rel. Diff. Bus	Rel. Diff.
36e	-0.210	-0.210	-13.63%	20.18%	0.98%
36j2	-0.053	-0.336	-1.74%	-1.03%	-7.03%

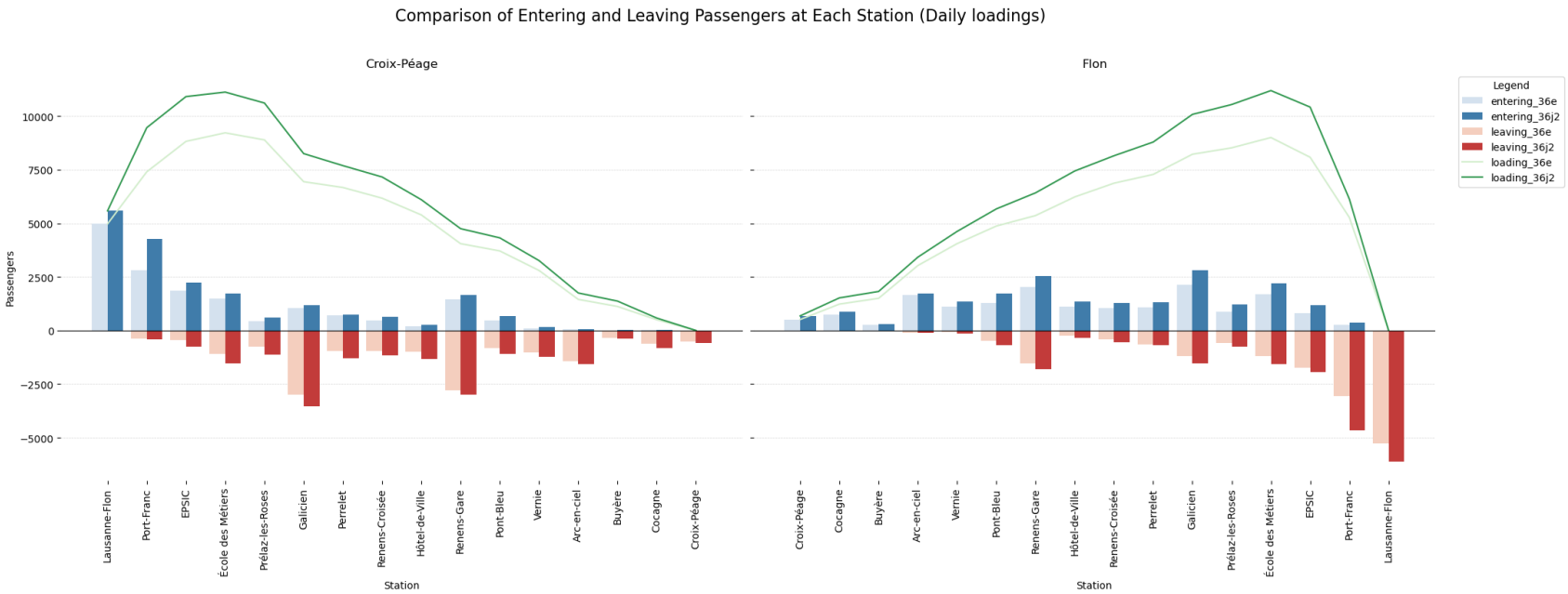
- Model **36j2**: Worse overall fit, but better predictions ability

Outline

Case Study: Future Tram (Lausanne)

- **Flon – Renens:** 2026
- **Croix-Péage:** 2030
- **Frequency:** 6 min
- **Capacity:** 300 pax
- **Fictive scenario:** 2023 Population, 2030 infrastructure

Case Study: Future Tram – Simulation Results



Significant ridership increase observed with 36j2 calibration.

Case Study: Future Tram – Simulation Results

Model	36e	36j	rel diff
Daily Loadings – Flon	16580	20950	26%
Daily Loadings – Croix-Péage	16110	19860	23%
MPH – Flon	1940	2370	22%
MPH – Croix-Péage	1340	1530	14%
EPH – Flon	1790	2280	27%
EPH – Croix-Péage	2060	2340	14%

Table: Comparison between models 36e and 36j for the new tram scenario

Conclusion

Key Takeaways

- Isolated **light rail preference** using passenger count data
- Light rail systems **complement** bus networks, and vice versa
- Tram coverage **influences** preference, some **corrections** are needed in different cities

Thank You!

Questions?

anne-valerie.preto@epfl.ch

Bibliography I


Axhausen, K., Haupt, T., Fell, B., and Heidl, U. (2001).
Searching for the rail bonus: Results from a panel sp/rp study.
European Journal of Transport and Infrastructure Research, 1.


Ben-Akiva, M. and Morikawa, T. (2002).
Comparing ridership attraction of rail and bus.
Transport Policy, 9:107–116.


Bunschoten, T., Molin, E., and van Nes, R. (2013).
Tram or bus; does the tram bonus exist?: 41st european transport conference, frankfurt, germany.
Proceedings of the 41st European transport conference, pages 1–18.

Bibliography II

Federal Office for Spatial Development, A. (2024).
Analysis of the stated preference survey 2021 on mode, route and departure time choices.
Research Report, Berne.

Scherer, M. (2011).
The image of bus and tram: first results.
In *11th Swiss Transport Research Conference*, Monte Verità, Ascona, Switzerland.