Modelling The Rise and Fall of Two-sided Mobility Markets with Microsimulation

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TRB 102nd Annual Meeting 2023
Washington, DC., January 8-12

Why Some Ride-sourcing Platforms Thrive and Others Don't?

We propose a novel **co-evolutionary** modelling framework to reproduce the market entry strategies for two-sided mobility platforms like **Uber**. In the ***MaaSSim*** agent-based simulator, our model captures day-to-day dynamics with agents making rational decisions to maximize their perceived utility. The methods we use for **agent's learning** distinguish us from previous works and enables us to produce essential **network effects** to run the **platform growth mechanism**.

Environment description: Platform notifies drivers and travellers about the ride-sourcing service through the marketing campaign. Notified agents make daily participation choice regarding the platform: i) drivers between working and not working and ii) travellers between ride-sourcing and public transport. Accordingly, **agents learn** from their environment and adjust their behaviours.

Methodology – S-shaped adjustment mechanism

- Perceived utility of agents is composed of **experience (E), word of mouth (WOM) and marketing (M)** components adjusted every day.

$$U_{i,t} = \beta_i^E . U_{i,t-1}^E + \beta_i^M . U_{i,t-1}^M + \beta_i^{WOM} . U_{i,t-1}^{WOM} + \beta_i^E . U_{i,t-1}^E + ASC + \varepsilon_i$$

- The key element of the proposed model lies in the **S-shaped** adjustment mechanism which allows us to realistically represent the agents' dynamics specific to the platform growth.
- Agents cumulate both **positive** and **negative** experiences and effects and eventually **stabilize** their expectations. At the same time, they remain **sensitive** to the system changes.
- We update each component *c* of utility along the S-shaped curve as follows:

$$U_t^c = \frac{1}{1+exp(\beta . CU_t^c)}$$

$$CU_t^c = \ln\left(\frac{1}{U_{t-1}^c} - 1\right) + \alpha . \Delta c_{t-1}$$

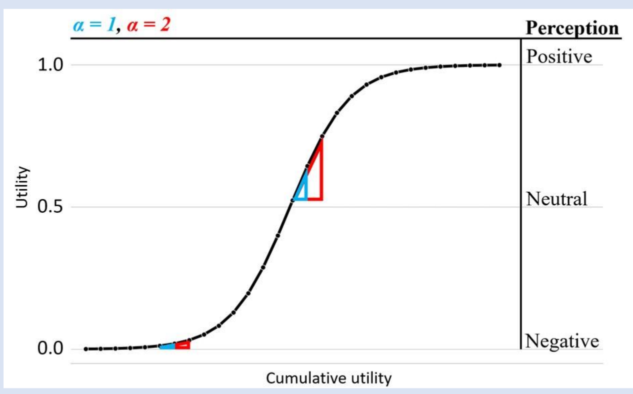

Figure 1. S-shaped learning curve for utility adjustment with high (red) and low (blue) sensitivities.

- Choice probabilities are then calculated with the classic **logit** model.

Experimental design

- A **400-day** simulation of **200 drivers** and **2000 travellers** on a **road-network of Amsterdam** with **six-stage market entry strategy**
- Agents have **neutral opinions** on the mode with **no initial experience**. They get notified through marketing and **share views** with their peers in their social network under **bandwagon effect**.
- **Commission rate, discounts and marketing** are platform's main tuning levers to steer supply-demand interaction toward profitability.

Day	Stage number	Name	Marketing	Commission	Discount
0 – 25	I	Kick-off stage	–	10%	–
25 – 50	II	Discount stage	–	10%	40%
50 – 100	III	Launch stage	5 [€/agent/day]	10%	40%
100 – 200	IV	Growth stage	–	10%	40%
200 – 300	V	Maturity stage	–	10%	–
300 – 400	VI	Greed stage	–	50%	–

Table 1. Six-stage market entry strategy

Results and insights

- Each agent follows a distinct, **unique evolution path** depending on its exposition to the marketing, word-of-mouth received from the peers and its experiences (Fig. 3).

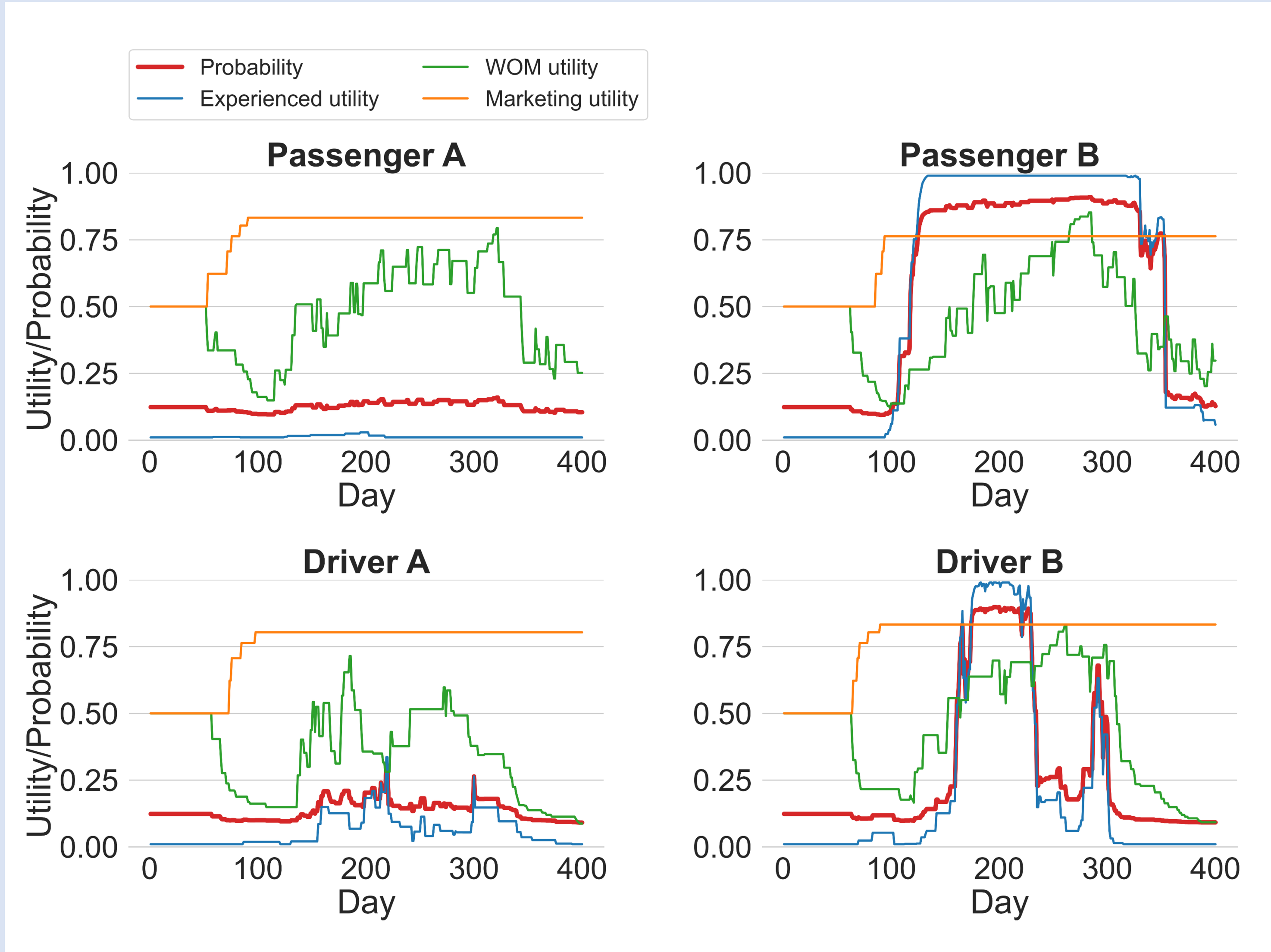

Figure 3. Evolution of utility components and participation probability at the agent level.

- When the platform reaches the **critical mass**, a strong **positive cross-side network effect** is produced from day 100 which has significant impact on **user acquisition.**
- When the platform **stabilize**, it stops offering discounts (stage V), which only slightly affects its stable market shares.
- **Negative cross-side network effect**, on the other hand, cause a collapse from day 300 (Fig. 4).

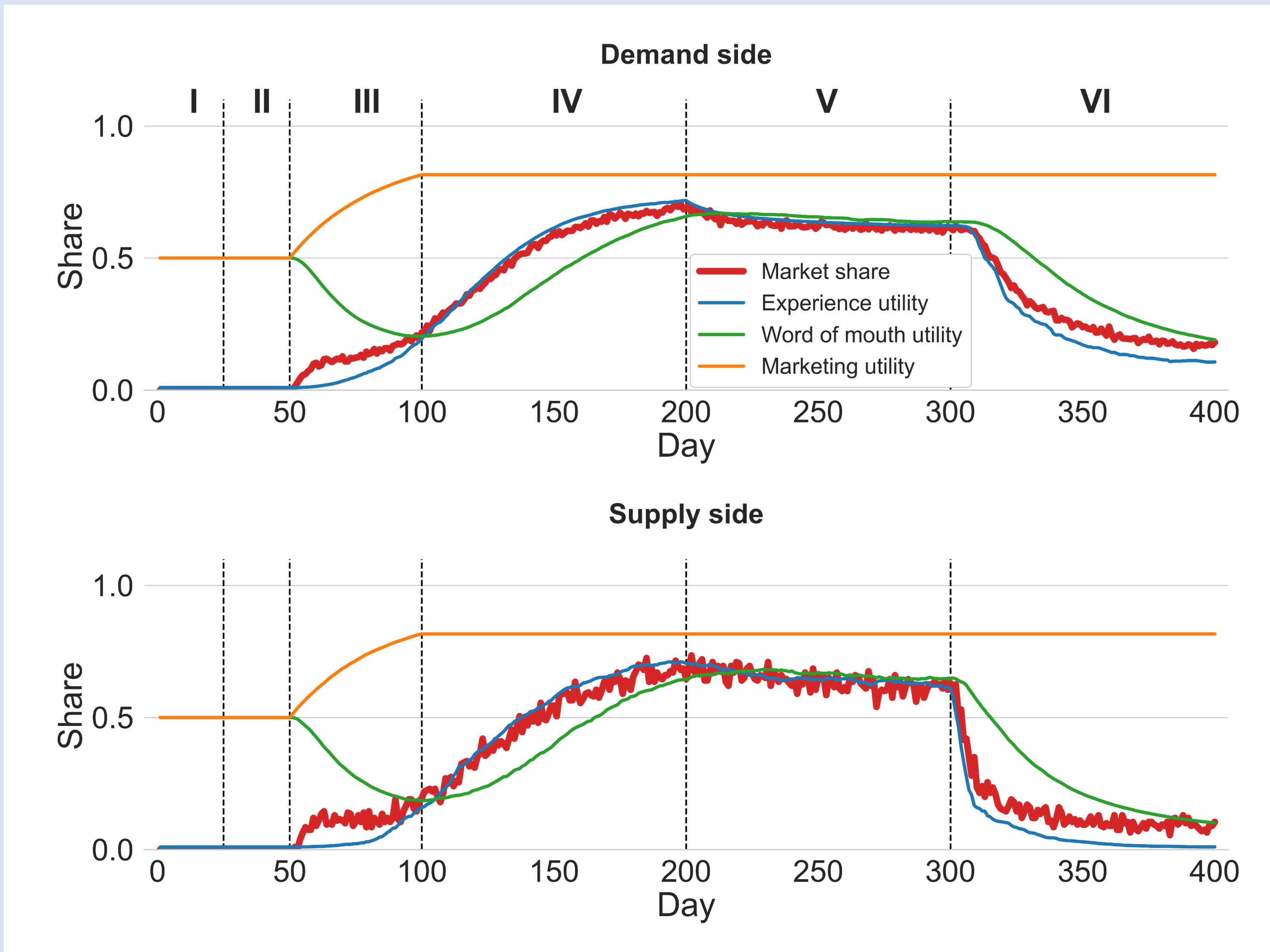

Figure 4. Evolution of the market entry strategy on both supply and demand sides in Amsterdam.

Results and insights

- The increased amount of **value creation** on both demand and supply sides boosts the network effects (Fig. 5).

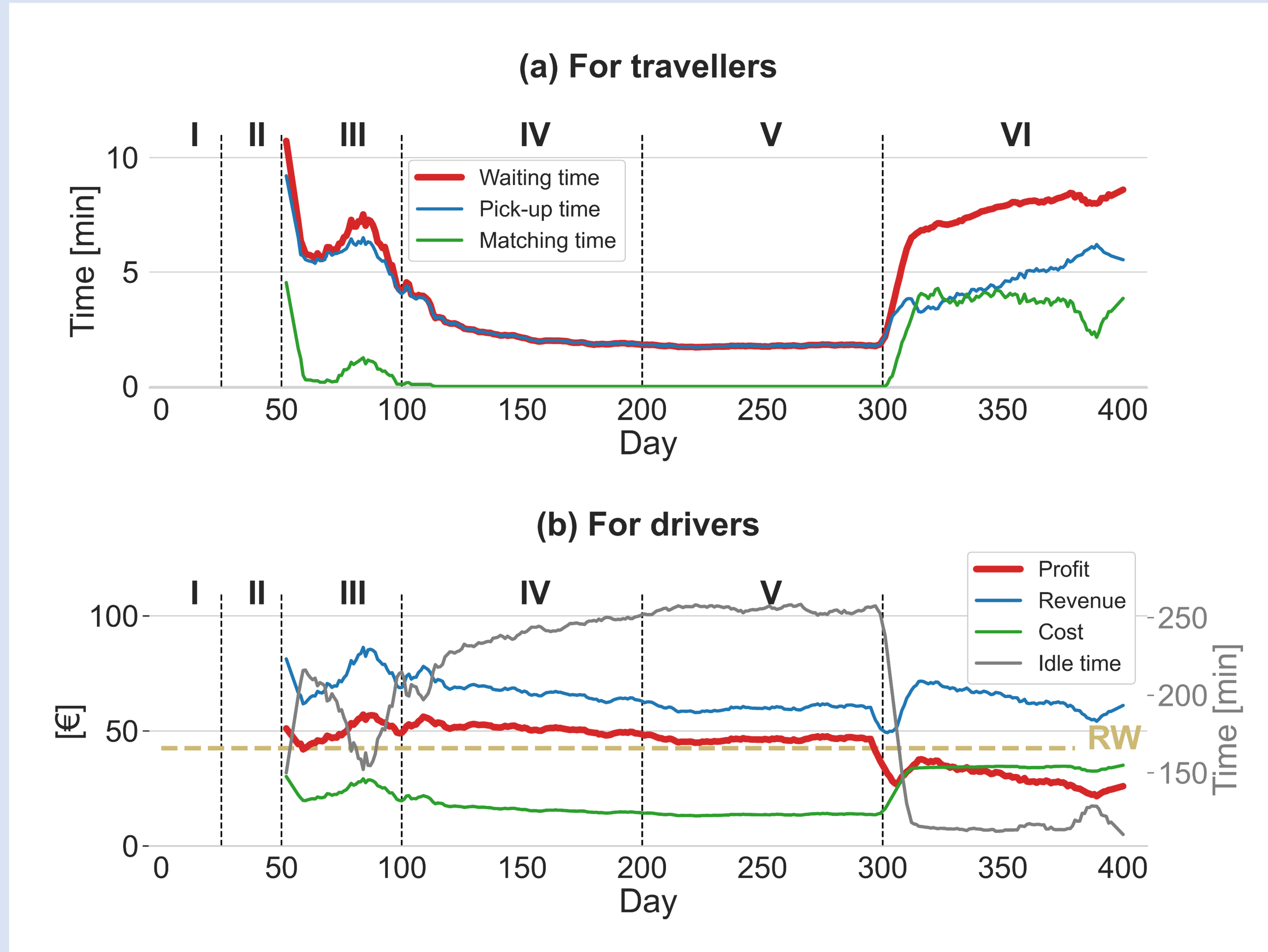

Figure 5. Evolution of key performance indicators for the supply and demand

- The increased commission after 300 days initially increases the profits, yet quickly the daily revenues become lower than in the maturity stage (Fig. 6).

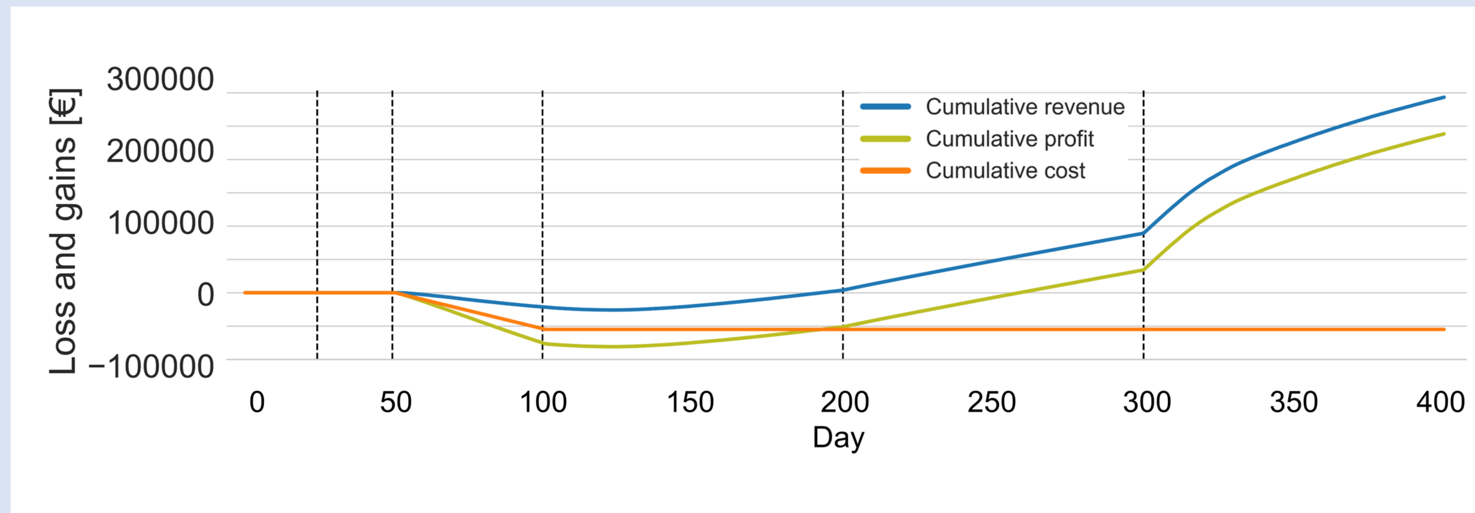

Figure 6. Cumulated loss and gains of platform

Conclusion

The novelty of our approach lays in the **S-shaped learning function**, which we advocate to be the framework capable to reproduce how agents build their experience, adapt, and stabilize their behavior with time. Furthermore, **critical mass** detection and strong **network effects** fused by **bandwagon effect** enables us to realistically model various **market entry strategies** for two-sided mobility platforms.

Acknowledgement

This research is funded by National Science Centre in Poland program OPUS 19 (Grant Number 2020/37/B/HS4/01847) and by Jagiellonian University under the program Excellence Initiative: Research University (IDUB).

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