Tokyo University of Science

Yaginuma Laboratory

The 24th Behavior Modeling Summer School

2025/09/24 (Wed.)

Back ground / Purpose (背景・目的)

In Koto Ward, where a railway gap existed between the north and south, construction is currently underway to extend the Subway Toyosumi Line.

南北に**鉄道空白地帯**が存在していた江東区では，現在「**地下鉄豊住線**」の延伸工事が進んでいる．

Estimation purposes:

① What are the travel purposes for which local residents use the Toyosumi Line, and how many users are expected.

② What is the level of user benefit along the Toyosumi Line.

① 沿線住民が**どのような目的**で豊住線を利用し，**どれだけの利用者数**が見込まれるか
② 豊住線沿線に対する**利用者の効用**はどのくらいあるのか

New Line Construction Section Map

Total project cost : 269 billion yen
Target opening : Mid-2030s
Operator : Tokyo Metro
Line extension : 5.2 km

Basic Analysis (基礎集計)

Different for commute and business

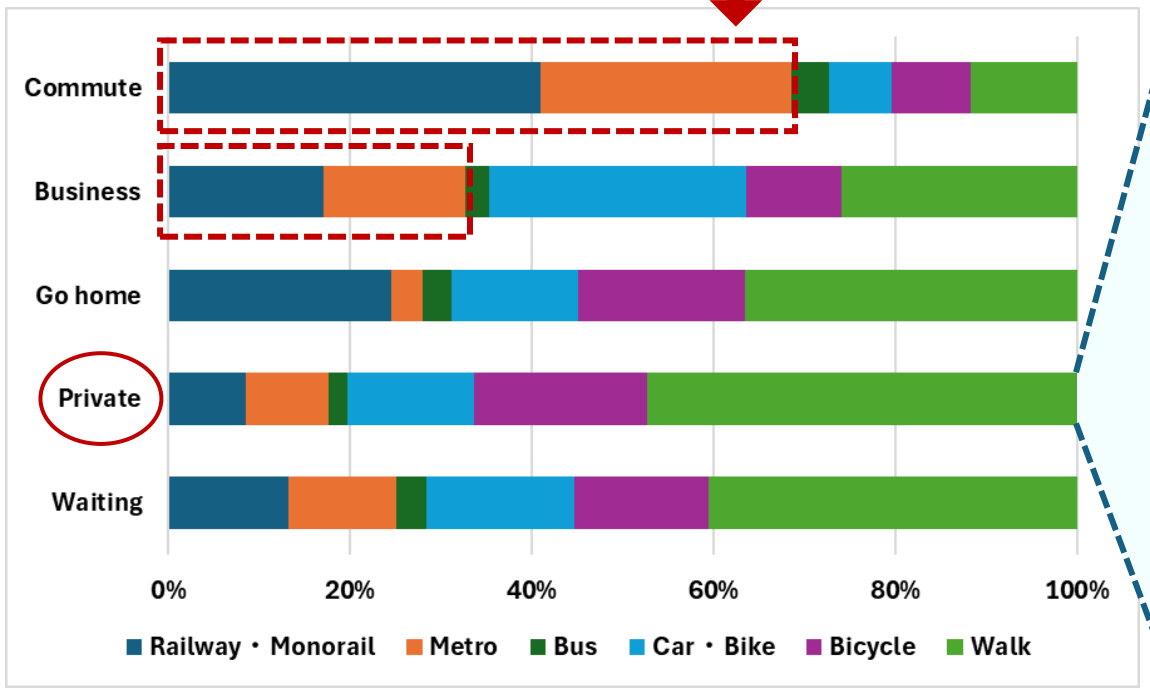

Fig.1 Primary Purpose and Proportion of Use of Main Transportation Modes

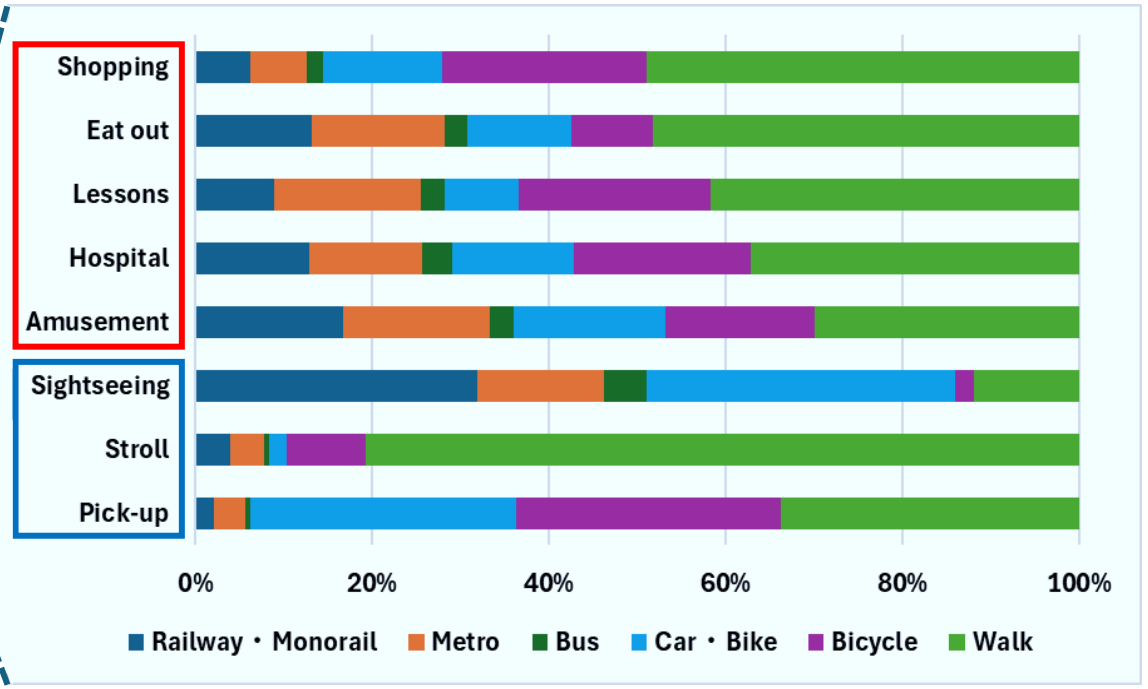

Fig.2 Detailed private purposes and proportion of representative transportation modes used

Regarding travel purposes for private activities, the top five items in the table show scattered choices, while the bottom three items exhibit a skewed distribution of selections.

Analysis (分析)

Data Preprocessing

- **Toyosu PP Data (2018～2021)**
- **The processing applied to the data used is as follows.**
  - Combined PP Data from 2018 to 2021.
  - Travel purposes were narrowed down to three categories: commute, business, and private.
  - For transportation mode selection, train and subways were grouped together.
    - ✓ Considering IIA (Independence from Irrelevant Aiternatives) characteristics.
  - Added column “Price_Car” (“Distance_Car” × 25 yen)
  - Added column “Head Train” (The number of trains was calculated using the average at Toyosu Station and Shinonome Station.)

Analysis (分析)

Estimation of Transportation Mode Choice Based on Extension of the Toyosumi Line
(MNL : maximum likelihood estimation)

Purpose

- Commute
- Business
- Private

Mode Choice

1. Train (+ Subway)
2. Bus
3. Car
4. Bicycle
5. Walk

Utility Function

time, cost, headway, constant term

$$V_{train} = \alpha \cdot t_{i,j_{train\_scaled}} + \beta \cdot c_{i,j_{train\_scaleed}} + \gamma \cdot h_{i,j_{train\_scaled}} + \delta_{train}$$

$$V_{bus} = \alpha \cdot t_{i,j_{bus\_scaled}} + \beta \cdot c_{i,j_{bus\_scaled}} + \delta_{bus}$$

$$V_{car} = \alpha \cdot t_{i,j_{car\_scaled}} + \beta \cdot c_{i,j_{car\_scaled}} + \delta_{car}$$

$$V_{bicycle} = \alpha \cdot t_{i,j_{bicycle\_scaled}} + \beta \cdot c_{i,j_{bicycle\_scaled}} + \delta_{bicycle}$$

$$V_{walk} = \alpha \cdot t_{i,j_{walk\_scaled}} + \beta \cdot c_{i,j_{walk\_scaled}}$$

Estimation Result (推定結果)

Name	Value	Std err.	T-stat.	P-value
α	0.0431	0.00679	6.35	2.14E-10
β	-0.0401	0.0187	-2.13	3.29E-2
γ	11.0	0.966	11.4	0.00
δ_{train}	16.4	0.626	26.1	0.00
δ_{bus}	17.9	0.608	29.4	0.00
δ_{car}	17.5	0.640	27.3	0.00
$\delta_{bicycle}$	16.2	0.590	27.5	0.00

Estimated Results for Commute Purpose

- **Sample size = 11017**
- **Rho square = 0.877**
- **Rho bar square = 0.877**

- **The consideration is as follows.**
  - First, let's look at the estimation results for people whose purpose of travel is commuting. The sample size was 11,017, and the adjusted likelihood ratio was 0.877.

Estimation Result (推定結果)

Name	Value	Std err.	T-stat.	P-value
α	0.00605	0.00490	1.23	0.217
β	0.103	0.0376	2.73	0.00627
γ	8.24	0.523	15.8	0.00
δ_{train}	14.4	0.388	37.0	0.00
δ_{bus}	19.3	0.124	156	0.00
δ_{car}	17.0	0.135	125	0.00
$\delta_{bicycle}$	17.0	0.0954	178	0.00

Estimated Results for Business Purpose

- **Sample size = 2010**
- **Rho square = 0.838**
- **Rho bar square = 0.837**

- **The consideration is as follows.**
  - Next, we look at the estimation results for people whose travel purpose is work. The sample size for travel purpose is 2010, and the adjusted likelihood ratio is 0.837.

Estimation Result (推定結果)

Name	Value	Std err.	T-stat.	P-value
α	0.0493	0.0170	2.90	0.0370
β	0.120	0.0307	3.92	0.000090
γ	6.38	0.303	21.1	0.0
δ_{train}	15.4	3.76	4.09	0.000042
δ_{bus}	18.1	3.71	4.88	0.000001
δ_{car}	17.4	3.79	4.58	0.000005
$\delta_{bicycle}$	16.7	3.67	4.55	0.000005

Estimated Results for Private Purpose

- **Sample size = 5511**
- **Rho square = 0.796**
- **Rho bar square = 0.795**

- **The consideration is as follows.**
  - We decided to focus on personal matters in this estimation because, compared to routine commuting and work, these tend to take place in different locations, which creates more diversity in movement.

Estimation Result (推定結果)

The consideration of the Estimation

- **Why were the rho bar squares over 0.4?**
  - A person did same trips, and they were duplicated.
- **Why was the value of headway coefficient too high?**
  - Different stations in Toyosu area is virtually aggregate into one station.
- **Why were the value of time coefficient and one of cost coefficient plus?**
  - Term of headway, which was low accuracy, might make them plus.

ありがとうございました

Estimation Result (推定結果)

Name	Value	Std err.	T-stat.	P-value
α	-0.0126	0.00598	-2.10	0.00
β	-0.107	0.0130	-0.818	0.00
δ_{train}	18.6	0.195	95.6	0.00
δ_{bus}	16.7	0.152	110	0.00
δ_{car}	15.8	0.197	80.1	0.00
$\delta_{bicycle}$	14.5	0.174	82.9	0.00

Estimated Results for Commute Purpose

- **Sample size = 11017**
- **Rho square = 0.635**
- **Rho bar square = 0.635**

- **The consideration is as follows.**
  - Both α and β are negative, meaning that utility increases as time and cost decrease. In other words, this result can be interpreted naturally.

Estimation Result (推定結果)

Name	Value	Std err.	T-stat.	P-value
α	6.45E-4	0.00278	0.232	0.817
β	-0.0158	0.0123	-1.28	0.200
δ_{train}	17.8	0.0859	207	0.00
δ_{bus}	17.6	0.0808	218	0.00
δ_{car}	15.2	0.128	118	0.00
$\delta_{bicycle}$	14.9	0.117	128	0.00

Estimated Results for Business Purpose

- **Sample size = 2810**
- **Rho square = 0.416**
- **Rho bar square = 0.415**

- **The consideration is as follows.**
  - We speculated that the coefficient for the time component being slightly positive might be because travel time for work is actually rather pleasant for people.

Estimation Result (推定結果)

Name	Value	Std err.	T-stat.	P-value
α	0.00711	0.00213	3.35	0.000822
β	0.0338	0.00944	3.58	0.000339
δ_{train}	17.9	0.0648	276	0.0
δ_{bus}	16.8	0.0648	259	0.0
δ_{car}	15.7	0.0846	186	0.0
$\delta_{bicycle}$	15.1	0.0782	194	0.0

Estimated Results for Private Purpose

- **Sample size = 5511**
- **Rho square = 0.413**
- **Rho bar square = 0.413**

- **The consideration is as follows.**
  - 時間・金額のパラメータが正なのでおかしい