Mode Choice Model Visualisation

Figure 1 visualises the results reported in Table 2 by presenting a dot–whisker plot of the coefficient estimates and their associated 95% confidence intervals for the Multinomial Logit (MNL) models. Results are shown for the full adolescent sample as well as separately for males and females. The vertical dashed line at zero denotes the point at which a coefficient transitions from a negative to a positive influence on the probability of selecting each travel mode. This plot therefore serves as a graphical representation of the parameter estimates summarised in Table 2.

A notable feature in the figure is the substantial uncertainty surrounding the monetary cost coefficient (β_{money}), which exhibits wide confidence intervals spanning zero across all three model specifications. This lack of statistical significance suggests that travel cost does not play a meaningful role in shaping adolescents' mode choice decisions in this sample. The estimated values are as follows:

- All adolescents: $6.499; [-17.345, ; 30.344]$
- Females: $10.561; [-18.371, ; 39.493]$
- Males: $-3.541; [-45.875, ; 38.793]$

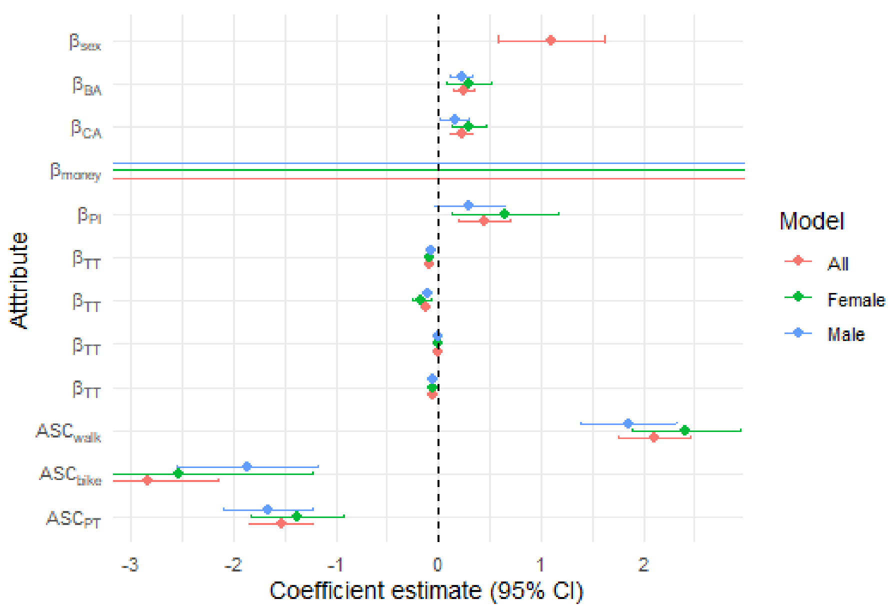

Figure 1: Coefficient estimates with 95% confidence intervals for MNL models

Travel time estimation

Reported travel times in the Victorian Integrated Survey for Travel and Activity (VISTA) dataset were verified against network-derived values. For each origin–destination pair, times were generated for car, Public Transport (PT), walking, and cycling during a representative peak period. These travel times formed the impedance inputs in the MNL. Active mode speeds were standardised at 15 km/h for cycling and 4.5 km/h for walking to ensure comparability across trip distances.

Network-based travel times using `r5r`

Non-cycling travel times were estimated using the R5 routing engine via the `r5r` package in R, which combines OpenStreetMap (OSM) networks with General Transit Feed Specification (GTFS) transit schedules. Trip origin and destination coordinates from VISTA were supplied to compute travel times for a 07:00 AM departure, representing typical weekday peak conditions.

PT and walking durations were obtained using `travel_time_matrix()`, specifying `TRANSIT` with walking egress for PT, and `WALK` for pedestrian trips. A one-minute time window allowed multiple departure samples, and upper limits for walking time (60 min) and total trip duration (700 min) prevented unrealistic paths. Trips with no viable PT connection were assigned `NA`. Car travel times were derived using `detailed_itineraries(mode="CAR")`, and the `total_duration` output was used directly as car travel time.

Cycling travel times using LTS-based routing

Cycling times were computed separately based on a Level of Traffic Stress (LTS)-classified bicycle network constructed from OSM data. A directed network was created and each link assigned one of four LTS categories. Routing was performed using the `igraph` package in R.

Trips with exact coordinates used the nearest network nodes. For cases with only Statistical Area Level 1 (SA1) identifiers, candidate nodes within or near each zone boundary were selected, favouring locations on LTS 1–2 links. If such nodes were unavailable, the search expanded to higher LTS routes. For each trip, one origin and one destination node were randomly selected from candidates to avoid centroid bias while maintaining reproducibility.

Shortest-time paths were computed by weighting each link by its length divided by a constant cycling speed (15 km/h = 4.167 m/s). Cycling travel time in minutes for a path P was calculated as:

$$T_P = \frac{1}{60} \sum_{e \in P} \frac{L_e}{v_{\text{bike}}} \tag{1}$$

where L_e is the link length (metres) and $v_{\text{bike}} = 4.167$ m/s.

Travel cost estimation

Monetary costs were assigned for private car and PT travel, while walking and cycling were assumed to incur no direct financial cost.

Public transport cost

PT fares were determined using the time-based Myki fare system applicable in Greater Melbourne during the VISTA survey period (2012–2020). PT users typically made two trips per day, and fares operate on a two-hour validity window with a daily cap. Accordingly, trips with a total duration of two hours or less were assigned a cost of 4 AUD, representing a single two-hour fare. Trips exceeding two hours were allocated the daily fare cap of 8 AUD. This rule approximates typical fare expenditure for commuters and ensures consistency with observed ticketing policy.

Car travel cost

Car operating cost was based solely on fuel consumption. Other charges, such as parking or tolls, were excluded due to limited availability in the VISTA dataset. Fuel cost was calculated using:

$$\Delta m_{\text{driving}} = \gamma_{d,\text{car}} \times d_{\text{trav,driving}} \tag{2}$$

where $\Delta m_{\text{driving}}$ is the total fuel expenditure (AUD), $d_{\text{trav,driving}}$ is trip distance (km), and $\gamma_{d,\text{car}}$ is the fuel cost rate (AUD/km).

The fuel cost per kilometre was derived using standard consumption rates for a medium petrol vehicle (11.8 L/100 km) from ATAP guidelines and the average fuel price in Victoria during the survey period (1.35 AUD/L). The resulting unit cost was:

$$\gamma_{d,\text{car}} = \frac{11.8 \times 1.35}{100} = 0.1593 \text{ AUD/km} \tag{3}$$

Thus, driving cost for each trip was computed as distance multiplied by this unit rate, providing a consistent estimate of fuel expenditure across the sample.