Task 10.3 Peak-Spreading

Base Generalised Costs

In the calibration of the updated WTSM we have used generalised costs averaged between the am peak and interpeak periods, the averaging being determined by the observed proportion of trips in the peak and other period:

If

P = (am peak + pm peak) / 24 hour trips(all modes) for a particular trip purpose

Then the mean generalised cost for this purpose and mode is given by:

P * am peak mode cost + (1-P) * interpeak mode cost

(We assume that the interpeak cost is appropriate for all off-peak journeys.).

In more precise mathematical notation:

$$P_p = (T^{7\text{-}9}_p + T^{16\text{-}18}_p)/T^{24}_p$$

where $T^{7\text{-}9}_p = \Sigma_{ijm} T^{7\text{-}9}_{ijmp}$ etc where i & j are zones, p is the trip purpose and m the transport mode

Then:

$$GC_{ijmp} = P_p * GC^{7\text{-}9}_{ijmp} + (1\text{-}P_p) * GC^{9\text{-}16}_{ijmp}$$

Important note: the proportions are (i) not mode-specific and (ii) relate to combined am and pm peak travel.

The Peak-Spreading Model

In the future years, we are concerned that the car travel time period factors for each purpose may change and, in particular, be affected by congestion pricing strategies.

<u>Simplified description</u>

We assume a logit choice model between the am peak period and the interpeak which uses as measures of utility the generalised cost of travel by car in the two time periods. We use an incremental implementation of the model, pivoting around the base year shares of travel between the two time periods which can be expressed as follows:

$$P^x_{am} = P^0_{am}/[P^0_{am} + (1\text{-}P^0_{am}).\ \exp(\Delta U^x\text{-}\Delta U^0)]$$

where:

P^x_{am}, P^0_{am} are the proportions of am peak trips in the base (0), derived from the time period factors, and alternative (x) scenarios

ΔU^x, ΔU^0 are the differences in the generalised costs of travel GC in the am and midday periods for the two scenarios factored by a sensitivity coefficient which converts them to utilities; ie

$$U^0 = \beta.(GC^0_{mid} - GC^0_{am})$$

where:

β is set to achieve the required elasticity.

The effective calibration of a useful model will be difficult. Nonetheless, the interest in investigating road pricing etc, requires some kind of peak-spreading module. Our inclination is towards a simple approach which would provide the required functionality, and in which the coefficients could be guessed/judgemental if necessary.

Detailed Specification

The approach which we shall adopt is an incremental model which estimates the change in the peak proportion as a function of the change in the peak/interpeak cost differential.

$$MF^1(d)^t_{pij} = \frac{MF^0(d)^t_{pIJ} * \exp\lambda_p.(GC^1(d)^t_{pij} - GC^0(d)^t_{pij})}{\Sigma_k[MF^0(d)^k_{pIJ} * \exp\lambda_p.(GC^1(d)^k_{pij} - GC^0(d)^k_{pij})]}$$

Where

MF are the matrix factors for car by direction d
t is the peak time period (am or pm)
the superscripts 0 and 1 describe base and policy
λ_p is implicitly negative
the choices (k in the denominator) are the am peak and pm peak and rest of day (the other 20 hours, using costs for the interpeak to represent all off-peak travel).

In principle λ_p should be larger than the distribution model parameter for car trips for each trip purpose; this parameter will be set to give reasonable results and be consistent with the Sydney Harbour Tunnel experience[1] and any other international evidence.

The above formula is applied to the am and pm peaks and it seems appropriate to assume that the impact on the interpeak is (i) in the reverse direction and (ii) half of the sum of these 2 effects (in that some of the change will be to the pre-am peak and post-pm peak). In other words, traffic spilled out of the am peak (or vice versa) would have to be assumed to split equally between the pre- and post-peak times; thus the impact on the interpeak would be half of the 'spill'; ditto the pm peak.

Finally we need to note that our method of determining purpose-specific generalised costs by a weighted average of the time period journey times is not entirely consistent with the peak-spreading module. In principle, we could improve the consistency in two ways:

- adjust the weighed 'base' time by the incremental implied change in the logsum cost out of the peak-spreading module;
- replace the averaged costs by the logsum.

In practice, these both seem unnecessary refinements adding to complexity and, in the case of the second, undermining existing calibrations.

The value of λ cannot be calibrated and must be set to give sensible results which also relate to the experience of the Sydney Harbour Tunnel.

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[1] Where we have some evidence of the change in time profile when additional capacity is added to an existing bottleneck (the bridge).