Modelling cycling rates to 2050

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What could happen if we get serious about cycling

Current expectations:
The kind of thing that’s needed:
Policy context

- GBC report published spring 2013 with ambitious plan for cycling
- Since then there has been little commitment to cycling from main political parties of DfT
- Parliamentary Question tabled by CTC revealed complete lack of ambition for cycling the National Transport Model
- DfT is currently updating its handling of cycling, but it will likely fall short of the vision needed to transform cycling in UK
- This research provides detail in space, time and demographics of how the shift to cycling could look in the coming years
Context: in graphics

- GBC 2025 target
- GBC 2050 target
- Percentage of trips by bicycle
- Data: NTM, NTS2013, TfL
- Model: Exponential, Linear, Logistic

Graph showing the percentage of trips by bicycle over years from 2000 to 2050, with targets for GBC 2025 and 2050. The graph includes data points and models for exponential, linear, and logistic growth.
The approach

- Occam's razor approach used: start simple, add complexity (distance, mode, spatial and temporal variables)
- Avoids distinction between ‘cyclists’ and ‘non-cyclists’
- Scenarios are ‘top down’ overall but assignment ‘bottom up’
- Focus on stages
- Outputs: increase in km cycled per person by place and time; concomitant decrease in driving
Modelling stages

1. Scenario development - overall % stages by bicycle nationwide
2. Allocation of stages to individuals depending on distance, mode and socio-demographic variables
3. Disaggregate by Local Authority
4. Output results into format useable by health and transport economists to estimate monetary savings
4 scenarios of change

- DfT: doubling in *number* (+74%) of stages made by bicycle to 2026
- Slow start: DfT until 2026 and acceleration to meet GBC by 2050
- ‘Go Dutch’: cycling uptake in a car-dominated world
- ‘Ecotechnic’: demand restraint and active travel
4 scenarios of change, visualised
NTS: foundation of future scenarios

- Travel in the UK’s National Travel Survey (NTS) is measured in stages and trips.
- Data in the NTS contains information on households, vehicles, individuals, trips and stages.
- The NTS is the basis of the future scenarios produced by the Department for Transport (DfT) and in this study.
- We therefore begin with current data from the NTS and move forward.
- Sample of individuals taken from NTS forms basis of weekly activity patterns, to be translated into health impacts.
National trip rates and modelling change

- Stages are the atomic elements of the NTS (7.8 vs 9.1 miles)
- A logical basis against which to model modal shift.
- DfT projects **doubling** in the number of stages by bicycle by 2025.
- Assume (for now) that stage distances and total number remain constant
Proportion of trips made by bicycle

Currently cycling accounts for just under 2% of all stages, commuting taking up disproportionate share of cycle trips:

<table>
<thead>
<tr>
<th></th>
<th>Shopping</th>
<th>Commuting</th>
<th>Visiting friends</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>All_modes</td>
<td>18.6</td>
<td>17.4</td>
<td>16.2</td>
<td>47.8</td>
</tr>
<tr>
<td>Bicycle</td>
<td>12.0</td>
<td>32.9</td>
<td>13.6</td>
<td>41.5</td>
</tr>
<tr>
<td>Bus</td>
<td>26.4</td>
<td>20.6</td>
<td>13.9</td>
<td>39.0</td>
</tr>
<tr>
<td>Car/van driver</td>
<td>19.7</td>
<td>22.0</td>
<td>13.4</td>
<td>44.9</td>
</tr>
<tr>
<td>Car/van passenger</td>
<td>17.8</td>
<td>6.8</td>
<td>23.5</td>
<td>51.9</td>
</tr>
<tr>
<td>Walk</td>
<td>16.8</td>
<td>11.9</td>
<td>13.4</td>
<td>57.9</td>
</tr>
</tbody>
</table>
Distance distribution of stages

- Network distance and mode are the most important parameters for determining probability of shifting mode
In the simplest case, cycling trips double by swapping 1.7% of stages to cycling in every band:
A close up of cycling

- Distribution of **cycling** stages has grown, shifted to the right:
Incorporating distance

- Simplest example is unrealistically assumes equal proportion of trips shift for every distance band
- In practice it’s more like an exponential decay (Iacono et al., 2011)
- Distance can be accounted for by setting probability of a shift as a function of distance

\[ p = \alpha e^{-\beta d} \]
Incorporating distance II

- Values from Iacono et al. (2011) were used: $\alpha = 0.4$, $\beta = 0.2$ for bicycle trips
- These parameters can and should be updated with better evidence
- Distance decay, $\beta$ is dependent on trip purpose, kept constant for now
Incorporating distance III

- The results look the same as for the simplest scenario yet they are subtly different
Comparing ‘distance switch’ with simplest scenario

- The purpose of the distance-dependent probability of switch was to provide more realistic switching.
- Proportion of trips > 10 miles by bike:
- Overcomes issue of unrealistic % of long trips by bike in simplest scenario

<table>
<thead>
<tr>
<th>Current</th>
<th>Simplest case</th>
<th>Distance-decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8</td>
<td>7.2</td>
<td>1.2</td>
</tr>
</tbody>
</table>
Comparing the scenarios II

![Comparison of scenarios](image)
Including mode of travel

With the per-trip probabilistic modelling framework set-up, driven by prior knowledge of the number/proportion of stages to be made by bicycle, it is easy to refine.

- Evidence suggests bicycle uptake disproportionately replaces walking and bus travel than car journeys.
- To include this subtlety, we simply assign a relative weight to each mode of travel, indicating how much more likely it is to be replaced by bicycle trips than the others.
- If a car we set at 0.5 and bus at 1, for example, half the number of car journeys, on average, would be replaced by bicycle trips than would bus stages.
- The absolute probabilities do not matter, as these are determined by the sample size in R’s `sample` function (as long as \( p < 1 \)).
Altering mode-specific probabilities

<table>
<thead>
<tr>
<th></th>
<th>Bus</th>
<th>Car.d</th>
<th>Car.p</th>
<th>Other</th>
<th>Walk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>0.5</td>
<td>0.6</td>
<td>0.5</td>
<td>1</td>
</tr>
</tbody>
</table>

- Possible issue of double counting
- Comparison of modes that were replaced by new bicycle trips
- Outcome is policy dependent: e.g. congestion charges
- E.g. cuts to bus services -> more bus journeys replaced
The impact of mode-specific probabilities:

% trips replaced by bicycle in different scenarios:

<table>
<thead>
<tr>
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<th>Bus</th>
<th>Car/van driver</th>
<th>Car/van passenger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>0</td>
<td>6.8</td>
<td>42.9</td>
<td>25.8</td>
</tr>
<tr>
<td>Distance + Modes</td>
<td>0</td>
<td>11.2</td>
<td>32.8</td>
<td>21.9</td>
</tr>
</tbody>
</table>

- No strong evidence on likely distribution
- Just distance scenarios used at present for ‘policy neutrality’
### Including trip purpose

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<thead>
<tr>
<th></th>
<th>Shopping</th>
<th>Commuting</th>
<th>Visiting/friends</th>
<th>Other</th>
<th>(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All_modes</td>
<td>18.6</td>
<td>17.4</td>
<td>16.2</td>
<td>47.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Bicycle</td>
<td>12.0</td>
<td>32.9</td>
<td>13.6</td>
<td>41.5</td>
<td>1.7</td>
</tr>
<tr>
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<td>26.4</td>
<td>20.6</td>
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- Current preferences may not reflect future change
- Low % could represent aversion to cycling for shopping. Or growth potential...
- Probabilities of switch by purpose is highly policy dependent
Including socio-demographics

- Not is inclined to cycle, especially in car-dominated settlements with poor cycle infrastructure
- Variability is a function of age: the young have been responsible for most growth in cycling in London and some elderly cannot cycle
- Large implications for health savings
- Strategy: modify probability of switching each stage to bicycle based on the age of the traveller
Including space

- To take account of space, we subset individuals by region (variable j58g)
- The characteristics of current trips in each region will then filter-down into probability of modal shift
- This will provide insight into how high growth rates will have to be in London for nationwide targets to be met
Trips distributions by region

- Greater London
- North East
- Scotland
- Yorkshire & Humberside

**Number of trips** vs **Miles**

**Mode**
- Bicycle
- Bus
- Car/van driver
- Car/van passenger
- Other
- Walk
Discussion and conclusion

- Region -> LA -> individual -> trip -> stage level analysis
- Short-term GBC parliamentary debate, monetary valuation is needed
- Increased physical activity due to cycling will be an output
- Emissions savings: relatively straightforward
- Estimating congestion savings still a challenge
- Mid-term aim: use scenarios to update 2011 work: Energy implications of modal shift to cycling to 2050 in the UK