# Cycling Opportunity: Model Methodology

The model is designed to inform the impact of providing discounts (£50, £100, £150, £200, 20%, 30%, 40% and 50% off) on a new cycle and accessories to those who are on low income, unemployed or economically inactive within the UK.

The broad function of the model is to:

* Estimate the number of trips/distance that would be cycled for various purposes, as well as the number of cycle trips/distance that are shifted from other modes
* Estimate the cost to government to provide the discount
* Estimate the impacts associated with the change in cycling levels, including:
  + Economic costs and benefits
  + Changes in greenhouse gas and local pollutants levels
  + Changes in physical activity (health care system savings and reduction in sick days)

The central input to the model is data from a representative survey of those in the UK of working age who are on low income, unemployed or economically inactive, undertaken as part of the ‘Cycling Opportunity’ project. A range of other data also feed in.

## Estimating trips and distance

In order to estimate the number of trips and the overall distance that would be cycled for various purposes, as well as the number of cycle trips/distance that are shifted from other modes, the key inputs were:

1. **The number of people who would use a discount[[1]](#footnote-2)**
   * The uptake of the Cycle to Work scheme in 2023 was used to indicate the general scale of uptake of a discount, in a year, in this context
     + We estimate that 0.827% of those eligible for the Cycle to Work scheme take it up in a given year. When applied to people on low incomes or not in employment, this is 96,737 people.
     + As an estimate of annual uptake, this rate of uptake seems more realistic than our survey results, where participants may have been overly optimistic (14% said they would be very likely to take up a 40% discount, equivalent to 1.6 million people).
   * Our survey data informed the difference between the discount levels, in terms of the number of people taking up the discount. Survey respondents were excluded from the modelling if they were outside of minimum or maximum willingness to pay criteria (see Exclusions from the modelling process section).
2. **The number of cycle trips that people would take if they had a discount on a new cycle.** This is based on survey data
   * Respondents were asked how many cycle trips they would do each week for individual purposes:
     + To/from Work
     + To/from Work in the future if a job is secured
     + To/from School, college or university, including escort trips with children
     + For enjoyment or fitness
     + For all other personal trips, including getting to and from the shops, visiting friends and family or going to the doctors
   * They were also asked how many of the cycle trips would be:
     + Replacing car trips
     + Replacing bus trips
     + Replacing train trips
     + Replacing walking or wheeling trips
     + Cycle trips that were taken on their previous cycle
     + Cycle trips that are new trips, not replacing a trip by another mode.
3. **Typical distance of a one way cycle trip for individual purposes**, also based on survey data.

Within a given discount level and trip purpose, the proportion of respondents in each ‘number of cycle trips per week’ category is summarised. The number of trips by those in each of the ‘number of cycle trips per week’ categories are then scaled up to the population size of those interested in that discount level.

As an example, if 0.62% of those interested in a 40% discount (the total population interested, in this example, is 96,737), said that they would cycle two trips a week to and from work, the annual cycle trips cycle by those who cycle two trips a week to and from work can be calculated in the following way:

*Cycle trips per day* (0.40) = *number of trips per week* (2) / the *number of working days in a week* (5)

*Annual cycle trips* (52,748) *= Population size* (96,737)\* *% of those who are interested in a 40% discount that cycle to trips a week to and from work* (0.62%) \* *Total number of days cycled per year for this purpose* (220[[2]](#footnote-3)) \* *Cycle trips per day* (0.40)

This process is repeated for each of the ‘number of cycle trips per week’ categories. The trip estimates generated across each of ‘number of cycle trips per week’ categories are summed, to obtain an overall annual trip estimate.

The overall annual trip estimates are then refined in two ways:

* Seasonal adjustment: to adjust the estimates so that they are more representative of year-round levels, rather than the time of year that they data was collected
* Trip chaining: accounting for trips that are double counted due to being part of a trip chain.

The same process is also applied to the cycle trip data relating to the source of the trip (e.g. cycle trips replacing car trips, etc).

In the survey data, upper and lower limits for the number of trips cycled were set (different levels for different trip purposes). Some trip purpose data was removed due to being outside of the limits.

Median trip distance values were calculated for each trip purpose/discount level combination. The median trip distance values are applied to the overall trip estimate for the relevant trip purpose, in order to generate the total distance cycled for that purpose.

## Estimating the cost to government to provide the discount

### Fixed £ value discount levels

For the fixed £ value discount levels (£50, £100, £150, £200) the cost to government was calculated by multiplying the number of people would take up the discount level by the value of the discount level.

### % discount levels

There is greater complexity in the calculation of the cost to government for the % discount levels. In our survey, respondents were asked:

* How much they’d be willing to pay for a new cycle (and any required accessories) after accounting for any financial support
* Which type of cycle (standard bicycle, electric bicycle, cargo cycle, adapted cycle) they’d be interested in using the financial support to purchase (if any).

Using this data, we were able to calculate:

* The median **total** bicycle (and accessories) cost (without discount) for each discount level
* The median **cost to government** to provide the discount value associated with the level of discount.

A median cost to government to provide the discount is calculated separately for:

* Standard bicycles
* Non-standard cycles (electric cycle, cargo cycle, adapted cycle).

To obtain a total cost to government, the median cost to government to provide the discount to an individual wanting to buy a **standard bicycle** is multiplied by the number of people taking up the discount to buy a **standard bicycle**. The same calculation is conducted for **non-standard cycles**, and the arising costs are summed.

The model allows the user to specify three different cycle type offerings:

* A 90% standard cycle/ 10% non-standard cycle split (based on the broad distribution of UK cycle sales, according to data provided by the Bicycle Association)
* A standard cycle only scheme
* A non-standard cycle only scheme.

These different cycle type offerings have different numbers of people using the scheme and different costs, associated with them.

## Economic costs and benefits

The calculation of economic costs and benefits is based on the Societal Gain Model, developed by Sustrans as part of the Index programme[[3]](#footnote-4). The Societal Gain Model puts a financial value on walking, cycling and driving by assigning values to their related costs and benefits. For example, it incorporates the cost to run a car and the health benefits to the NHS from being physically active cycling.

The benefits and costs included in our model are shown in the table below. Internal costs and benefits are those to the individual, while external costs and benefits are to society.

Table 1. Description of Societal Gain Model costs and benefits categories

|  |  |
| --- | --- |
| Cost/benefit | Description |
| Time Cost (travel time, non-work) | The value of time spent travelling. The value of time is from the country’s transport appraisal guidance and is divided by the average speed. No time cost is ascribed to leisure trips. Internal only. |
| Vehicle Operating Costs | The cost of owning and running a car (driving), cycle (cycling) or shoe wear (walking). Excludes initial purchase cost. For train and bus travel this is the cost of the fare (internal) and the rest of the operating costs (external). Internal cost; For cars, vehicle tax is considered an external benefit but an internal cost. |
| Prolonged Life | Longer life expectancy from physical activity. Internal benefit and a small external cost (welfare cost). |
| Health | Decrease in illness incidence, reduced cost of medical treatments, fewer days of sick leave. Includes both an internal and external benefit. |
| Congestion | The time loss imposed on *other travellers* because of simultaneous use of the road network, including travel time, operating cost and fuel cost. External cost. |
| Infrastructure Maintenance | Resurfacing, overlay and road markings of infrastructure used by cars. Infrastructure maintenance cost for cycling and walking is too low to quantify. External cost. |
| Local Air Quality | This relates to the health and environmental impacts of atmospheric emissions of pollutants from motorised vehicles (CO2, CO, SO2, NOx, PM10, Hydrocarbons, Benzene, 1,3-butadiene). External cost. |
| Noise | Based on the relationship between average noise levels and property prices. External cost. |
| Greenhouse Gases | The cost associated with the impact on climate change from vehicle CO2 output. External cost. |
| Indirect Taxation | Fuel duty. External cost. |
| Soil and Water Quality | Pollutants released to soil, water bodies and groundwater, such as hydrocarbons, non-gaseous exhaust, heavy metal particulates from the wear of mechanical components such as brake pads, as well as salt and gravel used for anti-icing or winter maintenance. External cost. |
| Well-to-tank Emissions | Emissions (of greenhouse gases and other pollutants) due to fuel production and transport to the consumer. External cost. |

The values assigned to each are based on the best available evidence.

Within each mode, the values for individual cost/benefit categories are totalled, to obtain a total cost/benefit per mile travelled by that mode.

The cost of time is only included for trips to/from destinations (such as to/from work, school, shops etc). Trips for enjoyment or fitness are made for their own sake, so time is not counted as an incidental cost.

The value of new cycle trips are calculated in the following ways:

* Cycle trips that are new trips, not replacing miles by another mode: Multiplying the miles cycled that are new trips, not replacing miles by another mode, by the total cost/benefit per mile cycled
* Cycle trips that replace trips by another mode (e.g. cycle trips replacing car trips): The difference between the value total cost/benefit per mile cycled and the total cost/benefit per mile travelled by the other mode is calculated. This value is then multiplied by the miles cycled that are replacing miles by that other mode.

The costs and benefits are also summarised using subsets of the Societal Gain Model, for example, performing the same calculations but only for internal operating costs, to indicate the financial costs and benefits to the individual doing the travelling.

The overall output from the Societal Gain Model is compared with the cost to government in order to calculate a benefit cost ratio for the delivery of the level of discount provided, based on the level of additional cycling in a year.

Table 2. Value per mile for each mode

(Positive values are benefits and negative values are costs)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cost/benefit | Cycling | Walking | Driving | Bus passenger | Train passenger |
| Time Cost (travel time, non-work) | -£1.30 | -£3.43 | -£0.48 | -£0.79 | -£0.56 |
| Vehicle Operating Costs | -£0.08 | -£0.07 | -£0.70 | -£0.40 | -£0.75 |
| Prolonged Life | £0.56 | £1.12 | - | - | - |
| Health | £0.59 | £1.17 | - | - | - |
| Congestion | - | - | -£0.30 | -£0.07 | £0.00 |
| Infrastructure Maintenance | - | - | -£0.002 | - | - |
| Local Air Quality | - | - | -£0.01 | -£0.01 | -£0.002 |
| Noise | - | - | -£0.004 | -£0.01 | -£0.02 |
| Greenhouse Gases | - | - | -£0.06 | -£0.03 | -£0.001 |
| Indirect Taxation | - | - | £0.08 | £0.04 | - |
| Soil and Water Quality | - | - | -£0.014 | - | - |
| Well-to-tank Emissions | - | - | -£0.010 | -£0.003 | -£0.01 |
| TOTAL per distance unit | -£0.24 | -£1.21 | -£1.50 | -£1.27 | -£1.35 |
| TOTAL (without Time Cost) per distance unit[[4]](#endnote-2) | £1.06 | £2.22 | -£1.02 | -£0.47 | -£0.78 |

## Changes in greenhouse gas and local pollutants levels

The tonnes of greenhouse gases (Carbon Dioxide (CO2), Methane (CH4) and Nitrous Oxide (N20), and local pollutants (Particulate matter 10, Particulate matter 2.5 and Nitrogen Oxides) and calculated by applying the UK government conversion factors to the cycle trips/distance that are replacing car/bus/train.

For greenhouse gas calculations, mode specific conversion factors were identified for car, bus and train. For local pollutants conversion factors were identified for car and bus.

## Changes in physical activity (health care system savings and reduction in sick days)

The external health savings from the Societal Gain Model are applied and summarised on their own. This is taken from Denmark-based research in which the health care system savings and employer benefits from a reduction in sick days, due on increased cycling, are summarised as a single value.

In addition, the number of employee sickness absence days, is calculated. This is based on detail in the Department for Transport appraisal guidance (TAG Unit A4.1) and the Active Mode Appraisal Toolkit.

## Exclusions from the modelling process

Some survey respondents were excluded from the calculations in the modelling process:

* Respondents who suggested an unviable value for each individual cycle type were excluded. In other words, any responses below the minimum cost for the specific discount level/cycle type combination were excluded from the modelling for that specific discount level. The minimum amount that the respondent would need to be willing to pay for a cycle are shown in Table 3, alongside the minimum cost for each cycle type.

Table 3. Minimum willingness to pay value in each cycle type/discount level combination

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cycle type | Minimum cost in survey | £50 | £100 | £150 | £200 | 20% | 30% | 40% | 50% |
| Standard bicycle | £140 | £90 | £40 | £0 | £0 | £112 | £98 | £84 | £70 |
| E-cycle | £550 | £500 | £450 | £400 | £350 | £440 | £385 | £330 | £275 |
| Non-standard cycle | £250 | £200 | £150 | £100 | £50 | £200 | £175 | £150 | £125 |
| Cargo cycle | £1,500 | £1,450 | £1,400 | £1,350 | £1,300 | £1,200 | £1,050 | £900 | £750 |

* Respondents who said they could not afford a cycle but then said they could afford a cycle more than 10% over the minimum quoted cost were also excluded. This equates to:
  + Bicycle: (£140 \*1.1) = £154 after discount
  + E-cycle: (£550 \*1.1) = £605 after discount
  + Non-standard cycle: (£250 \*1.1) = £275 after discount
  + Cargo cycle: (£1500 \* 1.1) = £1,650 after discount.

Sustrans is a registered charity in England and Wales (number 326550) and Scotland (SC039263).

We work for and with communities, helping them come to life by walking, wheeling and cycling.

We campaign to create healthier places and happier lives for everyone.

Join us on our journey. [www.sustrans.org.uk](https://www.sustrans.org.uk/)

1. This is based on the UK level population, but the relevant population size can be changed by the user in the model. [↑](#footnote-ref-2)
2. Number of working days minus annual leave and sickness absence [↑](#footnote-ref-3)
3. See <https://www.sustrans.org.uk/the-walking-and-cycling-index> for more information. [↑](#footnote-ref-4)
4. [↑](#endnote-ref-2)