

Cycle to Work scheme – Weekend Warriors or Daily Commuters

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1 Introduction

This paper presents the results from new research on the economic and mode shift implications of the Cycle to Work scheme. Cycling and walking are essential to the Scottish government's overall transport strategy, and the ambitious target of 10% of everyday journeys to be made by bike by 2020 has been set in the Cycling Action Plan for Scotland (CAPS). Due to their positive contribution to other key policy areas such as health, environment and well-being, calls for joint funding across government departments for active travel initiatives are increasingly being made.

As one initiative already 'funded' centrally via the tax savings scheme users make, we consider whether the Cycle to Work scheme should be a part of CAPS or whether it is more akin to an employee benefit package. The research used online surveys to collect self-reported data from scheme users. Economic assessment tools were used to build up a post-hoc appraisal of the scheme. DfT WebTAG guidance as well as the WHO's Health Economic Assessment Tool were used.

2 Background to this paper

2.1 Aims and objectives

The aim of the research was to assess the impact of the Cycle to Work (C2W) scheme, including an economic assessment of the scheme's benefits and dis-benefits. The research particularly focused on the scheme's impact on users' propensity to cycle.

Using data collected from user surveys, WebTAG (the UK Department for Transport's method of transport appraisal) and the World Health Organisation Health Economic Assessment Tool (HEAT), the research assesses the impact and overall benefits of the C2W scheme. In addition, it assesses, financially, which parties the benefits and dis-benefits accrue to. In light of the findings, it discusses whether CBA is the best form of appraisal for the scheme, and the policy implications of the results.

This study builds on what is already known about the uptake of the C2W scheme by quantifying the scheme economically for the first time. In the context of spending cutbacks and limited budgets it indicates whether the scheme is cost-effective when compared to other measures to increase cycling or broader efforts to improve public health. It also sheds light on whether cost-benefit analysis (CBA) is an appropriate tool for assessing the Cycle to Work scheme.

2.2 Outline of C2W scheme and previous studies

The C2W scheme was introduced by the UK government to “promote healthier journeys to work and to reduce environmental pollution” (DfT 2011a). As one of a number of measures that have been implemented with the aim of increasing cycling levels in the UK, it is unique

in being a non-infrastructure measure which is national in character. Figure 1 below shows estimated usage of the scheme since its introduction.

Figure 1: Estimated usage of the Cycle to Work scheme (data from DfT 2008 and Cycle to Work Alliance 2011 and 2013)

The scheme is usually implemented as a salary sacrifice arrangement. Employers give employees a loan to cover the cost of a bike and accessories. Equal repayments are then made over 12-18 months, taken from the employee's salary before tax or National Insurance deductions, effectively giving the employee a discount equivalent to the foregone tax and National Insurance (and the employer a discount equivalent to the National Insurance payments *they* would make on the employees' salary otherwise). Since 2010 a final 'fair market value' percentage payment has been required in order to formally transfer ownership of the bike to the employee (DfT 2012a, see Table 1 below for typical savings).

Table 1: A typical tax saving calculation for a basic-rate earner (Cyclescheme, 2013a)

Total cost of bike and accessories:	£600
Net cost of bike and accessories, including finance and admin costs (if applicable):	£600
Income tax saving over hire period:	£120
Employee NI saving hire period:	£72
Final market value percentage charge payment (7% of original price above £500)	-£42
Final cost of bike & accessories:	£450
Total saving:	£150
Gross salary sacrifice,* based on 12 month hire period:	£50
Net salary sacrifice,* based on 12 month hire period:	£34
Percentage saving over RRP (incorporating final payment value)	25%

*excludes final payment which is made separately

Since this research was carried out in summer 2013, the Cycle to Work Alliance published a report entitled 'The healthy commute: What impact does cycling to work have on employee health?' (C2WA, 2014). It presents results for a very high level assessment of the health benefits of the C2W scheme, using the WHO HEAT tool.

The Cycle to Work Alliance is made up of four of the largest C2W scheme providers (Cyclescheme, Cycle Solutions, Evans Cycles and Halfords). Its reports all have in common a frequent lack of transparency in result presentation makes conclusions on scheme usage ambiguous.

Based on the HEAT calculations the C2WA reported that the scheme prevented 509 deaths per year and generated £5.1bn savings in Government expenditure over a 10 year period (C2WA 2014 p. 7). However, the methodology used to derive these figures was flawed:

1. Results presented are for *all* C2W scheme users, not just those who change their cycling behaviour as a result of the scheme. This is despite it being stated in the same report that "54% of participants did not cycle to work before signing up to the scheme" (C2WA 2014 p. 6); *a clear indication that the weekly cycling of the other 46% of scheme participants cannot be attributed to the scheme itself.*
2. The actual data used for the calculations did not correlate cycle frequency with commute distance to work, but took the average frequency of cycle commuting (three times a week) and combined it

with the average commute distance (9.97 miles total). *A weighted average approach would have been more robust.*

3. The research *fails to consider the impact of other forms of physical activity which participants do on physical activity benefits.*

The report also wrongly stated that the £5.1 billion financial savings accrued to government, when in fact this figure relates to benefits to society as a whole due to the improved health outcomes which result from increased levels of cycling.

In addition to this piece of research, and the health economic analysis carried out by the C2WA, four studies on the C2W scheme have been carried out to date (to the researchers' knowledge). The Cycle to Work Alliance has produced two other reports on some of the impacts of the scheme (C2WA 2013 and 2011). Caulfield and Leahy (2011) focused on the benefits of the equivalent scheme in Ireland, and Elliott (2010) researched the C2W scheme within the broader context of university bike hire schemes in an unpublished dissertation thesis.

The scale and scope of the studies varied; Elliott's looked at one employer in-depth whereas C2WA (2011 and 2013) and Caulfield and Leahy (2011) collected data at a national level. Only Elliott's (2010) focussed on non-scheme-users as well. All had reasonable response rates from scheme users (14-22%) and the reported findings showed many similarities. The gender split range in the findings was fairly close; all found that 67-75% of scheme users were male. Caulfield and Leahy (2011 p. 44) found that in Ireland 48% of scheme users did not already own a bike and Elliott (2010 p. 47) found that 72% of scheme users did not already cycle to work. C2WA (2011 p. 5 and 2013 p. 5) found that 61% of scheme users in 2011 and 54% of scheme users in 2013 did not already cycle to work before signing up for the scheme.

Findings in relation to propensity to cycle and mode shift impacts are presented very differently and direct comparison is therefore problematic. In Elliott's findings (2010 p. 61) the proportion of scheme-users for whom cycling was their usual mode choice increased from 28% to 53%, making cycling the main mode choice of roughly 35% of those who previously did not cycle to work. Caulfield and Leahy's results (2011 p. 45) show that about 45% of new cyclists cycled to work at least twice a week. C2WA (2013 p. 10) only presents results for all users; it found that 66% of scheme users cycle to work three or more days a week.

Research on the connection between transport mode choice and health has increased significantly over the past two decades. Study results have widely confirmed a positive relationship between active transport and reduced risk of various diseases, in particular cardiovascular diseases. A widely-cited study is that of Anderson (2000), which found a reduced risk of mortality of approximately 40% for individuals who cycled to work, independent of other leisure-time physical activity. Reduced absenteeism has also been widely reported: Hendrikson et al (2010) found a reduction in the average duration of absenteeism of more than one day annually for commuter cyclists compared to non-cyclists.

Economic assessments of cycling which include health benefits generally have relatively high benefit-cost-ratios (BCRs) compared to traditional transport economic appraisals (Nordic Council 2005 cited in Cavill et al 2008 p. 292). Davis (2010 p. 1) found it 'astonishing' how high BCRs are in cost-benefit evidence on walking and cycling, from studies that include health and other benefits; only one extra cyclist was needed in a 30-year appraisal period for a £10,000 investment to break even (Davis 2010 p. 6). Rabl and de Nazelle (2012) looked at the benefits of mode shift to active transport from car in relation to health, and found an annual benefit of €1310 per new cyclist per year of cycling for the EU25 countries, with health benefits by far the most important item in the scenarios (Rabl and de Nazelle 2012 pp. 126-

128, see also Figure 2 below).

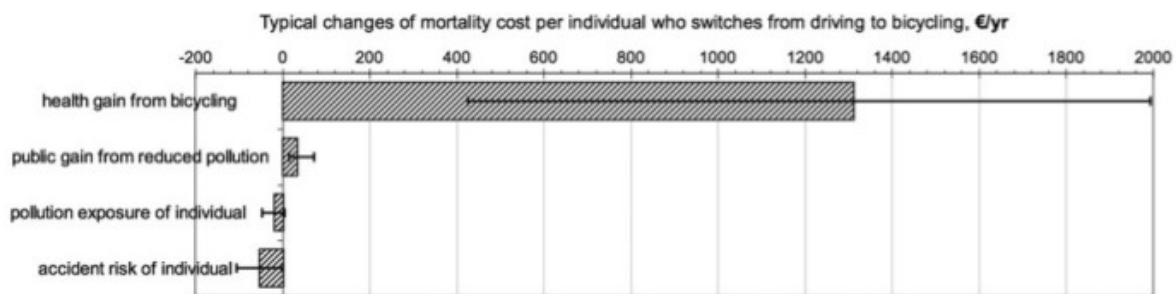


Figure 2: Typical changes of mortality cost per individual who switches from driving to bicycling (Rabl and de Nazelle 2012 p. 128)

WebTAG is the appraisal guidance produced by the DfT for appraising transport projects. Cope et al (2010; p. 8) applied WebTAG to results from the Cycle Demonstration Towns; the resulting BCRs ranged from 2.6-3.5:1. Health benefits accounted for between 70 and 96% of net benefits, and estimated accidents made up the biggest cost (Cope et al 2010 p. 8).

3 Appraising the impacts of the Cycle to Work Scheme

In STAG, impacts of a transport policy proposal are assessed within a framework of five objectives: environment, safety, economy, accessibility and integration. A central part to this analysis is a Transport Economic Efficiency analysis (also known by its acronym TEE) which is a transport cost benefit analysis. Arguably a transport cost benefit analysis with its focus on the marginal use benefits gives only a partial view of the benefits of the Cycle to Work scheme.

In the case of the cycle to work scheme, the primary impact of the scheme is on the purchase costs of a bicycle. The scheme has no significant influence on the cost of a cycling trip¹ per se. That is the scheme has no significant impact on the direct use costs of cycling. As cost benefit analysis theory indicates that the benefits of a policy initiative are the use benefits plus changes in external costs including safety, the environment minus the resource costs of the investment, this means that the core element to the appraisal (the use benefits – i.e. the change in the use costs) are zero.

The fact that the cycle to work scheme has a significant impact on the total costs of cycling makes this outcome seem bizarre. By lowering purchase costs the cycle to work scheme lowers the average costs of a cycling trip rather than the marginal costs of a trip. This can be illustrated as follows. A bicycle is bought for £600 by someone who currently doesn't own a bicycle and they use it to commute to work for 100 days a year over a 6 year period after which the bicycle is 'retired'. The marginal cost of the cycle trip is the generalised cost of the cycle trip (time plus maintenance related costs), which for the sake of argument is £2.50 one way (£2 time costs plus £0.50 maintenance costs). The average cost of the cycle trip on the other hand is the marginal costs plus the purchase costs spread over all the trips made with the bicycle, which in this example are 1,200.² The average cost of a cycle

¹ There are some examples in which replacement bicycles have been bought which are quicker (e.g. replacing a mountain bike with 'knobbly' tyres with a hybrid bike with 'road' tyres), or where bicycles with cheaper components have been bought which lead to slightly lower maintenance costs.

² 1,200 = 100 return trips X 2 legs per trip X 6 years

trip over the lifetime of the bicycle is therefore £3.00³ - that is 50p more than the marginal costs.

It is this average cost that affects the decision as to whether to purchase a bicycle or not – and therefore has a direct outcome on the ability of cycling to contribute to transport policy. If one also considers the fact that someone who does not cycle will be uncertain regarding how often they may actually cycle to work in the future, and therefore what the actual average cost of a cycle trip is this creates a further barrier to the take up of cycling. For example the ‘potential’ cyclist may intend to cycle 100 days a year, but in fact external pressures either associated with trip chaining (collecting children, shopping, visiting the dentist, etc.) may preclude this or they may find that they find cycling unbearable in heavy traffic. Thus there may be a risk that they may only cycle 50 times a year or in fact only use the bicycle in the first year of purchase. In both scenarios the average cost per trip increases quite significantly – whilst the marginal cost remains unchanged. The cycle to work scheme addresses this issue directly by reducing the purchase costs of the bicycle by a significant margin – average costs per trip are lowered and cycling to work is seen in a more positive light. However, economic efficiency as measured in a transport cost benefit analysis is not affected by the cycle to work scheme beyond its impacts on external costs – in this case congestion, air pollution, carbon and health impacts. It is for this reason that in our appraisal of the cycle to work scheme we present both a financial analysis and a cost benefit analysis. The financial analysis tracks the costs borne by each of the groups affected by the cycle to work scheme, whilst the cost benefit analysis demonstrates the gain in economic efficiency achieved through the cycle to work scheme.

3.1 Data collection initial analysis

The research used self-reported data from survey questionnaires which were completed by employees of selected public sector employment sites in Yorkshire. 254 people completed the surveys in total. Samples were intended to be random, with surveys promoted either to all scheme users or to the whole staff population at the employer in question.

Respondents were segmented into three groups for analysis:

1. Group 1: Those who did not own a bike prior to using the scheme (23% of the total)
2. Group 2: Those who owned a bike but cycled infrequently or not at all (30% of the total)
3. Group 3: Those who owned a bike and already cycled regularly (47% of the total)

3.2 Initial analysis

Prior to using the scheme, respondents from groups one and two reported no weekly cycling activity. After using the scheme, only 7% of group one and 8% of group two reported no weekly cycling activity. The impact of the scheme on cycling, and particularly cycle commuting levels, is outlined in Table 2 below.

Table 2: Impact of C2W scheme on cycling levels

Group	Cycling weekly	Cycling to work (any frequency)	Cycling to work regularly (2 or	Cycling to work daily (5 days per
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3 £3.00 = £2.50 marginal cost + £600 purchase cost/1,200 one-way trips

			<i>more days per week)</i>	<i>week)*</i>
1 (Non-bike owners)	93%	82%	75%	31%
2 (Bike owners who did little or no cycle activity)	92%	92%	84%	36%
3 (Bike owners who already cycled regularly)	100%	96%	89%	42%
All respondents	96%	92%	84%	38%

*Since not all employees work five days a week, and may work from home on some days, this percentage will underestimate the number who cycle to work every day that they are in work.

Results show that the scheme clearly does change propensity to cycle, with the vast majority of scheme users (96%) cycling weekly after using the scheme, an increase from 47% (the proportion that cycled weekly before using the scheme). Perhaps more significantly, the number of respondents cycling to work also more than doubles, from 42% prior to using the scheme to 92% after the scheme.

However, the context of these results is one in which the scheme attracts individuals who are more likely to cycle anyway: the most common reason for respondents who did not already cycle regularly for using the scheme was that they were “considering cycling anyway and the scheme seemed attractive” (39%). The second most common reason was that “the cost savings and spread payments made it feel less of a risk to try cycling as an option” (20%). This suggests that a high proportion (59%) of those who didn't cycle before using the scheme could already have been contemplating or preparing for cycling; *the scheme acted more like a catalyst or enabler*. This concurs with what Elliott's research found: scheme users were more likely to be considering cycling than non-users (Elliott 2010 p. 50).

Results also show that a high proportion of scheme users are existing cyclists (over half of scheme users in the sample). Many of these existing cyclists do not change their cycling behaviour after using the scheme (70%). This has implications for the scheme when considering its impact on propensity to cycle and its overall value for money for the government, as discussed further below.

3.2.1 Propensity to cycle for non-commuting trip purposes

The scheme also had a substantial impact on bike use for non-commuting purposes, with the number of respondents cycling for each purpose at least tripling (see Table 3 below).

Table 3: Change to bike use for different purposes, any frequency

Trip purpose	Proportion of sample using bike before	Proportion of sample using bike after
Taking children to school or extra-curricular activities*	6%	18%
Shopping	11%	52%
Personal business	13%	58%
Accessing public transport*	9%	28%
Travelling to leisure activities or visiting friends or family	14%	48%
Business travel	15%	28%

*Not all respondents will make this kind of trip by any mode, so actual percentages for those respondents who do make these kinds of trips will be higher.

Over 90% of respondents cycled for leisure purposes after acquiring a bike through the cycle to work scheme, again showing that people who expect to enjoy cycling will be more likely to use the scheme.

3.2.2 Further evidence of a mode shift to cycling

Respondents also gave up travel passes or season tickets, parking spaces or permits, or even their car, indications that cycling became their main mode choice either for commuting or in general (see Table 4 below). A number of other respondents were considering making these changes as a result of getting a bike through the scheme.

Table 4: Items associated with previous mode given up after mode shift to cycling

Item foregone after using the C2W scheme	Number of respondents who gave it up	Percentage of sample	Percentage excluding cyclists who did not change their behaviour
Travel pass/ season ticket	16	6%	9%
Parking space or permit	12	5%	7%
Car	14	6%	8%

Since respondents who use these modes are likely to commute either by car *or* by public transport (and not both modes), and some may not have previously used a travel pass or had a permit or had a dedicated parking space, these percentages are necessarily understated.

3.2.3 Mode shift from car

The average reduction in car mileage per week across the sample was approximately 20 miles.

However, this varied dramatically. A large proportion of respondents did not reduce any car mileage, either because they were not replacing car journeys with cycle journeys, or, for existing cyclists, because they had not changed their cycling behaviour. The proportions of the groups who did not reduce any car mileage as a result of using the scheme were: 49% of non-bike owners; 41% of those who had a bike but did not use it regularly before the scheme; and 81% of existing cyclists. When those who did not reduce their car mileage were not included in the analysis, the average reduction in car mileage was about 35 miles per week across the sample (average reductions were remarkably consistent across the different sample groups). However, within this there was great variation, with some respondents reducing their weekly driving by over 100 miles and others by only a few miles.

3.2.4 Health benefits

The impact of the scheme on respondents' health was limited by two main factors:

1. Most respondents (70%) were already getting the recommended weekly level of physical activity (150 minutes of moderate-intensity aerobic physical activity) before using the scheme.
2. Only around half of respondents increased their physical activity levels as a result of using the scheme.

However, for those respondents who were below the recommended level of physical activity, the scheme had substantial benefits; only 11% of respondents remained below the recommended level of physical activity after using the scheme. However, some respondents did reduce their level of physical activity after using the scheme (6%), primarily if they replaced walking with cycling and were therefore active for less time per week because cycling is a faster mode. Only one respondent moved from being above to below the recommended level of physical activity as a result of this.

Key descriptive statistics on reported levels of physical activity before and after using the scheme for the different groups is shown in Table 5 .

Table 5: Reported level of physical activity per week, minutes

Statistic	Group 1		Group 2		Group 3	
	Before scheme	After scheme	Before scheme	After scheme	Before scheme	After scheme
Minimum value	0	50	0	45	30	60
Lower quartile	120	200	30.5	190	190	215
Median	260	290	120	300	300	320
Upper Quartile	322.5	480	212.5	435	457.5	497.5
Maximum value	600	780	900	1080	1080	1080

4 Financial and cost benefit analyses and sensitivity tests

4.1 Assessment method/data used

Cost-benefit analysis is used to quantify the benefits of a project by converting all benefits to a common, monetary unit, which can then be compared to the cost of implementing the project. Table 6 below shows the objectives and sub-objectives that are considered in a WebTAG CBA; the following appraisal considers only the sub-objectives that are relevant to the C2W scheme, which are those highlighted in bold.

All objectives except physical fitness, accidents and public accounts are dependent on the level to which mode shift from car occurs.

Health benefits are assessed using the World Health Organisation's (WHO) Health Economic Assessment Tool (HEAT), which has been incorporated into WebTAG guidance by the DfT. HEAT is designed to be an accessible method of estimating health benefits for professionals without a health background (Kahlmeier et al 2011 p. 18). Results indicate only the order of magnitude of benefits for a group of people overall, and morbidity benefits are not included because of comparatively little evidence on morbidity and cycling in comparison to mortality benefits. *Results are therefore conservative since no disease-related benefits are quantified* (Kahlmeier et al 2011 p. 9). The DfT suggests morbidity benefits may be similar in size to mortality benefits (DfT 2012b p. 15). Appendix 1 shows the mechanics of the HEAT tool in greater detail.

Table 6: Department for Transport WebTAG Appraisal Objectives (DfT 2011b pp. 4-5)

Objective	Description
Environment	Includes noise, local air quality, greenhouse gases , landscape, townscape, biodiversity, heritage of historical resources, water environment, physical fitness and journey ambience
Safety	Includes accidents and security
Economy	Includes public accounts, transport economic efficiency , reliability, and wider economic impacts
Accessibility	Includes option values, severance, and access to the transport system
Integration	Includes transport interchange, land use policy, and other government policies

WebTAG calculations used survey data in combination with other subsidiary data sources, and numerous DfT 'TAG Units' for guidance on how to carry out the appraisal. Because the C2W scheme is funded out of general taxation rather than from the government transport budget, meaning that there are no 'upfront' costs to the government of running the C2W scheme, the tax and national insurance revenue losses from employee's savings were used as indicative costs to government, in order to provide a benefit-cost-ratio (BCR) for the scheme. An appraisal period of ten years was considered appropriate, ten years being a proxy for the typical lifetime of a bike (since some bikes can be expected to last less and some more time than this). Appendices 2 and 3 outline how the data was used in the appraisal.

Table 7 outlines all the various impacts of the C2W scheme, and indicates which are considered in the financial analysis and which in the CBA.

Table 7: Impacts of C2W Scheme – Financial and CBA

Impact	Financial analysis	Cost benefit analysis
• Accident dis-benefits		X
• Physical fitness benefits		X
• Absenteeism benefits for employers		X
• Decongestion benefits		X
• Other marginal external cost benefits from reduced car mileage (infrastructure, local air quality, noise greenhouse gases)		X
• Fuel duty revenue losses	X	X
• Vehicle Excise duty revenue loss	X	X
• National Insurance savings for employers	X	X
• National Insurance savings for employees	X	X
• National Insurance revenue losses for government	X	X
• Vehicle operating cost employee savings and industry losses	X	X
• Income tax losses for government	X	X
• User bike maintenance costs	X	X
• Fare revenue losses for public transport operators	X	X
• VAT gains for government from spending redistributed away from public transport fares	X	X
• Cost of bike for respondent	X	
• Bikes sales for industry	X	

• Commission on bike sales, C2W scheme providers	X	
• Opportunity cost of loan to business	X	
• Car sale benefit for users, loss for industry	X	
• Vehicle Excise duty employee saving	X	
• Income tax savings for employees	X	
• Fare savings for employees	X	
• Bike maintenance sales for the bike industry	X	
• Reduced turnover in the car industry	X	
• User car sales	X	
• Employee travel time benefits	-	-

4.2 Assessment method/data used

Conventional WebTAG CBA fails to account for many of the benefits of the scheme because it assesses the overall costs and benefits to society as a whole only. Because of this, further financial analysis of the benefits as they accrue to the different interested parties has also been carried out. Table 8 below provides a financial analysis of the impact of the scheme, in terms of which parties the various costs and benefits accrue to (including aspects not included in the standard CBA, such as the travel time savings some users realise due to a mode shift to cycling).

Table 8: Financial analysis of the impact of the scheme (values are the sum of discounted base year (2010) values for the 10-year lifetime of the bike in £000s)

Impact	Government	Employers	Employees	Cycle industry	Cycle to work scheme providers	Public transport providers	Car industry	Other	Total
Income tax and NI	-£55 (income tax and NI revenue)	£20 (NI payments)	£35 (income tax and NI payments)	-	-	-	-		£0
Cost of bike loan	-	-£17 (opportunity cost of loan)	-£135 (cost of bike, including final payment)	£114 (bike sales minus C2W scheme provider commission fee)	£21 (commission and final market value payments)	-	-	-£17	£0
Fuel/ vehicle operating costs	-£72 (fuel duty) -£19 (VED losses)	-	£252 (vehicle operating cost savings) £19 (VED savings)	-	-	-	-£180 (vehicle maintenance sales)		£0
Car sale	-	-	£33 (car sale revenue)	-	-	-	-£33 (car sales)		£0
Public transport fares	£60 (extra VAT revenue)	-	£300 (fare savings)	-	-	-£300 (fare revenue losses)	-	£60	£0
Bike maintenance	-	-	-£455 (maintenance costs)	£455 (revenue from bike maintenance)	-	-	-		£0

				ance sales)					
Total	-£86	£3	£49	£569	£21	-£300	-£213	£43	£0

Interestingly, the employees using the Cycle to Work scheme actually lose out in the financial analysis. The combined savings on vehicle operating costs and fares outweigh the added bike maintenance costs by around £100,000 for the whole group, but the overall cost of the bike is not fully recouped when the various costs and savings are balanced. This can largely be explained by the inclusion of the extra VAT payments scheme users make due on spending which is transferred from public transport fares to other goods which have VAT added. In reality, this 'loss' would not be perceived by users.

The stakeholder group which gains the most from the scheme is the bike industry, with spending on vehicle maintenance and public transport fares largely transferred to spending on cycle maintenance. The bike industry also gains from the sales of the bikes and accessories generated through the scheme. The stakeholders that lose out most from the scheme are the car industry and the public transport industry, as might be expected with a scheme that encourages a mode shift from these modes to cycling.

4.3 CBA and CBA sensitivity tests

The CBA results are outlined in Table 9. The scheme has a PVC of £0 because losses to central government revenue are classed as dis-benefits rather than costs. Two alternate BCRs were therefore presented: BCR2 classifies all lost government revenue as the 'cost' of the scheme to government, and BCR3 uses the capital cost of the bike to indicate the cost of the scheme.

Table 9: Results for the 10-year appraisal period, £1,000s

Conventional WebTAG CBA		Non-bike owners (n=55)	Existing bike owners who did not cycle (n=73)	Existing cyclists (n=115)	All respondents (n=243)
Economy	Fare revenue losses	-£122.0	-£189.0	-£46.0	-£358.0
	NI savings for employers	£5.0	£7.0	£11.0	£23.0
	Absenteeism	£11.0	£21.0	£9.0	£41.0
	Infrastructure	£0.5	£0.8	£0.4	£1.8
	Congestion	£77.0	£118.0	£58.0	£253.0
Environmental	Local Air Quality	£0.3	£0.4	£0.2	£1.0
	Noise	£0.5	£0.8	£0.4	£1.8
	Greenhouse Gases	£4.0	£6.0	£3.0	£14.0
Social	Physical fitness	£47.0	£438.0	£0.0	£485.0
Safety	Accident*	-£5.0	-£14.0	-£1.8	-£21.0
Public accounts	VED	-£7.0	-£13.0	-£3.0	-£23.0
	Income tax and NI	-£12.0	-£19.0	-£31.0	-£61.0
	Indirect Taxation (fuel duty and VAT)	-£2.0	-£2.0	-£10.0	-£14.0

CBA	PVB	-£3	£355	-£10	£344
	PVC	£0	£0	£0	£0
	NPV	-£3	£355	-£10	£344
	BCR1 (PVB/PVC)	Infinity – can't divide by 0	Infinity – can't divide by 0	Infinity – can't divide by 0	Infinity – can't divide by 0
	BCR2 (PVB/'true' cost to government)	-0.13	10.44	-0.22	3.51
	BCR3 (NPV/K*)	-0.10	8.44	-0.14	2.55

*K=the capital cost of the bicycles discounted back to 2010

The NPV and BCR vary substantially between the different groups. The main reason for this was the substantial difference in physical fitness benefits between groups 1 and 3 (non-bike owners and existing cyclists) and group 2 (those who owned a bike but did not use it prior to using the scheme). The physical fitness benefits were much greater for group 2 because individuals in this group increased their physical activity levels by a much greater amount after using the scheme than the other two groups (by an average of three hours per week, as opposed to 30 minutes for non-bike owners and 20 minutes for existing cyclists).

As the cycle to work scheme does not affect the overall transport budget it is not possible to calculate a BCR with the PVC set to the cost to the government transport budget as advised in appraisal guidance. Instead we have calculated two other BCRs, the first (BCR2) being to an overall cost to government, and the second (BCR3) considering the use of resources (i.e. the capital cost of the new bicycle). We can see from the overall cost to government ratio (BCR2) that the return is good overall, and very good for non-cyclists who own a bike. This is also the case for the NPV/K ratio. Overall, the BCR is fairly comparable to what has been found in the appraisal of other cycling investments, although this is largely because of the impact of the changes to physical activity by group 2 (the BCR for the other groups was negative). However, this BCR result is significant since it uses reported rather than estimated information, and also includes *all* WebTAG categories (such as the impact on the accounts of public transport providers), which few other analyses do.

4.3.1 Sensitivity testing

The DfT recommends carrying out sensitivity testing on the core assumptions made in cycling appraisals (DfT 2012b p. 33). Sensitivity testing gives an indication of the impact of the choice of objective parameters and the assumptions made in the appraisal. In the appraisal, the 'big ticket' aspects are fare revenue losses, fuel duty, physical fitness, absenteeism and congestion. Fare revenue losses and fuel duty figures were derived from information provided by respondents on how the scheme had impacted on their travel behaviour in these relevant areas. These aspects will therefore not be sensitivity tested (it is fairly obvious to readers what impact increasing or decreasing these values by 25% would have).

The impact of the assumptions and values used for the other 'big ticket' aspects is discussed below

4.3.2 Absenteeism

The study which informed DfT guidance on absenteeism found a reduction in short-term sick leave of 6-32% (DfT 2012b p. 29). This would benefit employers by between 0.4 and 2.1 days

gross salary costs (see Table 10 for values for the different segments).

Table 10: Sensitivity testing: NPV of absenteeism benefits per annum (based on 2013 salary data, undiscounted)

Reduced short-term sick leave	Group 1	Group 2	Group 3	All
0.4 days	£559.78	£1,056.92	£465.93	£2,082.62
1 day	£1,399.44	£2,642.30	£1,164.81	£5,206.55
2.1 days	£2,938.82	£5,548.83	£2,446.11	£10,933.76

Table 10 shows that changing this assumption does significantly change the absenteeism benefits of the scheme. Decreasing absenteeism benefits to the equivalent of 0.4 days less sick leave per employee affected would have little impact on overall results. Increasing benefits to the equivalent of 2.1 days less sick leave per employee would bring the PVB value for groups 1 and 3 closer to a positive figure.

An alternative assumption on absenteeism which *would* significantly affect the overall appraisal would be to assume that all commuters who increased their PA realised absenteeism benefits (this causes absenteeism benefits to approximately quadruple). The impact of this on annual absenteeism benefits for each group is outlined in Table 11 below.

Table 11: Sensitivity testing: NPV of absenteeism benefits per annum, if all respondents who increased their physical activity as a result of using the scheme created absenteeism benefits (based on 2013 salary data, undiscounted)

Reduced short-term sick leave	Group 1	Group 2	Group 3	All
0.4 days	£2,023.36	£4,149.91	£2,017.54	£8,190.81
1 day	£5,058.39	£10,374.77	£5,043.86	£20,477.02
2.1 days	£10,622.62	£21,787.02	£10,592.10	£43,001.75

4.3.3 Physical fitness

Physical fitness benefits were based upon the median values for weekly physical activity before and after respondents had used the scheme for each of the groups. Median values were used in preference to mean values because they were more representative, because of the existence of outliers within each group. In the appraisal, no physical fitness benefits were included for existing cyclists because the median level of physical activity for this group prior to using the scheme was already 300 minutes, and it is not known whether physical fitness benefits occur above this level of physical activity. However, the HEAT methodology and user guide does cite research which finds that physical activity has a continuous dose-response relationship with most health outcomes (Kahlmeier et al 2011 p. 9).

If the change in median weekly physical activity for existing cyclists is entered into the HEAT tool this adds £63,000 to the NPV for the ten-year appraisal period, although this would not cause the BCR to become positive (physical fitness benefits for this group were not included because most respondents

were above the 300 minute threshold at which the WHO believes extra health benefits – above the basic benefits realised at 150 minutes physical activity per week – are realised, and the median change in physical activity was also 0).

If physical fitness benefits are assessed with new segmentations for the whole group based on changes to physical activity level, this also influences the BCR and NPV for the whole group.

15 respondents produce physical fitness benefits because they reduce their physical activity level, by 100 minutes per week on average (median). This would equate to a reduction in -£23,000 over the ten-year appraisal period.

77 respondents do not change their physical activity level, and so would not generate any physical fitness benefits.

112 respondents increase their physical activity level as a result of using the scheme, 50 of whom were below the recommended level of weekly physical activity (150 minutes), and 31 of whom were between the basic and upper levels of physical activity (150-300 minutes per week). Applying the HEAT tool to these two groups generates £323,000 and £148,000 over the ten-year appraisal period respectively.

The total physical fitness benefits for the group when analysed in terms of physical activity levels before and after using the scheme rather than by cycling status before using the scheme generates overall benefits of £448,000 over the ten-year period, as opposed to £485,000 over the ten year period. This suggests that the original analysis is fairly robust for giving 'ballpark' figures based on the HEAT tool.

4.3.4 Congestion

The appraisal of decongestion benefits used the weighted average values for the UK for all regions and all time periods. More specific regional values could have been used for the analysis, however this is the only aspect of the analysis which would be region-specific and the research aimed to give an indication of the impact of the scheme in general, so this was felt to be a reasonable approach.

5 Discussion of results

5.1 Impact of including public transport revenue losses

It is significant that, excluding physical fitness benefits for group 2, fare revenue losses for public transport providers is the biggest item in the appraisal. This is an impact which is rarely included in other cycling appraisals (for WebTAG examples see Wilson and Cope 2011 and DfT 2012b itself; non-WebTAG economic assessments do not seem to include costs to transport providers, see for example the review of assessments by Cavill et al 2008). The inclusion of public transport revenue losses had a substantial impact in this appraisal. Scheme users who replaced bus travel with cycling made significant personal travel cost savings, but values are only included as 'business provider costs' not as 'user savings'. This was countered to some extent in the appraisal through the inclusion of the increased VAT revenues that are generated, since public transport fares are VAT-free but redirected spending can be assumed to be on goods which do have VAT added. On the other hand, much public transport provision in the UK is government subsidised, so any reduction in its use could increase subsidy costs, or lead to a reduced level of service for remaining passengers. For over-subscribed peak services on the other hand, passengers would experience a journey quality benefit if other passengers begin cycling, thereby reducing crowding.

5.2 The value for money of the scheme – a cycle funding perspective

If the results on the amount spent on the C2W scheme from the samples studied are representative of what is spent generally, the lost government revenue from income tax and National Insurance (at just under £350 per cyclist on average) might amount to as much as £192.5m (£157.5m of that since 2008). This equates to over £30m per year since 2008, roughly £0.50 per person. Current national cycling funding is meagre, about £2 per person per year (Walker 2013). If an amount equivalent to the lost revenue from the C2W scheme was instead set aside for other cycling projects, the government could increase cycle funding by 25% and avoid directly subsidising existing cyclists. It could instead more directly target those not currently cycling, or focus on hard measures which would more comprehensively benefit cyclists and encourage new cyclists.

5.3 The value for money of the scheme – a user-profile and public health perspective

The value for money of the scheme is reduced by the existing cyclists who take advantage of the scheme but don't change their behaviour. Use of the scheme by existing cyclists to extend their bike collection, sometimes multiple times, treats the scheme as a government subsidy for hobby or 'keep-fit' cycling. From a public health perspective, existing cyclists, as well as many other scheme participants, are not generally those population groups engaging in an unsafely low amount of physical activity (70% of scheme users were already taking adequate weekly physical activity). The equivalent funding, targeted towards those below the recommended level of physical activity (maybe through the NHS instead), might be more effective.

6 Conclusions

6.1 Impact of the scheme on propensity to cycle

The scheme substantially increases the cycling levels of its users. 96% of respondents start cycling weekly as a result of using the scheme, 84% start cycling to work at least twice a week. The scheme attracts many people who did no regular cycling beforehand (53% of all users in the sample). The scheme increases cycling levels for a range of non-commuting trip purposes, with the biggest increases occurring for shopping, personal business, accessing leisure activities or visiting friends or family. Around half of respondents use their bike for these trip purposes after using the scheme. The number of respondents cycling for business travel almost doubles to approximately 28% of all respondents. Respondents giving up their car, parking space, travel pass or other item associated with their previous commute mode is further evidence that the scheme changes propensity to cycle.

The scheme is somewhat limited by the fact that a large number of respondents who weren't already regularly cycling before using the scheme were already considering this mode before making use of the scheme. As would be expected, the scheme has a lesser impact on those less pre-disposed to starting cycling. Another limitation on the scheme's impact on propensity to cycle was its use by existing cyclists who do not change their cycling behaviour (~70% of all existing cyclists).

6.2 The benefits of the scheme

The scheme generated many benefits which were included in the appraisal. Health benefits were relatively high despite most scheme users (over 70%) already being sufficiently active. The scheme had a positive impact on physical fitness, absenteeism, decongestion and other externalities of car use. This was however countered by the high amount attributed to lost public transport revenue. Other quantified benefits that were not included in the WebTAG-based BCR revolved around benefits for scheme users including public transport fare savings as well as travel time benefits in comparison to respondents' previous mode. Benefits are lower for society overall where induced bike purchases cause an environmental burden.

6.3 Assessment of the scheme: its strengths and limitations

The scheme effectively meets the government objectives it sets out to, namely, increasing cycling, improving health, and reducing the environmental impact of transport. Appraisal results suggest it is good value for money for the government despite being used by many existing cyclists. It is favourable as an employee benefit scheme, especially when the VAT impacts from reduced public transport spending are not included. Its value for money compared to alternative measures which encourage cycling is comparable in CBA terms. Although it does not alter the marginal cost of cycling for the user it does alter the total costs of cycling. This is potentially a significant factor in the scheme's favour for attracting and enabling new cyclists, in contrast to many other measures to promote cycling. The VfM for the whole scheme would be better if it could be better tailored to those who increase the level of physical exercise above the 'threshold', however by effectively 'subsidising' cycling per se it reduces the generalised cost of cycling compared to other modes. Giving an economic advantage to those who choose to cycle also sends out a clear pro-cycling message and raises the status of cycling.

More specific data was collected on individual behaviour than is typically known for an appraisal, so assumptions were minimal. Sample sizes were smaller than hoped for, somewhat limiting the general applicability of findings. The research found evidence of activity substitution for some respondents who started cycling, which is often not considered in the appraisal of active travel modes.

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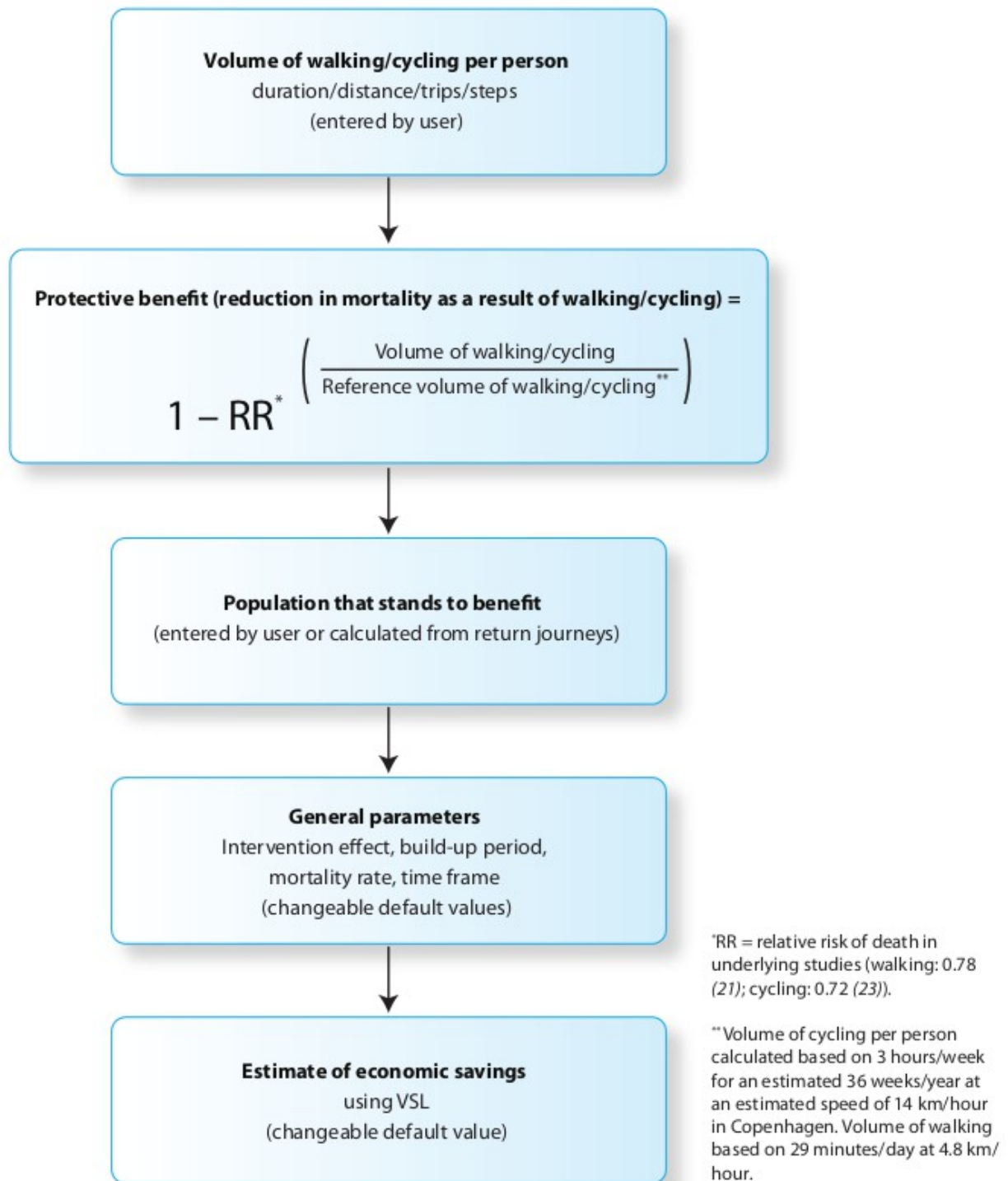
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Appendix 1: HEAT Methodology (Kahlmeier et al 2011 p. 22)



Appendix 2: Survey data used for appraisal calculations

Objective	Survey Data	Subsidiary data
<ul style="list-style-type: none"> Accident dis-benefits 	<ul style="list-style-type: none"> Minutes cycled per week before and after, converted into estimated distance 	<ul style="list-style-type: none"> The difference in accident rates between the UK and Denmark (HEAT accounts for the change in accidents due to a mode shift to cycling, but is based on Danish data) – (<i>Pucher and Buehler 2008</i>) WebTAG average value of a prevention of a cycle casualty - <i>Table A 4.1.2 (DfT 2013a)</i>
<ul style="list-style-type: none"> Physical fitness benefits 	<ul style="list-style-type: none"> Median minutes of physical activity per week before and after using the scheme for each group 	<ul style="list-style-type: none"> WHO Mortality database data for UK Value of a statistical life - <i>WebTAG Unit 3.14.1 (DfT 2012b p. 16)</i>
<ul style="list-style-type: none"> Absenteeism benefits* 	<ul style="list-style-type: none"> Number of respondents who went from being below to above the NHS recommended physical activity level (150 minutes per week) Average pay data 	<ul style="list-style-type: none"> Reduced absence due to increased physical activity - 1. <i>WebTAG Unit 3.14.1 (DfT 2012b p. 18)</i> 2. <i>Hendriksen et al (2010)</i>
<ul style="list-style-type: none"> Externalities Vehicle operating cost savings Fuel duty revenue loss 	<ul style="list-style-type: none"> Reduced car mileage per week 	<ul style="list-style-type: none"> Marginal external costs and indirect tax - <i>Table A 5.4.2 (DfT 2013a)</i> Average car running costs - (<i>AA 2013a/b</i>)
<ul style="list-style-type: none"> User time savings 	<ul style="list-style-type: none"> Reported commuting time savings compared to alternate mode 	<ul style="list-style-type: none"> VOT for commuting - <i>Table A 1.3.2 (DfT 2013a)</i>
<ul style="list-style-type: none"> Car sale benefit Vehicle Excise duty revenue loss* 	<ul style="list-style-type: none"> Reduced car ownership 	<ul style="list-style-type: none"> Average used car price - <i>Used Car Market Report 2013 (BCA 2013 p. 19)</i> Average car scrappage price - (<i>Barnes-Clay 2014</i>) Average CO₂ emissions, UK vehicle fleet - <i>Vehicle Licensing Statistics: 2012 (DfT 2013b p. 6)</i> VED emissions bands - <i>Vehicle tax rate tables (UK government 2013)</i>
<ul style="list-style-type: none"> Fare savings Fare costs for business providers* 	<ul style="list-style-type: none"> Reduced public transport fare expenditure 	-
<ul style="list-style-type: none"> National 	<ul style="list-style-type: none"> Amount spent on bike 	<ul style="list-style-type: none"> National Insurance

<p>Insurance savings for employers* and employees</p> <ul style="list-style-type: none"> • National Insurance revenue loss* • Cost of bike for respondent 	<p>and accessories, combined with respondent tax rate</p>	<p>Contributions - (HMRC 2013)</p>
<ul style="list-style-type: none"> • User bike maintenance costs 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Professional knowledge of bike maintenance costs and (<i>Jake's Bikes [n.d.]</i>)

All calculations marked with a '' were also uplifted by 19% to convert to market prices.

Appendix 3: How values were calculated for the 10-year appraisal period*

Impact	Initial figure calculation	Change in 10-year appraisal
Bike purchase price	Reported price discounted to reflect individual tax and National Insurance savings	One off payment
Final 'fair market value' payment	Original bike cost multiplied by 0.03 or 0.07 depending on its original value	One off payment
Car sale price	Assumption that half are re-sold and half are scrapped. Assumption that average used car sale price includes 15% mark-up	One-off payment
User time savings (commuting)	VOT for commuting used (Table A 1.3.2 DfT 2013a)	Changes over time as specified in Table A 1.3.2 DfT 2013a
Vehicle operating cost savings	Sum of data outlined in table xxx	None
Fare savings	Sum of data outlined in table xxx	None
Bike maintenance costs	Sum of data outlined in table xxx	None
Externalities (excluding accidents, physical fitness and absenteeism)	Use of WebTAG Databook (DfT 2013a) to estimate initial values and changes over the appraisal period	
Accidents	Use of WebTAG value for cycle casualties	None
Physical fitness	5-year accrual period (20% increments) as recommended by HEAT, then constant for years 6-10. Growth in line with GDP p.c. (DfT 2012b pp. 15-16)	
Absenteeism	Average of data outlined in table xxx	None
Government and business impacts (excluding fuel duty)	Uplift figures by 19% to convert to market prices	None
Fuel duty	Use of Tag Unit 3.9.5 WebTAG Databook (DfT 2013a) to estimate initial values and changes over the appraisal period (already in market prices so no uplifting)	

* All benefits are averaged over the whole sample regardless of how many respondents actually benefit.