THE VALUE OF TIME AND EXTERNAL BENEFITS IN BICYCLE COST-BENEFIT ANALYSES

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Abstract

We estimate the value of time gains, different cycling environments and additional benefits in cost-benefit analysis of cycling investments. Cyclists' value of travel time savings turns out to be high, considerably higher than the value of time savings on alternative modes. Cyclists also value other improvements highly, such as separated bicycle lanes. As to additional benefits of cycling improvements in the form of health and reduced car traffic, our results do not support the notion that these will be a significant part in a cost-benefit analysis, contrary to some earlier studies and beliefs. As to health effects, cyclists seem to take these largely into account when making their travel choices, so it would be double-counting to add total health benefits to the analysis once the consumer surplus has been correctly calculated. As to reductions in car traffic, our results indicate that the cross-elasticity between car and cycle is low, and hence benefits from traffic reductions will be small. However, the valuations of improved cycling speeds and comfort are so high that it seems likely that improvements for cyclists are cost-effective compared to many other types of investments, without having to invoke second-order, indirect effects. In other words, the bicycle is perfectly able to be viewed as a competitive mode of travel, rather than primarily a means to achieve improved health or reduced car traffic.

INTRODUCTION

It appears that bicycle as a mode of transport has received increasing attention over the latest years. There also seems to be an increasing interest among planners to improve the bicycle transport system. For example, the EU commission's Green Paper "Towards a new culture for urban mobility" (EC, 2007) states that "More attention should be paid to the development of adequate [bicycle] infrastructure". Bicycle is often an efficient mode of transport in terms of speed and cost for the traveler, and is also an efficient mode in terms of urban space. Still, cycle investments are seldom evaluated by using the standard cost-benefit analysis (CBA) that is used to evaluate road and rail investments. One possible reason is that the methodology is less developed for bicycle trips. Another possible reason is the implicit perception that cyclists have so low willingness to pay for time savings or other improvements that bicycle investments need to be motivated by "additional" benefits in the form of increased health, environmental effects or reduced road congestion. Indeed, there seems to be great expectations that such benefits will constitute a major part of the benefits in bicycle CBA.

Hence, it seems as if there is a growing need for reliable CBA:s for bicycle investments and cycle-related policy measures. This paper contributes to the development of better bicycle CBA methodology. The main purpose of the study is to estimate cyclists' value of travel time savings, as well as valuations of a number of other improvements: bicycle paths, waiting at signaled intersections and bicycle parking. A secondary purpose of the study is to estimate the magnitude of "additional benefits" of improvements that increase cycling, in particular health effects and (to a less extent) benefits from reduced car traffic. The results are based on a stated choice survey carried out among cyclists in Stockholm during 2008.

Time savings constitute, in general, the major part of the benefits of transport investments. For example, 90% of the benefits in the Swedish Transport Investment Plan 2010-2021 consist of reduced transport times and transport costs (Eliasson and Lundberg, 2010). Obviously, one needs reliable estimates of bicyclists' values of time to be able to evaluate benefits of improvements for cyclists. There are only a few previous studies devoted to cyclists' value of time. Wardman et al (2007) employ stated-preference (SP) and revealed-preference (RP) data to estimate a mode choice model for commuting trips, with a special focus on the bicycle mode. The model gives an implicit RP-based value of time of 18.17 €/hour[1] for cyclists, almost three times the value of time for the "alternative" (second-best) mode. Stangeby (1997) finds a value of time of 10.17 €/h[2] for cyclists in an SP study that resembles the present one.

Employing SP data, Wardman et al (2007) and Hopkins and Wardman (1996) find that cycle facilities which reduce risk are highly valued. For example, the latter study estimates the

[1] Using the exchange rate 1.15 £/€ and adjusting nominal 1999 valuations to nominal 2008 valuations by a factor 1.36, based on 1.5 %/year inflation and 2 %/year valuation increase due to income growth.
[2] Using the exchange rate 8.47 NOK/€ and adjusting nominal 1997 valuations to nominal 2008 valuations by a factor 1.46.

value of separate paths for cyclists to 30.11 €/hour relative to no cycling facilities. Analyzing the use of bicycle within different municipalities in the Netherlands, Rietveld and Daniels (2004) also conclude that physical aspects such as the number of stops and the safety of cyclists influence the generalized cost of cycling. Elvik (1999) discuss traffic safety in bicycle CBA in more detail.

Sælensminde (2004) and CBA practice in Nordic countries (Krag, 2005; Saari and Metsäranta, 2005; Swedish Environmental Protection Agency, 2005) argue that additional health effects constitute a major benefit in bicycle CBA. However, it is not evident that health effects should be treated as an *additional* (or ”external”) benefit, even if there is a broad consensus that there are significant health benefits to be gained from cycling. The question is to what extent health benefits are internalized, i.e. to what extent people take health effects into consideration when choosing whether to cycle. If health effects are internalized, then health benefits will be included as consumer surplus in the CBA, and adding health effects to the CBA will be double-counting. Since health benefits potentially constitute a significant part of total benefits (60-70% in Sælensminde's case studies), it is important to try to estimate to what extent health benefits are already factored in by bicyclists when they choose their mode of transport. We try to assess these effects by analyzing complementary survey questions. Obviously, awareness of health benefits may differ between cities, countries and contexts. Moreover, it is extremely difficult to know whether cyclists estimate effects on their health correctly, even if they are “aware” of the effect in principle: both over- and underestimations are possible. A central question is hence where the “burden of proof” lies, or, in other words, whether the “null hypothesis” in lack of conclusive evidence is that cyclists do take effects on own health into account or that they do not. The classic standpoint in the economics literature is that own health is primarily an individual responsibility, a position motivated by the fundamental principle of “consumer sovereignty”. This standpoint has been challenged from various angles. A particularly relevant discussion is the literature on “sin taxes” (O'Donoghue and Rabin, 2003, 2006), where optimal policy rules are derived for situations where consumers do not have full information or do not have complete self-control, and hence may act against their own best self-interest.

Another potential “additional benefit” of bicycle improvements is reduction in car traffic, resulting in reductions of emissions and congestion. Whether this effect will be significant will depend on the cycle/car cross-elasticity. In principle, this cross-elasticity should be possible to obtain from transport demand models. Unfortunately, such models are usually not developed with a great deal of attention on the possibility to forecast bicycle effects, and hence, results from them need to be corroborated by other forms of direct evidence. Katz (1995) concludes that traditional forecasting modeling techniques are not treating a minority mode such as cycling as good as other modes. One exception is Ortúzar et al. (2000) who estimate a dedicated bicycle demand model, although based on SP data. Another exception is Wardman et al. (2007), who estimate a mode choice model data to for commutes with a special focus on bicycle. To estimate this model they combine RP and SP and thereby adjust the scale of the model to be appropriate for forecasting. As Rietveld and Daniels (2004) point out, it seems that the bicycle competes primarily with public transport, but this may obviously vary between cities.

Cycling is an increasingly important mode of transport of Stockholm, especially in the urban centre. Roadside count data shows a steady increase beginning around 1990, with cycling volumes more than doubling in 20 years (City of Stockholm, 2009). In relative terms, the increase is particularly pronounced during wintertime. Cycling does not increase in other parts of Sweden, though, but seems to have a stable role in the transport system (National Travel Surveys 1997-2001 and 2006, own calculations). Bicycle mode shares vary surprisingly much between countries. Perhaps even more surprisingly, there seems to be no apparent connection to climate conditions. Sweden and the other Nordic countries have high bicycle shares, despite relatively cold winters. The top seven European countries in terms of bicycle shares are the Nordic countries together with Germany, the Netherlands and Belgium – Sweden is number five on the list (Rietveld and Daniel, 2004, quoting the EU Energy and Transport). It is unclear what role cultural differences and differences in transport planning plays to explain the differences in cycling shares.

The paper is organized as follows. Section 2 describes the survey and characteristics of the responding cyclists. Results are compared to the Swedish national travel survey, to estimate the representativity of the current study. In section 3, results from the value of time study is presented. Section 4 is devoted to the discussion of “additional benefits”, i.e. to what extent health and environmental benefits should be added to a bicycle CBA. Section 5 concludes.

SURVEY DESIGN AND RESPONDENT CHARACTERISTICS

The survey

The survey was carried out as a hand-out/mail-back survey among cyclists in Stockholm in August 2008. The survey was handed out to cyclists during peak hours (7-10 and 15-18) at signalized intersections in the city centre and on the roads leading to the city centre, together with prepaid answering envelops. Depending on their stated trip time, respondents were given different variants of the survey with different versions of the stated choice questions – one for journeys shorter than 30 minutes and one for longer journeys.

1422 cyclists were approached, of which 180 (13%) declined to participate. Respondents had to be older than 18 years, be on a journey longer than 15 minutes and understand Swedish. The restriction that the trip had to be longer than 15 minutes was necessary to ensure that the stated choice experiments were realistic. This eliminated a further 62 approached cyclists (4%). Out of the remaining 1180 respondents, 756 (64%) mailed back completed questionnaires. Adding declining and non-responding cyclists together, the total response rate becomes 56%.

Respondent characteristics

60% of respondents were female. The age distribution was fairly uniform in the interval 18-65 years, with an average of 41 years. The age distribution did not differ between genders.

Hence, cycling is not confined to younger age groups, contrary to beliefs sometimes encountered.

86% of the trips in the sample were work trips, with a somewhat higher share during morning hours and a somewhat lower share in the afternoon. The distribution of trip purposes did not differ much between genders. 92% of respondents were employed and 5% were students.

Trip times were fairly uniformly distributed in the interval 15-60 minutes, with an average of 29 minutes. The average trip length was 7 km. Trip lengths and times did not differ between genders. 90% of the respondents had access to a separated bicycle path on more than half of the trip.

The average income in the sample was 31 000 SEK/month (1 SEK is around 0.1€), somewhat higher than the average income in the county of Stockholm, which is around 25 600 SEK/month. However, this is the average of all persons 20-64 years with any salary during 2007 – including all part-time and seasonal workers (e.g. students), så this figure is bound to be lower than the average wage of peak hour work trips an ordinary weekday.

Obviously, the sample is not representative of all cycle trips in the county of Stockholm – work trips and peak-hour trips are oversampled, for example. The choice of sampling locations also tended to oversample longer trips (many locations were at the boundary of the inner city, which is separated by water from the rest of Stockholm). The table below compares characteristics of the trips in the sample with trips from the national travel survey. The first column describes all cycle trips in the county, the second column cycle trips starting or ending in the inner city (which is roughly comparable to the trips in our sample) and finally the sample of the current survey.

	Stockholm county	**Starting/ending in the inner city**	**Our sample**
Journey purpose: to/from work	54%	70%	86%
Average trip length	3.9	5.1	7
Average trip length, work trips only	4.9	5.8	7.4
Average trip time	18	22	29
Average trip time, work trips only	19	21	29
Trips by females	46%	40%	60%
Trips by employed	63%	78%	92%
Average age	38	38	41
Average income[3]	25 000	26 000	31 000

Trip lengths and trip times are bound to be higher in our sample, since trips shorter than 15 minutes were excluded in the present study. Moreover, longer trips have a higher probability to be included in our sample: the national travel survey is a random sample of individuals, while the probability to be included in a roadside survey like ours is proportional to trip length.

[3] The travel survey refers to the years 2004 and 2006, so income levels are not directly comparable.

This is the relevant sampling strategy when evaluating transport investments: the sample should reflect the composition of trips on a representative link. Income, share of work trips and share of employed respondents are also bound to be higher, since respondents were sampled during peak hours. The only surprising difference between our sample and the national survey is the higher share of females in our sample.

VALUE OF TIME ESTIMATES

The survey contained two stated choice experiments, comprising nine pairwise choices each. The setting in the first experiment was a choice between bicycle and the respondent's second-best mode (which turned out to be public transit for 87% of the respondents while the rest chose car). The alternatives differed in terms of travel time, travel cost and the share of the bicycle trip on a separated bicycle path. The setting in the second experiment was a choice between two alternative bicycle routes, differing in terms of travel times, number of signalized intersections, total waiting time at those intersections and whether there was a bicycle parking facility at the destination.

Experiment 1: Valuation of time savings and cycle paths

A logit model was estimated with the following specification of the utility functions. t_{street} is the travel time on a street shared with car traffic, while t_{path} is the travel time on a separate bicycle path. t_{alt} and c_{alt} is the travel time and travel cost with the alternative travel mode. t_0 is the travel time of the original trip, I the income of the respondent and $\bar{I}$ the mean income in the sample. γ is a mode choice constant, assumed normally distributed across the population but constant for each individual – this controls for the panel effects arising from repeated choices by the individuals. δ_{40} is a dummy variable equal to 1 if the respondent is older than 40 years.

Experiment 1:

$$\begin{aligned} u_{cycle} &= (\alpha_1 + \alpha_4 t_0) t_{street} + (\alpha_2 + \alpha_4 t_0) t_{path} + \gamma + \gamma_{age}\delta_{40} \\ u_{alt} &= \alpha_3 t_{alt} + \left(\beta_1 + \beta_2 \log\left(I - \bar{I}\right)\right) c_{alt} \end{aligned}$$

Estimation results are found in the table below. Model 1 is a restricted model without socioeconomic variables. After extensive testing of socioeconomic variables, model 2 was developed. Valuations do not change much between models.

	Model 1		**Model 2**	
Parameter	**Parameter value**	***t-test***	**Parameter value**	***t-test***
α_1 (travel time, street)	-0.227	*-21.9*	-0.300	*-20.0*
α_2 (travel time, bike path)	-0.15	*-16.1*	-0.222	*-15.8*
α_3 (travel time, alt. mode)	-0.125	*-16.4*	-0.115	*-14.7*
α_4 (effect of baseline travel time)	-	-	0.00176	*7.0*

γ, mean (mode choice constant)	3.53	*8.6*	4.37	*9.7*
γ, std dev	2.38	*21.5*	2.34	*21.5*
γ_{age} (add. mode constant for resp. > 40 yrs.)	-	-	0.631	*3.1*
β_1 (travel cost)	-0.0858	*-18.0*	-0.0840	*-17.5*
β_2 (effect of income)	-	-	0.0416	*5.0*
Number of draws	2000		2000	
Number of observations	6257		6257	
Number of respondents	710		710	
Log-likelihood:	-2736.076		-2692.766	
Likelihood ratio test:	3201.891		3288.511	
Rho-square:	0.369		0.379	
Adjusted rho-square:	0.368		0.377	

Values of time in SEK/h	**Model 1**	**Model 2** (evaluated at average sample income, 31 kSEK/month		
		Travel time 20 min	*Travel time 29 min (sample average)*	*Travel time 45 min*
Value of bicycle time on street	159	195	172	131
Value of bicycle time on bike	105	139	117	76
Value of time on alt. mode	87	104	81	41

The value of time on the alternative mode corresponds rather well to the value from the new Swedish Value of Time study (Börjesson et al., 2010), which is 68 SEK/h (for work trips with rail transit, which is the most relevant comparison; bus values are lower and car values are higher). The estimated values of cycling time on street are similar to the results of Wardman et al. (2007). Adjusting for inflation and GDP growth, they obtained a valuation of 18.17 €/h, based on revealed preferences for commuting trips. They are also similar to the (implicit) values of time in the national transport model SAMPERS, which are around 111 SEK/h (depending on trip length and gender; the SAMPERS value of time is higher for women and longer trip distances).

The value of cycling time savings is considerably higher than the value of time savings on the alternative mode: street cycling time savings are valued almost twice as high as time savings on the alternative mode. A similar result was obtained by Wardman, where cycling time was valued about three times as much as time savings on the alternative mode. A reasonable interpretation for this phenomenon is that cycling time is more onerous than car or transit travel time.

Cycling on a separated bicycle path instead of on a street with mixed traffic is valued to around 55 SEK/h. Investment costs for bicycle paths vary widely, but a typical value could be

6 MSEK per km (City of Stockholm, 2002). With typical assumptions[4], this would mean that bicycle paths are socially profitable already at yearly average cycling volumes of a little less than 300 cyclists per day – which in urban contexts is very low. Major bicycle paths can easily have 3000 cyclists per day, which gives an incredible benefit/cost ratio of around 13. Note, however, that this is excluding the opportunity cost value of land, which in urban contexts can be a considerable cost.

Both the models were used to test a number of hypothesis. The results of sensitivity tests and hypothesis testing are summarized below.

- The marginal utility of cost decreases with income. This is taken into account in model specification 2.
- The marginal utility of time, however, is not affected by income.
- Neither the values of time, nor the mode choice constant γ differ significantly between genders.
- Only 17% of the respondents choose bicycle in all 9 choices. Values of time do not change if these are excluded from the estimation
- Neither the value of time on the alternative mode, nor the mode choice constant γ, depend (significantly) on whether respondents had transit or car as their second-best mode.
- Neither the value of time on the alternative mode, nor the mode choice constant γ, is affected by whether it rained when the survey was carried out.
- The value of time does not change significantly if non-work trips are excluded from the estimation
- The marginal utilities of time and money do not depend significantly on age. The mode choice constant is lower for younger cyclists. A possible reason for this is that older cyclists value the exercise from cycling higher.
- Respondents who state that exercise is the most important reason for them to choose bicycle does not value of cycling time savings lower than other respondents. Nor do they have a significantly different mode choice constant.
- There is no evidence that the marginal utility increases with travel time (which otherwise is a commonly found phenomenon, see e.g. Fosgerau, 2005). Longer *baseline* cycling times, on the other hand, decreases the marginal disutility of cycling time. A natural interpretation would be that this is due to self-selection.

Experiment 2: The value of intersections and parking

In the second experiment, a logit model with the following utility function was used. t is travel time, t_{wait} is the waiting time at signalized intersections, s the number of such intersections and δ_{park} a dummy variable indicating whether there is a bicycle parking facility at the destination. The choice was framed as the choice between two alternative bicycle routes.

[4] 40 years investment lifespan, 4% discounting rate, 1% yearly traffic growth, average cycling speed 14.5 km/h, conversion factor from producer to consumer prices 1.21.

Experiment 2: $u_{route} = \alpha_5 t + \alpha_6 t_{wait} + \theta_1 s + \theta_2 \delta_{park}$

Parameter	**Parameter value**	***t-test***
α_5 *(time)*	-0.203	*-32.4*
α_6 *(waiting time)*	-0.219	*-15.4*
θ_1 *(number of signals)*	-0.208	*-19.3*
θ_2 *(bicycle parking)*	0.752	*21.3*
Number of observations:	6614	
Log-likelihood:	-3565.2	
Likelihood ratio test:	2038.5	
Rho-square:	0.222	
Adjusted rho-square:	0.221	

Value of bicycle parking	3.7	cycling minutes	*9.81*	*SEK*
Value of waiting time at intersections	2.0	cycling minutes	*5.30*	*SEK*
Value of one signaled intersection, in addition to the delay	1.1	cycling minutes	*2.92*	*SEK*

In the second experiment, there was no travel cost. Instead, intersections and parking facilities are valued in terms of journey bicycling minutes. In the second column, these values are converted into monetary terms using the values of time estimated in experiment 1.

ADDITIONAL BENEFITS

Improvements for cyclists are often motivated by indirect benefits in the form of increased health and reduced car traffic (causing a reduction of emissions, congestion etc.) For example, Sælensminde (2004) argue that such additional benefits constitute a major benefit in bicycle CBA. Health effects also carry great weight in (suggested or official) CBA practice in Nordic countries (Krag, 2005; Saari and Metsäranta, 2005; Swedish Environmental Protection Agency, 2005).

However, the size of health benefits in a CBA will depend on to what extent people take health effects into consideration when choosing whether to cycle. The potential to achieve benefits though reductions in car traffic will depend on the cycle/car cross-elasticity and how much of external effects from car traffic that is internalized through e.g. fuel taxes. This section tries to estimate the magnitude of these factors.

Health benefits

Cycling has significant health effects, e.g. in the form of reduced risk for cardiovascular diseases, especially for groups with low or moderate levels of other exercise. If improvements of cycling possibilities increases the cycling volumes, then this will likely have beneficial health effects. Whether these health effects should be added to the CBA, however, depends on the extent that they are already factored in when people make their decision of how much to cycle (if at all). If, hypothetically, travelers do consider the health effects they will get from cycling and make an accurate judgment of them, then the health benefits will turn up as part of the consumer surplus – both as increased demand for cycling and as a lower value of cycling time – compared to a situation where travelers do not consider health effects. Adding health benefits to a CBA *if* cyclists already factor in the health effects they are getting will hence be double-counting. To what extent additional health benefits should be included in bicycle CBAs depends on four things: the extent that cyclists get health benefits out of their cycling; the extent that bicycle improvements increases cycling[5]; substitution between cycling and other forms of exercise; and the extent that cyclists take health effects into account when making their travel decisions. We will examine each of these issues in turn.

Let us first note that cycling is an important exercise form for cyclists. For most, cycling is their primary form of exercise: more than 60% of cyclists exercise less than 2 hours per week apart from cycling. Moreover, our data support the expectation that better cycling possibilities will increase cycling. Cyclists are not (only) die-hard cyclists that choose cycle no matter what; the relative difference in travel costs and times between bicycle and alternative modes affect their choice. As noted above, the relatively moderate changes of travel times and costs in the choice experiment made 83% of cyclists choose the alternative mode at least once. One can reasonably assume that this argument works both ways, so better cycling possibilities will entice some travelers to switch from other modes, and hence potentially lead to health benefits.

However, these benefits are to some extent reduced by the fact that cycling is a substitute for other forms of exercise. We can estimate the magnitude of this effect by noting that around 60% of cyclists state that they would exercise more if they cycled less, or they already exercise considerably in other forms (more than 4 hours a week) (cyclists exercising more than four hours a week get considerably less additional health effects out of their cycling). Older cyclists are overrepresented in this group, and since they are the ones who get the most health benefits out of cycling, the potential total health benefit is reduced by up to 60%, depending on the rate of substitution between cycling and other forms of exercise.

The most difficult question is to what extent health benefits are internalized, i.e. to what extent travelers take health benefits from cycling correctly into account when making their travel choices. To shed some light on this, note that more than 52% of the cyclists state that exercise is the most important reason to choose bicycle. The share is even higher for older cyclists: for cyclists over 50 years of age, the share is 61%. Clearly, this group take health benefits into account, although it is of course possible that they may over- or underestimate these health benefits. Obviously, other cyclists may also consider health effects when choosing mode, even if exercise was not their most important reason. If there is a difference

[5] Ideally by getting more people to start cycling, i.e. not primarily by making current cyclists cycle more.

between the two groups as to the extent they consider health effects, this should show up in the estimations as a lower value of bicycle time for the group that quote exercise as the most important reason to cycle. But as mentioned above, this is *not* the case: the values of bicycle time of the groups are not significantly different. Hence, there is no evidence that the group stating other reasons than exercise for cycling disregards health effects.

Summing up, we can draw the following conclusions from our material:

- Improvements for cyclists tend to increase cycling, and since most cyclists exercise moderately in other forms, there are potential health benefits of cycling improvements
- To a considerable extent, however, these health benefits are reduced through substitution effects between cycling and other forms exercise. This is particularly pronounced for older cyclists, for which health effects are greater.
- It is virtually impossible to know whether cyclists have a correct understanding of the health effects of cycling. But our results give us no reason to believe that cyclists are unaware of these benefits. On the contrary, the high share of cyclists stating exercise as the primary reason for cycling, and the fact that values of time do not differ between this group and cyclists stating other primary reasons, point to the conclusion that cyclists are indeed well aware of the beneficial effects of cycling.

That cyclists are “aware” of the health benefits does not necessarily mean that they are able to make an accurate judgment of them. On the contrary, this seems highly unlikely: both under- and overestimations are likely to occur. Even if the evidence is far from conclusive - and probably never can be – the present study cannot falsify the null hypothesis that cyclists’ take health effects into account in their travel decisions. Hence, we would argue that health effects should not be included in cost-benefit analyses.

Available evidence is far from conclusive, and it probably never will be – but the evidence there is seems to indicate that health effects are indeed factored in when travelers make their decisions, and hence, health effects should not be included in the CBA, at least not entirely.

Benefits from reduced car traffic

At least in public debate, cycle improvements are often motivated by the need to reduce car traffic, There seems to be great expectations that improving cycling possibilities will entice car drivers to change to bicycle, thereby reducing congestion, emissions, noise etc. Such reductions of external costs from car travel should obviously be added to cycle CBA. On the other hand, a significant portion of such external costs are internalized through e.g. fuel taxes, and it is only the *external* part (i.e. the “non-internalized” share) that should be added to the CBA[6]. Outside congested urban areas, external costs of private car traffic such as noise, emissions, accidents and road maintenance are almost entirely internalized through

[6] In Swedish CBA practice, this is handled by presenting the total changes in external costs (emissions etc.) in the CBA, and then adding changes in fuel taxes to the CBA as well. In this way, only the non-internalised parts of the external costs remain in the CBA. Other countries may have other practices.

fuel taxes in Sweden (SIKA, 2006). Hence, the potential social benefits of reducing car traffic by cycle improvements is less than sometimes expected.

Another important factor is the cross-elasticity between car and bicycle. From our material, this cannot be estimated directly, but it is obvious that it cannot be large from one observation: the share of bicyclists quoting car as their second-best travel alternative is a mere 13%. This is consistent with several other studies that have shown that the cross-elasticity between public transit and bicycle is considerably higher than that between car and bicycle.

Hence, it must be concluded that bicycle improvements will generate very limited social benefits from reduced car traffic. First, even if all “new” cyclists come from existing and that merely switch mode, then we should expect that perhaps 10-15% of them change from car. Second, a large fraction of the induced cycle traffic will be “new trips”, not just existing trips changing modes, which will decrease the potential car traffic decrease even further. Third, only the non-internalized part of external costs from traffic should be included in a CBA, and except for congestion, the internalization rate is high.

These conclusions apply to our specific context, of course. First, Stockholm has good supply of public transit and a high transit share, especially in the central parts, and this increases the share of people having transit as their second-best mode. Second, the rate of internalization of external effects from car traffic varies widely between countries.

CONCLUSIONS

The bicycle is often an extremely efficient mode of transport in several respects – travel time, travel cost and space efficiency - and the seemingly growing interest in promoting the possibilities of cycling is promising. It is likely that there are many cost-efficient investments and other measures that will be discovered once traffic planners start to look more closely.

To identify the most cost-efficient improvements with the help of CBA, values of time are needed. Computing values of time for cycling is the main purpose of this study. The estimated values of time in our are fairly high, although not extremely high. Interestingly, values of time on the second-best mode (mostly public transit) coincide with values of time estimated for this mode in independent studies (after correcting for a slightly higher income). This supports the hypothesis that the reason for the higher value of saving cycling time is simply that cycling is more onerous than other modes. The estimated values of time are not representative for the average Swedish cyclist, however; work trips are overrepresented, incomes are slightly higher than average, and the Stockholm traffic situation differs from the rest of Sweden (higher congestion and better public transit). From the high values of time it may be concluded that investments and other measures that reduce cycling times may potentially be very socially profitable. The high willingness to pay for separated bicycle paths compared to cycling among cars suggest that such paths may be very socially profitable.

However, our impression is that cycling improvements are often motivated by secondary effects, such as health benefits and reduced car traffic. Our results do not support the hypothesis that such effects will constitute a major part of social benefits. Regarding health effects, they may be very significant – but our data suggests that these effects are internalized to a large extent, i.e. cyclists take a large share of them into account when making their travel choices. Adding health benefits to the CBA would hence be double-counting. Admittedly, it is extremely difficult to know whether cyclists estimate effects on their health correctly, even if they are "aware" of the effect in principle: both over- and underestimations are possible. Regarding car traffic reductions, it depends on the car/bicycle cross-elasticity and the fraction of external costs that are internalized. Both of these factors will vary between contexts, but from our study, the conclusion is that benefits from reduced car traffic will be very small.

Hence, the expectations that cycling improvements will yield large health or environmental arguments seem exaggerated. But on the other hand, there is no need to retort to "secondary effects"-argument to motivate cycling investments. The bicycle is in many contexts and circumstances an extremely efficient mode of transport – cheap, fast and requires little space or physical investments. As we have seen, the value of cycling time savings is potentially very high. In our opinion, the bicycle deserves to be viewed as an important and efficient mode of transport – rather than simply a means to obtain other effects.

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