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# The value of time and external benefits in bicycle appraisal

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ABSTRACT

We estimate the value of time savings, 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. Bicyclists seem to take health largely into account when making their travel choices, implying that 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, our results suggest that bicycle should be viewed as a competitive mode of travel and not primarily as a means to achieve improved health or reduced car traffic.



## 1. Introduction

The bicycle as a mode of transport has received increasing attention in recent 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" (European Commission, 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 also in terms of urban space. Still, bicycle investments are seldom evaluated 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, there seems to be a growing need for reliable CBAs for bicycle investments and bicycle-related policy measures. This paper contributes to the development of better bicycle CBA methodology. The main purpose of the study is to estimate bicyclists' value of travel time savings, as well as valuations of a number of other improvements: bicycle paths, bicycle parking, and shorter waiting times at signaled intersections. A secondary purpose of the study is to assess the magnitude of

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"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 usually constitute 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, 2011). 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 €/h[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 Hopkinson and Wardman (1996) find that cycle facilities which reduce risk are highly valued. For example, the latter study estimates the value of separate paths for cyclists to 1.60 €/h relative to no cycling facilities. Analyzing the use of bicycle within different municipalities in the Netherlands, Rietveld and Daniel (2004) also conclude that physical aspects such as the number of stops and the safety of cyclists influence the generalized cost of cycling. Elvik (2000) discusses 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 health effects constitute a major additional 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 key issue 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 this 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, 2006, 2003), where optimal policy rules are derived for situations where consumers do not have full information or self-control, and hence may act against their own best self-interest.

Another potential "additional benefit" of bicycle improvements is reductions of car traffic, resulting in reduced 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 mentioned earlier is Wardman et al. (2007) who estimate a mode choice model on combined RP and SP data, and thereby adjust the response scale to be appropriate for forecasting. As Rietveld and Daniels (2004) point out, it seems that the bicycle competes primarily with public transport.

In this paper, we study bicyclists in central Stockholm. Cycling is an increasingly important mode of transport in Stockholm, especially in the urban center. 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). Börjesson and Eliasson (2012) describe this rapid development on more detail and discuss possible reasons for it. 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). Ebert and Carstensen (2012) discuss the historical development of a bicycle-oriented planning in Northern Europe.

The paper is organized as follows. Section 2 summarizes the theory of valuation of travel time, and formulates a number of expectations about how the value of cycling time may vary. Section 3 describes the survey and characteristics of the responding cyclists. Results are compared to the Stockholm County travel survey 2004/2006, to assess the representativity of the current sample with respect to bicyclists in the whole county. In Section 4, results from the value of time study are

[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.