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ISSN: 0803-9763 (paper version)
ISSN: 0804-5585 (web version)
ISBN: 978-82-8433-016-7 (paper version)
ISBN: 978-82-8433-017-4 (web version)

DATE: December 2021

PUBLISHER: Ex ante academic press

Concept Research Programme
Norwegian University of Science and Technology
7491 NTNU – Trondheim
Norway
www.ntnu.no/concept

English Summary

In this report, we review changes over time in key assumptions and parameters in cost-benefit analysis (CBA) of road and railway investments in Norway. We show that these have a large impact on the estimated economic return on the investments. As far as we know, this is the first systematic mapping of CBA assumptions over time, making the study an important contribution to the debate on the use of economic appraisal in the transport sector. We also discuss the scientific foundations for current CBA practice.

Several previous studies have documented low estimated economic return on Norwegian transport projects, both in the case of selected and non-selected projects. Net benefits of projects in the National transport plan (NTP) have decreased over time, except for an increase in net benefits from the NTP 2010-2019 to NTP 2014-2023. Net benefits have on average been negative in most of these plans.

Our mapping covers the six NTPs starting with NTP 2002-2011 and the following assumptions and parameters: Discount rate, cost of public funds, project lifetime, analysis period and residual value, real price adjustment of unit values, unit values of travel time, unit values of traffic fatalities and injuries, and the social cost of carbon emissions.

In Norway, there have been no established routines regarding when unit values and CBA assumptions should be revised and how these should be documented. We have therefore used different sources in combination, like government white papers, reports from government commissions, guidelines from the transport agencies and documentation of the Norwegian Public Roads Administration's CBA tool EFFEKT. Together, these sources provide a good documentation of changes in CBA practice over time.

The review clearly shows that CBA assumptions have changed over time in a way that implies higher estimated net benefits, everything else equal. Both a lower discount rate, a longer period of analysis, new principles for calculating the residual value and real price adjustment of unit values contribute to this. Several of these changes occurred before NTP 2014-2023, based on the recommendations by the Hagen commission in 2012. In NTP 2022-2033, the

assumed lifetime of road investments (except more minor road renewals) has increased from 40 to 75 years, which is also the assumed lifetime of railway investments. Combined with a declining discount rate and real price adjustment of unit values, this implies that impacts that occur in a relatively distant future now account for a large share of the benefits of transport investments.

Unit values of travel time have developed somewhat differently for different user groups, with some large increases from one NTP to the next. Overall, however, the values have increased over time roughly at the same rate as the income level in Norway. The unit values of traffic fatalities and injuries have not increased much, owing to a reduction in the unit value of fatalities in the most recent NTP. The social cost of carbon emissions has increased in the most recent NTP. For most projects, the unit values of travel time will be most important for estimated net benefits, while impacts on fatalities and injuries and on carbon emissions play a more minor role.

To illustrate the impact on estimated economic return, we have conducted a case study of two planned road projects that have recently been subject to economic appraisal: *E39 Storehaugen–Førde* and *Riksveg 19 Moss*. We build on the results from the CBA tool EFFEKT based on current CBA assumptions and show how results changes when we use assumptions and unit values from previous transport plans. *E39 Storehaugen–Førde* has negative estimated net benefits based on current practice, while the alternative that we consider in the *Riksveg 19 Moss* project has positive net benefits.

In these analyses, we treat the impact of changes in unit values of travel time separately. The reason for this is that the increase in these values, which is partly related to an increase in the income level, constitutes a somewhat different type of change than a change in more general assumptions like project lifetime and the discount rate. It is therefore interesting to see how much estimated benefits change before we take changes in values of travel time into account.

As expected, the results show that estimated net benefits are highest (or least negative) when using the CBA assumptions from NTP 2022-2033 and smaller (or more negative) the older assumptions that are used. For *E39 Storehaugen–Førde,* the benefits to travellers, transport operators and third parties ('gross benefits') increase by on average 34 percent between one NTP and the next during the period, or 332 percent in total. For *Riksveg 19 Moss*, the average

increase is 29 percent, and the total increase is 253 percent. Accounting for higher unit values of travel time further amplifies the increase.

The assumptions have partly changed at different points in time, which allows us to draw some conclusions regarding their relative importance. The reduction in the discount rate from NTP 2006-2015 to NTP 2010-2019 resulted in a considerable increase in net benefits. A somewhat larger increase occurred in NTP 2014-2023, mainly due to a longer analysis period and the introduction of real price adjustment of unit values. A longer assumed lifetime of road projects in NTP 2022-2033 implies another considerable increase, in the same order of magnitude as the increase from NTP 2006-2015 to NTP 2010-2019. Here, a lower rate of real price adjustment partly pulls in the negative direction.

Despite more favorable CBA assumption in more recent years, many of the projects still have negative net benefits, as have many other projects in the NTP. If the assumptions had not been changed, net benefits would have been even more negative.

The scientific foundations for the assumption of a 75-year lifetime for both road and railway projects in the most recent NTP are limited, and uncertainty is high. In addition, one assumes that user benefits increase throughout this 75-year period, although decreasing rates of traffic growth and real price adjustment are used. Combined with a decreasing discount rate, this implies putting a high weight on relatively uncertain benefits in a relatively distant future. We recommend instead to calculate the residual value based on net benefits that decrease towards zero at the end of the project lifetime. One should also consider reintroducing a differentiated risk premium in the discount rate.

Also, we point towards some potential improvements and knowledge gaps related to the cost of public funds, real price adjustment, unit values of travel time and unit values of fatalities and injuries. There is a need for more knowledge on how estimated values of travel time depend on the choice of method, to what extent they are consistent with observed behavior and their relationship with travel distance.

In our opinion, our findings point towards a knowledge gap regarding the economic lifetime of transport investment. We recommend conducting empirical studies of this issue based on existing projects. There is a need for

more knowledge both on the duration of different infrastructure projects' lifetime and on the development of costs and benefits throughout the lifetime.

We also recommend establishing clearer routines for how CBA assumptions and unit values are to be revised and documented. One alternative would be a permanent board of experts that is responsible for this, similar to the ASEK committee in Sweden. We also recommend improving the government web pages that document the planning process behind the NTP and that CBA results are made more accessible and transparent.

Concept report series

Paper version: ISSN 0803-9763

Web version: ISSN 0804-5585

Norwegian version: https://www.ntnu.no/concept/concept-rapportserie

English version: https://www.ntnu.edu/concept/concept-report-series

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Concept er lokalisert ved Norges teknisk- naturvitenskapelige universitet i Trondheim (NTNU), ved Fakultet for ingeniørvitenskap og teknologi. Programmet samarbeider med ledende norske og internasjonale fagmiljøer og universiteter, og er finansiert av Finansdepartementet.

The Concept research program aims to develop know-how to help make more efficient use of resources and improve the effect of major public investments. The Program is designed to follow up on the largest public projects over a period of several years, and help improve design and quality assurance of future public projects before they are formally approved.

The program is based at The Norwegian University of Science and Technology (NTNU), Faculty of Engineering Science and Technology. It cooperates with key Norwegian and international professional institutions and universities, and is financed by the Norwegian Ministry of Finance.

Address:
The Concept Research Program
Høgskoleringen 7A
N-7491 NTNU
Trondheim
NORWAY

ISSN: 0803-9763 (paper version)
ISSN: 0804-5588 (web version)
ISBN: 978-82-8433-016-7 (paper version)
ISBN: 978-82-8433-017-4 (web version)