Institute of Transport Economics
Norwegian Centre for Transport Research

ENGLISH **Summary**

Driving comfort level, value of travel time, and route choice of car travellers

TØI Report 1923/2022 • Authors: Askill Harkjerr Halse, Stefan Flügel, Knut Johannes Liland Hartveit, Christian Steinsland • Oslo 2022 • 35 pages

- We provide updated recommendations on how to differentiate the value of travel time (VTT) by road type, to account for differences in the driving comfort level.
- The recommendations are based on a review of literature, empirical case studies, testing and practical considerations.
- We exploit three natural experiments where travellers can choose between a toll road and an alternative route, and where toll rates have changed over time.
- The results are consistent with a higher VTT on the old road, which has a lower level of driving comfort.
- Based on our results, we recommend a VTT on four-lane motorways which is 87 percent of the average VTT for private trips. The multiplier for business trips is 95 percent. We also recommend multipliers for other road types.

When travellers choose how, where, and how often to travel, they make trade-offs between factors like cost, travel time and other trip characteristics. This is the foundation of the economic theory of travel demand, which is used both in traffic forecasts and cost-benefit analysis of transport improvements. For instance, the trade-off between travel time and cost can be expressed in monetary terms as of the value of travel time (VTT). When estimating the benefits of a road investment, the benefits from shorter travel time typically account for most of the positive benefits of the project.

A subject which has not received much attention is how road type and road quality affect the choices of travellers. In a recent report, we recommended VTT multipliers for different road types, where higher-quality road types have a lower VTT. This implies higher estimated benefits of interventions that improve road quality or results in higher traffic on high-quality compared to low-quality roads. In this report, we expand the knowledge basis for such a differentiation and provide updated recommendations on VTT multipliers and how to apply these.

The knowledge basis consists of:

1. International literature on the VTT and revealed preference (RP) data
2. More empirical case studies
3. A review of the experiences with applying the VTT multipliers in practice
4. Testing the multipliers in travel demand modelling of long trips

This project focuses on road infrastructure and car travel. However, the importance of infrastructure quality and the travel experience more generally in economic analysis is a topic which is also relevant for other modes of transport.

Theory and methods

A cost-benefit analysis (CBA) shows the net benefits of an intervention in terms of total willingness to pay for the intervention. The theoretical point of departure for such an analysis is that preference of the agents can be derive from their choices (consumer sovereignty). This is also the point departure for revealed preference (RP) methods, where we use data on agents' observed choices to infer their valuation.

The willingness to pay to reduce travel time is expressed in terms of a generic VTT. We hypothesise that, in addition, travellers also are more likely to choose a road which is more comfortable or perceived as safe. We measure the value of driving comfort in terms of VTT multipliers. A multiplier lower than one for a given road type implies that the road type has a higher level of driving comfort than the average road.

In CBAs of road investments in Norway, a reduction in accident risk is included as a benefit, but accident risk is assumed not to affect the choices of travellers. This is a relatively innocent simplification when the risk level is relatively low. However, is creates some challenges when the purpose is to differentiate the VTT by road type, as some of the differences can probably be attributed to differences in accident risk. In our recommendations, we therefore adjust the VTT multipliers somewhat in order to avoid double-counting with accident risk.

Another factor which affects the choice of travel route is the design of intersections and off-ramps and other characteristics that make it more convenient to choose one of the routes. This effect can be considered independent of distance and travel time. In travel demand modelling, it would then take the form of a constant terms which we refer to as the 'signage effect'.

Based on aggregate data on travel choices, it may be challenging to separate the value of driving comfort related to road type from the impact of accident risk, the signage effect and the level of the generic VTT. One has make assumptions about one or more of these elements in order to estimate the others.

We depart from the same classification of road types as in the previous report, with four different road types outside urban areas and a single category for urban roads. The drawback of having such a rough classification is that there could be significant variation in road characteristics within each road type. This arguably applies in particular to the category "two-lane road with a median strip". The advantage is that such a simple classification does not require too much data on road characteristics.

Related topics in travel demand and valuation

As previously mentioned, the value of driving comfort is closely related to travel demand modelling and the VTT more generally. We have reviewed some selected empirical VTT studies. A key methodological distinction is the distinction between studies based on observed choices (revealed preferences, RP) and studies based on hypothetical choices (stated preferences, SP). A common finding is that the latter method results in a somewhat lower VTT. As we want our recommendations to be in line with observed behaviour, we put more weight on studies based on RP data.

One study on the route choices of travellers travelling to three tourist destinations in Italy finds a VTT which is roughly 3/4 of the wage rate. This is relatively high, and higher than many previous studies based on SP data. A study on the relationship between fuel prices and driving speed in the US finds a somewhat lower VTT. A recent example of an RP study considers the route choice of car travellers between Tvedestrand and Arendal, based on traffic count data. Based on how many travellers change their route after road tolls are introduced, the authors estimate a VTT per traveller of 207 NOK per hour for commuting, 120 NOK per hour for leisure trips and 1114 NOK per hour for heavy vehicles.

To which extent these values are higher or lower than the official value, which are based on SP data, depends on which values are compared. The VTT increases considerably with travel distance, a relationship which should be investigated more closely. If one applies a continuous relationship between VTT and distance in the analysis, the average VTT in a certain area or on a certain road section will typically be higher than if one applies discrete values per distance segment. This is also the case in our three case studies.

Many unit values are, as in our case, expressed in terms of a relative VTT (VTT multipliers). As the VTT is higher for business trips, the value of other trip characteristics in monetary terms will also be higher for business trips if the multiplier is the same. For some unit values, it has however been recommended to use a lower multiplier for business trips. This practice probably deserves some more discussion and investigation.

As road tolls are a key determinant of travel choices in our case studies, we also review the literature on the sensitivity to road tolls and travel costs more generally. In general, the demand elasticity of car travellers with respect to travel costs is higher on commuting trips than leisure trips. In studies of road toll projects, the demand elasticity with respect to road tolls is relatively high, about –0.5 in the short term. At the same time, some studies suggest that the elasticity is lower if the cost is less salient, for instance if less information about the costs are provided.

Empirical case studies

We have previously developed a mathematical model to estimate VTT multipliers for different roads in a specific case. In this model, there are two time periods: one with road tolls on the new road and one without. In this project, we have adjusted the model such that it can also be applied to cases where road tolls also change, but where there could be a toll both on the new and the old road in both time periods. We have applied this model to three cases. The data on traffic volume are extracted from the automatic traffic counters of the National Public Roads Administration.

The first case is the section Tvedestrand–Arendal, where a new four-lane motorway opened on July 2, 2019. Road tolls were introduced on the new road, but not on any of the alternative routes. Due to technical difficulties, road tolls were not collected before September 1. In the analysis, we compare traffic volumes on the new road and the most relevant alternative route before and after road tolls were introduced. We have adjusted the traffic volumes somewhat to take into account that the new road is not a relevant option for all of those who use the old road.

The second case is the section Løten–Eleverum, where a new four-lane motorway with a road toll opened on August 3, 2020. Tolls were not collected on the old parallel road. Here, we exploit that the toll rate on the new road was lowered on February 19, 2021 as a result of the national budget settlement.

The third case is the section Øyer–Tretten, where a new tunnel and road was opened on December 2012. The new road has two lanes and overtaking lanes on a part of the section. Road tolls were collected both on the new and old road from the beginning. Here, we exploit that the tolls on the old road were abolished on January 18, 2021 as a result of the national budget settlement.

In all three cases, we observe that the share of traffic on the old road is higher when the difference in road tolls in higher. Travellers on weekdays, when local trips arguably constitute a higher share, are more likely to choose the old road and are more sensitive to changes in road tolls. As an example, we show in Figure E1 the share of traffic on the old road between Øyer and Tretten before and after road tolls were abolished on the old road.

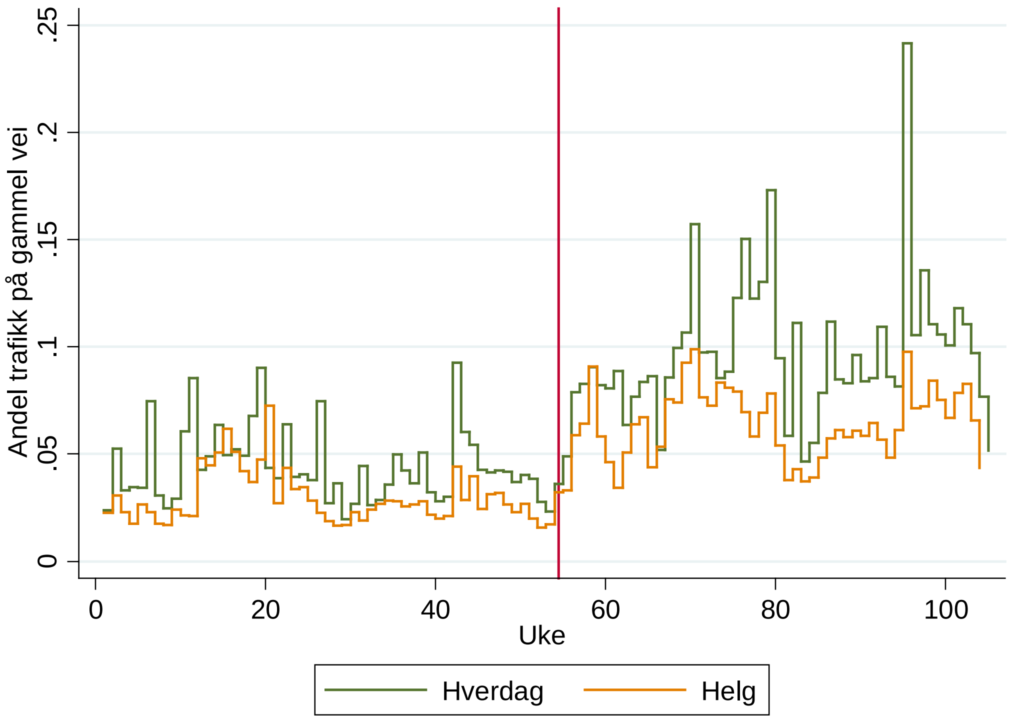

Figure E1: Share of traffic on the old road between Øyer and Tretten from week 1, 2020 to week 52, 2021. Passenger cars, both directions. The vertical line indicates the timing of the change in road tolls.

Based on the change in market shares, we can use our model to estimate the relative VTT of the old and new road, given assumptions on the level of the generic VTT and the signage effect. We have estimated an average generic VTT for each case based on the official Norwegian VTT values adjusted for travel distance and car occupancy. The results are shown in Table E1.

Table E1: Value of travel time (VTT) on the old road relative to the new road for each case, depending on assumptions on the signage effect. Passenger cars, all distances and trip purposes.

	Assumed signage effect		
	No effect	Medium (10 NOK)	Large (20 NOK)
All days			
Tvedestrand–Arendal	1,21	1,12	1,04
Løten–Elverum	1,56	1,36	1,18
Øyer–Tretten	1,23	1,10	0,97

In a second set of estimations, we departure from an average VTT that in the case of business travel only includes the VTT of the employee. This results in a lower average VTT, which implies that the difference in VTT between the new and the old road must be larger in order to explain the choices of the travellers. The results are shown in Table E2.

Table E2: Value of travel time (VTT) on the old road relative to the new road for each case, depending on assumptions on the signage effect, based on an average VTT which for business travel only includes the VTT of the employee. Passenger cars, all distances and trip purposes.

	Assumed signage effect		
	No effect	Medium (10 NOK)	Large (20 NOK)
All days			
Tvedestrand–Arendal	1,32	1,21	1,10
Løten–Elverum	1,73	1,49	1,27
Øyer–Tretten	1,31	1,16	1,02

The results suggest that travellers have a significant willingness to pay to drive on the new road, which is consistent with a model where the VTT is higher on low-quality roads due a lower level of driving comfort. In one of the two cases, the implicit value of driving comfort is even higher in one of the two new cases compared to Tvedestrand–Arendal. However, this might be a case where leaving the new road to take the old road does not appear as an obvious alternative to the travellers. The signage effect could be higher in this case than on the section Tvedestrand–Arendal.

We should also note that in the case of Øyer–Tretten, the choice is between a new and and old two-lane road, not between a four-lane and a two-lane road. This suggest that travellers value a new and straight road more generally, also when this only has two lanes.

Testing and application

Experiences from using the VTT multipliers in CBA in the previous version of the regional transport model (RTM) shows that user benefits are between 9 and 44 percent higher compared to the results based on a common VTT on all road types. In five out of seven examples, the difference is between 9 and 21 percent. Only one of the projects switches from having negative to positive net benefits. Experiences with the new RTM give similar results.

In these examples, the VTT multipliers are only used in the calculation of user benefits, not when modelling travel demand. Using the national transport model (NTM), we have conducted tests where we also include the multipliers in the route choice and demand model, in the case of long trips. This seems to have limited impact on the estimated user benefits. The impacts are also in the same order of magnitude as in the tests based on RTM.

Applying VTT multipliers for different road types only in user benefit calculations and not travel demand modelling does not have to imply a lower degree of consistency in the analysis. The reason is that there are already other inconsistencies. In order to match observed traffic volumes, the model applies a higher VTT when estimating travel costs in the route choice than in user benefit calculations and the demand model. As the comfort effect will typically be higher for roads that also have a high travel speed, applying VTT multipliers that account for driving comfort will typically contribute to a higher degree of consistency between traffic modelling and user benefit calculations.

Recommendations

Based on the findings in this report, we still recommend to apply different VTTs for different road types to account for the benefits related to driving comfort. In our assessment, it is acceptable to apply these only in the benefits calculations and not traffic modelling. Still, in the longer run, one should aim for as high degree of consistency as possible between the two.

Based on an overall assessment of the empirical evidence, we recommend the VTT multipliers in Table E3 and E4. The underlying assumption is that the employer’s share of the VTT in business travel does not depend on road type. This implies that the multipliers for different road types become more unequal (more different from 1) for commuting and leisure trips and more equal (closer to 1) for business trips. To avoid double counting with the value of accident risk, we apply the same judgement-based adjustment as before, namely 25 percent.

Table E3: Recommended VTT multipliers by road type for car drivers and car passengers in light vehicles, commuting and leisure trips. The multipliers are adjusted to avoid double counting with the value of accident risk in CBA.

	Relative to top level, unadjusted	Relative to top level, adjusted	Relative to average VTT	Report 1774
Urban roads (50 km/h or less)			**1,00**	
Four-lane road (above 50 km/h)	1	1	**0,87**	0,8
Three-lane road (above 50 km/h)	1,11	1,08	**0,94**	0,9
Two-lane road, median strip (> 50 km/h)	1,21	1,16	**1,00**	1
Two-lane road, no median strip (> 50 km/h)	1,40	1,30	**1,13**	1,15

Table E4: Recommended VTT multipliers by road type for car drivers and car passengers in light vehicles, business trips. The multipliers are adjusted to avoid double counting with the value of accident risk in CBA.

	Relative to top level, unadjusted	Relative to top level, adjusted	Relative to average VTT	Report 1774
Urban roads (50 km/h or less)			**1,00**	
Four-lane road (above 50 km/h)	1	1	0,95	0,8
Three-lane road (above 50 km/h)	1,04	1,03	0,98	0,9
Two-lane road, median strip (> 50 km/h)	1,08	1,06	1,00	1
Two-lane road, no median strip (> 50 km/h)	1,15	1,11	1,05	1,15

In the case of a new wide two-lane or three-lane road in the intervention alternative, the analyst should be allowed to override the default settings and choose a lower multiplier to account for the high road quality, such that the impact on CBA results can be investigated.

We recommend not to apply these multipliers in the case of heavy trucks. The reason is that benefits to heavy transport are mainly related to transport time and cost, and to a lesser extent driving comfort or the opportunity to conduct other activities while driving.

Our examples illustrate the opportunities that this kind of natural experiments provide, but also the limitations imposed by aggregate data. If one has data that to a larger extent makes it possible to distinguish between vehicle types and traveller segments, more opportunities will open up. Ideally, one should have individual level data on complete route choices. Here, we refer to the recommendations in a parallel project on valuation and RP data. Increasing digitalization implies that more and more data on observed travel choices become available. Using such data to infer the trade-offs of travellers and their valuation of trip characteristics will probably receive increasing attention in transport-economic research in the years to come.

We emphasize that practical recommendations regarding parameter values in travel demand modelling and CBA should be based on an integrated perspective. Even if a parameter value can be regarded as unbiased based on existing knowledge, it can result in counter-intuitive results when combined with other elements of the analysis framework. The development of models and tools should therefore not just be bottom-up, one must also ensure that the overall structure is maintained.

Institute of Transport Economics, Gaustadalléen 21, N-0349 Oslo, Norway, Phone +47 22 57 38 00 E-mail: toi@toi.no www.toi.no