Impacts of connected and automated vehicles: not everything can be converted to monetary terms

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Deliverable D3.3 of LEVITATE deals with converting impacts of connected and automated vehicles to monetary terms. Converting impacts to monetary terms is needed to include them in cost-benefit analyses. One of the objectives of LEVITATE is to develop a tool for performing cost-benefit analyses of policies designed to maximise the societal benefits of introducing connected and automated vehicles. This tool will be part of the policy support tool developed by LEVITATE.

Diverse impacts at several levels

Connected and automated vehicles will have diverse impacts at several levels. In work package 3 of LEVITATE, a taxonomy of impacts was developed. A total of 33 potential impacts were identified. These were classified into direct impacts (7), systemic impacts (12), and wider impacts (14). It is probably the wider impacts which will be of most interest to policy makers. These include impacts on the number of accidents, on air pollution, a potential transition to shared mobility, employment, land use, inequality in transport and trust in automation technology.

Available monetary valuations of impacts were found by means of a literature survey. Quite a few of the potential impacts of connected and automated vehicles can be valued in monetary terms. This applies to, for example, car ownership costs, car operating costs, travel time, congestion, road accidents, climate change, traffic noise, and local air pollution.

There are, however, important impacts for which a monetary valuation is not currently available. Three of the most important impacts for which there are no monetary valuations are changes in inequality in transport, changes in land use, and the potential for a collapse of trust in automation technology. Before discussing how these impacts can be included in policy analyses, some of the other results found in deliverable D3.3 will be briefly discussed.

Will there be demand for connected and automated vehicles?

There have been several studies of how much people are willing to pay for a fully automated car having connectivity technology. The results vary. However, they were judged to be sufficiently similar to propose an "average" demand curve, based on the studies for which a demand curve could be derived. Figure 1 shows this demand curve.

Maximum willingness to pay for a fully automated car is about 40,000 US dollars above the current price of a car. Based on the average price of new cars sold in the United States in 2017, an increase in price of 40,000 dollars is more than a doubling.

Still, a few consumers, 1 % is assumed in Figure 1, could afford a more expensive car and would be willing to pay for it.

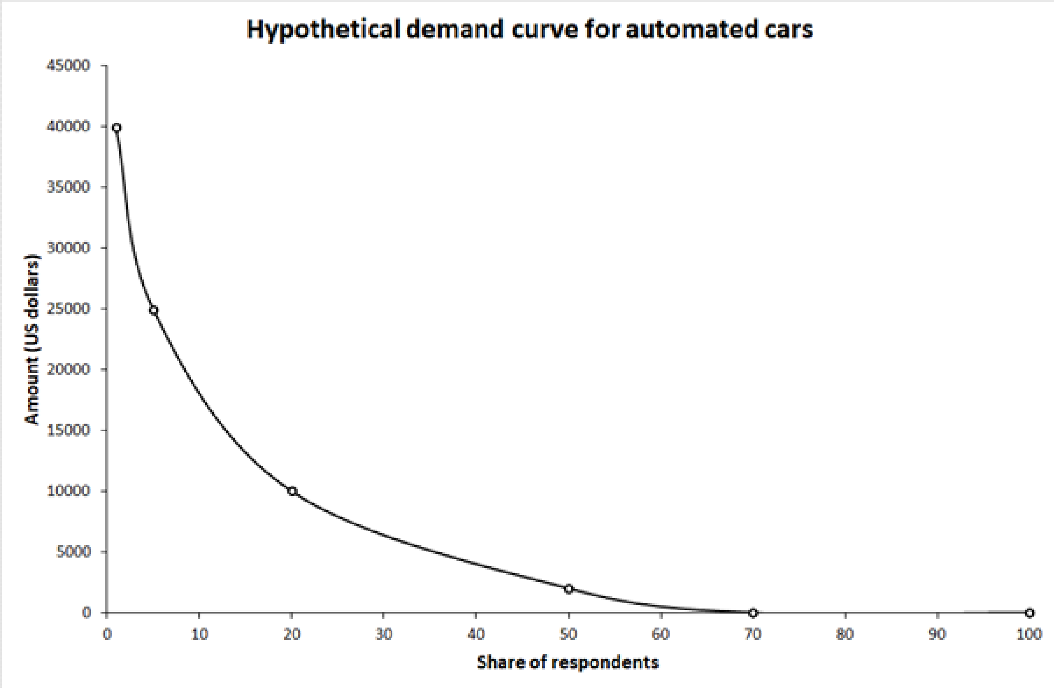

Figure 1: General demand curve for fully automated cars with connectivity

The cheaper a fully automated car gets, the more people will be willing to buy one. When the increase in price is 2,000 US dollars, 50 % of consumer are willing to pay for it.

The most interesting part of the demand curve is the flat part starting at 70 % and ending at 100 %. This part indicates that 30 % of consumers are not willing to pay anything at all for an automated car. This group probably includes passionate drivers, who would never be willing to give up driving. Should they be forced to? Some moral philosophers have argued that manual driving should be banned when automated car become safer than cars operated by humans. There are several objections to banning human car driving. One, completely overlooked by the moral philosophers, is that motorcycles are unlikely to ever become automated. Thus, if driving involving a higher risk than an automated car is banned, motorcycles must also be banned.

Current estimates of the price increase for an automated car range, roughly, between 10,000 and 40,000 US dollars. Most consumers are willing to pay far less than this. Still, automated cars are likely to reach high levels of market penetration. The increase in price will come down as a result of mass production and technological innovation, ultimately making automated cars affordable for most consumers.

What will be the largest benefits?

Connected and automated vehicles are expected to reduce traffic congestion, improve road safety, and reduce air pollution. Although these impacts are likely to occur. Preliminary estimates made in deliverable D3.3 suggest that the biggest benefit of connected and automated vehicles, in monetary terms, will be a reduction of costs of travel for users of the vehicles. The generalised costs of travel is the sum, in monetary terms, of all disadvantages of travel. In addition to direct outlays, this includes travel time and the risk of accidents. Connected and automated vehicles are likely to reduce the generalised costs of travel, mainly because the costs of travel time will become lower.

In a fully automated vehicle, you can work or relax, and the time spent will therefore be more valuable – i.e. less wasted – than when you drive a car, which at least requires a minimum of concentration and effort and allows for few distractions.

The most likely impact of lower costs of travel is an increase in travel demand. Studies made so far clearly indicate that individual travel is preferred to shared mobility. Therefore, the most likely impact of connected and automated vehicles is a growth in traffic volume and longer commuting distances. It is important that policy makers understand this, because a policy aiming for denser cities with more walking, cycling and public transport would have to actively counteract the principal benefits of connected and automated vehicles.

How can non-monetised impacts be dealt with?

The three most important non-monetised impacts of connected and automated vehicles are a loss of trust in the technology, changes in inequality in transport and changes in land use.

If, as a result of malfunctioning or cyber attacks, people no longer trust automation technology, the impacts could be very extensive, in particular if a loss of trust were to occur when the transport system is fully automated. The transport system would then essentially grind to a halt, and there would be widespread societal impacts.

Deliverable D3.3 discusses whether prospect theory can be applied to assess the impacts of a loss of trust in technology. According to prospect theory, the utility of a prospect (a wide concept that may include ordinary consumption) is evaluated from a reference point. The normal reference point is the status quo, or that things remain as they are right now.

Let us assume that automated vehicles are in widespread use. This state of affairs is the reference point and the utility of automated vehicles is assessed in the domain of gains, i.e. the utility of automated vehicles is viewed as positive and may be estimated in terms of the consumer surplus (i.e. the net benefits to consumers) associated with their use. This is indicated by the utility function in the upper right quadrant of Figure 2.

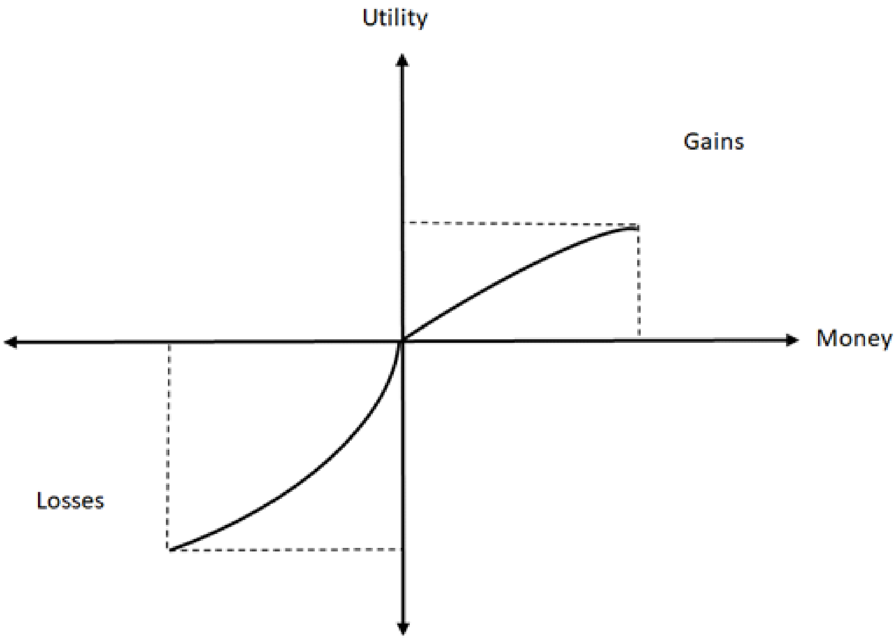

Figure 2: Changes in utility associated with gains and losses according to prospect theory

It is seen that the loss of utility associated with not being able to use automated vehicles is larger than the gain in utility from using them. If an estimate of the monetary value of the utility of using automated vehicles is available, one can use this as an anchor point for estimating the loss of utility from not being able to use automated cars.

As far as inequality in transport is concerned, it can be measured numerically by means of, for example, the Gini-index or the Palma-index. Changes in inequality can then be quantified. Converting changes in inequality to monetary terms remains difficult. Changes in inequality therefore cannot be included in cost-benefit analyses, but will have be assessed in non-monetary terms. This means that cost-benefit analyses cannot be the only formal tool for impact assessment applied in policy analyses. Policy analyses aiming to include all impacts must rely both on cost-benefit analyses and on a non-monetary assessment of changes in inequality.

Finally, changes in land use do not easily lend themselves to monetization. Land, of course, has a market price, but the market price will not necessarily reflect the objectives for land use set in public policy. Denser cities are likely to be more expensive that cities allowing large suburban areas in terms of the cost of land use. Properties are more expensive in cities and building houses is more complex and expensive. Yet, dense cities are associated with more active transport and less use of cars, which benefits public health. These benefits are not reflected in property prices. Like inequality, changes in land use must therefore be evaluated in non-monetary terms.