

Is time money? Philosophical perspectives
on the monetary valuation of travel time

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Abstract

This licentiate thesis consists of an introduction ('kappa') and three papers discussing various aspects of time as a commodity and the practice of valuing travel time.

The first paper is an analysis of the properties of time as an economic resource taking into account literature on behavior with regard to time. The intent is to provide better understanding of the underlying assumption of transferability between time and money in the context of transportation.

The second paper builds on the analysis in the first paper combined with the findings of a study of commuters travel experiences during disruptions in the train traffic on the Øresund strait between Sweden and Denmark. It contrasts the theoretical account of value of travel time with the experiences reported by commuters and argues that the view of travel time as strictly a disutility can be limiting from a planning perspective. Instead, it is argued that an alternative approach can be to make travel time 'plannable', meaning viewing travel time as time travellers can plan to spend in a certain way at a certain time.

The third paper argues that the diversity of possible mobility solutions based on self-driving vehicles has been somewhat overlooked in the current literature on value of travel time. Thus, the complexity of valuing travel time for self-driving vehicles has not been fully addressed. The paper consists of a morphological analysis of the parameters that might impact value of travel time for self-driving vehicles and a deeper analysis of five plausible self-driving vehicle mobility concepts. It is claimed that not all such concepts can be easily mapped into transport modes and that it might be more appropriate to differentiate value of travel based on travel characteristics.

Keywords: Value of travel time, value of time, travel time, mobility, urban transportation

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The second and third papers in this thesis have been co-written with Karin Winter and Albin Engholm respectively. I have greatly appreciated their knowledge and having the opportunity to write collaboratively. I’m thankful for our cooperations.

Two of the papers and the introduction to the thesis have been presented at the Higher seminar at the Division of Philosophy at KTH: I’m grateful for all the comments and feedback that have made this work better.

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Stockholm, June 2020

Maria Nordström

Sammanfattning på svenska

Denna licentiatavhandling består av en introduktion och tre artiklar som på olika sätt berör värdering av restid. Vare sig vi vill det eller inte är vår vardag driven av och bunden av tid. Vi planerar vår tid, spenderar vår tid och stressar när tiden inte räcker till. Det vi önskar, vill och måste göra tar tid; tiden villkorar helt enkelt mycket i våra liv. Om det är så att vi vill förflytta oss från en fysisk plats till en annan, kanske mellan hem och jobb eller skola, tar det tid. Den här specifika tiden, restiden, antas behövas på grund av behovet av att jobba, fika eller handla, inte genom en önskan om att resa i sig (även om det självklart finns resor vi gör för nöjes skull, där nöjet är själva resan). I och med att resan (och restiden) är nödvändig men inte i sig önskvärd är det ett grundläggande antagande inom fältet för transportekonomi att människor vill minimera sin restid i så stor utsträckning som möjligt. Det är det här antagandet som mycket av planeringen och investeringarna i transporter grundar sig på. Genom att undersöka betalningsvilja hos resenärer kan man sätta ett monetärt värde på potentiellt insparad restid: tid blir pengar. Men är det verkligen så enkelt? Till att börja med är tid och pengar de facto inte samma sak. Vi kan inte spara tid på samma sätt som pengar utan sparad tid måste användas omedelbart. Det blir därmed rimligt att anta att vad man gör med den insparade tiden spelar roll eftersom tiden känns mer värd om den kan spenderas på något meningsfullt. Vad man har möjlighet att göra beror ofta på sammanhanget och upplevs därför mindre flexibelt än när det gäller insparade pengar.

Denna avhandling resonerar vidare kring frågor om förhållandet mellan tid och pengar, i synnerhet den vanligt förekommande och generellt accepterade monetära värderingen av restid. Till viss del problematiserar avhandlingen antagandet att tid är peng-

ar och frågar sig om inte för mycket fokus läggs på tidskvantitet framför tidskvalitet och att kan det vara värdefullt att reflektera kring vilka transportinvesteringar som detta gynnar. Syftet är att undersöka om de vedertagna transportekonomiska modeller som tillämpas idag speglar sådant vi som samhälle värdesätter och lyfta aspekter som möjligen förbises.

Introduktionen till avhandlingen består av en metodologisk diskussion kring filosofins roll i tvärvetenskapliga projekt, en översiktlig teoretisk bakgrund till begrepp såsom rationalitet och välfärdsekonomi och en genomgång av teman som på ett eller annat sätt berör värdering av tid. Därefter sammanfattas artiklarna och introduktionen avslutas med slutsatser och ett avsnitt om möjliga framtida forskningsämnen.

Den första artikeln i den här avhandlingen handlar om hur förhållandet mellan tid och pengar kan bättre förstås genom att utgå från tiden som det primära att värdesätta. Denna analys och de insikter som analysen leder till kan därefter förklara och bättre underbygga antaganden som görs vid modellering av beslut rörande tid. I artikeln analyseras egenskaper av tid i relation till pengar som framkommit i beteendevetenskaplig och psykologisk forskning. I transportekonomi, likt traditionell mikroekonomi, utgår man från ett antagande om stabila rationella preferenser hos individer. Givet skillnader mellan hur individer verkar resonera kring tid jämfört med pengar kan man dock ställa sig frågan om det skulle kunna vara annorlunda att vara rationell med avseende på tid jämfört med att vara rationell med avseende på pengar. I synnerhet då det finns egenskaper hos tid som är så pass specifika att motsvarande egenskaper inte finns hos andra typer av objekt eller varor. Sammantaget hävdar vi att det enkla förhållandet mellan tid och pengar inte är tillräckligt rättfärdigat i ljuset av de faktiska skillnaderna mellan tid och pengar som verkar föreligga.

Den andra artikeln i avhandlingen rör upplevelser av restid och förhållandet mellan upplevelsen och de teoretiska antagandena som görs i transportekonomi. I artikeln analyserar vi upplevelser

av restid hos resenärer som påverkades av det plötsliga införandet av identitetskontroller vid resor mellan Sverige och Danmark 2015. Mot bakgrund av en studie där upplevelserna dokumenterades visar vi på aspekter av restid som upplevs men inte speglas i vedertagna transportekonomiska modeller. Artikeln delar upp dessa aspekter i tre kategorier: (i) aspekter rörande den faktiska resttiden och upplevelser av själva resan, (ii) kortsiktiga anpassningar till rådande omständigheter och (iii) långsiktiga anpassningar till rådande omständigheter. Vi menar att restiden behöver sättas i ett vidare perspektiv genom att se resan och restiden i ett sammanhang där planering av vardagen är en förutsättning för att få livet att gå ihop. Ett möjligt sådant perspektiv är att ur planeringssynpunkt sträva efter att göra tiden så 'planerbar' som möjligt, alltså att underlätta individers långsiktiga och kortsiktiga planering av både restid och resor, istället för att enkom se restid som onytt.

I tredje artikeln tillämpas till viss del insikter om vad som skiljer tid från pengar och dessa appliceras på värdering av restid för självkörande fordon. Värdet av restid beror traditionellt (bland annat) på transportmedel, det vill säga om resan görs med bil, buss eller tåg. Självkörande bilar har i litteraturen setts som ytterligare resslag, ofta en ny sorts bil. Vi menar dock att självkörande fordon kan mynna ut i många olika typer av transportmedel där vissa kommer att likna de vi har idag medan andra kommer att vara nya sett till reseegenskaper. Givet att dessa egenskaper är relaterade till aspekter som påverkar resenärers värdering av restid kommer tiden alltså vara olika mycket värd. Värdering av restid för självkörande fordon bli därför mer komplext än att lägga till ett eller ens några ytterligare transportmedel. För att belysa detta gör vi i artikeln en så kallad morfologisk analys där vi spänner upp ett lösningsfält vi menar täcker in aspekter som påverkar värderingen av restid för självkörande fordon. Sedan analyserar vi möjliga (och troliga) lösningar, där varje lösning motsvarar ett möjligt transportmedel, och menar att restidsvärdet för dessa

lösningar rimligen bör skilja sig åt. Det leder oss till att föreslå att ett alternativt sätt att segmentera restidsvärde skulle kunna vara att utgå från reseegenskaper, snarare än transportmedel som sådana. Sådana reseegenskaper skulle kunna vara privat/delad resa eller om resan sker efter tidtabell eller är "on-demand".

Sammanfattningsvis menar jag att monetär värdering av tid kan ses från tre perspektiv: (i) det linjära förhållandet mellan tid och pengar som sådant, (ii) aggregeringen av individers insparade restid till faktisk samhällsnytta och (iii) restidsförkortningars plats i kostnadsnyttoanalys och transportplanering i allmänhet. Transportinvesteringar görs på lång sikt och de samhällsekonomiska kalkyler som ligger till grund för dessa investeringar behöver därmed spegla både vårt förhållande till tid idag men även hur vi kommer att förhålla oss till tiden i framtiden. Rimligen kommer vi då ha lika mycket tid som idag, men kommer vårt förhållande till tid vara detsamma?

Slutligen föreslår jag i avhandlingen möjliga framtida teman att undersöka vidare, såsom transporträttvisa, aggregering av väldigt små restidsvinster och förhållandet mellan risker och tidsvinster.

Part I

Introduction

Philosophical perspectives on the monetary valuation of travel time

Time is an undeniable aspect of everything we do. Therefore, it is not surprising that time is a well-discussed topic in philosophy. Yet, whereas a lot has been said with regard to what time is, most discussions in decision theory are about value measured in monetary units. It is assumed that the conditions of rationality are the same regardless of topic of interest: it is the same to be rational with regard to income as it is to be rational with regard to time. However, it can be argued that time is significantly different from money or other commodities. Hence, it is warranted to look into the details of what time is, especially within the field of transport economics where valuing time plays an important role.

Transport economics is concerned with the allocation of resources on transport and the study of movement of people and goods. A transport economist is interested in matters of pricing, competition, transport and land use as well as welfare effects of transport pricing and transport investments, among other topics. Roughly, transport economists provide models which in turn deliver decision support for transport planners, practitioners and politicians (policy-makers). The foundation of transport economics is “mainstream economics”, neoclassical economics with concepts like utility theory and welfare economics. While I believe most transport economists are aware of the policy implications of their work, I perceive their primary focus to be on the models and technicalities of transport modelling.

So far, transport and transport economics has not gained any substantial attention from philosophers. Besides work on transport risks, transportation justice as well as in connection to environmental philosophy, the potential of considering the practice of transportation from a philosophical point of view has

been largely neglected. While moral implications of cost-benefit analysis in general have been discussed, the implications are often exemplified by referring to health care, perhaps being more obviously connected to matters of wellbeing and quality of life. I argue that transportation and transport infrastructure similarly has a large impact on our daily lives and deserve more attention from philosophers.

This thesis discusses philosophical aspects of valuing time as it is done in mainstream transport economics. The established view is that time is a major component of the generalised cost of travel and that there is a stable exchange rate between time and money. Additionally, the value of saved travel time functions as a proxy for the value of enhanced accessibility, regardless of whether people actually spend the saved travel time on additional travel.

This work aims to disentangle the concept of value of time and consider whether the specifics of time as a commodity have or should have policy implications. To do so, I will briefly present relevant topics from philosophy and economics as well as discuss notions of preferences and rationality. Moreover, I will examine the concept of time as a resource in itself and time as a resource in consumer theory. Lastly, I will try to provide a way forward by proposing three distinct perspectives from which valuing time could be considered. By better understanding the assumptions regarding value of time, policy decision-making related to matters where time value is an input could be improved.

The account of time being somehow special and not fully transferrable into monetary units is not in itself novel. Some scholars even take this for granted, for example assuming that “people usually make decisions about time and money differently” (Pfeffer and DeVoe 2012). In passing, others mention that “[u]nlike money, time does not need to have a monotonic subjective value or utility” (Abdellaoui and Kemel 2013). When questioned, some transport economists recognise that “on a strict constructionist

view, it is not possible to save time, only to transfer it between higher and lower valued activities” (Mackie et al. 2018). However, this is assumed to be irrelevant since the same can be said regarding many other consumer decisions: “People buy electric hedge trimmers in order to reduce the time and physical effort of trimming their garden hedge. If they then invest part of the time saving in trimming their next door neighbour’s hedge, this does not deny the value of investing in the hedge trimmer” (ibid.). This is to show that what people do with their saved time does not matter and “does not undermine the concept of travel time as a proxy for the value of enhanced accessibility”. Yet, using the reasoning of transport economics, if sufficiently many would save time on hedge trimming, perhaps there is reason to consider a state funded subsidy on trimmers? At least it seems worth considering the actual justifications of the assumption of complete transferability between money and time, which I intend to do.

The rest of this introduction (‘kappa’) is structured as follows. The next section presents methodological considerations related to this work and there is thereafter a short theoretical background. It is followed by a section of topics that provide a general background to the articles and a summary of the articles. Lastly, general conclusions are drawn and there is a brief discussion on future research.

Methodological considerations

The role of philosophy

Assume one is interested in ‘philosophy of transport’¹, similar to philosophy of technology or philosophy of healthcare. It seems reasonable to believe that philosophy can increase understanding of the mechanisms of transportation, perhaps by examining the nature of transportation or by applying methods and concepts from philosophy onto themes from the study of transportation. Where does one start? I believe a way forward can be to decide if one wants to act within the discipline of interest (transport) or combine it with one’s own discipline and/or other disciplines. For the purposes of easing this decision, I propose a stipulative definition of two approaches, an intradisciplinary and an interdisciplinary approach, developed in detail below. An example of the first approach is to discuss ethical implications of the cost-benefit analysis (CBA) methods currently used to evaluate possible transport projects and suggest various ways to incorporate aspects currently not taken into account. As a philosopher, one is then operating in the same space as transport economists, joining the discourse of transport economics. This can be contrasted to discussing the ethical implication of using CBA when evaluating possible transport projects in general, talking about transport economists, which is an example of the second approach. The target audiences of work using the second approach are not transport economists but rather decision-makers and researchers operating in other fields, such as philosophy.

¹I am using this expression somewhat casually, I do not wish to argue for a need to formally establish this type of sub-field. Instead, I discuss what ‘philosophy of [subject outside of philosophy]’ could potentially be. Moreover, I believe the work within (for example) ‘philosophy of transport economics’ could potentially fit both within transport economics and decision theory, among other fields. The philosophical interest is not dependent on a particular field, or so I see it.

Philosophy by examples

Traditionally, philosophy can be done using examples from other disciplines, both to provide a general setting for an argument as well as to actually strengthen it. Moreover, philosophers can gain knowledge from other fields and develop claims and theory with the ambition for it to be of interest to non-philosophers. Sven Ove Hansson's work on philosophical problems in CBA is an example of interdisciplinary philosophy in this sense (Hansson 2007). Stating that CBA is highly interesting from a philosophical point of view, he assesses ten philosophical issues with CBA from a practical view-point. My interpretation is that while primarily being a work of philosophy, there is an ambition to influence outside of the field of philosophy since the conclusion is that CBA should be used but with great caution and most CBA is carried out by non-philosophers. Another example is work by Broome, where he claims that

“[e]conomics is partly concerned with assessing the merits of economic arrangements and with deciding how governments ought to conduct their economic affairs. It makes judgements of right or wrong, good or bad, in economic matters. It needs criteria for making these judgements, and the criteria must come from ethics. On the other hand, economists have developed for their own purposes sophisticated methods of analysis that turn out to be useful in philosophical ethics.” (Broome 1999)

This illustrates a two-way relationship between the disciplines, where philosophers do not only contribute to economics but also bring insights from economics back to philosophy. I perceive this also to be a case of interdisciplinary applied philosophy, written with the ambition to explore areas where methods of economics can contribute to ethics as well as provide insight into some of the difficulties of economic theory. On the other hand, work by van Wee is framed more clearly within transport economics (van

Wee 2011). In his book on transportation and ethics, he states that ethical dimensions of transport are usually absent from mainstream transport literature. While the target audience of his work are researchers, practitioners and policy-makers, it is implied that they all function within the field of transport (economics), since “the book is primarily written for the mainstream transport community”. Additionally, the aim of the book is “only to make this target group aware of the ethical issues of transport, not to convince them of what is morally ‘right’ and what is ‘wrong’, nor to provide solutions of all the ‘problems’” (van Wee 2011).

The intra- vs interdisciplinary approach

If, for simplicity, we assume that applied philosophy can be defined as methods of philosophy applied to an additional discipline, a ‘philosophy of’ of sorts², claiming that there is a concept such as intradisciplinary applied philosophy can seem like an oxymoron. Isn’t ‘philosophy of transport’ by its nature interdisciplinary, bringing together philosophy (ethics, philosophy of science, moral theory, decision theory etc.) and the study of transportation? Moreover, the study of transportation can be seen as multidisciplinary in itself. Canonically, the definition of intradisciplinary is being within the scope of a discipline, or occurring between practitioners of a discipline. Therefore, I propose a definition of intradisciplinary applied philosophy that brings philosophy into the additional discipline of study, with *intradisciplinary applied philosophy* being philosophy occurring within the scope of an academic discipline other than philosophy with practitioners of the discipline as the main target audience. This can be applied to disciplines that are multidisciplinary, as long as there is a general

²As previously stated, I do not claim that there is a need to establish all possible sub-fields of ‘philosophy of’. Neither are the definitions tied to this expression, I do not wish to state that ‘philosophy of [subject outside of philosophy]’ is an expression of intra- or interdisciplinary. I am aware of sub-fields named ‘philosophy of [subject]’ that do not fit any pattern discussed in this introduction since they are already established sub-fields of philosophy.

understanding of the scope of the discipline. In any case, I claim that one can go narrow enough in any discipline for the term to be applicable, for example ‘transport economics’ rather than the study of transport in general. Interdisciplinary applied philosophy on the other hand stems from the general understanding of interdisciplinary research as combining two or more disciplines, having practitioners from multiple disciplines coming together. Thus, the proposed definition of *interdisciplinary applied philosophy* is philosophy of an academic discipline other than philosophy without commitment to any discipline or target audience. The approach can yield work relevant in various fields and can consist of various philosophical practices, raising both epistemological, methodological and cognitive aspects of any given field. There is also an inherent feedback loop back to philosophy, a philosopher using the interdisciplinary approach can contribute to the philosophical discourse using evidence or insights from other disciplines. This type of two-way knowledge transfer is not implied by the intradisciplinary approach.

Concluding remarks regarding methodology

Is philosophy aimed at transport economists even philosophy? I believe it is. As a philosopher, knowing and understanding your audience is crucial. If the intent is to question transport economics on the grounds of denying one or more of the premises of utility theory or neoclassical economics it can be assumed that the argument will carry very little weight for most transport economists, and the intent will fail. However, one can ask the right questions within the field of transport economics and evaluate these questions applying philosophical methods in such a way that the philosophical aims are satisfied. There’s nothing hindering a fellow philosopher from reading intradisciplinary work and joining the discussion on intradisciplinary terms, it can even be worthwhile in terms of progress within the discipline in question. However, it seems that the most beneficial approach in order to

make a potential philosophical contribution is the interdisciplinary approach, as well as if the intent is to make real-world impact since decision-makers are often interested in a wider scope, compared to the intradisciplinary approach.

Pragmatically, it seems reasonable to want to bring attention to matters of interest, sometimes by posing the right questions. While asking the right questions can be central to both intra- and interdisciplinary work, the expected response can differ. If we allow to differentiate between transport economics, which is narrower, and transportation planning, a broader perspective is easier in the latter sense. Work using the intradisciplinary approach in transport economics might not attract attention if the perspective is not narrow enough. Thus, if an argument needs a broader setting to be convincing, aiming at the transportation planner rather than the transport economists seems reasonable. In summary, the purpose of a project can align with both an interdisciplinary and an intradisciplinary approach although the interdisciplinary approach can be preferable if the project is intended to impact a wider audience. While the papers in this thesis are examples of the intradisciplinary approach, the introduction as such is intended to be interdisciplinary.

Theoretical background

Rationality

Neoclassical economics assumes that all behaviour can be explained in terms of rational agents who optimise over bundles of goods and services. As noted earlier, certain rationality criteria apply. Beliefs with regard to outcomes over feasible alternatives lead to a ranking of alternatives and choosing the most preferred bundle yields the highest utility. Since agents are assumed to choose rationally, an action is explained by being more attractive than any other feasible alternative. The preference incorporates everything relevant to the actual choice. “Economists regard choices

not as mental determinations but rather as actions that arise from constraints, preferences and expectations (or beliefs)” (Hausman et al. 2016). A choice is seen as rational when it is determined by a rational set of beliefs and preferences and preferences are usually taken to be predetermined. A utility function is defined to represent a preference ranking under the ‘necessary’ criteria (completeness, transitivity and continuity). Thus, “[a]gents are rational if and only if their preferences may be represented by ordinal utility functions and their choices maximize utility” (ibid.). If an agent’s preferences also satisfy an independence condition, they can be represented by an expected utility function in the presence of risk or uncertainty. Simply put, when one does what one prefers one is maximising utility. It should be noted that utility in itself is not something people seek as it is not the object of choice. Moreover, as noted previously, rationality is a normative notion while usually not considered to be a moral notion. Self-interested individuals with perfect knowledge prefer one alternative over another only if it is better for them. Therefore, we can identify how well-off someone is by looking at how well satisfied that individual’s preferences are. Welfare can be identified with preference satisfaction in this matter. This is the foundation of the aspiration of economics to satisfy individual’s preferences since people are better off (all else equal) when their preferences are satisfied. An agent’s preferences (rankings of states of affairs) are rational if they are complete and transitive. Yet, preferences are not always complete (in the presence of uncertainty) and can additionally be non-transitive as has been confirmed by experimental evidence. This does not mean that transitivity should not be a requirement of rationality but is “disquieting” (Hausman 2018).

Lastly, a short note on collective rationality and social choice. When moving from individuals to societies, further complications can arise. It can be claimed that it is not obvious which principles of rationality should govern the choices and evaluations of society. Moreover, any link between individual preferences and social

choices needs to be carefully examined and justified (Hausman 2018).

Welfare economics

Welfare economics is the theory of welfare as preference satisfaction. In the context of transport economics this means taking for example willingness-to-pay to indicate preferences and assuming that preferences are to be welfare-guiding. Given these assumptions, outcomes can be evaluated in terms of welfare as pure preference satisfaction. This allows mainstream economics not to commit to a view on what constitutes a person's good and focus on what is good for a person. By adopting this view economists also avoid matters of justification and paternalism. However, this makes it problematic to make interpersonal welfare comparisons, and few economists defend the view of policy as maximising total or average welfare. Instead, economists have normatively committed to the notion of Pareto efficiency: "the comparative ethical goodness of two outcomes depends upon their associated patterns of well-being; and (strong Pareto) that if everyone is at least as well off in outcome x as in outcome y , with at least one person strictly better off, x is an ethically better outcome" and extended it to cost-benefit analysis (Adler 2016) .

Given that the goal of a policy is to generate as much benefits (positive effects) and as little costs (negative effects) as possible, seen over society as a whole, the measured willingness-to-pay constitutes the benefit of a policy. In transport economics, a social benefit could be to seen as making activities and services easier to reach (improved accessibility). The benefits and costs are then plugged into cost-benefit analysis. Again, the assumption in standard CBA is that preferences revealed by individuals' willingness-to-pay in (hypothetical) markets can be used to value the outcome of a government policy implementation. By spending money on goods and services in the market individuals convey information regarding their economic preferences: "how much do

individuals prefer (or value) the social goal(s) a policy promises to achieve?” (Fuguitt and Wilcox 1999).

Among other concerns, cost-benefit analysis has been criticised for adopting monetary valuation of values that are usually not considered by using money as a unit of measurement, such as the value of a life. While one of the responses to this criticism suggests that the measuring unit when carrying out cost-benefit analysis doesn’t have to be money, “[i]t just happens that in our society, as well as in other advanced societies, money has long been used for exchange” (ibid.), I am not sure I find this entirely convincing as a counter-argument.

Additionally, there are concerns that willingness to pay (i.e. choices) is an imperfect indicator of preferences which in turn is an imperfect indicator of wellbeing. Everything that is known regarding preference satisfaction and wellbeing can be applied in the case of choices and preferences. For instance, agents are not always good judges of what will benefit them the most, even when they have all the necessary information. On the basis of this, some preferences among policies might not be appropriate to be considered welfare-guiding (Hausman 2018).

Economics, philosophy and policy

How (if at all) should philosophy influence policy and what is the role of philosophy of economics? Economics as such is claimed to be relevant to policy because of the information it provides concerning the consequences of policies, if implemented. Since economic models can provide predictions regarding outcomes of policy decisions, they are indeed relevant for policy as such (ibid.). An early view in transport economics was that the goal of the models was to ‘predict’ so that policies could accurately ‘provide’. Nevertheless, there is clearly normatively relevant content within the field of economics. As noted by Pearce, behaviour and preferences expressed in markets do not necessarily indicate what is morally correct (Pearce 1983). While the decisions revealed

in the market reflect the consumer preferences, they only show what is. They do not indicate what is right or wrong, nor do they indicate preferences with regard to how things ought to be. Moreover, when providing policy recommendations it has to be made clear that the economic models stipulate that everyone is perfectly rational and has perfect information (Hausman 2018). Here, there is reason to reflect upon what level of simplification is appropriate. The same holds for models in general, there is a trade-off between simplicity, transparency and tractability. For transport economics models, when modellers strive to capture as much as possible they can end up with models too complicated to fully grasp, and the output will no longer be predictable for certain scenarios. When discussing the matter of valuing time based on context one has to understand the limitations of the complexity of models with regard to usability.

Furthermore, the progress and findings of behavioural economics have raised concerns regarding the status of preferences in cost-benefit analysis (Robinson 2016), questioning if there are cases where revealed preferences should not be seen as welfare-guiding. Behavioural economics can identify ways in which we act irrationally and this can have implications on policy design and evaluation³. However, there is also a risk of revealed preferences being ‘overwritten’ without evidence-based justification. One approach incorporating findings from behavioural economics is to incorporate results in a pragmatic manner; Chetty argues “that the decision to include behavioural factors in economic models should be viewed as a pragmatic rather than philosophical choice” (Chetty 2015). Since individuals fail to make choices that that maximise wellbeing, policymakers should utilise other non-choice-based measures of wellbeing, such as subjective-wellbeing (SWB) surveys (ibid.). Further, it can be argued that behavioural eco-

³See the special issue with an introduction by Robinson 2016 for more on this, also see Congdon and Shankar 2018 for a recent overview of the role of behavioural economics in evidence-based policymaking.

nomics provides a case for “an objective-good (non preference based) view of well-being” on the basis of showing that individuals are not rational in their day-to-day lives (Adler 2016).

Catching up on ‘time’: themes relevant to valuing time

Specifics of time as a commodity

In a sense, time is like money and “the analogy with having, spending, saving and wasting money is pervasive” (Brown 1970). At the same time (no pun intended), time is clearly different from money if we consider the actual characteristics of time as a resource or commodity. It seems to at least be warranted to discuss these differences and possible implications with regard to the value of time. After all, a fundamental aspect of economic value is the idea of exchange, namely that a measure of the value of an object is what someone else is willing to give for it in exchange. The exchange in a market thus constitutes market value. As Brown pointed out, the analogies between time and money seem to be in the field of value of the individual, rather than market value. Even if we indirectly trade in goods and services that allow us to allocate time, it can be argued that time is a non-market good. While “the state of nature is that people are frequently trading between time, reliability and money in the travel choices” (Mackie et al. 2018) it is in a sense indisputable that time savings cannot be accumulated. Additionally, one can claim that time has a direction and cannot easily be transferred between individuals. The specifics of these aspects of time are discussed in detail below.

Non-accumulative

We all ‘have’ an equal amount of time to allocate per day, time that cannot be stored or saved. This means that small time savings cannot be aggregated and spent later, they can only be reallocated:

“The possibility of increasing marginal utility is especially pertinent to time because time cannot be saved and aggregated. Whereas people can save and aggregate some resources (e.g., money), so that each unit can be valued in accordance with its anticipated best use, this is not the case with time” (Festjens and Janiszewski 2015)

While one can claim that the monetary value of most goods fluctuate over time, I am still convinced that there is something special about time in this respect. As Steedman points out “it is striking that we often refer (in English) to buying time, meaning to incur some cost in order to defer an event” since money that is not spent now often can be spent later “[b]ut the next 17 minutes will always be ‘spent’ somehow and could never be ‘spent’ later” (Steedman 2003).

Moreover, going back to Zeckhauser’s work on time (Zeckhauser 1973), the value of time is also impacted by so-called indivisibilities. First, “the process of preparation may be enjoyable, but surely the payoff to a half-completed painting, manuscript, or medical education is not proportional to the payoff for the whole” (ibid.). Second, time allocation can serve as a kind of capital investment: “[t]he more one plays the piano, the greater one’s skill, and quite conceivably the more pleasure one receives from an hour at the keyboard” (ibid.). Examples like these suggest that besides being non-accumulative as such, there are good reasons for not assuming that a unit of time doing a particular activity has a constant value.

Irreversibility and directionality

Without going too deep into the philosophical discourse on the essence of time and temporality, there is at least a general notion of the direction of time, of temporal asymmetry and irreversibility. Clearly, this is a property of time which is not shared with money under regular circumstances. In a sense, money under conditions of extreme inflation could potentially exhibit the same charac-

teristics (non-accumulative and irreversible) since you cannot assume that a unit of money will carry the same value tomorrow as it does today. In a way, it is the linear progression of time that prohibits the accumulation of time units. As has been pointed out “[i]t is a very simple principle: the irreversibility of time. In space we can move either way, or any way; but time just goes on, never goes back. We represent time on our diagrams by a spatial coordinate; but that representation is never a complete representation; it always leaves something out” (Hicks 1976).

The notion of direction and the inevitable passage of time also brings up the question of whether we should differentiate between bundles of activities (time allocation alternatives) that include the same activities for the same duration but in different temporal order (i.e. does the order matter?). Assuming there are temporal relations between goods and services, certain goods can only be used at certain temporal positions. Once those temporal positions are passed, those goods cannot be used. An example of this is a theatre ticket to a performance at a specific date and time. When that particular time and day has passed, the ticket is not of much use. Additionally, all activities are temporally positioned with respect to other activities. The ticket holder would have to travel to the theatre before the start of the performance and not after.

Personal and non-transferrable

Many of us have the option of borrowing money in case of need, either from family and friends or from financial institutions offering loans. Time on the other hand is personal, it cannot be borrowed or lent in the same way. If I have some free, un-allocated time I cannot pass it along to someone who needs it. Obviously, I can offer to help with a time consuming task. Similarly, I can turn to services that will carry out activities that need to be done for me. But clearly there are more constraints and less flexibility with time and transferring time than there are with money.

'Time' in economics

The concept of time has long been an analytical tool in economic theory due to it being easy to incorporate when a linear notion of time is presupposed (Mosselmans 2005). Looking specifically at consumption, it is obvious that most consumption takes a certain amount of time but it is often considered without taking the temporal aspect into account. However, there are accounts that emphasise the fundamental role of time in individual economic behaviour. In a recent paper, Nistico discusses an early approach by H.H. Gossen where the central idea is that enjoying pleasant time is the goal of human action and demands are viewed as time-constraints (Nistico 2017). On a similar note, Linder wrote that "time devoted to enjoying different consumption goods is as essential in the consumption process as the goods themselves" (Linder 1970). This reasoning is somewhat in line with considering time as a thing and time as context as done by Winston when he argued that while time as a thing is viewed as input into the production process, it should also be viewed as the context within which an activity takes place (Winston 1982).

A more recent attempt to emphasise the role of time is by Ian Steedman who claims that "[t]o speak of time as an input is to speak misleadingly" (Steedman 2003). In his book, Steedman examines the implications on consumption theory when considering the consumer's time budget and claims that it is possible to be satiated in all goods and have no time to consume additional goods.

Another recent paper discusses the so-called commodification of time (as well as providing a definition thereof) and the potential implications (Fellner 2017). Looking at the literature on the value of time Fellner provides an overview of the discourse of the commodification of time. Interestingly, the starting point of time as a commodity is attributed to Becker's *A Theory of the Allocation of Time* which is also often referenced as a starting point in the literature on time in transport economics (Becker

1965). As will be developed in the section on time in transport economics, one underlying assumption of Becker's model is that there is perfect substitution between time and money. Finding Becker's analysis unsatisfactory, Zeckhauser argued that "the only ultimate source of utility is the disposition of time" (Zeckhauser 1973). Instead, he proposed a model where the objective is to maximise lifetime utility and an individual's welfare is a function of the pattern of time allocation. However, Zeckhauser also stated that time-related decisions are complex and intricate, and that they introduce nonconvexities of increasing returns which makes it impossible for a decision maker to optimise on an incremental basis. Moreover, he noted that actually aggregating lifetime utility from a series of allocations is challenging since it is unrealistic to consider preferences over allocations as separable. If the valuation problem were solved, new metrics for social welfare valuation could be developed.

Time in transport economics

It is generally assumed in transport economics that individuals seek to maximise their happiness or satisfaction with life (utility) which in turn is assumed to depend on the consumption of various goods and services and the activities individuals carry out during the time they have available. Thus, individuals seek to maximise their personal utility by choosing the best possible time allocation since different time allocations have different values that can be measured in monetary terms. This optimisation problem of sorts is to be solved for a fixed time period, roughly meaning we do our time allocation planning over a fixed time horizon.

The starting point for assigning value to the time allocated to an activity is Becker's theory of allocation of time (Becker 1965), which stems from incorporating a time variable into the theory of consumer choice and thereby explaining the supply of time individuals spend working. The theory tied a person's satisfaction to goods as well as time, and the usual income constraint was

reformulated to also include a time constraint. Each person was assumed to seek equilibrium between work time (yielding income) and time spent on consumption ('free' time). By viewing time as an economic resource of which everyone has a fixed quantity, a framework was established where various allocations of time lead to various utility levels.

Consequently, the value of free time (non-working time) has been obtained from analysis of choices individuals have made when having to choose between a time-consuming but cheap alternative and a more expensive but less time-consuming alternative, such as taking the slow but cheap train versus taking the expensive express train. This has also been expanded to take into account additional characteristics of travel modes and routes, such as comfort and reliability⁴. The generally accepted method consists in identifying the marginal rate of substitution between the travel time and travel cost using discrete choice models based on random utility theory. Individuals' willingness to pay to reduce travel time is interpreted as the subjective value of time (González 1997). For travel time in particular, the value of saving travel time is composed of two effects - the benefit of being able to allocate time to other activities and the benefit of reduction of time spent on a unpleasant activity (travelling). Travel is seen as a derived demand, we travel only to be able to reach the locations needed to do activities that yield value for us.

Becker's theory was later developed by others to include the notion of work time having a direct influence on utility by being pleasant or unpleasant (Evans 1972) as well as differentiating between activities (DeSerpa 1971) to allow for activities that the individual would like to spend less time on but cannot (such as travel time).

⁴Transport economics is a rich field with much work put into further incorporating various aspects of travel and personal characteristics into the models used to determine the value of travel time, which in reality depends on many variables. See Small 2012 for more on this. These developments will not be discussed here.

Eventually DeSerpa formulated the optimisation problem as a choice between commodity bundles. A commodity bundle is defined as $X = (X_1, \dots, X_n, T_1, \dots, T_n)$ where X_i is the quantity of the t th good and T_i is the time allocated to the i th good. Moreover, it is assumed that the individual is rational and has a complete, consistent preference ordering among the possible consumption bundles. Based on this a utility function $U(X)$ can be expressed. Furthermore, boundary conditions are established by there being a limited amount of money an individual can spend (which is bounded by individual income) and a fixed period of time, which DeSerpa defined as the length of the decision period. This leads to a time constraint, the amount of time allocated to the various goods must add up to the total time available. Also, since in reality some allocations of time are a matter of necessity, there is a defined limit on minimum time needed to consume a certain chosen good. In these cases, an individual can choose to allocate more time than required on an activity but not less. Attributing a positive value to saving time from any activity presupposes that the saved time can instead be spent on another activity with greater value.

Given a subjective value of time, a total value for a time saving can be calculated by taking the value of the time saving per traveller times the number of travellers affected by a particular intervention. In very simple terms, the benefits of a transport change are then calculated by taking the total value per day times a reasonable number of days (most changes have long term effects, with benefits calculated over decades)⁵ using an appropriate discount factor. It is recognised that there is not a single value of travel time and there are a multitude of factors that cause variation in the value of travel time of across individuals

⁵It should also be noted that there are various approaches to aggregate individuals' value of time (such as travel time savings) for social appraisal, not all of which assume that time influences individual utility (a more straight-forward move is to assume that saved time equals more work time which benefits society as a whole).

but also for the same individual traveller. These factors often include travel mode (car, bus, train, etc.), purpose of trip, income, trip distance, productive use of travel time (Small 2012). It is also recognised that there are unobserved factors that contribute to the observed heterogeneity (De Borger and Fosgerau 2008). The practice of aggregating individual willingness to pay for a shorter commute and taking that to be the value for society as a whole has been criticised on the basis that the decision to finance a government transportation project should be grounded on society's willingness to pay to improve mobility which does not necessary equal the aggregated amount that individuals are willing to pay for the same improvement: "society has its own budget and its own priorities, and clearly total welfare is not necessarily the simple sum of all users' benefits" (Jara-Díaz 2007). Additionally, there is a general awareness of the complexity of understanding temporal behaviour and a lot of research is focused on the mechanics of time allocation to various activities. Besides trade-offs between activities at home and activities at other locations, there are also trade-offs between activity duration and travel time (Timmermans et al. 2002).

As briefly mentioned in the first section, in the end travel time value serves as a proxy for the value of enhanced accessibility. A change in the transport system leads to a change in accessibility that in turn leads to development and a real economy change. Thus, the transportation changes lead to second round effects such as effects on agglomeration, productivity and labour markets. These effects result in changes in the final economy quantities: the benefits to travellers, prices to consumers, economic rents to labour and land (Mackie et al. 2018). The actual social benefit of transportation is seen as improving accessibility: making activities and services easier to reach by decreasing travel times or changing land use.

Critiques of cost-benefit analysis of transportation investments

One analysis claims that there is a misleading 'local ontology' among transportation model makers which translates into "erroneous epistemological assumptions about the possibility of precise predictions and the validity of willingness-to-pay investigations" (Næss 2006). The critique is based on both ontological and epistemological factors and subsequently Næss also draws attention to the ethical assumptions on which these evaluations are usually based. The main concerns are that models underestimate long-term environmental consequences when valuing them in monetary terms. Næss claims that transportation models to a large extent are 'black boxes' that produce high-level conclusions without being transparent regarding some of the underlying assumptions or rather, not clarifying aspects that have been decided to be irrelevant at an early stage (ibid.).

Næss also questions whether or not it is meaningful to aggregate tiny increments of time savings to constitute economic value from a societal point of view. My understanding of the view of the proponents of the appraisal process using cost-benefit analysis is that they claim that it is necessary to link changes in a transportation system to the economy by referencing the changes in accessibility and that these changes in turn need to be defined as changes in travel time (Mackie et al. 2018), tiny or large. Additionally, while not the primary focus of this thesis, it should be pointed out that ethical concerns have (for example) been raised in an overview of ethical perspectives of using CBA for the ex-ante evaluation of transport policy (van Wee 2011).

Time in consumer research

In the field of consumer research, time has been considered from multiple perspectives⁶. While time can be seen as a resource that

⁶See (Lallement and Gourmelen 2018) for a recent review of perspectives of time in consumer research.

can be spent or exchanged for money, it is not equivalent to money for various reasons developed in detail below.

Slack

Slack in this context is defined as the perceived surplus of a given resource available to complete a focal task. There is research indicating that individuals expect greater slack for time in the future compared to the present and that they expect slack for time to be greater than slack for money (Zauberman and Lynch Jr 2005). Moreover, people “exhibit steeper discounting and more present-biased preferences for future investment of time than of money” (ibid.). Individuals perceive changes over time in the supply of slack more optimistically for time compared to money. This can be exemplified by my own expectations of having more free time to allocate after this thesis is finished compared to now but also not expecting there to be any significant change in my income. ‘Rationally’, I know that the amount of tasks that I will have to allocate time to and plan for will probably stay the same, but I remain optimistic.

Uncertainty and loss aversion

Another concept often mentioned in the literature is the fungibility of time. Leclerc et al. believe that “uncertainty is more aversive in time than monetary decisions mainly because outcomes of time (losses or savings) cannot as easily be transferred” (Leclerc et al. 1995). They assert that time is less fungible than money and planning is more important within the context of time. Since uncertainty makes planning more difficult, people are in general more aversive to time uncertainty. This claim is subsequently supported in other studies where it is concluded that time is less fungible than money (Abdellaoui and Kemel 2013). The so-called fungibility of money allows individuals to accept risks more easily. Abdellaoui and Kemel exemplify this by suggesting that it explains why an increase in the taxi fare due to being stuck in

a traffic jam on the way to the airport has less impact than the potential delayed arrival to the airport and subsequently missed flight. When comparing attitudes towards time and money, they concluded that in the gain domain, utility is more concave for money than for time.

It should be noted that a study in specifically transport economics (also) showed that participants were more loss averse in the time dimension than the cost dimension (De Borger and Fosgerau 2008). More absolute value was attached to a time loss than a time gain, and the time values increased with the time difference. A large gap in willingness to pay and willingness to accept was also confirmed. The authors claim that perhaps the degree of loss aversion diminishes in situations with a less clear reference point. However, if models ignored reference-dependence in situations where preference-dependence was present, there would be bias.

Differences in mental accounting

As partly discussed above, there are a number of aspects that make time different from money: (1) time cannot be replaced or inventoried, (2) time cannot be as easily aggregated and (3) accounting for time is a much less common activity than accounting for money and is thus less routine (Soman 2001). Taking these reasons together resulted in a suggestion of the exercise of mental accounting being different for time than for money. For example, Soman found that the typical phenomena of sunk cost was not observed for time in the same way as it was for money. However, this seems instinctively strange. I'm certain that many recognise the hesitance to change tasks when having spent time on something that seemingly isn't working for that very reason of the sense of sunk cost. Nevertheless, Soman suggested that the difference in mental accounting was related to time being more difficult to value and account for.

Others have also identified systematic differences in how people spend time versus money, differences that could potentially be explained by a greater ambiguity in the value of time (Okada and Hoch 2004). People are more easily able to accommodate negative temporal outcomes by being more creative in their reasoning about decisions and adjusting the value of their temporal input. This is argued to depend on the ambiguity in the value of time. The term ‘ambiguity’ is used by the authors to capture the difference in opportunity cost between temporal and monetary contexts since they claim that the opportunity cost for time is harder to assess and it is thus ambiguous. Since time isn’t as easily exchangeable and cannot be saved for later use the next best thing to do with time is harder to determine and the opportunity cost becomes more context dependent.

One proposed view, connected to the difference in mental accounting, is that money is an instrument of exchange and involves considerations of value which prompt analytical thinking whereas time is experienced and time considerations thus relate to experiences of affective concepts (Lee et al. 2015). This distinction is supported by a study that shows that “a choice situation involving the consideration of money activates a more analytical mode of processing than a choice situation involving time” (ibid.). Moreover, this distinction affects the consistency of preferences with choices regarding money having lower preference consistency.

Time and happiness

A fairly recent development in consumer theory and psychology is the connection between time and happiness. In a way it seems obvious that how we spend our time more or less influences our state of mind. However, this development is specifically with regard to valuing time in monetary terms. It seems that putting a price on time creates impatience which affects individuals’ ability to derive happiness from pleasurable experiences (DeVoe and House 2012). Also, while individuals can be prompted to

think of time like money, this causes more stress and decreases environmental behaviour (DeVoe and Pfeffer 2007; DeVoe and Pfeffer 2011; Whillans and Dunn 2015). Priming individuals to think about money caused people to work more and socialise less, decisions that are generally assumed to have the consequence of less happiness. Individuals primed to think about time were motivated to spend more time with friends and family and work less, choices that can generally be assumed to lead to more happiness (Mogilner et al. 2018). Moreover, people focusing on money rather than time are even found to be less ethical in their reasoning (Gino and Mogilner 2014).

On the other hand, the opposite has also been argued for. Namely, that “an economic evaluation of time use is likely to lead to more positive attitudes and decisions and actions consistent with well-being in domains where time use is primarily utilitarian” (Pfeffer and DeVoe 2012). The argument for this view is that decisions will be better (as will the resulting attitudes) when making decisions in a utilitarian domain using an economic evaluation frame. Taking the activity of commuting as an example, the authors claim that since it is perceived as the least enjoyable activity during the day as well as being inversely related to well-being, understanding that the commute is an economic necessity will result in better decisions.

One study that showed that making train passengers more aware of the passing of time during a journey had a negative influence on their appraisal of time. In contrast, conditions without information led to the passengers having more positive emotions and a higher hedonic appraisal of time (Galetzka et al. 2018). Moreover, they showed that a clean environment with slow music resulted in a positive appraisal of time and resulted in a more pleasant travel experience. The authors concluded that further research is needed to understand the impact of the journey environment to make people enjoy their journey.

Reference and context

It is generally acknowledged that individuals tend to interpret alternatives in decision problems as gains or losses relative to a reference point. This is also the case for decisions on time allocation, perhaps even more so. There are various ways of looking at scheduling constraints, planning goals and the importance of context, for example to consider the presence of so-called boundary tasks (Tonietto et al. 2018). Clearly, the values of many other resources also depend on the context of use, and it is often assumed that there is a diminishing marginal utility of goods. With regard to time, an argument can be made stating that the demand for time as a resource is constant and hence that this violates one of the conditions that lead to diminishing marginal utility. Festjens and Janiszewski claim that “[t]his violation occurs because the length of a block of time determines the activities that can be considered for its use” (Festjens and Janiszewski 2015). Meaning, a larger block of time should be valued higher per unit since having a larger block of time allows one more flexibility when allocating time and the opportunity to engage in more meaningful activities. Thus, the value of a block of time depends on its expected use and a block of time spent on a meaningful activity is worth more than the same amount of time spent on a less meaningful activity. A study by Festjens and Janiszewski shows support for the appearance of a zone of indifference for small time gains and losses while being valued in line with diminishing marginal utility (ibid.). Moreover, the study shows increasing marginal utility for moderate time gains and losses as well as diminishing marginal utility for large time gains and losses. This supports the theory that “[m]oderate amounts of time exhibit increasing marginal utility (disutility) because larger blocks of time provide a more diverse set or usage opportunities” while a small time block makes it difficult to imagine how more or less time would be beneficial leading to diminishing marginal utility.

Temporal autonomy

Going back to time in transport economics, while the overarching social benefit is seen as improved accessibility, freeing up time for travellers that they could spend as they wish (i.e. not on travel) is still the main mechanism by which accessibility is reached. Especially since it is actually not necessary for the saved time to be spent on additional travel; how the saved time is spent is irrelevant. Another way of looking at this (sometimes) stated aim of transport economics is that there is an assumption to promote temporal autonomy⁷ by giving individuals more control over how they choose to use their time by shortening time spent on (necessary but unwanted) travel. The concept of temporal autonomy has been proposed to enable further discussion on the relationship between work time and leisure time and provide arguments regarding the maximisation of 'free' time as a desirable end (Goodin et al. 2008). However, while "[s]overeignty over one's time, or anyway some appreciable portion of it, is as central to leading an autonomous life as is sovereignty over one's body" (ibid.), as is the case with autonomy in general, temporal autonomy is not the only moral good there is (ibid.). One could argue that if the state really wanted to promote temporal autonomy, it would implement basic income or other measures that allow its citizens to spend less time working (if they wanted to). It seems peculiar to focus on minutes that can be saved in traffic when there are many more time consuming activities⁸. Transport economists might respond by saying that this reasoning is unfair, after all the value of travel time (savings) is just a proxy for accessibility. Accessibility

⁷Unfortunately, there is not enough space in this introduction to do justice to the discourse the notion of discretionary time (the time over which you have autonomous control) compared to leisure and 'spare time' (Goodin et al. 2008) as well as to have a substantial discussion on the concept of time poverty.

⁸While there is evidence that shows that the commute is the most stressful part of the day (for some), this alone does not justify the focus on shortening the commute. I believe the focus could equally be on making it less stressful.

is what is actually being promoted, not temporal autonomy as such. Enhanced accessibility drives land development and overall economic growth, that is the end-goal. However, overall economic growth seems far from the willingness-to-pay studies measuring the value of getting one's commute shortened by x minutes. While not fully developed in this thesis, the methodological choices here seem to warrant more consideration.

Summary of articles

Article 1: Let me save you some time... On valuing travellers' time in urban transportation

This article considers how anomalies related to behaviour aspects of time-specific decisions together with theory of value of time can inform time allocation and provide better understanding of appropriate assumptions when modelling time-value decisions.

We analyze the various properties of time as an economic resource using findings in behavioral economics and psychology. It seems reasonable to question and analyse if there is reason to consider rationality with regard to time as somehow special, especially in the context of value of time having a significant role when calculating potential benefits of a transport improvement and making policy decisions on transport planning.

After an introduction to the methodology of value of travel time and value of time studies as well as the basics of modelling value of time, we briefly discuss valuing time in the context of preference satisfaction and welfare economics in general. Traditionally, transport economy theory depends on the assumption of rational behaviour and stable preferences. Studies that showcase specific deviations from rational behaviour with regard to time are then considered in detail.

Additionally, we claim that the specifics of time as a good justify the question of whether being rational when making decisions about time (how to spend time) can be seen as significantly

different than being rational with regard to other goods. In part, this is due to time being a good that cannot be stored or saved, only transferred (or reallocated). Hence, other constraints are warranted when making rational decisions regarding the object 'time' besides what is usually discussed in the context of intertemporal choice (which can be applied to all types of goods). More insight could possibly be gained by looking at choices with regard to time separate from choices over time.

Taking these two points together (the behaviour insights and the specifics of time), we conclude that finding time converted to money is comparable to other values converted into money is an assumption that would seem to require more justification than currently given. Moreover, the potential effects of disregarding aspects of value of time can lead to policy implications that are not warranted.

Article 2: Learning from Travel Time Experiences: A Case for 'Planable' Travel Time

The article contrasts commuters' experiences of travel time due to a sudden long-term disruption on the Oresund strait between Sweden and Denmark with the theoretical account of travel time. We argue that the understanding of travel time as a disutility limits the societal analysis from aspects that could be considered vital to sustainable mobility and transport planning. Furthermore, it might also lead to inferences that seemingly go against the experiences of individual travellers. Instead, we propose the notion of striving to make travel time "planable" time for travellers.

We make a case for taking qualitative experiences of travellers into account since it can be claimed that former experiences are what forms judgments and beliefs. By understanding experiences of travel, actions and choices can be further understood. While experiences can be hard to disentangle, they can illustrate what (if anything) of a journey is perceived as important and which elements of travel that matter when making long-term decisions

on residential and workplace location. This especially holds for the main case discussed in the paper, namely the disruption in travel caused by sudden instalment of border controls between Sweden and Denmark. When the border controls were implemented, aspects of the commute that were previously taken for granted changed on a short notice. This highlighted qualitative aspects of the journey that indicated that the additional travel time made an impact on their daily lives, though longer journey duration and lower reliability was the largest components of the change.

The article summaries the results of a study carried out among commuters that were impacted by the border controls. It consisted of both a qualitative and quantitative part and the findings were divided into three categories of experiences: (1) changes during the time spent travelling such more congestion and increased stress, (2) short-term adjustments due to changed travel patterns and (3) long-term consequences of the decreased accessibility such as considerations of moving or changing workplace location. These three categories were then analysed on the basis of traditional transport economics with the aim of how and to what extent the experiences of travellers were represented in the transport models.

Our conclusion is that not all aspects identified in the study are incorporated into state-of-art travel models and while they potentially could be, it is unclear if it is necessary as long as transport planners are aware of the shortcomings of the models that are used. Instead of guiding model development, travel experiences can directly provide insight into why people behave in a certain way and this can be fruitful when developing alternatives for transport investments. In other words, if the models mainly focus on travel duration and are used to develop alternatives for transport investments, then other alternatives with a more qualitative focus might not even be considered. As long as travel time is considered a disutility, the full potential of travel time as

useful is not explored. We suggest that an alternative goal for transport planners could be to make travel time as ‘planable’ as possible for people to do with it as they please. While duration will remain of importance the frontier is in contributions to support investments in qualitative aspects, especially considering behavioural changes towards more sustainable travel behaviour.

Article 3: The complexity of value of travel time for self-driving vehicles - a morphological analysis

Understanding the implications of self-driving vehicles on travel time values is and will be crucial when developing transport models in order to accurately value transport investments and predict future travel patterns. Traditionally, one of the main parameters that determine value of travel time is travel mode, usually decomposed into travel by car, bus or train as well as cycling and walking. Thus far self-driving vehicles have been added as one (or several) additional modes, to be operated in parallel with ‘traditional’ modes. To our knowledge, there has been little discussion on the proper segmentation of self-driving vehicles into modes. In this article, we claim that a shift to self-driving vehicles will blur the lines between car travel and travel by public transport. The introduction of self-driving vehicles will not only result in changing manually driven cars to self-driving cars and manually driven buses to self-driving busses. Self-driving vehicles will also be deployed under new business and service models by both existing and new transport providers.

To support this claim, we carry out a morphological analysis to illustrate the diversity of mobility concepts based on self-driving vehicles and the complexity of determining the value of travel time for such concepts. In the analysis, we consider four categories of parameters: (i) vehicle characteristics such as automation level, form, capacity, operating speed, interior design focus, (ii) operating principles such as vehicle ownership model, service model, operating model, (iii) journey characteristics such

as access and/or waiting time, travel conditions, reliability and variability and (iv) traveler characteristics such as risk perception and perceived safety. The identified parameters and parameter attributes result in a morphological matrix that spans all possible alternative solutions. Out of these, we select five plausible, logically consistent solutions, aligned with current literature on possible SDV-based mobility concepts, and analyse them based on the implications of the concept characteristics on the total value of travel time. The analysis highlights a range of characteristics that impact value of travel time for the identified SDV mobility concepts. Furthermore, the analysis supports that there is a relative variation in the value of travel time between each of the respective SDV mobility concepts. At the very least, the concepts are significantly different with regard to these characteristics.

We conclude by suggesting that future transport research could consider moving away from specifying value of travel time for each existing and potential travel mode. Instead, we suggest that value of travel time models should employ a range of travel and service characteristics (self-driving/manually-driven shared/non-shared, private/non-private, etc.) to reflect the heterogeneity in value of travel time in a context of rapid technological advancements.

Concluding discussion

I believe the practice of valuing time in monetary terms could be considered from three perspectives: (i) the (linear) exchange between time and money as such, (ii) the aggregation of individual time savings into a societal benefit and (iii) the role time savings play in cost-benefit analysis and transport planning in general. The three suggested perspectives are considered in detail below.

(i): Given that the properties of time and money are substantially different and that evidence from consumer research shows that people make decisions about time and money differently, the

transferability between time and money needs to be justified or at least further examined. This is the primary focus of the first paper in this thesis. One aspect here is whether there is something substantial about time that warrants it being treated differently? When reflecting upon my own time allocation optimisation in relation to how I actually act (which I guess could be seen as my revealed preferences), I often conclude that my actions are far from optimal. My preference, if asked, would obviously be to never be late, and yet I sometimes am (and it is fully my own fault). My intuition is that for time in particular, many of us do not act in accordance with how we would want to act, our stated preferences and actions differ. Can these instances of behaviour be explained by mistakes or ignorance and handled by approximating that people have perfect information about all relevant facts? Considering that if prompted to think about time in terms of money, people's preferences with regard to time conformed to preferences with regard to money, this can seem to be the case. However, if an inquiry presupposes that one hour is worth \$10 and communicates this to the participants, any results that show that the participants indeed treated an hour as being valued at \$10 cannot be grounds for a stable value of time nor can it be used as an argument in favour linear transferability between time and money. An argument of this form is clearly circular. Hence, it is not the case that people can be made to think about time in terms of money. Consequently, this claim cannot be used as an argument for treating time and money similarly (regardless of context).

(ii): Travel time savings often make up a substantial part of the benefit side of the cost-benefit analysis. The value of each unit of time is calculated (taking willingness-to-pay data as input), together with the number of affected travellers and the average time each traveller is assumed to save. One critical assumption here is that the social value of a project is equal to the

population's aggregated willingness-to-pay for the consequences of said project (Næss 2006). However, it could be argued that the value for something for society cannot be reduced to aggregated willingness-to-pay. Going back to the properties of time, while aggregated money carries a meaning aggregated time across many individuals does not in the same way. Additionally, what are the implications of people becoming less happy when having to think about time in terms of money? Moreover, the value of time is often established in studies where respondents are asked to make hypothetical travel choices as if they were paying travel costs from their own budget, in exchange for personal travel time gains. It can be argued that "such travel choice decisions of individuals in their role of consumer of mobility are likely to be a poor proxy of how they in their role of citizen believe government should spend tax money to generate travel time gains for large numbers of travellers" (Mouter and Chorus 2016).

(iii): As the second article argues, the commitment to time measured by duration even when considering qualitative aspects of a journey can be limiting. There seems to be a case for development of methods used in transport economics to incorporate some of the learnings on time-specific behaviour in consumer theory and behavioural economics. Additionally, a general debate on the overall goal of transport policies seems warranted. If transport economists are to provide decision material for policy purposes on the basis of a connection between stated preferences, value of time and accessibility, a clear link to wellbeing needs to be established. If the (political) goal implies that the long-term strategy is to meet accessibility needs by measures other than facilitating more traffic by shortening travel time, the dominating "predict and provide" approach needs to be abandoned (Næss 2006). Furthermore, if it is the case that perception of time is more related to happiness than perception of money, social choices and infrastructure planning might need to be re-focused. There

seems to be a methodological conundrum here: by being set on viewing time as a disutility, the implications regarding time and happiness are being overlooked. This reasoning is in line with the perspective in the second paper, where we urge planners and decision-makers to be aware of implications of the assumptions that are being made when developing the models they use.

Future research

Accessibility and transportation justice

As mentioned earlier, the appraisal system is just using travel time savings as a proxy for the benefits of accessibility. This makes it possible to establish a link between a suggested transport scheme and the economic outcomes. Not only is taking time savings as a proxy for accessibility convenient, it is also said to be necessary. The previously mentioned paper by Mackie et al “questioned whether changes in accessibility can be defined in terms of anything other than some amalgam of changes in time, reliability, comfort and money cost which make up an index of real service quality” (Mackie et al. 2018).

However, this statement seems to disregard the value accessibility actually provides to individuals, meaning access to goods and services. Surely, a measure of accessibility could be defined as the set of goods and services actually available to individuals? Perhaps I am misunderstanding the claim made by Mackie et al. since it almost seems peculiar. In a society where digital services are on the rise and there being a myriad of goods one can order online (that might be delivered by drones in the not too distant future, to avoid the traffic limitations altogether), defining accessibility strictly in terms of transport service quality seems at least limiting. Furthermore, a lot of the discussion on transportation justice is being carried out in terms of accessibility. I believe more could be done to examine the implications of the assump-

tion between value of time and accessibility, possibly related to transportation justice and the notion of temporal autonomy.

The value of small time savings

The common approach in transport appraisal is the constant unit value approach, i.e. to use a constant value of time savings per unit of time irrespective of the size of the time saving. This means that a very small time saving per individual traveller can be considered valuable from a societal point of view, given that the number of affected travellers is sufficiently large. In fact, the transportation infrastructure projects considered give rise to time savings per traveller that are relatively small (less than 5 minutes). Yet, common experience and experimental findings suggest that small amounts of time are of little value for the individual. There are arguments of varying strength in the literature both in favour of and against the constant unit approach. However, it can be claimed that it is unclear what the societal value of small time savings actually consists of, since time cannot be accumulated in the same way as money can. From the societal perspective, time as a resource is a personal, non-aggregative good. Nevertheless, the general assumption in transport economics is that even travel time savings so small that they are not perceived by the travellers will eventually lead to economic growth. One potential line of argument that could be pursued is that due to the non-accumulativity of time, the value of a short time saving has to stem from the individual that receives the benefit. Either she values it as such (perception is implied) or it will regardless of her perception eventually lead to an improvement of her wellbeing. As it stands in the literature, the latter is assumed but not fully justified.

Time-saving bias and risk behaviour

One aspect of the perception of time that has not been discussed in this thesis is the notion of time-saving bias. Namely, that time

that can be saved by increasing the speed is often overestimated (Svenson 2008). This is important since there is often a trade-off between travel time and safety when making transport policy decisions, often by value of time and value of a statistical life being components of the cost-benefit analysis. However, this has been criticised on the grounds of individuals' preferences as consumers of mobility inferred through (hypothetical) route choices being a poor proxy for how the same individuals in their role of citizen believe that government should trade-off safety and travel time. One study shows that "individuals in their role as citizen assign substantially more value to safety than travel time when compared to their consumer choices" (Mouter et al. 2017). This is referred to as the consumer-citizens duality. There is empirical evidence of individuals valuing safety more in their role as citizens compared to when they value safety in their role as drivers. For example, individuals tend to choose the fastest route as drivers while in the role of citizens recommending that the government build the safer route (ibid). Suggested explanations include varying perceptions of risk when in the two roles (cognitive explanation) and that individuals believe that the state should assign more value to safety than drivers do (normative explanation). The normative explanation stems from a belief that government should assign greater value to safety.

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