

Doctoral Thesis in Philosophy

Time, justice and the future of mobility

Essays in philosophy of transport

MARIA NORDSTRÖM



Time, justice and the future of mobility

Essays in philosophy of transport

MARIA NORDSTRÖM

Academic Dissertation which, with due permission of the KTH Royal Institute of Technology, is submitted for public defence for the Degree of Doctor of Philosophy on Thursday the 28th of April 2022, at 10:00 a.m. in F3, Lindstedsvägen 26, Stockholm.

Doctoral Thesis in Philosophy
KTH Royal Institute of Technology
Stockholm, Sweden 2022

Introduction © Maria Nordström

Paper I published in *Essays in Philosophy* according to CC-BY 4.0 license; © Nordström, Hansson & Beser Hugosson

Paper II manuscript © Maria Nordström

Paper III published in *East Asian Journal of Philosophy* according to CC-BY-NC 4.0 license; © Maria Nordström.

Paper IV published by Informa UK Limited, trading as Taylor & Francis Group, according to CC-BY-NC-ND 4.0 license; © Nordström & Engholm.

Paper V manuscript © Maria Nordström

Cover photo: Jens Mohr: Ekonomiska museet/SHM (CC BY)

TRITA-ABE-DLT-229

ISSN 1650-8831

ISBN 978-91-8040-183-8

Printed by: Universitetservice US-AB, Sweden 2022

Contents

Abstract	4
Thesis composition	5
Acknowledgments	6
Sammanfattning på svenska (Summary in Swedish)	7
Introduction	12
1. What is transport economics?	14
2. The role of philosophy	27
3. Valuing time	35
4. Considerations on justice	49
5. What does the future hold?	64
6. Summary of papers	68
7. Concluding remarks	73
Article I: Let Me Save You Some Time... On Valuing Travelers’ Time in Urban Transportation	87
Article II: Transport <i>justice of what?</i>	113
Article III: Bridging Temporal and Transport Justice: A case for considerations of time use in urban justice	135
Article IV: The complexity of value of travel time for self-driving vehicles – a morphological analysis	163
Article V: Norms and gendered narratives in studies of attitudes toward automated vehicles – a review	183
Theses in Philosophy from KTH Royal Institute of Technology	209

Abstract

MARIA NORDSTRÖM, *Time, justice and the future of mobility: Essays in philosophy of transport*, Doctoral thesis in Philosophy. *Theses in Philosophy from the Royal Institute of Technology* 69. Stockholm, 2022, 212 pp. ISBN 978-91-8040-183-8. TRITA-ABE-DLT-229.

This thesis in philosophy consists of an introduction ('kappa') and five papers on three themes related to transport: valuations of time, the metric of transport justice, and future mobility solutions.

The first paper analyses the properties of time as an economic resource taking into account literature on behaviour concerning time. The intent is to add to the understanding of the underlying assumption of transferability between time and money in the context of transportation.

The second paper is on the metric of transport justice. If we are concerned with distributive justice in the context of transportation, what type of good is being distributed? So far, most of the transport literature on transport justice takes accessibility to be the most appropriate metric. However, I argue that many operationalisations of accessibility are insufficient as metrics of justice. They are both too narrow and exclude relevant burdens of transportation. Additionally, accessibility can be achieved by other, non-travel-based means. I end by formulating tentative criteria for an alternative metric of transport justice.

The third paper considers temporal justice in the context of transportation. Building on an argument against the claim of substitutability between time and money, I argue that temporal perspectives have been overlooked in the literature on transport justice. In part, this might be due to accessibility being the established metric of justice. Most common measures of accessibility do not capture temporal constraints and might consequently not capture temporal inequalities. Based on the case of gender differences in travel patterns and behaviour, I argue that an

alternative account of the appropriate metric of transport justice is needed to capture temporal constraints and reflect gender inequalities sufficiently.

The fourth paper argues that the diversity of possible mobility solutions based on self-driving vehicles has been somewhat overlooked in the current literature on the 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 the 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. It might be more appropriate to differentiate the value of travel based on travel characteristics.

The fifth paper is a literature review of work on attitudes toward automation technology, specifically self-driving vehicles. In particular, I examine the narratives and values related to gender. Generally, women tend to be more sceptical of the prospect of automated vehicles. The review found that this tendency is often explained by women being more risk-averse and less tech-savvy. Moreover, the policy recommendations in the examined literature based focus on educational efforts. Such perspectives can downplay or neglect 'valid' reasons why women are less enthusiastic. Moreover, needs related to women's specific travel patterns might not be considered in the design and planning process. In conclusion, more awareness is needed of the gender differences, needs and expectations to ensure that future transport solutions are designed with everyone in mind.

Thesis composition

This thesis consists of an introduction and the following five research articles:

- I. **M. Nordström**, S. O. Hansson and M. Beser Hugosson, “Let Me Save You Some Time... On Valuing Travelers’ Time in Urban Transportation”, *Essays in Philosophy* vol. 20, no. 2. 2019.
- II. **M. Nordström**, “Transport justice of what?”, submitted manuscript.
- III. **M. Nordström**, “Bridging Temporal and Transport Justice: A case for considerations of time use in urban justice”, *East Asian Journal of Philosophy* 1 (3), pp. 45-69, 2022.
- IV. **M. Nordström** and A. Engholm, “The complexity of value of travel time for self-driving vehicles – a morphological analysis”, *Transportation Planning and Technology* 44 (4), 400-417. 2021.
- V. **M. Nordström**, “Norms and gendered narratives in studies of attitudes toward automated vehicles – a review”, submitted manuscript.

In the introduction, the research articles will be referenced with their Roman numerals as per above.

Acknowledgments

First and foremost, I would like to express my gratitude to my main supervisor Karin Edvardsson Björnberg for giving me the opportunity to do a PhD and for guiding me through it with a kind hand. I would also like to thank to my so-supervisor Sven Ove Hansson for insightful comments and for the willingness to share his immense knowledge. I am also grateful to my co-supervisors Muriel Beser Hugosson and Anders Karlström for introducing me to the field of transport economics. Toward the end of the PhD project, Lars Lindblom joined as a co-supervisor, and I am sincerely thankful for his valuable suggestions and encouragement.

At the beginning of my PhD, I had the opportunity to spend time at the Department of Transport Science. Thank you to Oskar Blom Västberg, Emma Engström, Shiva Habibi, Per Olsson, Christer Persson and Marcus Sundberg for welcoming me and helping me in my efforts to learn about and understand the field of transport. I have also had the pleasure of collaborating with Albin Engholm and with Karin Winter; I really enjoyed writing and exploring ideas with the both of them.

During my time at KTH, I have had the privilege to work alongside Jesper Ahlin Marceta, Patrik Baard, William Bülow, Robert Frisk, Henok Girma Abede, Jesper Jerkert, Björn Lundgren, Payam Moula, Karl Sörenson, Anna Wedin, and Li Zhang, at various stages of their PhD educations. I am grateful for everything I have learned from them and for the friendships I have made. My fellow PhD students have been my greatest support system, always having useful suggestions and kind words.

I am also grateful to have worked with great colleagues at the Division of Philosophy, such as Johan Berg, John Cantwell, Barbrö Fröding, Till Grüne-Yanoff, Betty Jurdell, Niklas Möller, Karoliina Pulkkinen, Mark Ryan, Tor Sandqvist, Fatemeh Tayebi, Per Wikman Svahn, Sebastian Östlund and the rest of the TAMOS crew. I will surely miss all our stimulating discussions!

Doing a PhD has not always been my intention. When I left KTH at the end of my engineering studies, I was certain that I would not be back. I am glad I did return. But it should be said that I would not have had the courage to take on a PhD in Philosophy without the encouragement from my friends (thank you!) and family. I am fortunate to have parents that always encouraged learning as well as creativity and curiosity.

Lastly, I am so grateful to Odd for making this work possible, for all the support, encouragement and for believing in me even when I did not quite do so myself. Thank you also to Liv and Edvin for all the joy you bring to my life!

Sammanfattning på svenska (Summary in Swedish)

Denna avhandling i filosofi består av en introduktion och fem artiklar som på olika sätt handlar om transport. Övergripande kan transportforskning sägas handla om att studera transportsystemet och dess samverkan med och påverkan på samhället och människor. Det kan handla om planering och utvärdering av infrastruktursatsningar, policyutveckling och frågor som rör framtidens transportsätt. En del transporter är förstås varor och gods som behöver flyttas på men fokus i denna avhandlingen är transporten av människor. Transportforskning är ofta tvärvetenskaplig men hittills har transporter och transportsystemet fått relativt lite uppmärksamhet av filosofer. Detta menar jag är synd, transporter utgör en inte obetydande del av vår vardag och har stor påverkan på hur vårt samhälle ser ut. Därmed finns en rad relevanta och intressanta frågor gällande hur transporter fungerar och bör fungera i framtiden.

Utgångspunkten för avhandlingen var ursprungligen värdering av tid, eftersom det är ett centralt begrepp inom transportekonomi. Vare sig vi vill 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, behövs 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 grundläggande antagande inom 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 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 pengar 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. Vidare utforskar denna avhandling frågor som rör rättvisa och transporter. Vad är en rättvis fördelning av transport? Är det att alla kan ta sig till ett jobb på 40 minuter? Är det att det finns välskötta och upplysta trottoarer i närområdet (oavsett medelinkomsten hos områdets invånare)? Eller är det att storskaliga infrastrukturprojekt inte bara gynnar bilister utan också förbättrar för, till exempel, cyklister? Den faktiska frågan som har studerats i denna avhandling är dock betydligt mer modest: vilket mått på rättvisa borde man tillämpa? Givet att transporträttvisa handlar om en rättvis fördelning av transport – vad är det som fördelas? Som exemplen ovan illustrerar är det inte helt enkelt, det finns olika aspekter som man ta utgå från.

Inledningen till avhandlingen består av en kort introduktion av transportekonomi, en diskussion kring filosofins roll i detta sammanhang och en genomgång av tre teman: värdering av tid, rättvisa och framtidens transportsätt. Därefter sammanfattas artiklarna och slutligen dras korta slutsatser.

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 rättfärdigt i ljuset av de faktiska skillnaderna mellan tid och pengar som verkar föreligga.

Den andra artikeln i avhandlingen handlar om hur rättvisa ska förstås inom 'transport' eller snarare vilket mått på rättvisa som är lämpligt. Om man vill undersöka huruvida en fördelning av 'transport' är rättvis, vad är det då som har eller ska fördelas? Transportinvesteringar finansieras ofta av allmänna medel och det ligger i allmänhetens intresse att säkerställa att det inte enbart är några få som gynnas. Men innan vi kan undersöka hur fördelningen ser ut måste vi reda ut vad det är vi ska mäta. I den mån denna fråga har undersökts tidigare har det gjorts inom transportvetenskapen där det är vedertaget att det som fördelas är 'tillgänglighet'. Detta är förståeligt, transport (infrastruktur, kollektivtrafik, m.m.) gör det möjligt för människor att förflytta sig och därmed blir platsberoende varor och tjänster tillgängliga för dem. Samtidigt är det långt ifrån alla varor och tjänster som är platsberoende. I artikeln argumenterar jag för att måttet 'tillgänglighet' både inte är tillräckligt, eftersom vissa relevanta aspekter av transport inte täcks in, och problematiskt eftersom transport inte alltid är nödvändigt för 'tillgänglighet'. Om tillgänglighet kan uppnås på andra sätt, vad är det som motiverar att måttet 'tillgänglighet' antas mäta just (potentiella) transporter? Ska man ska mäta 'tillgänglighet' finns det inte skäl särskilja tillgänglighet tack vare fysiska transporter utan man bör likställa, till exempel, digitala alternativ. Ett meningsfullt mått på transporträttvisa bör istället mäta individens möjligheter att förflytta sig, utan att nödvändigtvis bygga på just den tillgänglighet som förflyttningen möjliggör och egentligen alls varför förflyttningen sker.

Det tredje artikeln kopplar samman tid och rättvisa. Tid (och tidsrättvisa) har uppmärksammats relativt lite inom politisk filosofi. En anledning är troligen att det förutsätts att tid och pengar är utbytbara. Om så är fallet är det tillräckligt att mäta rättvisa i monetära mått, individer kan sedan utifrån sina egna preferenser omvandla pengar till tid. Dock konstaterades det redan i första artikeln i denna avhandling att tid och pengar verkar vara olika sett till viktiga egenskaper. Dessutom finns ytterligare argument mot utbytbarheten mellan tid och pengar. Det verkar därför finnas goda skäl till att studera rättvis fördelning av tid i sig, i synnerhet inom transport där restid och restidsförkortningar är centralt. Jag menar dock att om man använder måttet 'tillgänglighet' riskerar man att inte kunna fånga orättvisor sett till just tid. Det här kan illustreras genom att se till skillnader i resvanor och resemonster mellan män och kvinnor. Dessa skillnader är svåra mäta

om man enbart ser till tillgänglighet – utbudet av varor och tjänster styrs i mångt och mycket av var man bor. Men trots att man bor tillsammans och rent teoretiskt har tillgång till samma utbud kan ens möjligheter att faktiskt tillgodogöra sig utbudet vara kraftigt begränsade av, till exempel, bristen på tid som i sin tur uppstår på grund av olika ansvar för, till exempel, hemmet. Därför verkar det åtminstone relevant att se till tidsmässiga förutsättningar i sammanhanget 'transporträttvisa', utöver att mäta ren 'tillgänglighet'.

I fjärde artikeln tillämpas till viss del insikter från första artikeln om vad som skiljer tid från pengar. Dessa insikter 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 sorters transportmedel där vissa kommer att vara nya sett till reseegenskaper. Givet att dessa egenskaper påverkar resenärers värdering av restid kommer tiden 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".

Slutligen så är den femte artikeln en litteraturstudie av artiklar som handlar om attityder gentemot självkörande bilar. I flera artiklar som analyserats framkommer det att kvinnor överlag är mer negativt inställda till självkörande bilar, jämfört med män. Detta förklaras bland annat av att kvinnor undviker risker i större utsträckning och är mer teknikfientliga. Flera artiklar lyfter behovet av utbildningsinsatser med kvinnor som målgrupp för visa på fram fördelarna med självkörande bilar. Bilden som framstår är att man inte anser att kvinnor kan ha legitima anledningar till att vara mer skeptiska. Samtidigt diskuteras inte kvinnor specifika resemönster, förutsättningar eller behov. Risken blir att man inte utformar transportlösningar som blir attraktiva för kvinnor, och att de fördelar som ofta lyfts med självkörande bilar (t.ex. mer hållbart resande) då inte realiserats.

Introduction

Imagine living in circumstances of hyperinflation. If you do not spend your money today, it will be worthless tomorrow. The notes become pieces of paper that do not carry any specific meaning. They might as well be used for origami. Presumably, such extreme circumstances affect how money is being spent. It would even affect decision-making and what is perceived as rational.

What does hyperinflation have to do with transportation? Well, the fundamental underlying assumption in transport economics is that there exists a stable long-term rate of substitution between time and money, sometimes called the value of (travel) time. The assumption of substitutability between time and money is at the center of this thesis; the initial aim was to consider whether time is like money at all. Namely, to some extent, time is like money under hyperinflation. The ‘free’ time that I have today and choose not to spend in any particular is essentially worthless tomorrow. I cannot even make origami out of yesterday’s wasted minutes. Intuitively, it seems like my decisions on time today would reflect this fugitive nature of time. Perhaps even make the decisions regarding time substantially different from decisions regarding money. What would this mean for the underlying assumption of substitutability between time and money in transport economics?

The reflection above illustrates a problem that I believe is philosophically interesting. But it is only one example of matters in the field of transportation that might be of interest to philosophers. This thesis started with an inquiry into the value of time and ended with work on values in studies of attitudes toward self-driving vehicles. Many other interesting, relevant and pressing questions were discovered along the way. While the starting point was ‘transport economics’, the end result has a broader scope. Transport economics is in many ways the foundation that research in transportation, including transport planning, policy and decision-making, builds on. However, topics and research questions in transport studies also relate to matters of justice, equity and the future of mobility; topics that this thesis ended up being about.

	Time	Justice	Future mobility solutions
Paper I	✓		
Paper II		✓	
Paper III	✓	✓	
Paper IV	✓		✓
Paper V		(✓)	✓

FIGURE 1 – The various themes introduced in the introduction and their relevance to the papers included in this thesis.

The secondary aim of this thesis has ultimately become to showcase types of research questions that could constitute ‘philosophy of transport’. The actual contributions in the thesis relate to the valuation of time, considerations of justice and questions related to future mobility solutions. I have argued for more justification of the assumption of substitutability between time and money, questioned accessibility as the presupposed metric of transport justice and analysed narratives in the studies of attitudes toward automated vehicles. Nevertheless, this is only a selection of questions. Collectively, I hope they might motivate why philosophers should care more about the seemingly mundane practice of transport than they have done thus far; questions of transport relate to our environment, our public space, our right to movement.

This thesis consists of an introduction (‘kappa’) and five papers. The papers are summarised in Section 6. The aim of the introduction is to set the stage and provide context for the papers included in the thesis. To do so, I introduce the field of transport (economics) and three relevant themes: (1) time, (2) justice, and (3) future mobility solutions. The relevance of the various themes to the papers is illustrated in Figure 1. Parts of this introduction have been published in my licentiate thesis (Nordström 2020).

A note on terminology is warranted. Some authors use ‘transport’ and ‘mobility’ interchangeably (Epting 2021). I do not. However, I do use ‘journey’ and ‘trip’ interchangeably while terms such as ‘travel’ (the journey you take), ‘transport’ (what you need to travel), ‘mobility’ (movement) and ‘accessibility’ (potential to reach the things you value) refer to specific concepts that will be explained throughout the thesis. Furthermore, while it can be argued that ‘transport’ is not a discipline (like philosophy or psychology) but merely an *object* of study (Van Wee 2011), I will refer to transport research, transport studies and ‘the field of transport’ mostly as to transport economics. However, the subject of transport can be studied from several disciplinary backgrounds. This thesis suggests that the subject of

transport could and should be studied from the perspective of philosophy, as well.

The rest of this introduction is structured as follows. In Section 1, I introduce the field of transport economics. I then, in Section 2, discuss the role of philosophy in relation to transportation and the research field of transport. In Section 3, I cover various aspects of valuing time. Section 4 is about the considerations of transport and temporal justice related to the question ‘justice of what?’ in transport justice. In Section 5, I consider how technological advancements might impact the future of mobility, related to philosophical considerations. Section 6 is a summary of the papers included in this thesis. In Section 7, I present brief concluding remarks.

1. What is transport economics?

Roughly, transport economics is concerned with allocating resources on transport and studying the movement of people and goods (this thesis focuses exclusively on the movement of people). A transport economist is interested in pricing, competition, transport and land use, and the welfare effects of transport pricing and transport investments, among other topics. Transport economists develop models which, in turn, deliver decision support for transport planners, practitioners and policy-makers. The foundation of transport economics is “mainstream economics”, neoclassical economics with concepts like utility theory and welfare economics. The neoclassical position is dominant in articles published in transport-focused journals (Kębłowski and Bassens 2018). Thus, following standard neoclassical economics, individual travellers are assumed to be rational and aim towards maximising their own utility. By asking them questions about their preference between alternatives (see Figure 2), their willingness to pay for travel time savings can be established. Aggregating over many respondents with varied characteristics and circumstances makes it possible to elicit a monetary value of travel time – a rate at which a change in travel can be compensated monetarily (De Jong and Kouwenhoven 2020).

Thus, traditional transport economics is concerned with the individuals’ aggregated choices between various travel modes, routes and destinations as well as with the trade-offs between travel time, travel cost, comfort, and so on. Travel, i.e., the activity of moving enabled by means of transportation, is assumed to be a derived demand. This means that travelling is seen as a burden you undertake to do what you *actually* want to do at the desired destination. Furthermore, travelling takes time and time is considered the single most important dimension of the product ‘travel’

	Option A	Option B
One way fuel cost	£ 33.30	£ 53.00
One way travel time by car	4 hours 23 minutes	3 hours 30 minutes
Which to you prefer?	Option A <input type="radio"/>	Option B <input type="radio"/>

FIGURE 2 – An example of a simple question measuring willingness to pay for a reduction in travel time (Hess et al. 2020).

(Jara-Diaz 2007). In short, the value of travel time is the difference between the opportunity value of travel (the utility that could be attained if the travel time was spent on some other activity) and the utility created while travelling compared to some reference activity (De Jong and Kouwenhoven 2020). The theoretical foundations can be traced back to Becker’s work on time allocation (Becker 1965) and have been developed since (see more on time valuation in transport in Section 3.3).

Every journey has a generalised cost that includes the actual monetary cost as well as all other ‘costs’, such as time, discomfort, stress due to delays, and so forth. A rational traveller is expected to compare all available alternatives and choose the alternative with the lowest generalised cost, all things considered (see the question in Figure 3, p. 41, which is more complex than the question in Figure 2). Assuming that the population of travellers is on average rational, models developed by transport economists can be used to predict expected travel choices regarding mode and route. The passengers are assumed to individually assess the value of a change to the transportation system. Their accumulated willingness to pay reflects the total value that a particular change yields; if the value is positive, then the change is presumably an improvement.

Considering that the generalised cost is intended to capture all aspects of travel, everything that affects or could potentially affect the overall travel experience must be included. Ultimately, the generalised cost is considered in monetary terms and used to compare to the direct and indirect costs of implementing a particular change to the transport system. However, not all of the components of the generalised cost are easy to value in monetary terms. Some components are straightforward since they are

actual costs, such as travel fare and the costs of owning and maintaining a car. Furthermore, some models are considered reliable when considering specific components of the generalised cost, such as the value of time (Small 2012). Still, there are no models that can claim to include all possible (and relevant) aspects of a journey; we might not even know all the relevant aspects. Moreover, it is a challenge to decouple certain parts of the overall generalised cost, such as distinguishing between the value of waiting time and transfer cost. The value of some aspects, such as a loss of natural environment or impact on zones of cultural significance, are hard to value in themselves. These factors are not part of the generalised cost and must be considered separately as part of the transport planning process.

Nevertheless, as mentioned above, the models developed in transport economics are used to weigh the benefits of a transport change (such as shorter travel time) against investments costs and other downsides (such as environmental damages equalling environmental costs). The standard approach is to carry out a cost-benefit analysis, a framework that enables the evaluation of public spending decisions intended to improve public welfare. However, to carry out a cost-benefit analysis, it is necessary to reduce complex reality into manageable variables, thus relying on an idealisation (Næss 2006). There are also other drawbacks and philosophical problems with cost-benefit analysis (Hansson 2007). For example, as pointed out above, it can be inappropriate to put a monetary value on certain values, such as biodiversity. Still, such monetary valuations are sometimes adopted as part of the cost-benefit analysis. A response to this critique is that the measuring unit does not have to be money; it is just convenient: “[i]t just happens that in our society, as well as in other advanced societies, money has long been used for exchange” (Fuguitt and Wilcox 1999, p. 52). Furthermore, it can be argued that the incommensurability of values will remain, even if measured in another ‘currency’ than money. However, it is precisely this incommensurability that Næss refers to when suggesting that it might not be possible to reconcile incommensurable values by technocratic calculations (Næss 2006). Instead, he argues, the political nature of decisions on transport infrastructure should be recognised.

While the steps and components of a transport model might seem pretty straightforward (individuals make choices, transport researchers model and predict such choices), it is evident that the transport network does not function in a vacuum. Transport can be said to be interwoven with spatial developments and general trends in society (Van Wee 2011). Therefore, additional consequences of any transport project also have to be considered in a transport economics framework. In addition to the

direct user benefits through lower generalised costs, transport investments also bring about wider economic benefits (Pogonyi 2020). Such benefits include induced investments through changes to the attractiveness of an area, employment effects due to increased connections to employment, and productivity impacts due to relocations of jobs to high-productivity areas, according to Pogonyi. Moreover, as the density of economic activities increases, workers and firms become more productive, which is sometimes referred to as so-called agglomeration effects. Since cities have a higher spatial concentration of economic activity, moving to a city leads to agglomeration benefits. However, there is often a trade-off between rent and transportation cost (including time) since rents tend to be higher in spatially concentrated areas. There is still much to learn about the relationship between increased density, welfare and the quality of life (*ibid.*) Another perspective is how digitalisation can impact agglomeration effects. Given the changing shopping behaviour, it might not be as beneficial for the retail sector to remain in the city centre. However, the manufacturing sector still prefers to be in proximity to its suppliers to shorten delivery chains. All in all, there is empirical evidence of transport projects tending to have a positive impact on the economy (Pogonyi 2020). However, as Pogonyi notes: “much of the effects are transmitted to the nonusers of the network: for instance, part of the benefit from cutting travel times is transferred to landlords through increased rent, or firms transfer their benefits to their consumers through increased quality or decreased cost” (Pogonyi 2020, p. 152).

Notably, in the context of transport research, the term ‘behaviour’ is commonly used as ‘travel behaviour’ to describe the observed actions of travellers (Avineri 2012). While some recent work in transport research integrated insights from psychology with neoclassical theory, only a few direct references are made to behavioural economics. Avineri notes that instead of building on behavioural economics, research in travel behaviour is linked to work in psychology and sociology, even though behavioural economics could provide a useful conceptual framework (Avineri 2012). Moreover, insights from behavioural economics could be used to encourage behaviour change, even though certain insights might not be transferable to a transport context.

Lastly, it should be mentioned that it is common to view the total welfare change caused by a transport investment as consisting of (i) the option value of having the option of consuming a good, even if it is the option is not taken advantage of, and (ii) the non-use value, i.e., the existence of goods that are not directly consumed nor that there is an intention to

consume them (Laird et al. 2009). In a way, the benefit is in the *potential*: “transport is seen to serve a social function providing accessibility to social and economic opportunities irrespective of whether or not a trip is made” (ibid., p. 173). Mobility (see Section 1.3) can also be conceptualised as potential transport (Sager 2006). While considering potential travelling rather than actual travelling is the established norm, Sager argues that the advantages meant to follow from higher mobility are not necessarily realised with rapidly increased transport (2006). While the possibility of travel might be valued in itself, the additional value of the choice set being enlarged and potentially raising preference fulfilment builds on individuals actually travelling. Sager also notes that if too many individuals merely enjoyed the potentiality of transport, the system would break down.

1.1 Theoretical background: the notion of rationality

Neoclassical economics assumes that all human behaviour can be explained in terms of rational agents who optimise over bundles of goods and services. Moreover, specific rationality criteria apply. Beliefs about 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 determined by a rational set of beliefs and preferences, with preferences usually taken to be predetermined. The conditions on an agent’s preferences (rankings of states of affairs) are that they ought to be complete and transitive in order to be considered rational (Hansson and Grüne-Yanoff 2008). Yet, preferences are not always complete (in the presence of uncertainty) and can also be non-transitive, as confirmed by experimental evidence. According to Hausman, this does not mean that transitivity should not be a requirement of rationality but is disquieting.

Given the established preferences, a utility function can be defined to represent a preference ranking under the above mentioned ‘necessary’ criteria (completeness, transitivity and continuity (Steele and Stefánsson 2015)). Thus, “[a]gents are rational if and only if their preferences may be represented by ordinal utility functions and their choices maximize utility” (Hausman et al. 2016). 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, though the independence criteria is contested (Steele and Stefánsson 2015). While rationality is a normative notion, it is usually not considered 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. So, the goal becomes to satisfy individuals' preferences to increase welfare – people are better off (all else equal) when their preferences are satisfied.

In the context of transport economics, willingness-to-pay is assumed to indicate preferences (see Figure 2 and Figure 3). Preferences are assumed to be welfare-guiding, meaning welfare is measured by preference satisfaction. Given these assumptions, outcomes can be evaluated in terms of welfare considered as pure preference satisfaction. This allows economics not to commit to any view on what constitutes a person's good (or welfare beyond preference satisfaction). The goal of a policy is to generate as many benefits (positive effects) and as few costs (negative effects) as possible, seen over society as a whole. Here, the sum of the measured willingness-to-pay indicates the total benefits of a policy. The benefits and costs are then plugged into cost-benefit analysis. However, 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. For instance, agents are not always good judges of what will benefit them the most, even when they have all the necessary information. Based on this, some preferences among policies might not be appropriate to be considered welfare-guiding (Hausman 2003).

1.2 Transport models

The transport system is a complex system with great societal impact (Van Nes and De Jong 2020). Given the potential long-term impact and the societal costs of large-scale investments, the need for analysis and appraisal of such proposals is understandable. According to Van Nes and De Jong, transport models originated from a car traffic engineering perspective, with the purpose of analysing the consequences of changes in the transport system. The main components of an aggregate transport model are usually trip generation, trip destination and modal choice (i.e., which travel modes are used). The basic unit is a trip or a tour (a roundtrip). Given the spatial distribution of locations (zone data), the travel behaviour can be modelled as link flows with respective travel times. The components of a

disaggregated model, such as a discrete choice model, can be choices over destination, travel mode and route. Transport models allow for a systematic comparison of alternatives, useful from both transport engineering and decision-making perspectives. However, models can only capture part of the prevailing complexity of large-scale, integrated systems (Van Nes and De Jong 2020). So, they are, by definition, limited by the simplifications made when modelling the system as well as by the quality of input data. Still, they allow for a systematic analysis of changes. The dilemma between the benefits of using models and the limitations that exist is inherent to modelling as such.

Even though so-called four-stage models ('predict and provide') have been historically dominating in transport research, so-called activity-based models are considered a viable alternative that might be more realistic (ibid.). It is generally conceptualised that individuals' choices firstly concern the activities they want to participate in. These activities are, in turn, tied to specific locations. It follows that there is a need to travel, so subsequent decisions are made regarding transport mode, travel route, time of departure, and so on. If individuals have scheduling goals (such as an activity starting at a specific time) they need to meet, they are presumed to choose the departure time which is most suited for their scheduling goal. Ultimately, it is assumed that each individual has to decide how to schedule and reach activities that require travel from one location to another. To accommodate this, multiple activity-based models have been developed, starting in the 1970s and gained momentum since the 1990s (Rasouli and Timmermans 2014). According to Rasouli and Timmermans, such models can improve behavioural underpinnings while achieving higher spatial and temporal resolution. However, the adaptation and use of such models in practice has been slow, perhaps because the details on how people decide on their activity patterns are so complex. Time constraints on individuals' desired activities affect how pressed for time the individuals' are when travelling. There is an expected heterogeneity that has led to the segmentations of trips based on, for example, trip purpose and mode type. Generally, commuting and business travel have a higher value of time than travel for leisure (Abrantes and Wardman 2011). Banister et al. problematise these established generalisations and stress that the variables presented above often are part of a tightly woven cluster of possibilities and constraints (Banister et al. 2019). Though some appointments are fixed in time, additional activities might be added and make a trip seem more worthwhile. Additionally, Mokhtarian et al. speculate that desire to travel in itself can lead to finding an activity that would require travel so that

the actual activity becomes the justification for travelling (Mokhtarian et al. 2015).

While there are, as noted previously, limitations to most models due to the inherent need to make simplifications or idealisations, being transparent with regard to limitations is crucial. The criticisms by Banister et al. (2019) of the generalisations have to be viewed in the context of the purpose of the models. In particular, if the following claim by van Nes and de Jong is true: “[i]n applications, limitations of the models are not always acknowledged, the logic of the models sometimes remains unclear, and the model itself as well as the model results can still influence the planning process more than is justified” (Van Nes and De Jong 2020, p. 122). Given that the results of transport models are sometimes intended to be decision-guiding, this seems particularly worrying. However, the degree to which there is a lack of communication on the limitations of models is not clear. Regardless, there seem to be important methodological considerations worth reflecting upon.

1.3 Mobility and accessibility

Two central concepts of this thesis are the notion of mobility and the notion of accessibility. While they are intertwined, they are also important to distinguish. According to Handy, failure to do so can lead to missed opportunities to find new solutions to transportation problems (Handy 2020). One common view is that mobility ought to be understood as the physical movement of people (Ferreira et al. 2012) with a mobility-enhancing approach aimed at easing such movement. A simplistic way to measure mobility is in terms of the territory that can be reached given a specific amount of time and money (Levine et al. 2019). Thus, a mobility-enhancing approach would favour transport infrastructure (such as roads). Accessibility, on the other hand, is a measure of potential opportunities (activities and destinations). Thus, according to Levine et al., accessibility can be measured by the number of destinations that can be reached given a specific amount of time and money. Hence, an accessibility-enhancing approach could include proximity and connectivity, thereby creating additional destinations rather than improving transport infrastructure. However, the distinction is not always as clear-cut.¹ Handy notes that while good mobility can contribute to good accessibility, good accessibility can be achieved by other measures

¹There is also the notion of *motility*, defined as the capacity for mobility (Shliselberg and Givoni 2018). Building on the view that mobility can be seen as a basic human functioning valued as a stand-alone resource for personal flourishing, Shliselberg and Givoni argue that has a value as objective for (transport) policy.

as well (2020). Moreover, secondary effects of mobility-enhancing measures (such as widening a road) can negate the initial benefits in accessibility.

The mobility-approach has been presumed as standard in transport economics. Given that mobility can be understood as ease of travel, it is often conceptualised as speed. Since time savings are valued in transport economics, they can be achieved by increasing mobility if mobility is, for instance, operationalised as speed. Thus mobility maximization (speed) is one of the goals of transport investments because it can reduce travel time. Furthermore, such an investment will also enhance accessibility. On the standard view, providing more mobility (coupled with increased accessibility) will increase welfare, social progress and lead to an increase in human freedom (Khisty and Zeitler 2001). Yet, Khisty and Zeitler claim that the link between mobility and (human) progress is not clear and that little is known about the connection between growth, development and human progress (*ibid.*). Nevertheless, this claim, as they note, depends on the definition of mobility: “if mobility is taken to mean the maximization of physical movement, or optimization of space consumption, as implied in virtually every engineering and economic approach, we find that we end up with” excessive and imbalanced mobility (*ibid.*, p. 598). Khisty and Zeitler further argue that such a development would endanger the sustainability of modern society and the quality of (human) life. Note that mobility, at least the way it is framed here, is “coupled with increased accessibility”. It is not speed as such, or even mobility as such, which leads to an increase in welfare. Rather, it is the consequence of a mobility increase that enhances accessibility. Hence, it is understandable that Ferreira et al. consider mobility to be a means to reach the essential goal of accessibility (2012). They define mobility as “physical movement undertaken either to have access to people, places, and events and/or to provide enjoyment for the traveler resulting from the experience of physical movement in itself” (*ibid.*, p. 688). They further note that there are negative social meanings of being mobile; for instance, improvements in mobility might lead to attractive destinations and people becoming more spatially disjointed. In light of this (among other consequences of increased mobility), “[m]obility is actually associated with debates of a quite philosophical nature” (*ibid.*, p. 689). The intrinsic merit of mobility (as defined by Ferreira et al.) is worth discussing further. Especially in contrast to good accessibility, which according to Ferreira et al., is a democratic right (2012).

As noted above, accessibility is the other important concept in transport research and planning, urban planning and geography, as well as in policy-making (Geurs and Van Wee 2004). Given that the purpose of the

transportation system is to provide opportunities to take part in spatially dispersed activities, it is understandable that accessibility can be seen as the true goal for transportation planning (Handy 2020). Shorter travel times serve as a proxy for enhanced accessibility since ‘saved’ travel time can be transformed into reaching additional destinations or taking part in new activities. Whether time is actually ‘saved’ from the individual’s perspective is discussed further in Paper III. Nevertheless, a change in the transport system leads to a change in accessibility that in turn leads to development and a real economic change. Thus, the transportation changes lead to second-round 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.

As is perhaps obvious from the previous paragraph, fully understanding the concept of accessibility can be quite difficult since it is complex (Geurs and Van Wee 2004). Moreover, it can be defined and operationalised in a variety of ways. Geurs and van Wee define it as “the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)” (ibid., p. 128). They also identify four types of main components of accessibility: (i) land-use, (ii) transportation, (iii) temporal constraints and (iv) individual characteristics. The first component reflects the land-use system, the distribution and amount of opportunities at various locations. The second component is the transportation system and related infrastructure, since accessibility can be considered from the perspective of different transport modes. The third component is the temporal constraints, i.e., the time individuals have to allocate on transport. The last component reflects the individual characteristics of the travellers, such as age, income and physical ability. Having a driver’s licence and access to a car is an example of an individual component of accessibility.

Geurs and van Wee also identify four types of measure of accessibility, namely measures based on (i) infrastructure, (ii) locations, (iii) persons and (iv) utility (ibid.). The last measure (utility-based) has its origin in transport economics and is connected to viewing accessibility as a proxy for economic benefits of a transport investment, as discussed above. An example of the first measure (infrastructure-based) is ‘level of congestion’, whereas an example of the second measure is “the number of jobs within 30 min travel time from origin locations” (ibid., p. 129). Person-based

measures provide the best basis for considering individual circumstances since for this type of measure, individual levels of accessibility are being measured. However, these types of measure are rarely found in mainstream transport research. Instead, they are more common in the field of space-time geography (Hägerstrand 1970).

As noted above, accessibility is usually measured and evaluated using indicators based on spatial data. However, such a measure has been found to poorly reflect so-called perceived accessibility, defined as the perceived potential to take part in activities that are spatially dispersed (Pot et al. 2021). Pot et al. argue that the mismatch is due to unawareness and the measure not considering the subjective evaluation of the accessibility components. The measure based on spatial data can only serve as a proxy for the actual experience of accessibility. Similarly, it has recently been found that conventional methods can overestimate accessibility levels and underestimate accessibility inequalities (Ryan and Pereira 2021). By comparing ‘objective’ indicators based on land use and transport with ‘subjective’ indicators (i.e., self-reported perceptions of accessibility), Ryan and Pereira were able to show that the heterogeneity in people’s perception of accessibility was being overlooked.

The appraisal system often takes 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. It can be “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, p. 641). While this statement reflects a common view, it seems to disregard the value accessibility actually provides to individuals giving them access to goods and services. A measure of accessibility could be defined as the set of goods and services *actually* available to individuals. In a society where digital services are on the rise and there is a myriad of goods one can order online (which might be delivered by drones in the not too distant future, avoiding road traffic limitations altogether), defining accessibility strictly in terms of transport service quality seems narrow. This also relates to taking accessibility as the metric of transport justice, as is considered in Paper II and III. Should the metric of distributive justice be accessibility, or are there other aspects of transport worth capturing?

1.4 Methodological considerations

In a way, transport economics could be seen as a mix of engineering and economics. It has the neoclassical foundation coupled with the engineering mindsets of the practitioners. Hence, it can be argued that “the process of developing transport policy involves a language imbued by mathematical models and technical knowledge” (Kębłowski and Bassens 2018, p. 414). Marsden and Reardon found that two-thirds of the 100 papers they studied from two leading transport policy journals focused on quantitative analysis alone, without engaging with real-world examples (Marsden and Reardon 2017). They argue that their findings highlight the so-called technical-rational paradigm in transport research, and that aspects such as context, power and resources are being ignored: “the literature is more concerned with creating or improving tools to help decide on which piece of infrastructure to invest in, than in engaging with a critique of the infrastructure strategy on which the investment priorities are (and in turn the tools used) guided in the first place” (ibid.).

The discussion on the nature of transport modelling is not only recent. In the 1980’s, Supernak argued that transportation modelling was still a “not-too-well-developed” research field that faced methodological challenges or ‘complaints’ (Supernak 1983). For example, theories applied in transportation were borrowed from microeconomics, social sciences, and physics rather than being developed for the particular field without fully examining the adequacy of this practice. Supernak’s critiques of transport modelling prompted a response from Polak where he noted philosophical issues implicit in the arguments by Supernak (Polak 1987). First, there is “[t]he temptation is to believe that transportation modelling and the study of travel behaviour is, in some sense, a natural science” (ibid., p. 64). Polak argues that, on the contrary, transport phenomena are not ‘law-like’ in their nature. While there might be observable patterns of empirical regularities in transport phenomena, the focus should, according to Polak, be on the causal mechanisms that generate these patterns. Specifically, “that the causal mechanisms operating in a given situation are logically distinct from the observable patterns of activity to which they may give rise” (ibid., p. 67). Polak also considers the difference between ‘scientific’ and ‘operational’ models. Supernak and Stevens later responded that the examples from natural sciences he used ‘misled’ Polak to conclude assumptions of the nature of transport modelling (Supernak and Stevens 1987). The point of contention seems to be the degree of regularities of traveller’s behaviour, and how the regularities are to be understood and subsequently modelled.

While Supernak and Stevens advocate for asking ‘what’, ‘where’, ‘when’, ‘how’, and ‘how much’ to develop models based on “reliable functional relationships among operationally definable traveler variables” (p. 77), Polak (according to Supernak and Stevens) would prefer asking ‘why’ and thus focus on travellers’ motivations and intentions. They also note that the distinction between ‘scientific’ and ‘operational’ models is not as clear as Polak suggests.

Despite examples such as the scholarly exchange above, Timms argues that the interest in methodological issues in the field of transport modelling and transport economics can be said to be sparse given that the fields can be traced back to the 1950s (Timms 2008). In particular, according to Timms, there has been little interest in connecting and building on concepts from philosophy of science when considering methodological issues of transport models. He argues that the most prominent ‘philosophy’ in transport modelling has been positivism² and the understanding that the validity of models depends solely on the accuracy of the models predictions. Viewing accuracy as the main epistemic value is understandable, given that the main purpose driving the development of transport models has been to make predictions. At the same time, concerns have been expressed over model accuracy, especially regarding long-term models (ibid.). Empirically, forecasts have been shown to overestimate traffic. However, the argument against (what Timms refers to as ‘pure’) positivism is based on Polak’s argument discussed in the previous paragraph: there are no law-like regularities in travel behaviour. Hence, Timms argues that a positivist approach is inadequate, especially for long-term modelling. Instead, Timms suggests for communicative rationality to be an appropriate foundation for transport modelling (Timms 2008).

All in all, I believe that the lack of terminology based on philosophy of science, as noted by Timms, should not be interpreted as a lack of interest in overarching methodological issues. There are on-going internal discussions in the discipline on the suitability of various methods (such as the critique of cost-benefit analysis covered in Section 1). A recent contribution particularly relevant to the topic of this thesis is the critical appraisal of the use of so-called simple time-money trade-offs (Hess et al. 2020). While stated choice surveys are the established method to elicit value of travel time in transport economics, great differences exist between the actual approaches used. Large national studies building on simple time-money trade-offs are commonplace in Europe. In contrast, more complex

²In simple terms, positivism is the view that knowledge is based on experience, so findings are only meaningful to the extent that they are verifiable, for example by observation.

study setups are preferred in Australia and South America where there is more local focus. National studies typically seek to establish a reliable long-term measure of value of time for appraisal and are motivated by the ‘value’ of continuity and comparability. In their appraisal of the reliability of the considered methods, Hess et al. point out two issues with simple time-money trade-offs, namely the empirically evident differences in valuation across formats and the lack of clarity on how respondents actually interpret travel time (ibid.). The authors note that “[s]imple time-money trade-offs have often been the topic of heated discussions at conferences” and I think this points toward an obvious methodological interest. According to Hess et al., most criticisms of simple time-money trade-offs concern ‘realism’, here understood as consistency with real world choice settings. In the real-world, a choice between expensive but fast train vs. cheap but slow bus is essentially a mode choice that brings in implicit issues of comfort, reliability and status. So, a choice between time and cost without any additional context (see Figure 2) is not representative of real-world alternatives. However, more complex models with more than two attributes make the modelling of behavioural phenomena more complicated and lead to an increase in computational complexity and data requirements (Hess et al. 2020). These methodological trade-offs are not unique to transport modelling. Here, insights from philosophy of science could contribute to conceptual clarity (as will be discussed in Section 2). How to model traveller behaviour and which value of time to use for appraisal and forecast purposes are the research questions that remains to be answered: “[w]e do not have an a priori truth and our decision on which value should be used needs to be guided by which one we trust more and which seems more reliable” (ibid.). Further work on these methodological questions can benefit from philosophical perspectives.

2. The role of philosophy

Transportation challenges require solutions beyond the thinking that comes with humankind's immediate mobility needs

— Shane Epting,

The morality of urban mobility: technology and philosophy of the city

Transportation and the act of travel have received limited attention from philosophers. A notable exception is Thomas, who has recently written a book on the meaning of travel (Thomas 2020). She noted that while some philosophers travel extensively, there are no books on the philosophy of

travel, no lecture courses and no conferences. She argues that philosophy of travel should be ‘a thing’, and I agree. However, while she considers travel to be tangled with philosophy, the philosophical questions are not necessarily related to everyday travel. Rather, she poses questions such as “[i]t is ethical to visit the Great Barrier Reef if its corals are withering?” (ibid.). Her questions relate to a greater extent to the the experience of the journey than the questions considered in this thesis. While her book is clearly on travel, the topic of this thesis is on transport, i.e., the means, infrastructure and social structure that enable travel. The topic of transportation in this limited sense has been studied even less by philosophers. Yet, the transportation research literature (and field) has plenty of philosophically interesting questions: What is fair in the context of transport investments? (Wee and Mouter 2021). What would a ‘fair’ distribution of road space look like? (Nello-Deakin 2019). Can intense mobility patterns be unethical? (Ferreira et al. 2012). How suitable is cost-benefit analysis for *ex ante* evaluations of transportation project? (Van Wee 2011). It seems like a philosopher could help disentangle these questions. Moreover, some of these questions are rather urgent. On the one hand, we as a society depend on mobility; on the other hand, our mobility practices are not sustainable (Bertolini 2017). This is certainly a dilemma.

To the degree that transportation has been considered in philosophy, it has often been specifically as urban transportation, sometimes as a subfield to ‘philosophy of the city’ (Epting 2019b). Should ‘philosophy of transport’ be ‘a thing’? I believe so. There are several perspectives within the scope of ‘transport’ that can be philosophically relevant, such as how transport-specific resources should be distributed. Moreover, I believe that there are multiple ways in which philosophers could contribute to the field of transport studies (if they wish). For example, there are relevant aspects of philosophy of technology (the transportation system is a nexus of technological artefacts), philosophy of science, philosophy of public policy and specifically philosophy of economics (since transport economics is a subfield of economics).

There is a warranted fundamental ethical concern about transport, according to Khisty and Zeitler (2001). However, they argue that “the dominance of engineering and economic approaches to transport research has largely prevented qualitative and ethical research from manifesting itself as an important interpretive framework” (ibid.). They further identify three problems: (i) lack of scholarly traditions to lean on for transport ethics, (ii) the challenge to explain the place of ethics to engineers and economists in transport research and, (iii) a lack of interest in the adverse

effects of transport among the general public. Khisty and Zeitler suggest that phenomenology understood as the philosophy of experience can be helpful to nourish an ethical debate within the transport sector, taking human experiences of transport as a starting point. But phenomenology is only one possible approach. The (probable) rise of self-driving vehicles has inspired ethicists and a body of work in philosophy of technology (see Section 5.1). Another possible perspective is based on philosophy of economics, as noted above. If philosophy of transport more clearly becomes an established subfield, it would likely be a multidisciplinary discipline building on multiple perspectives and approaches. Examples of such approaches are developed further in the remainder of this section.

2.1 Philosophy of the city

Philosophy of the city³ is a multidisciplinary field, building on the philosophical interest in the city as the object of study. The philosophical interest is understandable since cities have become places where the majority of humans live (Simon 2021). However, the philosophical interest in cities and the questions such interest raises is not only building on recent philosophical thought. Problems can be traced back to ideas by Plato and Aristotle and the theories of the ideal city (ibid.). Despite such ancient roots, works of philosophers on the topic of the city have sometimes been classified as social science rather than philosophy, at least in the Western tradition (Noll et al. 2019). Both Iris Marion Young and Hannah Arendt have written on the city, but, according to Noll et al., these works have received little attention among philosophers.

As a multidisciplinary field, philosophy of the city includes many topics and dimensions. Examples include urban aesthetics and efforts to formulate a framework for assessing how the urban environment relates to the human experience (Lehtinen 2020). Such studies cover understanding how cities are envisioned, experienced and assessed and should have implications for how future cities are planned (ibid.). Another perspective builds on environmental ethics, crucial to how we understand cities and the role cities have and ought to have in transitions to more sustainable futures (Epting 2018). According to Lehtinen, “[t]here is an increasing need to understand how philosophy can contribute to the current discussions on urban design and social and sustainable methods to develop the city”(Lehtinen 2020). Lastly, the city can also be considered from the perspective of philosophy

³See Simon (2021) for an introduction of the Philosophy of the City Research Group and a brief overview of the history of the field.

of technology.⁴ Nagelborg et al. argue that the city has yet to receive much attention from philosophers of technology (Nagenborg et al. 2021). However, attention is likely to grow given the developments in urban technologies. Examples of current and potential research include the ethics of technology for studying so-called ‘smart’ cities (the role of emerging technology in the context of the city will be developed further in Section 5.1).

The recent rise in philosophical interest in the city is encouraging. However, I believe that despite transportation being at the centre of urban living, with the transport network being the urban circulatory system, conceptualising philosophy of ‘transport’ as merely a subfield of philosophy of the city would be a mistake. While there are many potential lines of inquiry that are related to the role of the transport network to city life, other questions concern rural travel. Transportation infrastructure is crucial for sparsely populated areas. It is, arguably, sometimes more vulnerable (for example when all travel is dependent on one bridge or one road⁵). From a justice perspective, rural transport should not be forgotten. Interestingly enough, it has in work on rural accessibility been noted that the spatial separation which limits people’s abilities to reach and engage in opportunities and activities may be overcome by other means that movement (Farrington and Farrington 2005), implications of which are discussed in Paper II. All in all, while I see that there are relevant overlaps between philosophy of the city and philosophy of transport, philosophy of transport should at least be explored as a standalone field. What that could entail is further developed below.

2.2 Philosophy of transport economics?

The problems in transport economics are fundamentally problems of economics, only applied to a sector with specific characteristics (De Palma et al. 2011). Hence, it seems reasonable to turn to the philosophy of economics as a starting point for philosophy of transport economics. Philosophy of economics can broadly be said to consider the questions of rational choice, appraisal of economic outcomes and the ontology of economic phenomena (Hausman 2003). All of these questions are certainly relevant in the context

⁴There are many more topics, such as political philosophy and questions of housing policy, migration policy and democratic ideas (Noll et al. 2019), as well as specific questions on inclusive and exclusive design.

⁵Van Wee et al. have introduced the concept of ‘substitutability’ which is intended to highlight such vulnerabilities as well as relate to freedom of choice, is it enough to have access to one alternative (Van Wee et al. 2019)?

of transport economics. Moreover, the same divide proposed by Hausman for philosophy of economics can be applied to philosophy of transport economics: action theory, ethics/political philosophy and philosophy of science (ibid.). Some of the core epistemological and ontological questions concerning economics are also relevant for transport economics, especially matters related to social scientific naturalism⁶ (especially since transport economics often is connected to engineering, adding to its 'natural science' sentiment) and matters related idealisation. Transport models (presented in Section 1.2) also deserve methodological reflection. However, as discussed in section 1.4, the methodological discussions in the transportation field rarely explicitly draw on philosophy of science (or philosophy of economics). Finally, questions related to welfare and efficiency are crucial in traditional welfare economics (ibid.). The same questions are relevant in the context of transport, and there is a literature in philosophy of economics to build on.

It should be noted that the lack of connections between the field of transport economics and philosophers is perhaps not unique. There is still disagreement on the relationship between philosophy and economics (Vromen 2021). Initially, the goal of philosophy of economics was to encourage methodological reflection among economists, with philosophy being a source to draw on (ibid). However, Vromen argues that there now seem to be two parallel methodological discourses, one among methodologists (for example, philosophers) and one among economists. He suggests that the intended audience of the work has shifted: "[i]nstead of contributing to the advancement of economics by bringing in insights from philosophy of science, it seems we now primarily want to contribute to the advancement of philosophy of science by taking examples from economics as a case study". Given that philosophy of transport economics is not (yet) established, I think there can be lessons learned from such developments in philosophy of economics. Suppose the intent is to engage with transport economics on the grounds of questioning one or more of the premises of neoclassical economics. In that case, it might be the case that such arguments carry little weight for most transport economists, and the intent will fail. However, one can pose research questions relevant in the eyes of transport economists within the field of transport economics and apply philosophical methods so that philosophical aims are satisfied while adding to the field of transport economics.

⁶In very simple terms, naturalism in the philosophy of social sciences is the view that laws and principles in the natural world can be extended into the studies of society and social science.

2.3 Economics, philosophy and policy

Should philosophy influence policy (if yes, then how?) and what is the role of philosophy of economics in policymaking? Economics as such is claimed to be relevant to policy because of the information it provides concerning the potential consequences of policies under consideration. To the degree that economic models can provide reliable predictions regarding outcomes of policy decisions, they are indeed relevant for policy as such (Hausman 2003). An early view in transport economics was that the goal of the models was to ‘predict’ so that policies could accurately ‘provide’: predictions of future traffic growth informed decisions on infrastructure to expand road capacity (Lyons and Urry 2006). 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 2003). 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 (as considered in Section 1.4). For transport economics models, when modellers strive to capture as much as possible, they can end up with models too complicated to be fully grasped, and the output will no longer be predictable for certain scenarios. In discussions about the valuation of time based on context, one has to understand the limitations of the complexity of models with regard to usability.

For transport economics specifically, questions related to the role of transport economics for policy purposes are considered particularly relevant since “[t]he path from theory to application is often shorter in transport economics than in other fields of economics” and “[n]ew concepts and theoretical developments are quickly adapted toward application and combined with expert advice and field experience into policy recommendations for decision makers” (De Palma et al. 2011, p. 2). However, this puts great responsibility on those that work on theories and models. Kębłowski and Bassens have discussed to what extent policymakers and practitioners make sense of transport reality based on the insights and recommendations from transport economics practitioners (Kębłowski and Bassens 2018).

They argue that mathematical models of transport economics and their simplifications have contributed to making policymakers embrace the goal of an efficient and sustainable urban transport system (*ibid.*).

Additionally, the progress and findings of behavioural economics have raised concerns regarding the status of preferences in cost-benefit analysis (Robinson 2016). Behavioural economics can identify ways in which we act irrationally, and this can have implications for policy design and evaluation.⁷ 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 behavioral factors in economic models should be viewed as a pragmatic rather than philosophical choice" (Chetty 2015, p. 28). Since individuals fail to make choices that maximise wellbeing, policymakers should utilise other non-choice-based measures of wellbeing, such as subjective wellbeing (SWB) surveys (Chetty 2015). Furthermore, it can be argued that behavioural economics 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). However, as Adler notes, the difficulties in measuring wellbeing are genuine, and there is no magic cure, not even SWB surveys.

Lastly, in the context of equity, applied philosophers can perhaps provide guidance and help policy-makers disentangle ethical theories. Especially, since it can be argued that "[f]or policy makers it might be difficult to choose between the ethical frameworks they can adopt to evaluate the fairness of a specific distribution of burdens and benefits resulting from a transport policy" (Wee and Mouter 2021, p. 119). Even if certain scholars argue in favour of a particular framework, there is no consensus about which ethical framework to use. A solution for policymakers can be to turn to empirical research on the ethical preferences of citizens for guidance, according to Van Wee and Mouter. A small number of contributions in the transportation literature adopt this approach of studying the preferences with regard to transport policy options, specifically the desirability of the impact on distributions. The potential large-scale introduction of self-driving vehicles on the road has also given rise to a body of work that studies the vehicles as 'moral machines', as well as citizens' attitudes toward such vehicles (see Section 5.2 and Paper V). However, substituting norma-

⁷See 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.

tive theories with people's preferences on what is fair (and even employing measures such as 'willingness to pay for fairness') seems problematic, to say the least.

2.4 Concluding remarks on the role of philosophy

The initial approach in this thesis was to 'apply' philosophy to transport economics. The intention was to carry out work within the scope of transport economics with practitioners of the discipline as the main target audience. To a degree, this approach is reflected in Paper I. However, throughout the project, the direction of the research changed. Though I believe a philosopher can contribute to the field of transportation by, for example, conceptual analysis and by drawing on theories in philosophy, there are also questions that are philosophically interesting regarding the practice of transportation. These are, among others, matters of temporal justice (discussed in Section 4.5 and Paper II) and transportation justice and ethics of emerging technologies and how they are framed (Paper V). Similarly to philosophy of the city, philosophy of transportation has the potential to become multidisciplinary and to contribute to the understanding of transport and mobility.

Part of this thesis ended up being an effort to disentangle the concepts that are central to the discourse on transportation and mobility. It is clear that 'time' is a key concept in transport economics, but if and how to consider travel time in relation to transport justice is not obvious. For example, when Epting notes that a lack of appropriate transportation is a reason for why people are stuck in poverty, he formulates it in terms of time use: "[i]t is entirely unrealistic to expect people to self-determine the means for social and economic advancement if they are spending, say, three to five hours per day from their home to their job or multiple part-time jobs" (Epting 2021, p. 5). On the one hand, such an observation is in line with the main underlying assumption in transportation research: that travel is a derived need, and the main benefits are from shorter travel time. On the other hand, Epting continues and notes that transportation systems are designed without keeping the vulnerable and marginalised in mind (Epting 2021). For many, where to live is not an actual choice or a trade-off between longer travel time and cheaper accommodation, as if they could have chosen to spend more on living costs and a shorter commute. In reply to critics of her book (which I will cover in Section 4.2), Rose highlights this lack of choice in a transport-related example (Rose 2017, p. 107-108):

Consider [...] the question of where to invest in improving the

speed and efficiency of a city's public transportation systems. It might be the case that the city's high-income workers, who choose to live in its suburbs, and its low-income workers, who can afford to live only in its outer rings, spend the same amount of time commuting into work, but the low-income workers spend more *necessary* time commuting – a distinction that [...] ought to inform a just transportation policy.

The role of time and temporal autonomy will be further developed in Section 3.6. The connections between travel, time use and justice are arguably complex. Thus, this thesis should be viewed as a starting point, an attempt to conceptually analyse what is at stake. Plenty more can be done, and I believe there is a place for philosophy here. Plausibly, these matters are of philosophical interest.

Finally, the philosopher who ventures into the field of transport has to be mindful of the great expertise and knowledge in the field. I have done my best to do the transport economics and transport justice literature justice. What I believe a philosopher can contribute with are insights, methods and parallels to other disciplines with similar challenges. For example, Epting formulates his aim as to highlight the potential ethical concerns that a planner's decision might bring about and not to challenge the authority of the planning professionals (Epting 2021). I believe it is in everyone's interest to work collaboratively, given that transport is crucial for society.

3. Valuing time

Time is in one way or another the topic of Paper I, Paper III and Paper IV. This section provides context and covers themes relevant to the topics of these papers. The starting point is the monetary valuation of time. 'Time is money' is an aphorism quote, often attributed to Benjamin Franklin. His intention was to point out that when you are not working even though you could, you are spending or throwing away the money you could have earned. However, Franklin was not the one to coin this particular expression (Chayka 2017). In fact, it can be traced back as far as to ancient Greece and the biographer Plutarch even though the phrase gained more recognition when it was printed in a British newspaper in 1719 (ibid.) According to Chayka, today, the phrase is almost like conventional wisdom. However, time in its essence is not like money at all. Consider the example of hyperinflation from the introduction. The purpose of the example was to show that, however spending behaviour might change given the circumstance of

hyperinflation, it seems reasonable to assume that there are similarities in behaviour regarding time.

One can argue that other types of goods also differ from money in this regard. Apples can go bad (so an apple that is worth something today is rotten and worthless tomorrow) and concert tickets are only valuable prior to the start of the performance (if you are late, then your ticket holds no value). Neither apples nor concert tickets are 'like' money. Still, there is a functioning market for these goods. One can buy and sell apples as well as concert tickets. Time cannot be traded directly, and there are additional circumstances of time as a commodity that are special (see 3.1). Moreover, as will be discussed in Section 4.1 (and is the premise of Paper III), there are other convincing arguments for why the time-money substitutability claim is false (Rose 2016).

3.1 Time as a commodity

It has been argued that time is like money and "the analogy with having, spending, saving and wasting money is pervasive" (Brown 1970, p. 173). 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. While "the state of nature is that people are frequently trading between time, reliability and money in the travel choices" (Mackie et al. 2018, p. 641), 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. Even if we indirectly trade in goods and services that allow us to re-allocate time, it can be argued that time is a non-market good. The presumption of a market is crucial since 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 concern the value for the individual rather than market value. So, the specific characteristics of time and how they relate to time as a commodity are relevant in the circumstance where time is considered a good. The three main characteristics (non-accumulativity, irreversibility and non-transferability) are further discussed below.

Time is 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 (Festjens and Janiszewski 2015, p. 179):

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.

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 “[i]t 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, the value of time is also impacted by so-called indivisibilities (Zeckhauser 1973). According to Zeckhauser, “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” (p. 670). Time allocation can also 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” (p. 670-671). 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.

Time is irreversible and has a direction

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 that is not shared with money under regular circumstances. As noted in the introduction, money under conditions of hyperinflation could potentially exhibit the same characteristics (non-accumulative and irreversible). Under such circumstances, one cannot assume that a unit of money will carry the same or similar value tomorrow as it does today. Without the usual characteristics of money, the banknotes and coins stop being money at all, at least in the sense we are used to.

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, p. 115).

The notion of direction and the inevitable passage of time also raises the question of whether we should differentiate between bundles of activities of the same activities for the same duration but in a different temporal order. Meaning if it is the same activities for the same amount of time, does the order of the activities matter? Assuming there are temporal relations between goods and services, certain goods can only be used at certain temporal instances. Once those temporal instances are passed, those goods cannot be used. An example is a theatre ticket to a performance at a specific date and time. The ticket has no remaining value when that particular time and day has passed (except perhaps sentimental value). Furthermore, 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.

Time is 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 with transferring money.

3.2 Time in economics

Time can be studied in economics in various ways and has long been a subject of study for economics. If a linear notion of time is presupposed, then it can be easy to incorporate time into an analytical model in economics (Mosselmans 2005). For example, there are dynamic models where a uniform and objective notion of time captures economic processes (Economia 2015). Time can also be studied as a type of currency, something we have and can spend. For example, Ricardo developed a theory of relative prices based on hours of labour as input (Ricardo 1817). Looking specifically at consumption, it is obvious that most consumption takes a certain amount of time, but the temporal aspect is often not considered. However, some

accounts emphasise the fundamental role of time in individual economic behaviour. Nisticò 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 (Nisticò 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, p. 76). 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 provided by Ian Steedman, who claims: “[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 its 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 following 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, p. 668). 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. They introduce nonconvexities of increasing returns which make 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. Such metrics could then include temporal components.

3.3 Time in transport economics

Value of time can be seen as the key number in transport economics, and it has been extensively researched and studied for a fairly long time (Wardman 1998). In short, value of travel time is the amount of money at which a change in travel time can be compensated. Reducing travel time increases utility (De Jong and Kouwenhoven 2020). As discussed earlier, some models use value of time to combine transport time and cost into a single variable, called ‘generalised cost’ (ibid.). For appraisal purposes, value of travel time is the rate society is willing to pay for time savings. For forecasting purposes, value of travel time is used to predict the behaviour of the travellers.

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 to 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.

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). 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 i 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 since there is 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 the minimum time

needed to consume a particular chosen good. In these cases, an individual can allocate more time than required on an activity but not less. 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 an unpleasant activity (travelling). Given all this, the value of travel time to be used in appraisal can be formulated as follows (De Jong and Kouwenhoven 2020):

$$\text{VTT} = \frac{\mu}{\lambda} - \left(\frac{\partial U}{\partial T_{\text{travel}}} \right) / \lambda \quad (1)$$

where VTT is the value of travel time, U is the utility, T_{travel} is the travel time, and μ and λ are the Lagrangian multipliers of the time constrain and the money budget, respectively. The equation implies that value of travel time can be written as the difference between the opportunity value of time and the utility created while travelling (*ibid.*). 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. Consequently, the value of free time (non-working time) has been obtained from an analysis of choices individuals have made between a time-consuming but cheap alternative and a more expensive but less time-consuming alternative (see Figure 2, p. 2). Duration is by far the dominating aspect in transport economics models. The total duration of travel is understood to be the main component of the perception of the travel (Hensher 2011). However, the theoretical framework has also been expanded to take into account additional characteristics of travel modes and routes, such as comfort and reliability (see Figure 3).

In order to facilitate plans, reliability is considered one of the most important factors when assessing value of travel time in transport economics (Li and Hensher 2011). Travel time variability matters to travellers since it can cause longer waiting times, missed connections and arrival at the destination later (or earlier) than expected. Unreliability is both an inconvenience cost due to occasional delays as well as a cost of routinely choosing an earlier departure time to allow for expected delays. There are various ways to measure travel time reliability, for example, using the probability distribution of the travel times (Engelson and Fosgerau 2016). Based on this, the variability of travel time can be defined, for example, as the standard deviation of the travel time distribution (Small 2012). The transport models then strive to establish a cost to the traveller due to changes in the mean travel time or in the dispersion of the distribution of the travel times (*ibid.*).

Another characteristic that has been widely recognised to impact the

value of travel time besides reliability is congestion (Li et al. 2010). It is acknowledged both in theory and in applications that congested time is uncomfortable, and thus the value of time (savings) in congested conditions is higher (Abrantes and Wardman 2011). A journey on public transport under congested conditions is significantly more burdensome. Congestion will likely be experienced as more stressful and will impact the ability to do other tasks while travelling. Other aspects that are known to impact value of travel time are *coherence* and *interruptions* of travel time. For example, walking and waiting time are clearly important features of travellers’ perception of the overall travel time, and the value of (shortening) waiting time is generally higher than (shortening) the value of in-vehicle time (Abrantes and Wardman 2011).

The generally applied method then identifies the marginal substitution rate between travel time and travel cost using discrete choice models based on random utility theory (as discussed in Section 1.2). Individuals’ willingness to pay to reduce travel time is interpreted as the subjective value of time (González 1997).

	Details of Your Recent Trip	Alternative Road A	Alternative Road B	Alternative Road C
Time in free-flow (mins)	15	14	16	16
Time slowed down by other traffic (mins)	10	12	8	12
Time in Stop/Start conditions (mins)	5	4	6	4
Uncertainty in travel time (mins)	+ /- 10	+ /- 12	+ /- 8	+ /- 8
Running costs	\$ 2.20	\$ 2.40	\$ 2.40	\$ 2.10
Toll costs	\$ 2.0	\$ 2.10	\$ 2.10	\$ 1.90
<p>If you take the same trip again, which road would you choose?</p> <p>Current Road <input type="radio"/> Road A <input type="radio"/> Road B <input type="radio"/> Road C <input type="radio"/></p> <p>If you could choose between the new roads, which would you choose?</p> <p> Road A <input type="radio"/> Road B <input type="radio"/> Road C <input type="radio"/></p>				

FIGURE 3 – An example of a stated choice question to elicit willingness to pay including parameters of reliability (Hensher 2010).

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)⁸ using an appropriate discount factor. Even though a stable rate of substitution between time and money is assumed and needed for welfare appraisal purposes, many factors have been found to cause variation in the value of travel time across individuals as well as for the same individual traveller. These factors often include travel mode (car, bus, train, etc.), purpose of trip, income,⁹ trip distance, productive use of travel time (Small 2012). It is also recognised that there are factors such as loss aversion that contribute to the observed heterogeneity (De Borger and Fosgerau 2008).

Since travel is considered a derived need, shorter travel time is assumed, everything else being equal, to be better than longer travel time (linearity in the value of time is generally assumed). However, the simplicity of this assumption has been questioned. Mokhtarian and Salomon have found the ideal average one-way commuting time to be a little over 16 minutes (Mokhtarian and Salomon 2001). They also found that the number of respondents who would prefer a commute as short as up to two minutes to be very low (3%). This finding indicates that the desire to eliminate the commute completely might be very low. Travellers, in contrast to the underlying assumptions in transport economics, might value the time spent on the commute for various reasons, such as not having to work from home. Travel time and travel in general can be useful in ways not reflected in the current models. Moreover, the demand for time efficiency has also been criticised for being an untenable social and moral practice (Khisty and Zeitler 2001). Transport projects that lead to so-called time efficiency are considered valuable from a social welfare point of view. However, Khisty and Zeitler argue that “in the name of time efficiency, all relevant moral information is excluded” (2001). Additionally, interventions that are generating higher welfare and consequently lead to more efficiency also lead to larger adverse distributional effects (Kristoffersson et al. 2017).

⁸It 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).

⁹Individuals with higher income value time savings higher, this is referred to as the income effect. While it is recognised, there is no consensus on how to deal with income-based heterogeneity in value of travel time.

Further criticism has been voiced toward the practice of aggregating individual willingness to pay for a shorter commute and taking that to be the value for society as a whole. The basis of the critique is that the decision to finance a government transportation project should be based on society's willingness to pay to improve mobility. However, society's willingness does not necessarily 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-Diaz 2007, p. 106). There is also 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).

Lastly, it can be noted that while transport economists tend to measure duration objectively and linearly (clock time), some research indicates that commuters' response to time duration is non-linear (Johansson et al. 2003). For example, travellers were less time-sensitive for very short or long distances. Interestingly, while the travel time used when modelling the expected behaviour is often the actual timetable time, time can actually be perceived individually. It has been suggested that a so-called distorted perception of travel time can be a reason for discrepancies between forecast models and actual behaviour of travellers (Peer et al. 2014). Moreover, it has been proposed that the distinction between the actual and perceived time, including ways travel time can be stretched or compressed, depends on the individual's state of mind and activity engagement, which is linked to expectations of what is feasible for a given journey duration (Watts 2008).

3.4 Insights on valuing time from consumer research

While time can be seen as a resource that can be spent or exchanged for money, empirical insights from the field of consumer research provide reasons for why time might not be straightforwardly equivalent to money.¹⁰ Such findings include the notion of slack, uncertainty and loss aversion, differences in mental accounting, and reference dependence.

Slack in this context is defined as the perceived surplus of a given resource available to complete an important task. There is research indicating that individuals expect greater slack for time in the future compared to

¹⁰See (Lallement and Gournelen 2018) for a recent review of perspectives of time in consumer research.

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” (Zauberman and Lynch Jr 2005, p. 25). Individuals perceive changes over time in the supply of slack more optimistically for time compared to money. Another related 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, p. 118). They assert that time is less fungible than money. Therefore, planning is more critical in the context of time. Since uncertainty makes planning more difficult, people are generally more averse 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 monetary 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 the subsequently missed flight. A study in transport economics has also shown 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 the degree of loss aversion perhaps 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.

There are also 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 can more easily accommodate adverse 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 to capture the difference in opportunity cost between temporal and monetary contexts (Okada and Hoch 2004). The opportunity cost for time is harder to assess; it is thus ambiguous. Since time is not as easily exchangeable and cannot be saved for later use, the next best thing to do with available time is harder to determine. Thus, the opportunity cost becomes more context-dependent. Another perspective is that accounting for time is less routine than accounting for money (Soman

2001). For example, Soman found that the typical phenomenon of sunk cost was not observed for time in the same way as it was for money. However, this seems intuitively strange. Many might recognise and hesitate to change tasks, having spent time on something that seemingly is not working, for the very reason of the feeling of sunk cost. Nevertheless, Soman has suggested that this finding might depend on the difference in mental accounting. Related to the difference in mental accounting is a view of money as an instrument of exchange, involving considerations of value which prompt analytical thinking, whereas time is experienced and time considerations instead 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” (Lee et al. 2015, p. 194).

Lastly, 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). Tonietto et al. found that an hour before a scheduled meeting felt shorter than an hour without anything scheduled directly afterward (*ibid*). 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 to the effect 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, p. 178). This means that 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 (Festjens and Janiszewski 2015). 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” (ibid., p. 178). In contrast, a small time block makes it difficult to imagine how more or less time would be beneficial, leading to diminishing marginal utility.

3.5 Insights from psychology: time and happiness

A relatively recent development in consumer theory and psychology is the connection between time and happiness. For example, it has been suggested that time provides unique insights into human wellbeing that income alone cannot capture (Masuda et al. 2021). In a way, it seems obvious that how we spend our time impacts our state of mind. However, this development is specifically relevant concerning 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 as money, this causes more stress and decreases environmentally beneficial behaviour, such as recycling (DeVoe and Pfeffer 2007, 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 have been found to be less ethical since they cheat more (Gino and Mogilner 2014). When focused on money, people behave in self-interested but not self-reflective ways. Thinking about time can, according to Gino and Mogilner, encourage people to reflect on who they are and make them less prone to unethical behaviour. In their study, they found that shifting people’s attention to time decreased dishonesty (ibid.).

On the other hand, the opposite has also been argued for. Namely, that “an economic evaluation of time 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, p. 56). This view argues that decisions will be better (as will the resulting attitudes) when they are made 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 of the day,¹¹ as well as being inversely related to wellbeing, understanding that the commute is an economic necessity will result in better decisions.

One study showed that making train passengers more aware of the passing of time during a journey negatively influenced their appraisal of time (Galetzka et al. 2018). In contrast, conditions without information led to the passengers having more positive emotions and a higher hedonic appraisal of time (ibid.). Moreover, the researchers showed that a clean environment with slow music resulted in a positive appraisal of time and 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. Future research will also surely provide more insights into the general relationship between time and life satisfaction, as Masuda et al. (2020) suggested.

3.6 Temporal autonomy

Going back to time in transport economics, while the overarching social benefit is seen as improved accessibility, freeing up time for travellers to spend as they wish (i.e., not on travel) is still the primary 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 autonomy 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 to provide arguments regarding the maximisation of 'free' time as a desirable end (Goodin et al. 2008). Gooding et al. argue that "[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., p. 32). Similarly, time can be seen as time necessary to develop the capability for exercising critical thought and meaningful action: "autonomy begins with self-determination over one's time" (Shippen 2014). In their work on time poverty, Williams et al. argue that time is a scarce resource needed to produce goods, obtain services, and ensure leisure (Williams et al. 2016). Thus, they argue that time, along with income, is a basic economic resource

¹¹Recent research confirms that time spent on commuting is negatively associated with wellbeing, even if the size of the effect of weekly commuting hours on wellbeing is relatively small (Zijlstra and Verhetsel 2021)

needed for well-being. Such arguments seem to support the overarching goal of shortening necessary travel time. However, as discussed in Paper III, whether time is actually saved in a sense that matters to the individuals is not apparent.

Additionally, 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 activities.¹² 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 is what is actually being promoted, not temporal autonomy as such. Enhanced accessibility drives land development and overall economic growth, which 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.

4. Considerations on justice

Given that one point of departure of this thesis was the valuation of time in transport economics and the substitutability between time and money, reflections on the role of temporal aspects of justice followed. Questions of transport justice and equity are becoming increasingly prevalent in the transport literature. However, as will be discussed in this section, most of the considerations of transport justice are based on 'accessibility' as the metric of justice. Consequently, the scope of the justice-related questions in this thesis (i.e., Paper I and Paper II) is the question of 'justice of what?'

A metric of justice is required for any theory of distributive justice since it is the metric that dictates what it is we should make sure people have an equal amount of, or what we ought to care about, in order to realize justice (Gheaus 2018). The metric for justice has been suggested to be either resources, access to advantage, wellbeing, or capabilities. Additionally, there are the distribuenda of justice: goods that are to be distributed by institutions and policies in order to bring about a just distribution of the metric of justice (ibid.). It can be the case that a separate metric is used to determine if justice prevails while an established injustice is compensated

¹²While 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.

for by other means. Examples of the *distribuenda* of justice are money, rights, opportunity for desirable positions and leisure time, according to Gheaus (2016). Notably, people can agree on the *distribuendum* of justice while at the same time disagreeing on the correct metric of justice. This is exemplified by the difference between resource theorists and capability theorists; they agree on the goods that ought to be distributed by the state but not on the metric as such. In the transport literature, the ‘what should be distributed in a fair way’ has been conceptualized as the *equalisandum* (Martens 2012). My understanding is that this the term *equalisandum* seems to be closer to the *distribuendum* of justice than to the metric of justice, as it will be discussed in this thesis.

It should be noted that the focus of this thesis is solely on the metric of transport justice and not on the distributive principles. Hence, I do not consider or explore which principle might be more suitable in the context of transport. Regardless of which distributive principle we eventually agree on (if an agreement is possible), we must first agree on what we are distributing. Therefore, I believe considering the metric of justice is both warranted and important.

4.1 Theories of *justice of what?*

On one conception, the appropriate metric of justice is welfare (Dworkin 1981a). Welfare can be understood as enjoyment, pleasure or preference satisfaction. Resources are valuable insofar as they produce welfare and should be distributed in a way that ensures equal welfare. However, welfare as the metric of justice has been criticised. One prominent line of critique is by Rawls. He argues against a metric based on welfare, in part due to such a metric catering to so-called expensive tastes. Suppose resources are to be distributed in a way that ensures equal levels of welfare. In that case, someone might require more resources on the basis of expensive taste, such as the appreciation of expensive wines. Rawls instead formulates an account based on primary goods with social basis of self-respect being the most important (Rawls 2001). Primary goods are all-purpose goods needed to pursue any life plan. Could ‘time’ or ‘free time’ in some respect be such a good? Brake argues in the context of so-called relationship goods that while a good being necessary for the pursuit of any life plan is not a sufficient condition for it to be considered a primary good, access to personal relationships cannot be guaranteed by the just distribution of other goods (Brake 2017). Therefore, it can be justified to consider relationship goods as goods the distribution of which is a concern for

justice, especially if they are necessary to develop the two moral powers of a person, i.e., a sense of justice and a conception of what is valuable in human life. A similar case could be made for considering (discretionary) time as such a justice-relevant good. Having discretionary time, i.e., time one has full autonomy over, could certainly be considered a necessary basis for self-respect. Notably, self-respect here is not understood as an attitude toward oneself. Rather, it is the social basis of self-respect that counts as a primary good (Rawls 2001, p. 60). Rawls further exemplifies that a right to "certain forms of real property, such as dwellings and private grounds" is to be seen as a social basis of self-respect since it is deemed necessary for the adequate development and full exercise of moral powers. Following the same reasoning, 'mobility' or 'the ability to transport oneself' could be necessary "to have a lively sense of their worth as persons and to be able to advance their ends with self-confidence" (ibid., p. 59). The same could be said for 'accessibility'; to be able to advance one's ends, one needs to have access to means towards those ends.

Starting with similar critiques of equality of welfare catering to expensive tastes, Dworkin formulates a theory of equality of resources (Dworkin 1981b). Instead of an equal split of resources, he proposes an allocation of resources based on an auction where people would enter the market on equal terms by having an equal initial budget. Such an allocation would pass the so-called envy test; no one would prefer someone else's bundles of resources. Cohen rejects Dworkin's position of quality of resources and argues that justice has to include elements of welfare (Cohen 2011). He argues for the metric of justice to be understood as equal access to advantage (including resources). Advantage is to be viewed as including but also wider than welfare, with unjust disadvantage prevailing when one cannot be held responsible.

Another commonly considered metric of justice is based on capabilities which are needed to achieve so-called functioning. Capabilities are 'doings and beings', i.e., various activities and states people can achieve if they choose, while functionings are capabilities that have been realised (Robeyns 2011). Scholars who favour capabilities and scholars who favour resources agree on principles of justice being formulated to ensure effective access to the means people need to satisfy their objective interests (Anderson 2010). However, those who advocate for a capabilities-based account argue that the index of primary goods will be too inflexible to account for the differences in individuals' needs. Anderson puts forward four reasons for favouring capabilities over a resource-based metric: (1) resources are means to functionings and principles of justice should be formulated in terms

of ends rather than means, (2) capabilities are sensitive to structural and psychosocial injustices which cannot be remedied by a redistribution of resources, (3) capabilities are better suited to handle individual variations, and (4) citizens express their claims in terms of capabilities rather than in terms of primary goods. Anderson illustrates the third reason with a transport-related example based on parking spaces specifically reserved for the disabled. She claims that such parking spaces could not be justified by the resourcist approach since it “is caught in the contradiction between its call for ‘unbiased’ public infrastructure” (ibid., p. 93) and thus not being able to adjust the “package of resources” based on individual needs. A potential reply could be that parking space is not a requirement of justice, but Anderson does not find this convincing, and I must agree with her. If not with regard to the specific need for parking space but due to the difficulty of drawing a line between public infrastructure that is a requirement for justice and that is not. If no public infrastructure is deemed a resource that is a requirement for justice, formulating an account of transport justice on a resourcist basis will be difficult.

Lastly, a metric of justice can be seen as either subjective or objective (Anderson 2010). Subjective metrics, according to Andersson, define “the measure of justice relative to subjective evaluative states of individuals”, for example, happiness and preference satisfaction (ibid., p. 85). Objective metrics, in turn, are objective states of individuals or their possessions. Such metrics are either goods external to the person, such as income, job opportunities, and legal rights, or states of the person, such as health, mobility, and literacy. Anderson argues further that a theory of justice must explain why an objective or subjective metric is preferred. On her view, the appropriate metric of justice should be objective since it then avoids the issue of adaptive preferences; it also satisfies the publicity condition and limits claims to states people are responsible for providing to each other (ibid.).

4.2 Transport justice

Historically, matters of equity and fairness have received less attention than questions of effectiveness and efficiency in the transportation literature (Wee and Mouter 2021). In cost-benefit analysis, the commonly used method of appraisal, distributional effects are purposely not evaluated. According to van Wee and Mouter, it is believed that evaluation would depend on one’s ethical perceptions. Thus, the general position has been that equity concerns should be handled by the taxation system rather than

specific transport projects. More recently, the tension between efficiency and equity considerations in project appraisal has been the focus of major debate (Thomopoulos et al. 2009). There has also been a significant rise in interest in questions of transport equity and justice in transport research and adjacent fields. Van Wee and Mouter suggest that the attention in academia might in part be triggered by the attention for justice outside of the transport domain (2021).

Even with the recent rise in interest, there is still is "little conceptual clarity about what justice means in the transport context" (Pereira et al. 2017, p. 170). Others plainly note that "[e]quality is a fuzzy concept" (Kristoffersson et al. 2017, p. 100). Still, multiple transport scholars have considered various justice theories, their applicability and possible consequences for project appraisal (Martens 2016; Pereira et al. 2017; Nahmias-Biran et al. 2017, among others). Often, the position is to challenge the utilitarian basis of transport planning (Nahmias-Biran and Shiftan 2016). If considerations of equity cannot be sufficiently handled by cost-benefit analysis, adapting a framework which would incorporate and access equity considerations might be way forward (Thomopoulos et al. 2009). However, according to Epting, even if it is possible to attain transport justice, no one person or group has the necessary perspective and can provide the information to do so (Epting 2021).

As noted above, it is common among the scholars who write on the topic of transport justice to consider specific normative theories or principles and subsequently apply them to the circumstances of transportation. Nahmias-Biran et al. (2017) provide an overview, including attempts to expand Rawls' theory of justice, exploring Walzer's spheres of justice as a potential basis of an account of justice as accessibility and the capabilities approach.

Sometimes a distinction is made between horizontal and vertical equity¹³ (Thomopoulos et al. 2009). Horizontal equity refers to the comparable treatment of comparable individuals, groups or regions, whereas vertical equity refers to the special treatment and protection of disadvantaged individuals, groups and regions. An example of horizontal equity would be the equal distribution of public funds on transport initiatives among different regions. An example of vertical equity would be to ensure a minimum level of transport within all parts of a country or specific region (ibid.). To my understanding, these concepts are used when evaluating policy alternatives.

¹³Other types of equity that can be considered include territorial equity, spatial equity, social equity and so forth. See Thomopoulos et al. for an overview of these types of equity considerations (2009).

The metric of transport justice

Most of the literature in transport justice focuses on accessibility, with transport justice being measured in levels of accessibility. For example, Pereira et al. argue that “transport accessibility, rather than resources or travel behavior, stands out as the most promising focal variable of distributive justice” (2017, p. 178). However, taking accessibility as the metric of justice is not straightforward. For starters, it is assumed that what matters is accessibility to that which people have reason to value. Such a definition arguably required more clarification. One understanding, in the context of the capabilities approach, is that individuals should have a minimum level of accessibility that ensures they can meet their basic needs, such as access to food stores, education, healthcare, employment (ibid.). On the one hand, the definition of basic needs can then be carried out elsewhere. On the other hand, understanding which needs are basic and what level of access is minimal is a prerequisite to be able to access if a level of accessibility is sufficient.

Additionally, an illustration of the complexity of “accessibility to what?” can be found in the chapter on transport equity by van Wee and Mouter (2021). Their starting point is the WHO definition of equity which specifically references avoidable or remediable differences. With this in mind, van Wee and Mouter argue that “differences in levels of accessibility are to a large extent unavoidable and non-remediable” (ibid., p. 107). The example they give is to consider theatres and swimming pools:

It is unavoidable that people living nearby have better access to such destinations [i.e. theatres and swimming pools] than people living at a larger distance. And building many theatres and swimming pools across cities would be extremely expensive. In other cases, differences can be reduced by policies, the planning of shopping centers being a clear example. (ibid., p. 107)

I find this quote to be quite telling since it presumes that the cost of building swimming pools and theatres cannot reasonably be lower than value of having a swimming pool or theatre nearby. So, the authors seem to be making a presumption of what it is that people value and to what extent. Moreover, it is telling that the example of cases where new construction nearby might be warranted are shopping centres – destinations which very well might be substituted by digital alternatives whereas the activity of swimming (and, arguably the experience of going to a live theatre perfor-

mance) cannot. I believe this example conveniently relates to the topic of Paper II. If accessibility is the metric of justice, it does not on its own provide us with answers as to “access to what?”. The issues (as well as the benefits) with accessibility as a metric of justice are developed in detail in the following section.

4.3 Accessibility as a metric of justice

Accessibility as a resource

Can accessibility be seen as a resource? First of all, it is arguably objective. Moreover, there exists a market of sorts for accessibility, namely the housing market. One’s place of residence is usually considered the point of origin for evaluating whether certain destinations or services are available or not. Transport infrastructure can also be evaluated based on place of residence (are there pavements, functioning street lights, bus stops, proper roads?). Housing locations that have more ‘accessibility’ are often more expensive, whether it is an apartment in Manhattan or a house in a suburb with access to good schools, healthcare, parks and nature, and so on. Nevertheless, it is not always the case that access to employment is reflected in the price of suburban living. It can be quite the opposite – moving to the suburbs can require a long commute for work with local job opportunities being limited. This is, assumingly, known to those who move to the suburb and is a trade-off they are willing to make. Hence, the housing market can reflect some of the value of accessibility but not in a straightforward way. Obviously, there is no market for ‘accessibility’ as such. Furthermore, ‘accessibility’ consists of multiple components; for example, to have access to a job that is within reasonable driving distance you need both a means of transportation (such as a car or public transport) as well as the appropriate infrastructure (road, bridge, sidewalk, parking, etc.). Hence, if we were to identify a (unjust) lack of access to job opportunities, we would have to further analyse if this is due to a lack of employment opportunities as such, a lack of infrastructure (such as bad roads, congestion leading to unreasonable travel times, etc.) or a lack of means (no car, no driving licence, no available public transport). While these components could function as resources to be redistributed and thus function as the *distribuenda* of justice, accessibility in itself cannot be. A parallel can be drawn to health and healthcare, as Anderson does, where healthcare can be distributed whereas health cannot. Still, it is unclear if ‘accessibility as a resource’ could be further defined without clarifying accessibility to what.

An alternative can be to view accessibility as access; Cohen uses the

term access to combine having the opportunity to achieve a good and the actual outcome. He argues that access is better than just 'opportunity' since shortfalls in personal capacity might detract from opportunity; one might have opportunity but lack access, which should be of egalitarian concern (Cohen 2011). So, access on Cohen's view, in contradiction to how the term accessibility is used in the field of transport, combines both opportunities and outcomes: "a person enjoys access to something which he does not have only if he has both the opportunity and the capacity to obtain it" (ibid., p. 40). Furthermore, capacity should not be confused with capability: "[u]nder equality of access to advantage, the normative accent is not on capability as such, but on a person not lacking an urgent desideratum through no fault of his own: capability to achieve the desideratum is a sufficient but not a necessary condition of not suffering such a lack" (ibid., p. 59). In his writings, Cohen uses a transport-related example of a woman who is too poor to afford the train ticket to visit her sister (p. 176). If she were to try to board the train, she would not be able to overcome the train conductor's interference. Hence, she is entirely capable to board the train: "there is no deficiency in her ability to do so which restricts her independently of the interference that she faces" (ibid.). Still, she does not have access to her sister. Whether or not she has accessibility will depend on whether monetary considerations are included in the measure of accessibility. It is not obvious that they are. Hence, "access to advantage" is stronger than "accessibility" in the sense that you might be considered to have accessibility but not have access. However, it is not clear if access avoids further defining access to what.

Accessibility as a capability

There is a growing literature in the transport field arguing that the appropriate theory of distributive justice for transport justice is the capabilities approach and that accessibility should be considered a capability (Vecchio and Martens 2021). Following the capabilities approach, only ends are of intrinsic importance: "the end of justice is to secure for individuals their capacity to function as equals in society" (Anderson 2010, p. 88). Assuming the ends are well-being and development, they should be discussed in terms of people's capabilities to function, that is "effective opportunities to undertake the actions and activities that they want to engage in" (Robeyns 2003, p. 6). A distinction should be made between the realised and the effectively possible, i.e., the capabilities can be seen as sort of 'freedoms'. Following the reasoning on health as a capability with "clean water, access

to medical doctors, protection from diseases" (ibid., p. 7) and so forth as resources necessary for this capability, accessibility can be viewed as a capability with the resources being transport infrastructure, transportation skills and means of transportation. Still, it is odd to consider 'accessibility' without considering access to what. As can be noted, Robeyns suggests that access to medical doctors is a resource necessary for the capability of health. Accessibility (i.e., access) is almost implied. Should it not be imperative to first define accessibility to what, similarly to how "[w]e must first determine what the relevant functionings are before we can identify which resources that are needed to achieve these functionings" (Anderson 2010, p. 87)?

Robeyns argues that the capabilities approach should be viewed as a framework rather than a theory (2003). Therefore, we cannot support and should not strive for one definite list of capabilities. Instead, the list of capabilities is context-dependent. Similarly, it could be that for the purpose of actual transport policy, the people that are affected by the policy could decide on what type of destinations that should count as valuable. Thus, these destinations would function as the answer to 'access to what'. Such an approach would, as in the context of the capabilities approach in general, require public deliberation and participation. However, capabilities are also, at least by Robeyns account, individualistic in the sense that the evaluation of functionings and capabilities is the evaluation of the well-being of individuals. Hence, it would be impossible to speak of the capability, and subsequently, the accessibility of a community. This, I believe, is a potential reason for why accessibility as a capability is somewhat unclear; accessibility is dependent on public goods and structures of the society. Robeyns actually illustrates the example of recognizing that social and environmental factors influence the conversions of commodities into functionings with a transport-related example. In her example, a bike is a commodity, and the functioning is 'to transport oneself safely', with the public infrastructure being a characteristic of society that supports different levels of the functioning given the same commodity. In this example, it is evident that the public infrastructure, which enables accessibility, can increase or decrease the capability of individuals. But these public goods do not, according to Robeyns, enable a community capability. Furthermore, I believe another issue remains. According to Robeyns, the list of capabilities has to be exhaustive and non-reducible. The question is whether the list is truly non-reducible if it both contains the capabilities such as 'health', 'education', etc. *and* 'accessibility' since many for the former capabilities presuppose the latter (i.e., access). For instance, having the capability

‘health’ presumably implies having resource ‘access to health’. What is left of the capability ‘accessibility’ beyond access to all other capabilities?

4.4 Time as the metric of justice

Considering that time is different from money (argued in Paper I), it seems warranted to consider time in its own right in the context of justice. Moreover, as has been briefly mentioned in Section 3.6, Rose argues that citizens’ claims to free time are grounded in the principle that citizens have legitimate claims to fair shares of the resources that are required to exercise their liberties and opportunities (Rose 2016). For example, “to exercise one’s right to vote, to participate in a town meeting, or to join in a protest, one must have not only the means to travel to the polls, the town hall and the public square, one must also have the free time to exercise these liberties” (Rose 2021, p. 56). Here, it can be noted that Rose includes means of transportation that arguably ensure physical access as well as points out that time is needed as well. So, what is needed is means of transportation and free time, including travel time. While Rose does not distinguish between travel time and time to carry out the activity at hand, it is a distinction worth making. If the travel time to the polling station is significant, one might be discouraged from voting at all, even if the actual time it takes to vote is short. Similarly, less time is left to join in a protest if travelling to the protest takes long. So, not only is travel time required, it can be the determinant of whether one has enough free time or not.

Similarly to transport, time has been somewhat neglected in political philosophy even though free or discretionary time can be seen as an essential element of a decent life. In her book, Rose provides a summary of what political philosophers have said on the topic of time (Rose 2016). She argues that the so-called *time-money substitutability claim* is the reason why distributive theorists have not paid much attention to temporal resources (ibid.). If there is substitutability between time and money, it would be sufficient for a theory of justice only to consider the distribution of income and wealth. However, Rose argues that the time-money substitutability claim is false because it rests on two false assumptions. The first is the perfect divisibility of labor demand, namely that “all individuals can freely choose to reduce their hours of paid work to the level they prefer” (Rose 2016). This, she claims, is empirically false. The second assumption is the perfect substitutability of money and basic needs satisfaction, i.e., all household and basic bodily needs can be met by purchasing goods or services. This is false since not all activities can be bought with money. Despite being true

that for some necessary activities, one can substitute income for time, “it does not follow that a theory of justice is entitled to assume that citizens should make such a substitution” (ibid.). Rose further argues that under some social circumstances, hiring somebody to help meet one’s household or bodily needs presents a threat to civic equality. She considers free time as a justice-relevant resource rather than a specific good.

It can be questioned whether the discussions of time in political science, such as by Rose, endorse a particular meta-view of time and if so, if it matters. Plotica argues that any treatment of time as a quantity relevant for matters of justice relies on a particular notion of time, namely clock-time (Plotica 2019). Both Rose and Goodin et al. consider ‘free’ or ‘discretionary’ time, i.e., a quantity of how much time individuals have (Rose 2016; Goodin et al. 2008). However, as Plotica argues, the treatment of time as a defined and measurable unit is in itself not value-neutral. An hour in the morning might not be meaningfully qualitatively the same for persons with different biological rhythms. Thus, uncritical reliance on clock-time “reinforces many of the same temporal logics and practices that leave so many people so pressed for time and with so little control over the time they do have” (ibid., p. 793). Another perspective is to consider the value of time besides its duration (as is the practice in transport research where time is valued differently based on the circumstances of travel); what is relevant from the perspective of distributive justice is time with a certain value (Tyssedal 2021). Tyssedal argues that simply ‘free’ or ‘discretionary’ time does not actually track discretion over time which is of moral relevance, nor do these concepts track valuable time. If time is to be considered a resource “for which units differ in value” (ibid., p. 188) based on the amount and pattern of time as well as on other available resources. These considerations are aligned with the specifics of time considered in Paper I, as well as relate to time being a resource as developed in Section 4.5.2.

All in all, if the time-money substitutability claim is false, then it is worth considering time as a potential metric of justice. Such an inquiry could encompass the appeal to take value of time or have a more pluralistic account of temporality (as suggested by Plotica). Given the significant role of travel time in transport studies, it seems like considering time could be an alternative (this is argued in Paper III). However, there are also specifics of time as a metric that are worth developing further, as is done in the following section.

Time as a subjective or objective metric?

When considering time as a potential metric, the suggested distinction by Anderson between a subjective and objective metric becomes less clear-cut. On the one hand, time is objective in the sense that it is objectively measurable (i.e., clock-time). On the other hand, it can be questioned whether it is really external to the person or even a state of the person. Presumably, the states that Anderson lists can be objectively evaluated, i.e., how healthy someone is, or how literate (2010). Similarly, an external resource such as income or wealth can be objectively evaluated. Even considering the marginally diminishing value of money, meaning that an additional \$10 might feel like a lot to someone poor compared to someone rich, \$10 can buy an equal amount of goods on the market regardless of how the amount of money is perceived. The question is then if it is possible to objectively judge how much time someone has? Technically, we all 'have' 24 hours per day to spend. So what matters is arguably not duration but the amount of discretionary time, time we can freely allocate towards activities we value, the time left after we have done all the activities that are (strictly) necessary. It seems odd to consider this amount of time external to the person. Instead, it is reasonable that one hour of 'free' time would be valued more greatly by someone who is time-poor compared to someone who might not have the same time-consuming responsibilities and subsequently has more free time. This might even be reflected in their willingness-to-pay for faster transportation, someone who is time-poor is willing to pay more than someone in no hurry.

Consequently, how much one hour is worth depends on how much it is valued by the respective individual. Surely, it cannot be externally, objectively valued? The underlying assumption is that there is no market for time, at least not in the same sense as there is for other goods. Time as a commodity cannot be directly traded. Hence, we cannot turn to the market to get an 'objective' value for time. Does this mean that time has to be a subjective metric? Is the amount of discretionary time one has purely a subjective evaluation of a state, such as how happy one is? This also seems somewhat strange, given that time is measurable to the extent that we can objectively say something about how much time one has. An individual that works a full-time job, has a long commute, takes care of all the household responsibilities and caters to an elderly relative surely has less discretionary time than an individual that works from home without any household responsibilities or elderly relatives to take care of. This evaluation does not seem to only be an evaluation of their subjective states.

So, whether time is objective or subjective is not entirely clear. Nonetheless, there might be an alternative solution. Anderson notes that Dworkin advocated for a version of equality of resources that includes resources internal to the self, such as the ability to hear and see (Anderson 2010, p. 98). This would then be classified as a “hybrid view”, according to Anderson. However, given that Dworkin values such internal resources in monetary terms which is an external resource, Anderson believes it still leans toward a standard resourcist view. I assume that these internal resources (which is a term Dworkin does not seem to use) are the ‘people’s powers’ Dworkin considers to be a type of resource but not the kind of resource that is relevant for the theory of equality (more on this below). I would thus presume that Dworkin’s account is not hybrid due to him dismissing these resources as applicable when considering the equality of resources. Still, the note by Anderson at least acknowledges the possibility of hybrid views.

Time as a resource

On Dworkin’s account, ‘something’ being a resource presupposes a market (Dworkin 1981b). Is there a market for time? An example by Dworkin seems to allude that there is since it is suggested that a person can be “required to purchase leisure time” (p. 312). However, as argued in Section 3.1 and Paper I, time is not a commodity that can be directly sold or bought. It can only be reallocated from one activity to another. While it is true that there is a labour market where those who possess sought-after talents and skills can trade their time for money, such an exchange between time and pay does not guarantee leisure time. Besides work, time has to be allocated toward personal needs such as sleep, food intake, and travel to and from work. Furthermore, one can have responsibilities such as household work and care for others. The assumption is that the money earned by working and trading time can be spent to free up time by having someone else carry out certain activities for you, such as having someone else clean your house. But activities such as sleep and food intake cannot be delegated to someone else, even if they possibly can be done more efficiently to save time. All in all, the so-called market for time consists of trading ‘activities’ rather than trading time as such. Is this significant? There are some obvious restrictions on such a market, and one can certainly question if it is to be regarded as ‘free’. Furthermore, it should be clear that the resource ‘time’ does not function in the same way as the resource ‘money’.

The above reasoning shows that there are multiple dimensions of time: (i) time as such (duration), (ii) discretionary time (i.e., time that can be freely

allocated), and the (iii) quality of time. From a justice perspective, what would seem to be relevant is undoubtedly not only the amount of time one has (we all have 24 hrs/day) but the amount of free or discretionary time we have. The restrictions and specifics of time as a commodity also relate to the degree to which time can be redistributed. Not only can time not be bought and sold, but it also cannot be directly redistributed. It would seem that even if there is a time-based metric of justice, time cannot function as the distribuendum of justice. Additionally, it seems reasonable to assume that if someone has very little time, he or she can only be compensated for set time shortage in monetary terms to a degree. As argued above, all potential temporal commitments and needs cannot be compensated monetarily. Imagine that Adam is suffering from extreme tiredness and narcolepsy, requiring him to take regular naps and having to sleep for a longer time per day than usual. From a temporal perspective, it can be argued that Adam has an unjust lack of time both from the perspective of duration (having to sleep for longer per day) and from the perspective of quality of time since having to take disruptive breaks affects the quality of time expenditures. If it is found that this is an injustice that should be compensated, it cannot be fully compensated for in monetary terms. If Adam is required to sleep for longer, a money transfer can perhaps enable him to work less and thus give him more discretionary time. However, no monetary transfer can compensate for the interruptions to his activities caused by narcolepsy and give him uninterrupted time. Thus, his lower quality of time (due to interruptions) cannot be monetarily compensated. The question is whether Adam can be compensated by any other means or to what extent.

Time, especially in the above example with Adam, can also be compared to 'people's powers', as in a person's physical and mental powers which are used to make something valuable out of one's life (Dworkin 1981b, p. 300). People's powers are, on this view, resources that are used together with material resources. Still, Dworkin finds it troublesome to design an equality of resources that would provide an initial compensation to alleviate differences between people in such resources, since it could require a benchmark of what is 'normal'. Thus, while people's powers are resources, they should not be considered resources that can be distributed through political measures based on a version of equality of resources, especially since they cannot be manipulated or transferred. Following a similar line of reasoning, it could be concluded that time cannot function as a resource for the theory of equality, at least on Dworkin's account. The duration is the component of time that is considered key in transport economics; people

are assumed to want to travel for as little time as possible and be willing to pay for shorter travel times. However, there is also a qualitative aspect to travel illustrated by the willingness to pay to travel first class. A train ticket in first class costs more than a ticket to travel in second class even though the time the journey takes is the same. The price difference is motivated by qualitative aspects: more convenient seats, more space, less noise. These qualitative aspects might enable the traveller to spend the travel time more productively, or just make the trip more pleasant. This brings us back to the qualitative aspect of time noted in the discussion of time as a resource. From the perspective of welfare, resources are valuable insofar as they produce welfare. Clearly, how you spend time affects your welfare, either how pleasurable your time is or to what degree your preferences over time-allocations are fulfilled. So, on a welfarist account, time could to some degree function as the distribuendum of justice (disregarding that time cannot be directly distributed, which would render this quite difficult). It can be argued that any time-related aspects are ensured by the provision of monetary funds: as long as you are able to afford the expensive first-class ticket then the distribution of time does not matter. However, as has been noted, not all time-shortages can be compensated by money due to the non-substitutability of time and money. Thus, time itself would presumably be relevant for a welfarist account.

4.5 A pluralistic metric for transport?

It could very well be the case that there might be warranted to consider a pluralistic account of the metric of transport justice, similarly to considering a pluralistic metric of distributive justice to capture the differences between adults and children (Lindblom 2018). A pluralistic metric would mean that the metric would have different content for children and adults. We know that being able to independently transport oneself is connected to sense autonomy for the elderly. Likewise, children might have specific transportation needs that have to be considered. For children, the activity of transportation is sometimes more closely related to play than to reach a particular destination, for instance, the activity of riding a bike. The activity of riding a bike can be valuable irrespective of if it serves the purpose of getting to a specific place. For children to have the freedom to go on a bike ride, there needs to exist infrastructure that accommodates this. The children also need access to a bike and have learned to ride a bike. It can be argued that these requirements, especially with regard to the infrastructure, are more extensive than for adults to enjoy the same

freedom. We might require more of ‘child-friendly’ infrastructure. As Lindblom notes, a pluralistic account tends to get unpleasantly messy. Still, accessibility, as has been noted in the context of accessibility as a resource above, consists of multiple components. So, it could seem that it will inevitably get messy in either case. As in the case of children, a pluralistic metric of transport justice might be necessary (Lindblom 2018). It could then include temporal aspects as well as the ability to travel and move, besides the standard consideration of accessibility.

5. What does the future hold?

Matters of justice and equity seem particularly relevant when considering the ongoing changes and developments in the transport sector. As with many aspects of society, current technological developments drive changes in travel patterns and in travel behaviours. The transformation and the shift to mobility solutions of the future is happening as we speak (or as you read this thesis). App-enabled sharing economy, the ability to work and carry out activities remotely and emerging transportation technologies will probably impact the way we travel (Mouratidis et al. 2021). According to Mouratidis et al., the COVID-19 pandemic is likely to reshape the importance of digital alternatives.¹⁴ Even before the pandemic, Swedish data showed that the travel patterns of teleworkers differ; they make significantly fewer and shorter trips than those that did non-telework (Eldér 2020). Working from home might make the commute redundant but can generate other trips. There will probably be changes to the value of travel time brought about by the ‘new normal’ of working remotely (Hensher et al. 2021). All of these changes will, in turn, impact the built environment and land use (Mouratidis et al. 2021). Moreover, we do not yet know how drones and robots for land use and travel will impact transportation behaviour, but it is likely that they will. In Paper II, I mention delivery and service drones as an example of a technology that might enhance accessibility without being an instance of ‘travel’. These technological changes and shifts give rise to philosophically interesting questions, some of which are further developed in this section.

Another ongoing shift likely to shape future transportation is the need for more sustainable transport solutions. Additionally, the constant strive for shorter times has been questioned. Banister et al. introduce the highly relevant concept of reasonable travel time (RTT) as a way of offering an

¹⁴Mouratidis et al. specifically consider telecommuting (telework), online shopping, online education, teleconferencing, teleleisure, telehealth, and online social networking (2021)

alternative to the traditional emphasis on minimising travel time regardless of travel conditions (Banister et al. 2019). In their concept they include not only the door-to-door clock time but also travel perceptions and the characteristics of the destination. Furthermore, the introduction of automated vehicles is believed to lower the value of travel time since time will be spent more productively (more on this below). If time can be spent in worthwhile ways, does it still make sense to minimise it?

5.1 Technological advancements and the future of the city

In the context of transport, self-driving (or automated) vehicles are the technological advancement that is expected to greatly affect the transportation sector. This development can be seen as a significant socio-technical transition that will significantly impact the entire mobility system and the urban form in the city. It is believed that the introduction of self-driving vehicles can improve efficiency on the roads and contribute to a more sustainable transport system (Ryan 2020). However, more focus should be put on the societal dimension of the transition to automated vehicles (Milakis and Müller 2021). Researchers should also do more to understand how automated vehicles might hinder or help social justice (Epting 2019a). According to Epting, philosophers have thus far neglected to consider how these technologies might affect vulnerable people.

How automated and shared vehicles will impact the values of travel time remains to be seen. In Paper IV, we argue that the value of travel time for self-driving vehicles is complex and depends not only on the change in value of in-vehicle time but also on the system's design, such as how parking will work. Regardless, the question of value of travel time is crucial since the infrastructure projects that are being appraised right now likely will outlive non-automated vehicles.

The introduction of self-driving vehicles is far from the only example of emerging technologies that might affect transportation. The rise of AI enables much more data-driven transportation systems, for example, offering mobility as a service, 'smart' traffic controls and ITC solutions that enable travel planning. Some of these developments are framed as the emergence of the 'smart' city, or rather smart *cities*. Not only will the vehicles themselves be automated, but the technological advancements will allow for a transformation of the entire system. Seemingly harmless, this transformation also gives rise to important questions of social justice (Mladenovic and McPherson 2016). The concept of 'mobility as a service' combined with 'smart' traffic control can make it possible to price access

to the roads according to the principles of a free market (Sparrow and Howard 2020). This would be an economically efficient way to allocate the scarce good 'space on the road' which is in line with commonly accepted principles in transport economics (ibid.)¹⁵. However, such commodification of the road system and public space can increase inequalities and challenge the democratic perception of what public space is. As Sparrow and Howard argue, ordinary people on the road would have to 'make way for the wealthy'. The technological advancement of cars being connected and the traffic control system being 'smart' and dynamic makes it technically possible to make cars of those who have paid a premium to pass cars of those who have not. So, those who can pay may actually be able to save time on the road. It is almost as if the simple time-money trade-off that previously has been criticised for being unrealistic (see Section 1.4) can be made real. But is it desirable? From the perspective of transport economics, increasing the extent to which markets are used to deliver road transport is desirable (ibid.). While, according to Sparrow and Howard, privatisation of transport is not unprecedented (after all, private companies operate public transport), the privatisation of access to roads is problematic. Private cooperations would be controlling access to mobility and would be able to survey people's movements at unprecedented levels. Just because potentially there can be a market does not mean that there should be a market. The issues raised by Sparrow and Howard highlight the need for reflection on the role and significance of mobility and, ultimately, what type of future cities we envision.

5.2 Values and narratives

To my knowledge, there is no prominent discussion of values in the mainstream literature on transport economics. A possible explanation for this is the discipline's neoclassical roots and the view of economics as a positive science free from any value judgement. However, as has been discussed in Section 2.2, the value-ladenness of economics has gained recent attention in philosophy of economics (Małecka 2021). Values enter economics at the stages of theory foundation and development of concepts, at the stage of modelling and during hypothesis testing and acceptance (Reiss 2017). Reiss argues that theories of rational choice are, in fact, substantive normative assumptions (ibid.).

Even though values are rarely considered in the literature of transport

¹⁵After all, road space is a scarce good and pricing is seen as the most efficient policy tool (Vanoutrive and Zijlstra 2018)

economics, new technological advancements have challenged the common understanding of transport as being value-free. For example, self-driving vehicles have received a lot of attention from ethicists (Hansson et al. 2021; Borenstein et al. 2019). The idea of self-driving vehicles has also served as a real-life example of the well-known trolley dilemma. This resemblance has been explored in the Moral Machine project at MIT (Awad et al. 2018). The Moral Machine is an online experiment that gathered over 40 million decisions from millions of people globally. The project has provided insights into how participants reason about moral dilemmas. However, it has also been criticised for being largely responsible for the dilemma since there can be morally correct ways to program autonomous vehicles which are not presented as viable alternatives to the project's participants (Furey and Hill 2021). Furey and Hill argue that the project makes it seem like there is a conflict between what the car consumer will purchase and what the consumer thinks is moral. Such a narrative might make manufacturers, policy-makers and potential consumers unnecessarily wary of self-driving vehicles. Furthermore, the focus on trolley-problems tends to put the responsibility on the individual and the private car, rather than considering how the technology will impact society at large (Borenstein et al. 2019). These are key system-level issues that will have to be figured out.

Clearly, there are values and narratives in the field of transport research that deserve further analysis. Here, I believe that philosophers can make valuable contributions as they already have done concerning autonomous vehicles. However, the actual resemblance of self-driving cars to trolleys is just the tip of the iceberg. There are more pressing issues, such as the commodification of public space discussed in the previous section. An alternative perspective is also presented in Paper V where I explore the narrative and underlying values in studies of attitudes toward self-driving vehicles. Such narratives and values might impact future mobility solutions and the whole transportation system. Hence, they should be considered to a greater extent.

For instance, the importance of values in the design of future transport solutions can be highlighted by applying certain design approaches. An approach like value sensitive design could be used during the design process of automated vehicles. Value sensitive design can also be utilised in the design of transportation infrastructure to ensure a sustainable system aligned with human values (Watkins 2021). But value sensitive design is just one particular approach. What is crucial is to emphasise the need for reflection, both from philosophy of science and philosophy of technology perspectives.

6. Summary of papers

Paper I: Let me save you some time... On valuing travellers' time in urban transportation

This paper examines how anomalies related to behavioural aspects of time-specific decisions together with theory of value of time can provide better understanding of appropriate assumptions when modelling time-value decisions.

We analyse the various properties of time as an economic resource using findings in behavioural 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 the 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.

Consequently, 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. This is partly 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 is currently given. Moreover, the potential effects of disregarding aspects of value of time can lead to policy implications that are not warranted.

Paper II: Transport justice of what?

Building on the recent literature on distributive justice in transport research, this article explores the question of what the metric of justice in this particular context should be. What type of good is it that is being distributed? Thus far, most of the discourse of transport justice has been based on accessibility as the presumed metric. Increased accessibility is seen as the primary goal of transport policies. Hence, considering ‘accessibility’ as that which should be equally distributed seems warranted. Yet, I argue that the common measures of accessibility are insufficient as the metric of justice. Further, I suggest criteria for an alternative metric of transport justice.

The paper starts with a brief introduction to the field of transport studies and an account of the discourse on justice in the transportation literature. I then present my main arguments. First, I argue that accessibility as a metric is too narrow and excludes certain burdens of transportation. Aspects as who has to endure the smell of exhaust fumes, noise and pollution have been largely neglected in the literature on transport justice. I believe this might in part be due to the difficulty of incorporating such aspects given accessibility as the metric. Second, I argue that in many ways, accessibility is not actually dependent on transport. While it is to a degree acknowledged in the transport literature that there are alternative ways of accessing goods and services, this insight is mostly missing from the literature on transport justice. Nevertheless, if we accept that transport is purely instrumental, transport justice has to be viewed through the lens of travel being a necessity to reach specific ends, such as employment, education, health services and so on. Hence, any account of transport justice has to be formulated related to the ends the travel is intended to meet. So, if there are alternative ways of getting access to education, they are as valid as travel-based ones. Thus, an accessibility-based metric does not actually sustain mobility or the act of travel as such. If this is intentional, then the use of the metric is understandable. But seemingly, one would want a metric that actually relates to the activity of travel or to mobility. The third argument against accessibility is based on such a metric, making transport justice redundant. Accessibility as a metric does not track inequalities that are not tracked in other ways. If there is a lack of accessibility to healthcare, there is also a lack of healthcare. So, the inequality in accessibility to healthcare can be formulated as inequality in healthcare. Presumably, such inequalities are highlighted and handled elsewhere than by transport policies. It is not evident that a lack of healthcare should or could be remedied by transport

interventions.

At the end of the paper, I consider what we require from a metric of transport justice. Broadly, it is for the metric to be independent from other goods, to track the activity of movement (so, mobility or travel), to include intrinsically motivated reasons for travel and to relate to the individuals ability to utilise transport. I conclude by suggesting that formulating criteria can provide guidance for alternative formulations of a metric of transport justice. I believe that there is a place for transport justice if it refers to the foundations needed to secure the right to mobility and the freedom of movement without building on accessibility.

Paper III: Bridging temporal and transport justice: a case for considerations of time use in urban justice

The aim of this paper is to consider the topic of temporal justice in the context of transportation. Building on an argument by Rose against the time-money substitutability claim, I argue that temporal perspectives have been overlooked in the literature on transport justice.

The established metric of justice in transport is accessibility. Even though there are person-based accessibility measures that allow for considerations of individual's temporal constraints, these measures are rarely utilised for equity purposes in mainstream transport economics. Instead, infrastructure-based or location-based measures are more common. However, such measures run the risk of not providing the necessary basis for an analysis to capture certain inequalities. Such a risk is exemplified by the case of gender differences in travel patterns and behaviours. These differences have been studied and empirically substantiated. Cultural, economic, physical, and psychological barriers affect women's travel. Women's trips are often multipurpose and more complex, involving multiple stops, for example, dropping off children at school on the way to work. Such trips reflect specific transport needs. However, not all transport models have taken such travel patterns into account. The simplest models only accommodate direct (A to B) travel. Furthermore, these gender differences are rarely highlighted in the literature on transport justice. The differences in time-use are also not captured if they are not related to travel per se. Hence, the temporal constraints some might have and that affect transport options and choices might go unstudied.

Based on this, the paper argues that an account of transport justice with (place or location-based) accessibility as the chosen metric cannot not sufficiently reflect gender inequalities. An alternative account based on

'time' could provide better tools to analyse the consequences of transport interventions. Hence, I argue in this paper that time needs to be considered in its own right for urban justice to reflect the circumstances of urban living.

Paper IV: 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 crucial when developing transport models to accurately value transport investments and predict future travel patterns. Traditionally, one of the main parameters determining the value of travel time is travel mode, usually decomposed into travel by car, bus or train, and 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 attributes result in a morphological matrix spanning 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 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.

Paper V: Norms and gendered narratives in studies of attitudes toward automated vehicles – a review

It is believed that a transition to automated vehicles can facilitate a transition toward a more sustainable transport system. However, such a transition requires an emphasis on shared mobility and an adaptation of the new transportation alternatives among the public. In transportation studies, there has been a rise in papers that consider attitudes towards automation technology and adoption intention. In this paper, I carry out a review of such literature and examine the narratives and values related to gender.

Four overarching themes are identified in the literature: (1) general attitude and intention to use, (2) risk perception, (3), tech-savviness and (4) matters of control. I also analyse the policy recommendations that many articles provide. There is an evident gap in how men and women feel about autonomous vehicles. Women tend to be more sceptical. Broadly, it is, based on the review, explained by women being more risk-averse and less tech-savvy. Women also dislike giving away control (though this theme is less prominent). The policy recommendations in the literature based in these findings focus on educational efforts. It is presumed that a 'male' level of excitement toward automated vehicles is the baseline. Thus, the risk-averseness might, for example, be solved by marketing campaigns. Though some suggestions on design features might make automated vehicles more attractive to women, they are not necessarily well founded. Instead, they seem based on speculations about what women want.

What is important to highlight in this context is that women's needs and travel patterns have been neglected in the transport field before. While the introduction of new transportation technology and new modes of travel seemingly make it possible to design for everyone, the male perspective is (as often) taken for granted. Valid reasons for why women are sceptical (such as them actually being at higher risk in traffic accidents) and needs

related to their travel patterns are not considered.

On the one hand, emerging technologies can transform the transportation network into something entirely new. On the other hand, this requires rethinking of the network as such, including the technology itself, the design of the services and the infrastructure. Unawareness of established norms and narratives can hinder innovation, and the ‘something new’ risks becoming the same old, only automated.

7. Concluding remarks

Remember the dilemma that was introduced in passing in Section 2? On the one hand, we as a society depend on transport and mobility; on the other hand, our mobility practices are not sustainable. I hope that this thesis might provide new ways of looking at the dilemma or at least make a case for philosophers to be more involved in the scholarly and even public debate on such matters. Lyons and Urry have argued that “social science has or should have a central part to play in shaping the future of transport” (Lyons and Urry 2006, p. 12). Perhaps there is a part for philosophy to play as well.

As I have tried to convey in this thesis, understanding the value of transport, what we *actually* value is key. Therefore, conflating mobility and accessibility is not helpful. A focus on accessibility might potentially lead to digital alternatives replacing travel. Whether such a development is desired remains to be seen. This thesis has partly been written in circumstances of a pandemic with many countries adopting various lockdown measures. My impression is that having to stay at home, even with basic needs being satisfied, has been perceived as limiting by many. There is something to be said for the experience of travel, even if it is everyday and mundane. The busy commute has perhaps not been what people have missed the most. But the opportunity to travel certainly has value and the right to travel needs to be guarded. Gaps in mobility that are not by choice need to be understood and compensated.

Connecting this line of reasoning to time is also essential. Our dependency on mobility in our daily lives means we need to plan. We keep track of schedules, time tables, we check apps on our phones for the latest status on the roads to know when to leave. We plan our mobility based on our time constraints. Besides the gap in mobility, we also risk a gap in time use. Those connected can work remotely, not spend time travelling and have more free time. They will probably also be the ones that afford automated vehicles and will have more time than those that cannot. There

have been recent arguments made in the media for work time reductions for those that cannot work remotely to compensate for the inequality in time. It is reasonable to assume that such a discussion will be even more relevant when automated vehicles are introduced. Self-driving vehicles risk widening the gap in discretionary time between those that can work remotely and those that cannot.

As spatial constraints become less relevant, temporal constraints might become more critical. Nowadays, I can take part in local municipal assembly meetings online, so even democratic participation has increasingly been made possible through digital means. And the digitalisation efforts are surely growing. What does equality of opportunity mean in an increasingly digital world? Theoretically, I have endless opportunities to study, and even work – but who has the time? If there are opportunities, it is my responsibility to make time? But having time should not just be up to the individual; fair discretionary time is a societal matter. This thesis is a tentative step toward connecting transport justice, temporal justice and future mobility. I hope many future steps will follow.

References

- Abdellaoui, Mohammed, and Emmanuel Kemel. 2013. “Eliciting prospect theory when consequences are measured in time units: ‘Time is not money’”. *Management Science* 60 (7): 1844–1859.
- Abrantes, Pedro AL, and Mark R Wardman. 2011. “Meta-analysis of UK values of travel time: An update”. *Transportation Research Part A: Policy and Practice* 45 (1): 1–17.
- Adler, Matthew D. 2016. “Behavioral economics, happiness surveys, and public policy”. *Journal of Benefit-Cost Analysis* 7 (1): 196–219.
- Anderson, Elizabeth. 2010. “Justifying the capabilities approach to justice”. *Measuring justice: Primary goods and capabilities*: 81–100.
- Avineri, Erel. 2012. “On the use and potential of behavioural economics from the perspective of transport and climate change”. *Journal of Transport Geography* 24:512–521.
- Awad, Edmond, et al. 2018. “The moral machine experiment”. *Nature* 563 (7729): 59–64.
- Banister, David, et al. 2019. “Reasonable travel time – the traveller’s perspective”. In *A Companion to Transport, Space and Equity*. Edward Elgar Publishing.

- Becker, Gary S. 1965. "A Theory of the Allocation of Time". *The Economic Journal* 75 (299): 493–517.
- Bertolini, Luca. 2017. *Planning the mobile metropolis: Transport for people, places and the planet*. Macmillan International Higher Education.
- Borenstein, Jason, Joseph R Herkert, and Keith W Miller. 2019. "Self-driving cars and engineering ethics: The need for a system level analysis". *Science and engineering ethics* 25 (2): 383–398.
- Brake, Elizabeth. 2017. "Fair care: Elder care and distributive justice". *Politics, Philosophy & Economics* 16 (2): 132–151.
- Brown, Donald G. 1970. "The value of time". *Ethics* 80 (3): 173–184.
- Chetty, Raj. 2015. "Behavioral economics and public policy: A pragmatic perspective". *American Economic Review* 105 (5): 1–33.
- Cohen, Gerald Allan. 2011. *On the currency of egalitarian justice, and other essays in political philosophy*. Princeton University Press.
- Congdon, William J, and Maya Shankar. 2018. "The Role of Behavioral Economics in Evidence-Based Policymaking". *The ANNALS of the American Academy of Political and Social Science* 678 (1): 81–92.
- De Borger, Bruno, and Mogens Fosgerau. 2008. "The trade-off between money and travel time: A test of the theory of reference-dependent preferences". *Journal of urban economics* 64 (1): 101–115.
- De Jong, Gerard, and Marco Kouwenhoven. 2020. "Value of travel time and travel time reliability". *Standard Transport Appraisal Methods. Advances in Transport Policy and Planning* 6:43–74.
- De Palma, André, et al. 2011. *A handbook of transport economics*. Edward Elgar Publishing.
- DeSerpa, Allan C. 1971. "A theory of the economics of time". *The Economic Journal* 81 (324): 828–846.
- DeVoe, Sanford E, and Julian House. 2012. "Time, money, and happiness: How does putting a price on time affect our ability to smell the roses?" *Journal of Experimental Social Psychology* 48 (2): 466–474.
- DeVoe, Sanford E, and Jeffrey Pfeffer. 2011. "Time is tight: How higher economic value of time increases feelings of time pressure." *Journal of Applied Psychology* 96 (4): 665.
- . 2007. "When time is money: The effect of hourly payment on the evaluation of time". *Organizational Behavior and Human Decision Processes* 104 (1): 1–13.

- Dworkin, Ronald. 1981a. "What is equality? Part 1: Equality of welfare". *Philosophy & public affairs*: 185–246.
- . 1981b. "What is equality? Part 2: Equality of resources". *Philosophy & public affairs*: 283–345.
- Elldér, Erik. 2020. "Telework and daily travel: New evidence from Sweden". *Journal of Transport Geography* 86:102777.
- Engelson, Leonid, and Mogens Fosgerau. 2016. "The cost of travel time variability: Three measures with properties". *Transportation Research Part B: Methodological* 91:555–564.
- Epting, Shane. 2019a. "Automated vehicles and transportation justice". *Philosophy & Technology* 32 (3): 389–403.
- . 2018. "Philosophy of the city and environmental ethics". *Environmental Ethics* 40 (2): 99–100.
- . 2021. *The morality of urban mobility: technology and philosophy of the city*. Rowman & Littlefield.
- . 2019b. "The Philosophical Dimensions of Urban Transportation: Introduction". *Essays in Philosophy* 20 (2).
- Evans, Alan W. 1972. "On the theory of the valuation and allocation of time*". *Scottish Journal of Political Economy* 19 (1): 1–17.
- Farrington, John, and Conor Farrington. 2005. "Rural accessibility, social inclusion and social justice: towards conceptualisation". *Journal of Transport geography* 13 (1): 1–12.
- Fellner, Wolfgang. 2017. "The Value of Time: Its Commodification and a Reconceptualization". *Eidos. A Journal for Philosophy of Culture* 2:37–53.
- Ferreira, António, Els Beukers, and Marco Te Brömmelstroet. 2012. "Accessibility is gold, mobility is not: A proposal for the improvement of Dutch transport-related cost-benefit analysis". *Environment and Planning B: Planning and Design* 39 (4): 683–697.
- Festjens, Anouk, and Chris Janiszewski. 2015. "The value of time". *Journal of consumer Research* 42 (2): 178–195.
- Fuguitt, Diana, and Shanton J Wilcox. 1999. *Cost-benefit analysis for public sector decision makers*. Greenwood Publishing Group.
- Furey, Heidi, and Scott Hill. 2021. "MIT's moral machine project is a psychological roadblock to self-driving cars". *AI and Ethics* 1 (2): 151–155.
- Galetzka, Mirjam, et al. 2018. "The psychological value of time". *Transportation research procedia* 31:47–55.

- Geurs, Karst T, and Bert Van Wee. 2004. "Accessibility evaluation of land-use and transport strategies: review and research directions". *Journal of Transport geography* 12 (2): 127–140.
- Gheaus, Anca. 2018. "Hikers in Flip-Flops: Luck Egalitarianism, Democratic Equality and the Distribuenda of Justice". *Journal of Applied Philosophy* 35 (1): 54–69.
- Gino, Francesca, and Cassie Mogilner. 2014. "Time, money, and morality". *Psychological Science* 25 (2): 414–421.
- González, Rosa Marina. 1997. "The value of time: a theoretical review". *Transport reviews* 17 (3): 245–266.
- Goodin, Robert E, et al. 2008. *Discretionary time: A new measure of freedom*. Cambridge University Press.
- Hägerstrand, Torsten. 1970. "What about people in regional".
- Handy, Susan. 2020. "Is accessibility an idea whose time has finally come?" *Transportation Research Part D: Transport and Environment* 83:102319.
- Hansson, Sven Ove. 2007. "Philosophical problems in cost–benefit analysis". *Economics & Philosophy* 23 (2): 163–183.
- Hansson, Sven Ove, and Till Grüne-Yanoff. 2008. "Preferences". *Stanford Encyclopedia of philosophy*.
- Hansson, Sven Ove, Matts-Åke Belin, and Björn Lundgren. 2021. "Self-Driving Vehicles – An Ethical Overview". *Philosophy & Technology*: 1–26.
- Hausman, Daniel, Michael McPherson, and Debra Satz. 2016. *Economic analysis, moral philosophy, and public policy*. Cambridge University Press.
- Hausman, Daniel M. 2003. "Philosophy of economics".
- Hensher, David A. 2010. "Hypothetical bias, choice experiments and willingness to pay". *transportation research part B: methodological* 44 (6): 735–752.
- . 2011. "Valuation of travel time savings". In *A handbook of transport economics*. Edward Elgar Publishing.
- Hensher, David A, Matthew J Beck, and Camila Balbontin. 2021. "What does the quantum of working from home do to the value of commuting time used in transport appraisal?" *Transportation Research Part A: Policy and Practice* 153:35–51.

- Hess, Stephane, Andrew Daly, and Maria Börjesson. 2020. "A critical appraisal of the use of simple time-money trade-offs for appraisal value of travel time measures". *Transportation* 47:1541–1570.
- Hicks, John R. 1976. "Some questions of time in economics". *Evolution, welfare and time in economics*: 135–51.
- Jara-Diaz, Sergio. 2007. *Transport economic theory*.
- Johansson, Börje, Johan Klaesson, and Michael Olsson. 2003. "Commuters' non-linear response to time distances". *Journal of Geographical Systems* 5 (3): 315–329.
- Kębłowski, Wojciech, and David Bassens. 2018. "All transport problems are essentially mathematical': The uneven resonance of academic transport and mobility knowledge in Brussels". *Urban Geography* 39 (3): 413–437.
- Khisty, C Jotin, and Ulli Zeitler. 2001. "Is hypermobility a challenge for transport ethics and systemicity?" *Systemic Practice and Action Research* 14 (5): 597–613.
- Kristoffersson, Ida, Leonid Engelson, and Maria Börjesson. 2017. "Efficiency vs equity: Conflicting objectives of congestion charges". *Transport Policy* 60:99–107.
- Laird, James, Karst Geurs, and Chris Nash. 2009. "Option and non-use values and rail project appraisal". *Transport Policy* 16 (4): 173–182.
- Lallement, Jeanne, and Andrea Gourmelen. 2018. "The time of consumers: A review of researches and perspectives". *Recherche et Applications en Marketing (English Edition)*: 2051570718792172.
- Leclerc, France, Bernd H Schmitt, and Laurette Dube. 1995. "Waiting time and decision making: Is time like money?" *Journal of Consumer Research*: 110–119.
- Lee, Leonard, et al. 2015. "Money, time, and the stability of consumer preferences". *Journal of Marketing Research* 52 (2): 184–199.
- Lehtinen, Sanna. 2020. "Editorial Introduction to the Special Volume on Urban Aesthetics". *Contemporary Aesthetics* 8.
- Levine, Jonathan, Joe Grengs, and Louis A Merlin. 2019. *From Mobility to Accessibility*. Cornell University Press.
- Li, Zheng, and David A Hensher. 2011. "Crowding and public transport: A review of willingness to pay evidence and its relevance in project appraisal". *Transport Policy* 18 (6): 880–887.

- Li, Zheng, David A Hensher, and John M Rose. 2010. "Willingness to pay for travel time reliability in passenger transport: A review and some new empirical evidence". *Transportation research part E: logistics and transportation review* 46 (3): 384–403.
- Lindblom, Lars. 2018. "Childhood and the Metric of Justice". In *The Routledge Handbook of the Philosophy of Childhood and Children*, 317–327. Routledge.
- Linder, Staffan Burenstam. 1970. *The hurried leisure class*. New York: Columbia University Press.
- Lyons, Glenn, and John Urry. 2006. "Foresight: the place of social science in examining the future of transport".
- Mackie, Peter, Richard Batley, and Tom Worsley. 2018. "Valuing transport investments based on travel time savings – a response to David Metz". *Case Studies on Transport Policy*.
- Małecka, Magdalena. 2021. "Values in economics: a recent revival with a twist". *Journal of Economic Methodology* 28 (1): 88–97.
- Marsden, Greg, and Louise Reardon. 2017. "Questions of governance: Rethinking the study of transportation policy". *Transportation Research Part A: Policy and Practice* 101:238–251.
- Martens, Karel. 2012. "A justice-theoretic exploration of accessibility measures". In *Accessibility Analysis and Transport Planning*. Edward Elgar Publishing.
- . 2016. *Transport justice: Designing fair transportation systems*. Routledge.
- Masuda, Yuta J, Jason R Williams, and Heather Tallis. 2021. "Does Life Satisfaction Vary with Time and Income? Investigating the Relationship Among Free Time, Income, and Life Satisfaction". *Journal of Happiness Studies* 22 (5): 2051–2073.
- Milakis, Dimitris, and Stephan Müller. 2021. "The societal dimension of the automated vehicles transition: Towards a research agenda". *Cities* 113:103144.
- Mladenovic, Milos N, and Tristram McPherson. 2016. "Engineering social justice into traffic control for self-driving vehicles?" *Science and engineering ethics* 22 (4): 1131–1149.
- Mogilner, Cassie, Hal E Hershfield, and Jennifer Aaker. 2018. "Rethinking time: Implications for well-being". *Consumer Psychology Review* 1 (1): 41–53.

- Mokhtarian, Patricia L, and Ilan Salomon. 2001. "How derived is the demand for travel? Some conceptual and measurement considerations". *Transportation research part A: Policy and practice* 35 (8): 695–719.
- Mokhtarian, Patricia L, Ilan Salomon, and Matan E Singer. 2015. "What moves us? An interdisciplinary exploration of reasons for traveling". *Transport Reviews* 35 (3): 250–274.
- Mosselmans, Bert. 2005. "Time and value in the history of political economy". *Foundations of science* 10 (3): 325–345.
- Mouratidis, Kostas, Sebastian Peters, and Bert van Wee. 2021. "Transportation technologies, sharing economy, and teleactivities: Implications for built environment and travel". *Transportation Research Part D: Transport and Environment* 92:102716.
- Næss, Petter. 2006. "Cost-benefit analyses of transportation investments: neither critical nor realistic". *Journal of critical realism* 5 (1): 32–60.
- Nagenborg, Michael, et al. 2021. *Technology and the city: Towards a philosophy of urban technologies*. Vol. 36. Springer Nature.
- Nahmias-Biran, Bat-hen, and Yoram Shiftan. 2016. "Towards a more equitable distribution of resources: Using activity-based models and subjective well-being measures in transport project evaluation". *Transportation Research Part A: Policy and Practice* 94:672–684.
- Nahmias-Biran, Bat-hen, Karel Martens, and Yoram Shiftan. 2017. "Integrating equity in transportation project assessment: A philosophical exploration and its practical implications". *Transport reviews* 37 (2): 192–210.
- Nello-Deakin, Samuel. 2019. "Is there such a thing as a 'fair' distribution of road space?" *Journal of urban design* 24 (5): 698–714.
- Nesticò, Sergio. 2017. "Consumption Choices and Time Use: History, Theory and Potential Empirical Evidence". *Economia. History, Methodology, Philosophy*, no. 72: 219–238.
- Noll, Samantha, Joseph S Biehl, and Sharon M Meagher. 2019. "Introduction: Transforming philosophy and the city". In *The Routledge Handbook of Philosophy of the City*, 1–16. Routledge.
- Nordström, Maria. 2020. "Is time money? Philosophical perspectives on the monetary valuation of travel time".
- Economia. 2015. "Time in Economics Call for Papers". Visited on 02/22/2022. <https://journals.openedition.org/oeconomia/1891>.

- Okada, Erica Mina, and Stephen J Hoch. 2004. "Spending time versus spending money". *Journal of consumer research* 31 (2): 313–323.
- Pearce, David. 1983. "Ethics, irreversibility, future generations and the social rate of discount". *International Journal of Environmental Studies* 21 (1): 67–86.
- Peer, Stefanie, et al. 2014. "Over-reporting vs. overreacting: Commuters' perceptions of travel times". *Transportation Research Part A: Policy and Practice* 69:476–494.
- Pereira, Rafael HM, Tim Schwanen, and David Banister. 2017. "Distributive justice and equity in transportation". *Transport reviews* 37 (2): 170–191.
- Pfeffer, Jeffrey, and Sanford E DeVoe. 2012. "The economic evaluation of time: Organizational causes and individual consequences". *Research in Organizational Behavior* 32:47–62.
- Plotica, Luke Philip. 2019. "The Fight for (Free) Time". *Polity* 51 (4): 780–806.
- Pogonyi, Csaba G. 2020. "The wider economic benefits of transportation". *Standard Transport Appraisal Methods. Advances in Transport Policy and Planning* 6:129–164.
- Polak, John. 1987. "A comment on Supernak's critique of transport modelling". *Transportation* 14 (1): 63–72.
- Pot, Felix Johan, Bert van Wee, and Taede Tillema. 2021. "Perceived accessibility: What it is and why it differs from calculated accessibility measures based on spatial data". *Journal of Transport Geography* 94:103090.
- Rasouli, Soora, and Harry Timmermans. 2014. "Activity-based models of travel demand: promises, progress and prospects". *International Journal of Urban Sciences* 18 (1): 31–60.
- Rawls, John. 2001. *Justice as fairness: A restatement*. Harvard University Press.
- Reiss, Julian. 2017. "Fact-value entanglement in positive economics". *Journal of Economic Methodology* 24 (2): 134–149.
- Ricardo, David. 1817. *On the Principles of Political Economy and Taxation: London*.
- Robeyns, Ingrid. 2003. "The capability approach: an interdisciplinary introduction". In *Training course preceding the Third International Conference on the Capability Approach, Pavia, Italy*, 29.
- . 2011. "The capability approach. Stanford Encyclopedia of Philosophy".

- Robinson, Lisa A. 2016. “[Ir] rationality, Happiness, and Benefit-Cost Analysis: Introduction to the Special Issue”. *Journal of Benefit-Cost Analysis* 7 (1): 1–11.
- Rose, Julie. 2016. *Free time*. Princeton University Press.
- Rose, Julie L. 2017. “Justice and the resource of time: a reply to Goodin, Terlazzo, von Platz, Stanczyk, and Lim”. *Law, Ethics and Philosophy*: 105–122.
- . 2021. “Rationing with time: time-cost ordeals’ burdens and distributive effects”. *Economics & Philosophy* 37 (1): 50–63.
- Ryan, Jean, and Rafael HM Pereira. 2021. “What are we missing when we measure accessibility? Comparing calculated and self-reported accounts among older people”. *Journal of Transport Geography* 93:103086.
- Ryan, Mark. 2020. “The future of transportation: ethical, legal, social and economic impacts of self-driving vehicles in the year 2025”. *Science and engineering ethics* 26 (3): 1185–1208.
- Sager, Tore. 2006. “Freedom as mobility: Implications of the distinction between actual and potential travelling”. *Mobilities* 1 (3): 465–488.
- Shippen, Nichole Marie. 2014. *Decolonizing time: Work, leisure, and freedom*. Springer.
- Shliselberg, Rebecca, and Moshe Givoni. 2018. “Motility as a policy objective”. *Transport reviews* 38 (3): 279–297.
- Simon, Jules. 2021. “Introduction: Introducing Philosophy of the City”. *Topoi* 40 (2): 387–398.
- Small, Kenneth A. 2012. “Valuation of travel time”. *Economics of transportation* 1 (1-2): 2–14.
- Soman, Dilip. 2001. “The mental accounting of sunk time costs: Why time is not like money”. *Journal of Behavioral Decision Making* 14 (3): 169–185.
- Sparrow, Robert, and Mark Howard. 2020. “Make way for the wealthy? Autonomous vehicles, markets in mobility, and social justice”. *Mobilities* 15 (4): 514–526.
- Steedman, Ian. 2003. *Consumption takes time: implications for economic theory*. Routledge.
- Steele, Katie, and H Orri Stefánsson. 2015. *Decision theory*.
- Supernak, Janusz. 1983. “Transportation modeling: lessons from the past and tasks for the future”. *Transportation* 12 (1): 79–90.

- Supernak, Janusz, and Walter R Stevens. 1987. "Urban transportation modeling: The discussion continues". *Transportation* 14 (1): 73–82.
- Thomas, Emily. 2020. *The Meaning of Travel: Philosophers Abroad*. Oxford University Press.
- Thomopoulos, Nikolas, Susan Grant-Muller, and MR Tight. 2009. "Incorporating equity considerations in transport infrastructure evaluation: Current practice and a proposed methodology". *Evaluation and program planning* 32 (4): 351–359.
- Timmermans, Harry, Theo Arentze, and Chang-Hyeon Joh. 2002. "Analysing space-time behaviour: new approaches to old problems". *Progress in human geography* 26 (2): 175–190.
- Timms, Paul. 2008. "Transport models, philosophy and language". *Transportation* 35 (3): 395–410.
- Tonietto, Gabriela N, et al. 2018. "When an Hour Feels Shorter: Future Boundary Tasks Alter Consumption by Contracting Time". *Journal of Consumer Research*.
- Tyssedal, Jens Jørund. 2021. "The Value of Time Matters for Temporal Justice". *Ethical Theory and Moral Practice* 24 (1): 183–196.
- Van Nes, Rob, and Gerard De Jong. 2020. "Transport models". *Standard Transport Appraisal Methods. Advances in Transport Policy and Planning* 6:101–128.
- Van Wee, Bert. 2011. *Transport and ethics: ethics and the evaluation of transport policies and projects*. Edward Elgar Publishing.
- Van Wee, Bert, Sander Van Cranenburgh, and Kees Maat. 2019. "Substitutability as a spatial concept to evaluate travel alternatives". *Journal of transport geography* 79:102469.
- Vanoutrive, Thomas, and Toon Zijlstra. 2018. "Who has the right to travel during peak hours? On congestion pricing and 'desirable' travellers". *Transport policy* 63:98–107.
- Vecchio, Giovanni, and Karel Martens. 2021. "Accessibility and the Capabilities Approach: a review of the literature and proposal for conceptual advancements". *Transport Reviews*: 1–22.
- Vromen, Jack. 2021. "What are we up to?" *Journal of Economic Methodology* 28 (1): 23–31.
- Wardman, Mark. 1998. "The value of travel time: a review of British evidence". *Journal of transport economics and policy*: 285–316.

- Watkins, Kari Edison. 2021. "Using value sensitive design to understand transportation choices and envision a future transportation system". *Ethics and Information Technology* 23 (1): 79–82.
- Watts, Laura. 2008. "The art and craft of train travel". *Social & Cultural Geography* 9 (6): 711–726.
- Wee, Bert van, and Niek Mouter. 2021. "Evaluating transport equity". *Advances in Transport Policy and Planning* 7:103–126.
- Whillans, Ashley V, and Elizabeth W Dunn. 2015. "Thinking about time as money decreases environmental behavior". *Organizational Behavior and Human Decision Processes* 127:44–52.
- Williams, Jason R, Yuta J Masuda, and Heather Tallis. 2016. "A measure whose time has come: Formalizing time poverty". *Social Indicators Research* 128 (1): 265–283.
- Winston, G.C. 1982. *The Timing of Economic Activities*. Cambridge University Press.
- Zauberman, Gal, and John G Lynch Jr. 2005. "Resource slack and propensity to discount delayed investments of time versus money." *Journal of Experimental Psychology: General* 134 (1): 23.
- Zeckhauser, Richard. 1973. "Time as the ultimate source of utility". *The Quarterly Journal of Economics*: 668–675.
- Zijlstra, Toon, and Ann Verhetsel. 2021. "The commuters' burden: The relationship between commuting and wellbeing in Europe". *Travel behaviour and society* 23:108–119.

