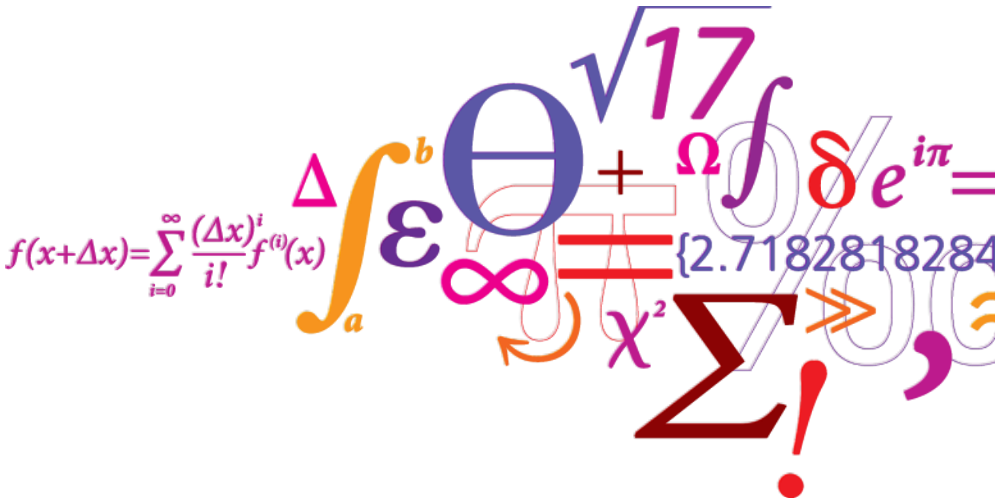
Improving the representation of consumers' choice in transport within E4 models



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Motivation

- Bottom-up (BU) energy system models describe in detail the technical, economic and environmental dimensions of an energy system
- They are **weak in representing consumer behaviour**: only one central decision maker is considered
- The **behavioural dimension** is fundamental in decision making in the transportation sector → It shall not be neglected
- Important to represent real realistic consumers' choice in transport

For more info: Venturini et al., Improvements in the representation of behaviour in integrated energy and transport models, Forthcoming in International Journal of Sustainable Transportation.

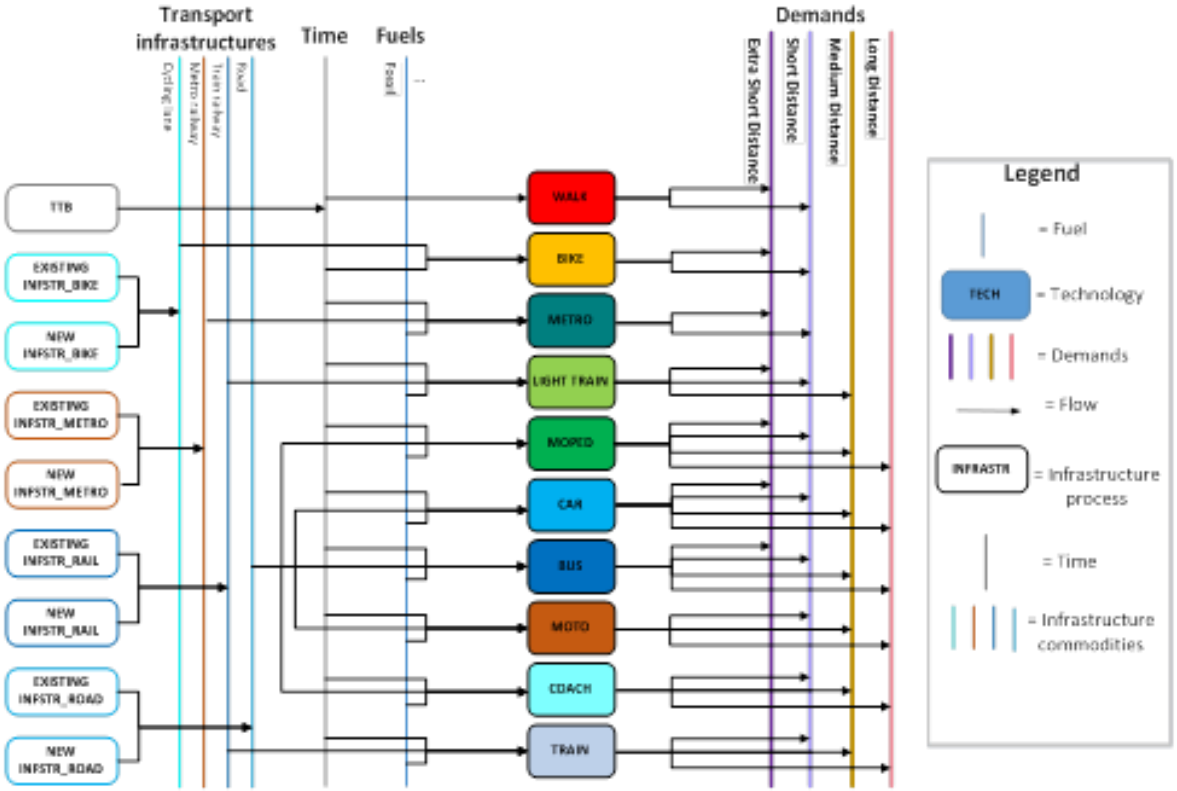
Models developed

- This PhD project has developed several methodologies to improve the representation of consumers' choice in transport within the BU optimization energy system model TIMES
- Models allow to modellers and policy makers to analyse within a unique modeling framework both technology related policies and behavioural policies for transport
- Approaches tested with TIMES-DK
- The models developed can be classified in four categories: modal choice vs. vehicle choice and soft-linking vs. endogenous

	Soft-linking	**Endogenous**
Modal choice	ABMoS-DK	TIMES-DKMS, MoCho-TIMES, TIMES-DKEMS
Vehicle Choice	DCSM	

TIMES-DKMS

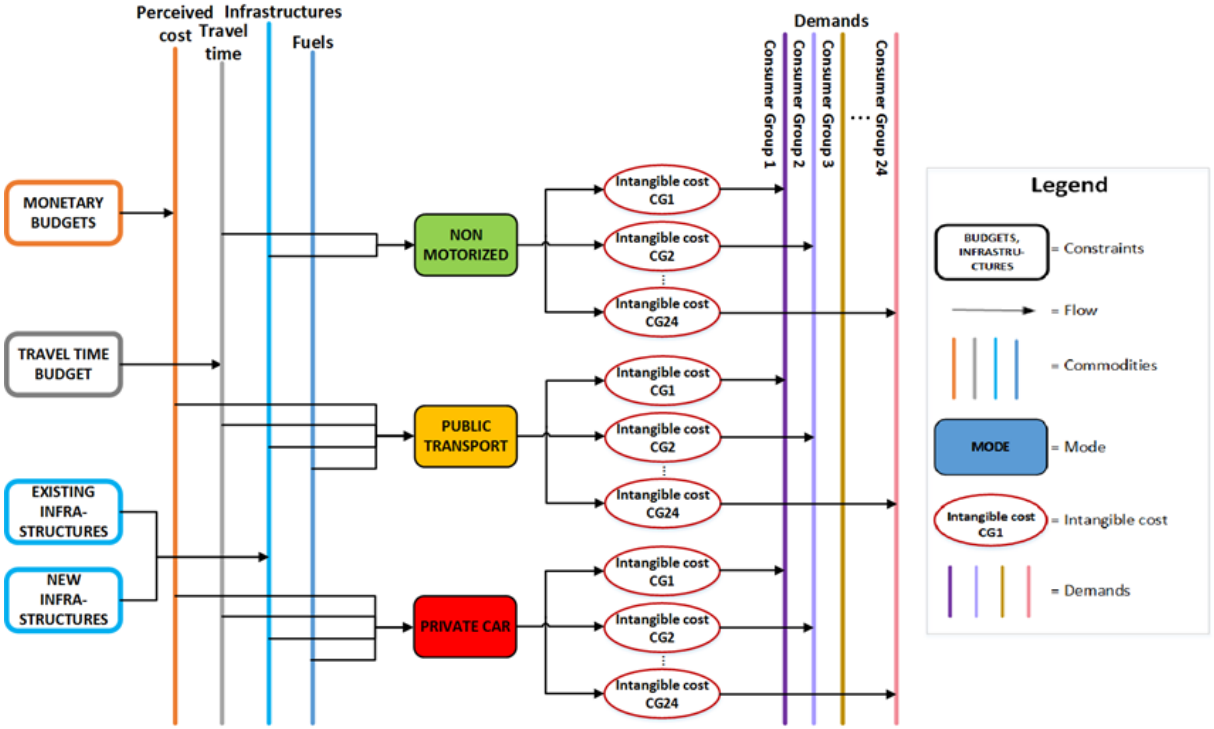
- Endogenous modal shift, integrated in whole energy system model
- Regulated by speed + Travel Time Budget (TTB) and infrastructure requirements



Tattini et al. (2018) Reaching carbon neutral transportation sector in Denmark – Evidence from the incorporation of modal shift into the TIMES energy system modeling framework, Energy Policy, 113:571-583. https://doi.org/10.1016/j.enpol.2017.11.013

MoCho-TIMES

- Endogenous modal choice, standalone transportation sector
- Integrates socioeconomic/demographic attributes and level-of-service attributes
- Consumer heterogeneity to capture diverse modal perceptions
- Intangible costs monetized to quantify modal perception across consumer segments



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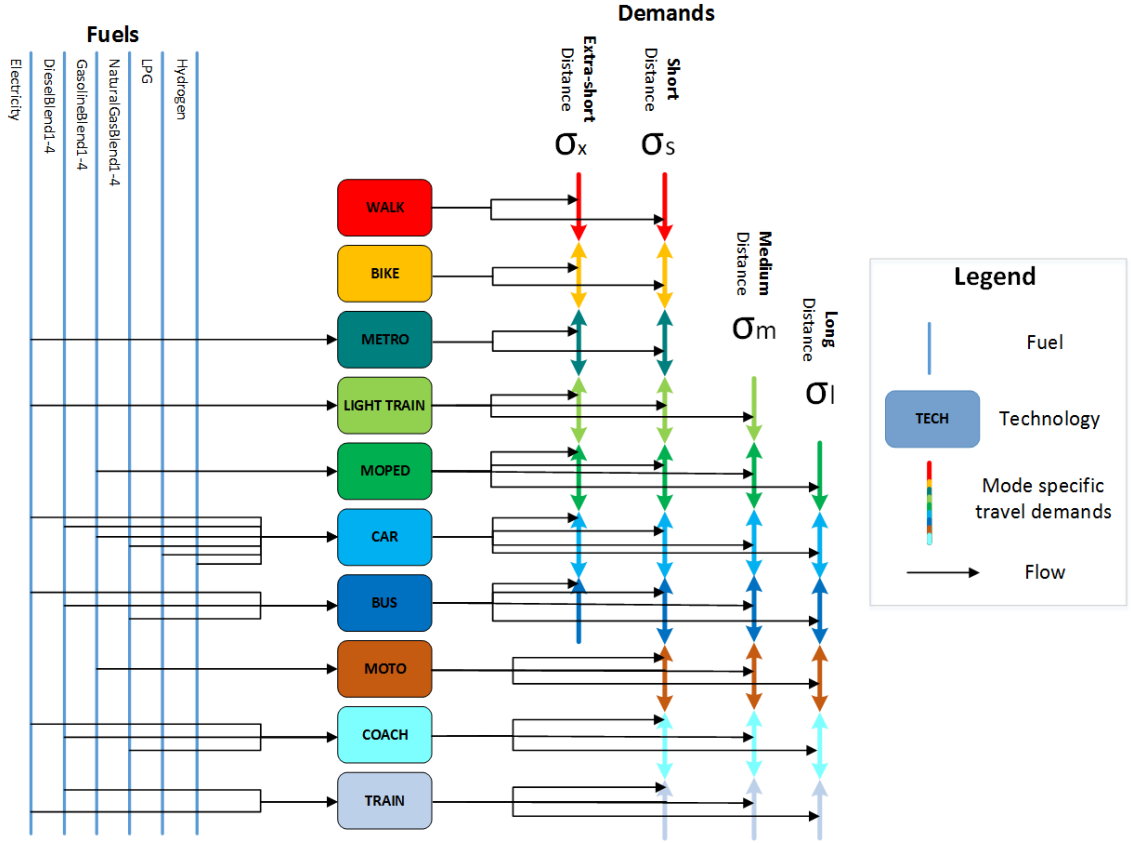
TIMES-DKEMS

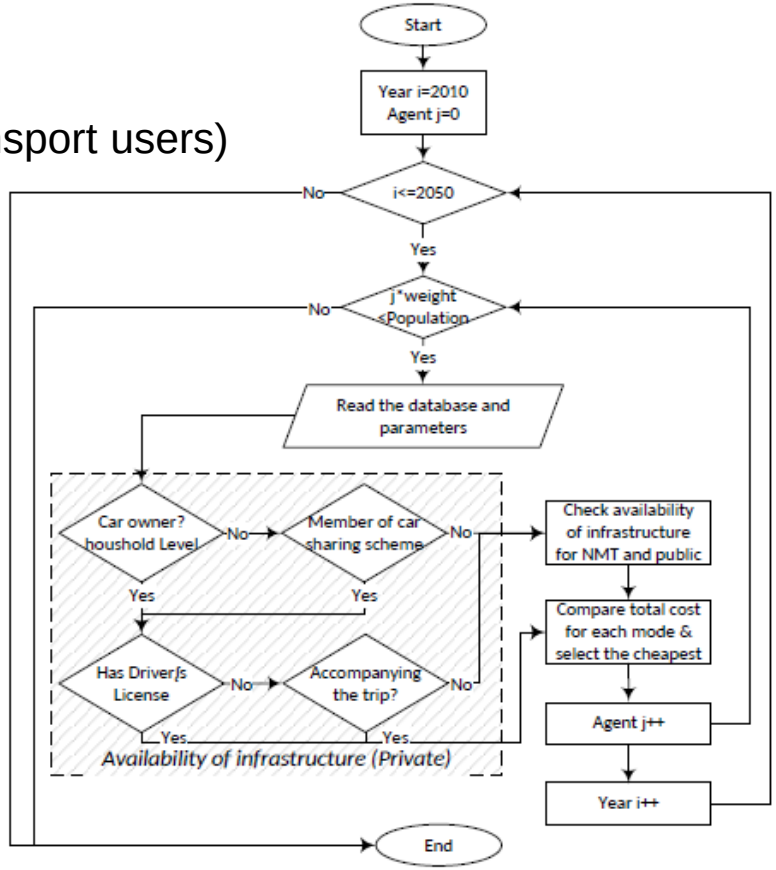
- Endogenous modal shift, standalone transportation sector
- Integrates elasticities of substitution
- Based on elastic demand functions formulation within TIMES-Micro



Salvucci et al. Modelling transport modal shift in TIMES models through elasticities of substitution, Under preparation for Applied Energy

ABMoS-DK

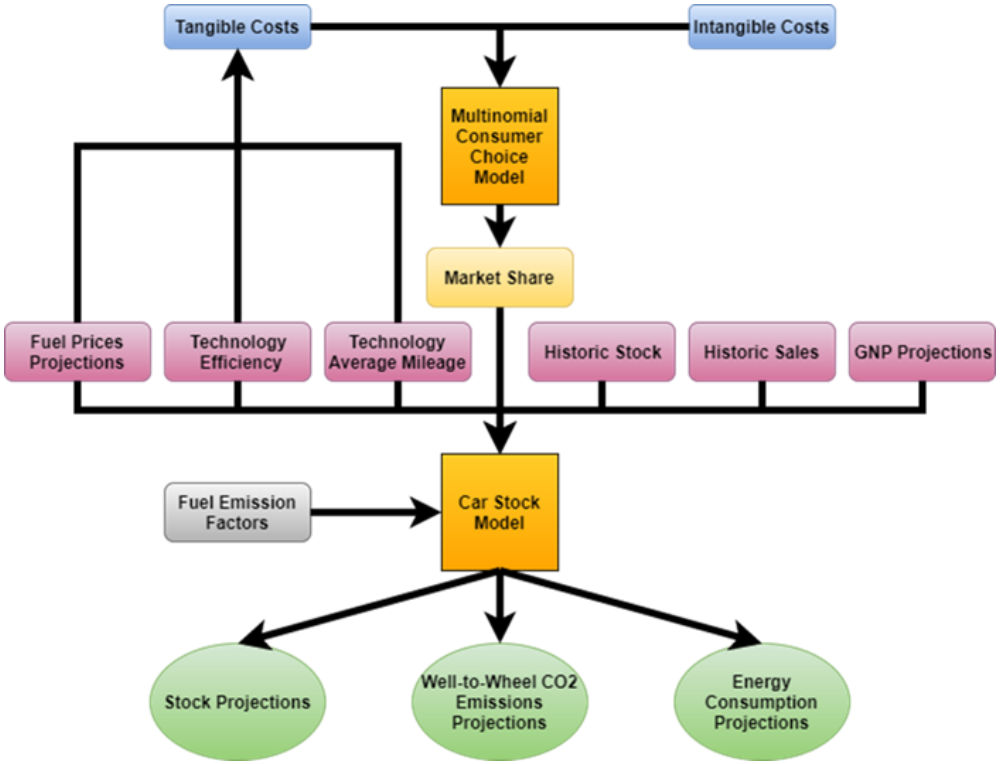
- Agent Based model that simulates modal choice in inland passenger transportation sector
- Meant to be soft-linked with TIMES-DK
- High socioeconomic disaggregation of agents (transport users)
- Mode choice algorithm with decision rules
- Algorithm compares utilities of alternative modes
- Utilities based on tangible and intangible costs



Ahanchian et al. Analyzing effects of transport policies on travelers' behaviour for modal shift in Denmark. Case studies on Transport policy [under review]

DCSM

- Simulation model of Danish car sector, meant to be soft-linked with TIMES-DK
- Two components: Consumer choice model + CarStock model
- Consumer choice model integrates realistic vehicle choice, based on tangible and intangible costs and integrates consumers' heterogeneity



Mulholland et al. (2018) The cost of electrifying private transport – evidence from an empirical consumer choice model of Ireland and Denmark, Forthcoming in Transportation Research Part D

Discussion on modeling approaches

Purpose: to guide fellow researchers and modellers in the selection of the most suitable modeling framework to incorporate behaviourally realistic consumers' choice in transport within BU optimization E4 models.

In four steps:

1. Describe behavioural features incorporated in the models for improving the representation of consumers' choice in transport

2. Compare models wrt their capability to render the behavioural features identified

3. Discuss the suitability of the models to address diverse types of energy and transport analyses and to answer to diverse types of policy questions

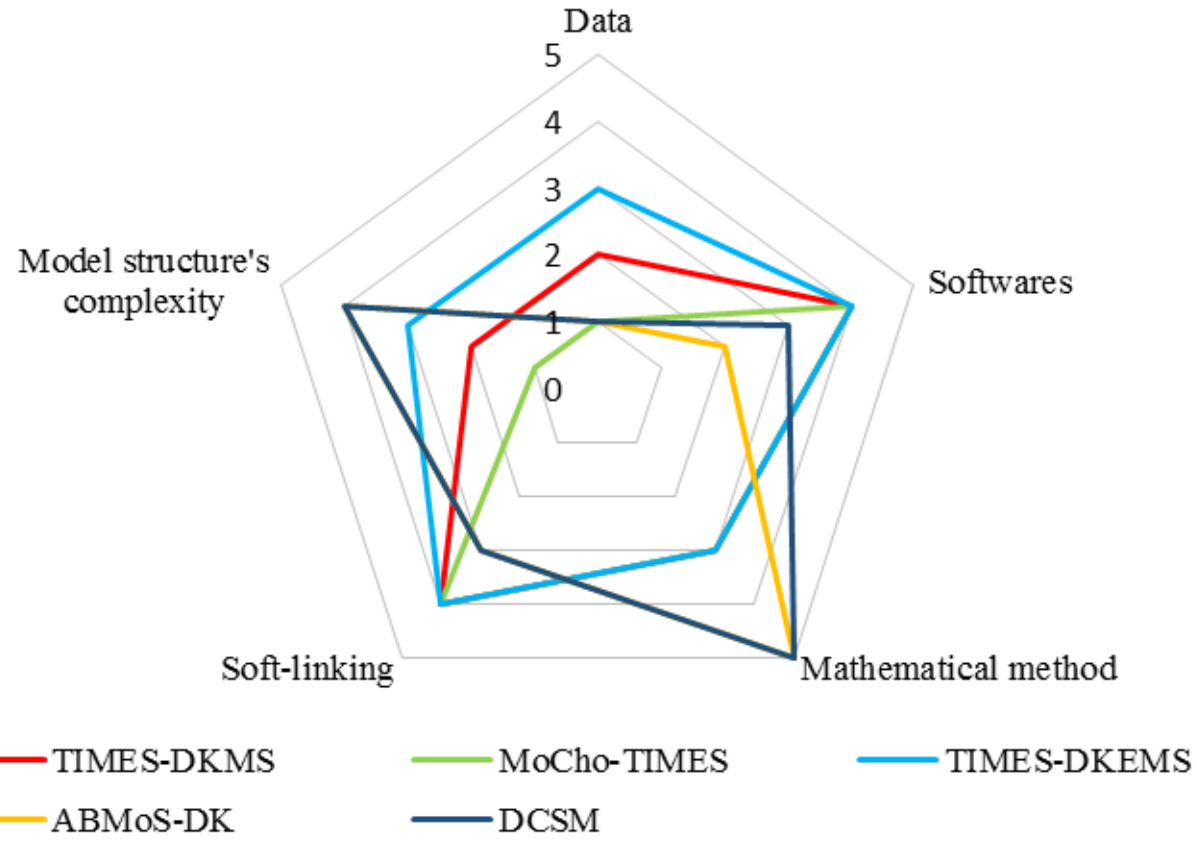
4. Compares modelling efforts and data requirements that the models proposed imply and the feasibility to replicate their methodologies

Behavioural features and models' capability to depict them

	TIMES-DKMS	MoCho-TIMES	TIMES-DKEMS	ABMoS-DK	DCSM
Heterogeneity		++		+++	++
Behavioural attributes	+	++		+++	++
Tangible costs		++		++	+
Spatial dimension		+		++	+
Infrastructure capacity	+	+			
Elastic transport demands			+		+

The performances of the models concerning the representation of the key behavioural features are determined with respect to TIMES-DK. The comparison is qualitative: +++: significant improvement; ++: major improvement; +: minor improvement.

Modeling efforts, requirements and model reproducibility



The comparison is qualitative. The scale is from 1 to 7, where 1 is the lowest grade, corresponding to a significant higher effort compared to TIMES-DK, 4 corresponds to an effort equivalent to the one of TIMES-DK and 7 is the highest grade, corresponding to a significant improvement with respect to the backbone model.

COMETS

Further information in upcoming PhD thesis:

Tattini J. (2018), Improving the representation of consumers' choice in transport within energy system models, Technical University of Denmark, Management Engineering

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8. **DCSM**: *Mulholland E., Tattini J., Ramea K., Yang C., Ó Gallachóir B., (2018). The Cost of electrifying private transport – Evidence from an empirical consumer choice model of Ireland and Denmark, Transportation Research Part D: Transport and environment*
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