Behavioral realism in IAMs: vehicle choice case study

Kamila Krych, 09.03.2022

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Improving the behavioral realism of global integrated assessment models: an application to consumers' vehicle choices

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Introduction

Energy use is influenced by behavioral features

Policy-relevance

Bounded rationality

Heterogeneity

Non-optimizing heuristics

Social influence

Non-monetary preferences

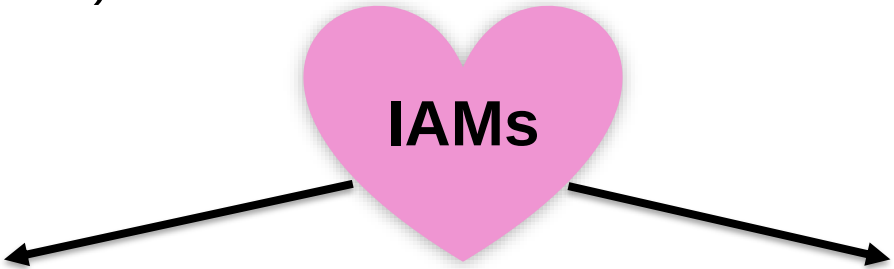
Infrastructure & context

Immediacy effects
(discount rate)

Institutions

Behavioral realism in models today*

- A few **energy-economy models** incorporate heterogeneity, non-monetary preferences etc. (Canadian CIMS, UK's BLUE model, French Res-IRF)



- Technology rich
- bottom-up
- inter-temporal optimization

(MESSAGE, TIAM-UCL, DNE21+)

→ **Discount rates**

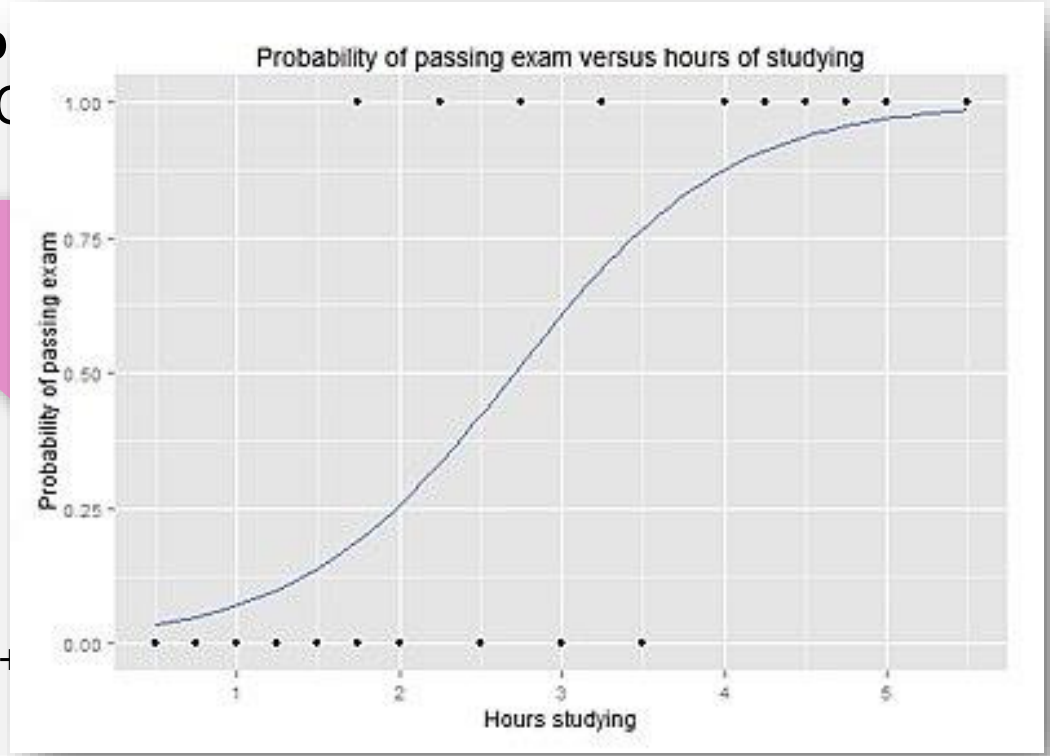
- Simulation models
- Limited temporal foresight
- Recursive-dynamic modeling

(GCAM, IMAGE)

→ **Multinomial logit functions**

Behavioral realism in models today*

- A few **energy-economy mo**
  monetary preferences etc. (C
  French Res-IRF)



- Technology rich
- bottom-up
- inter-temporal optimization

(MESSAGE, TIAM-UCL, DNE21+

→ **Discount rates**

Vehicle choice – behavior is key!

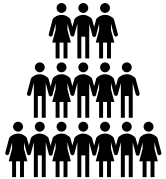
Vehicle choice is influenced by behavioral features

Bounded rationality

Non-optimizing heuristics

Non-monetary preferences

Immediacy effects
(discount rate)



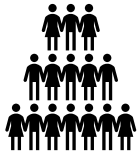
Heterogeneity

Social influence

Infrastructure & context

Institutions

We shouldn't include it all



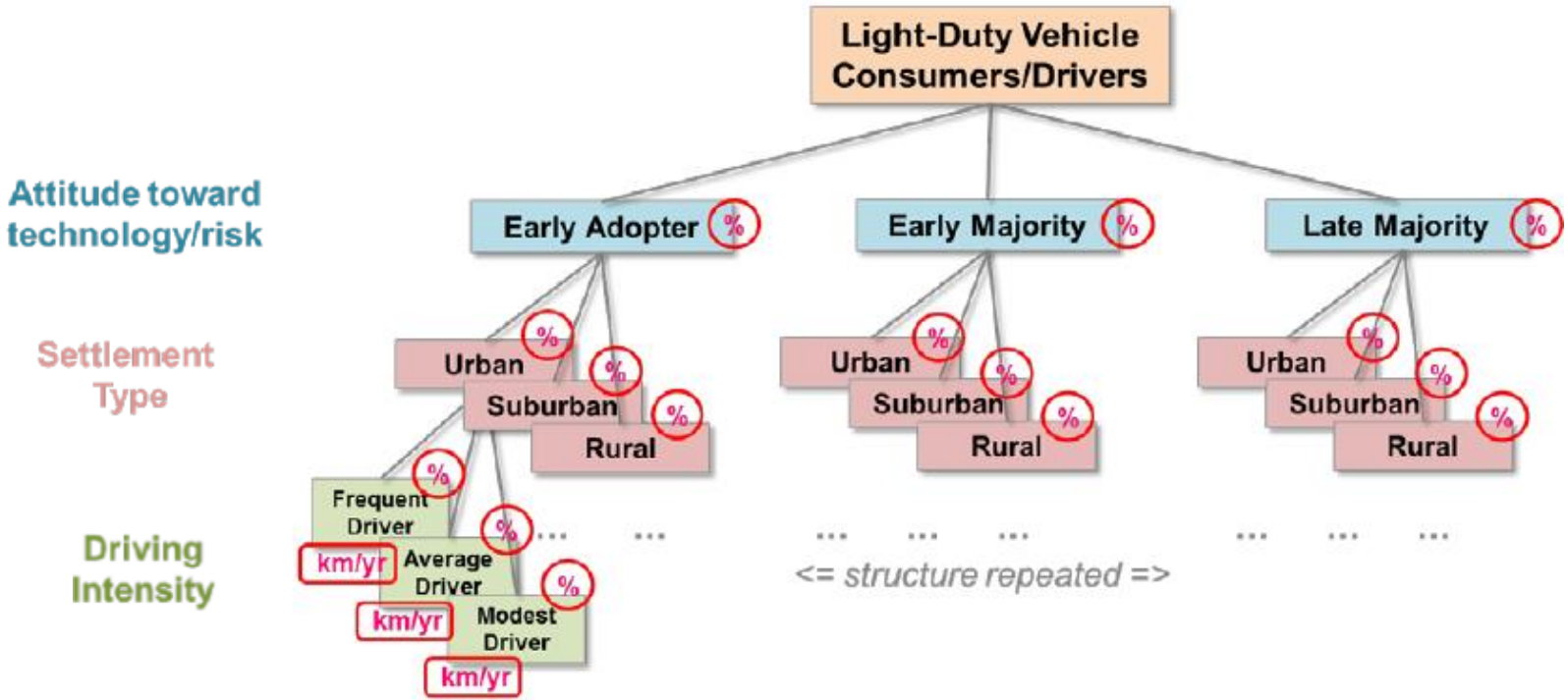
Behavioral Feature	Description	strength of evidence	tractable	policy lever	impact
Heterogeneous preferences	Adoption propensity	high-medium	maybe	maybe	yes
	Driving practices	low	no	no	maybe
	Environmental concern	medium	maybe	no	yes
	Attitudes to vehicles	high-medium	maybe	no	less
Non-monetary preferences	Refueling network	high	yes	yes	yes
	CO_2 emissions	high-medium	yes	yes	yes
	Range, battery time, warranties	high	yes	maybe	yes
	Vehicle range	high-medium	yes	no	yes
Social influences	Neighborhood effects	high	maybe	yes	yes
	Information transmission	high	maybe	maybe	yes
Contextual conditions	Refueling availability	high	maybe	yes	yes
	Refueling location	medium	maybe	yes	yes
	Incentives	high	yes	yes	yes

Methods

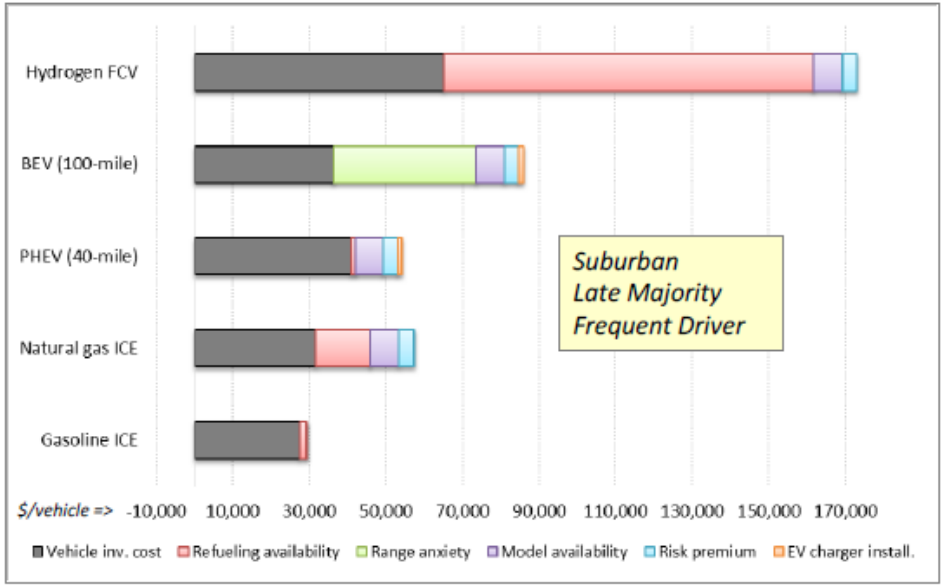
Case study in MESSAGE

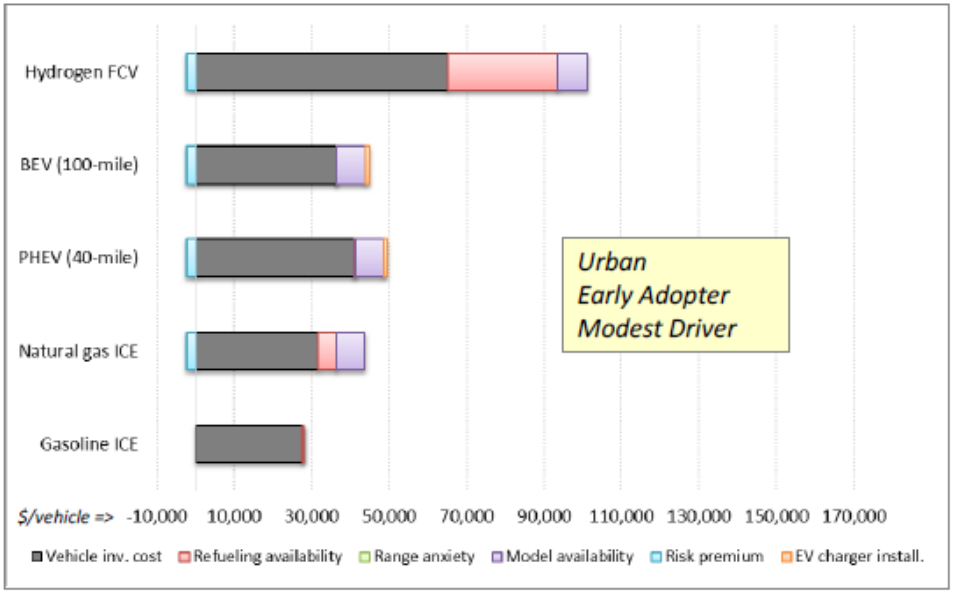
- in particular „MESSAGE-Transport” with alternative fuel vehicles
  - ICE, HEVs, PHEVs, **FCVs**, **BEVs**
- Scenarios 2020-2100
- Goal: 600 ppm in 2100, 2.7 deg temp increase
- Uniform carbon price from 2020, growing 5%/year
- Behavioral aspect:
  - Step 1: Disaggregate demand
  - Step 2: Assess disutility costs (MA^3T model)

Step 1: Disaggregate demand



Step 2: Assess disutility costs





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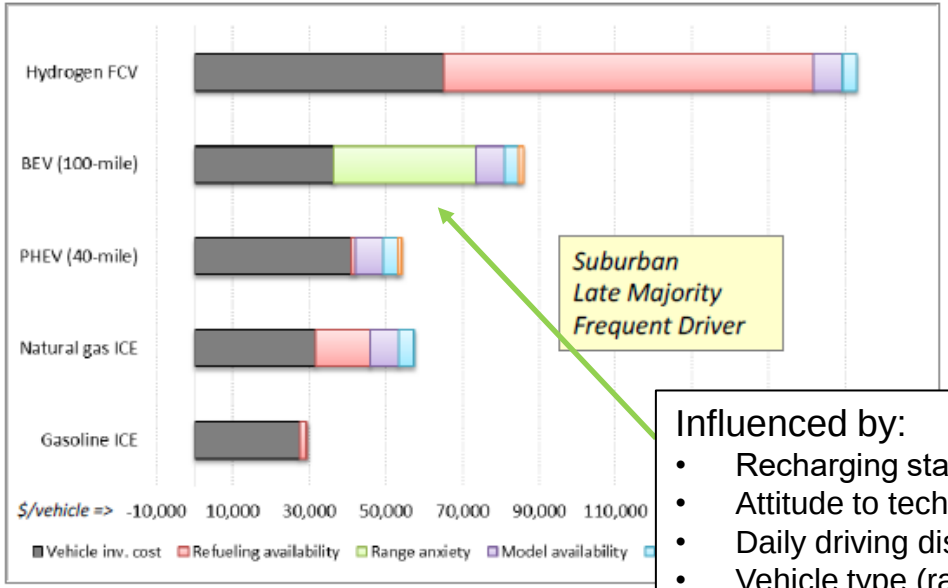

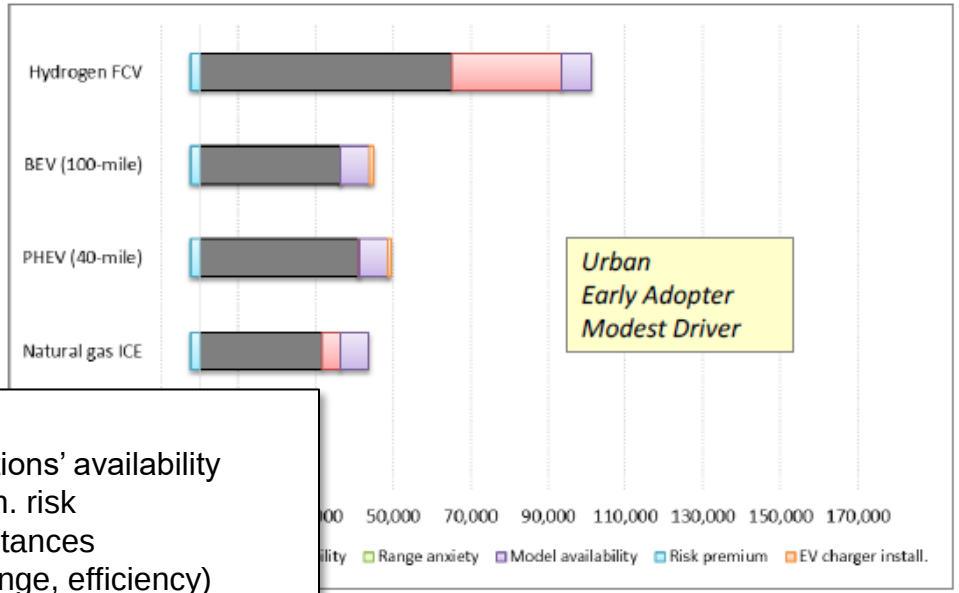

Influenced by:

- Recharging stations' availability
- Attitude to techn. risk
- Daily driving distances
- Vehicle type (range, efficiency)

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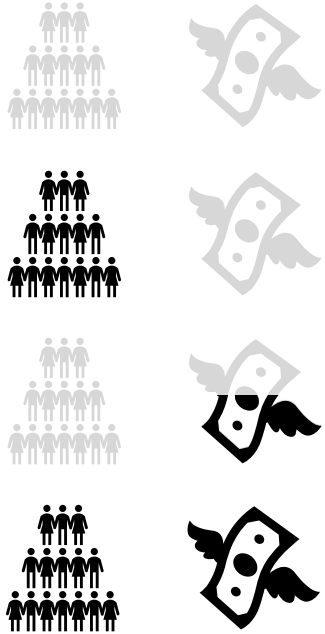
Scenarios

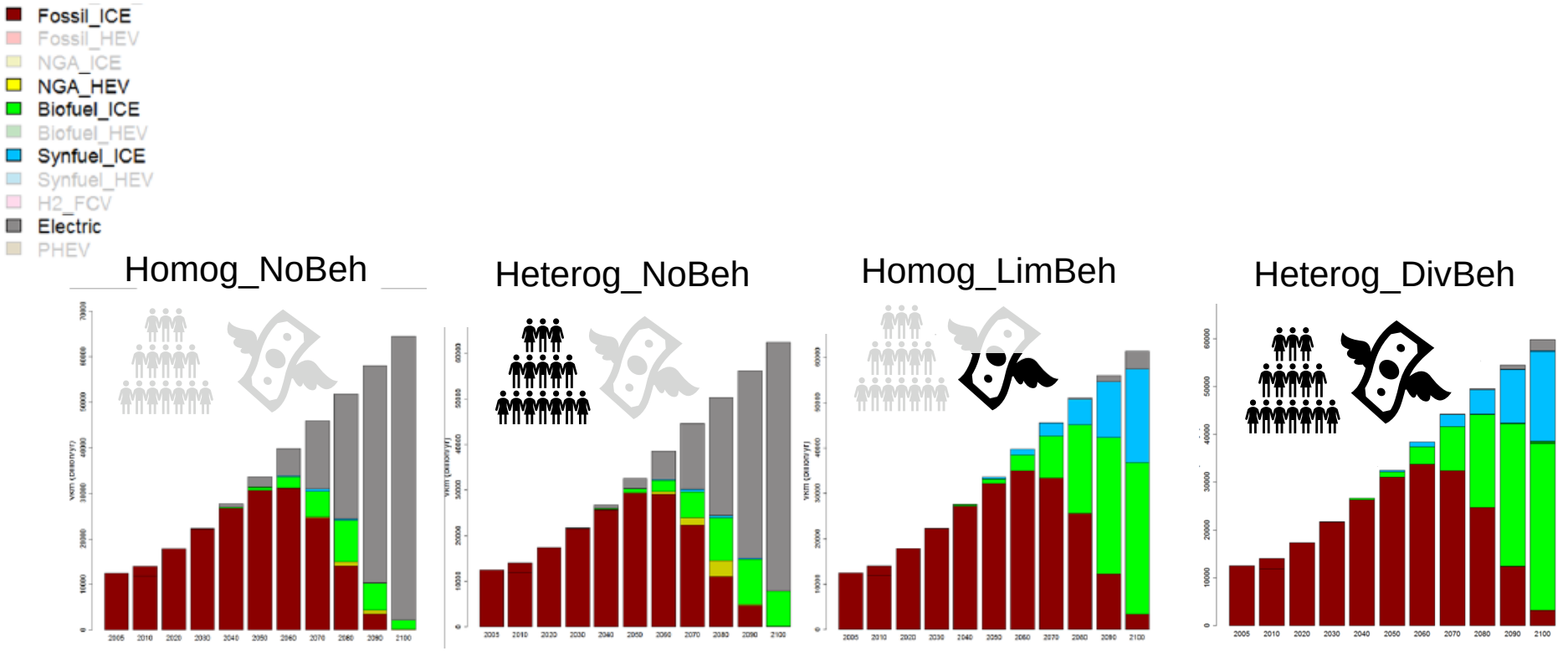
1. Scenario „Homog_NoBeh”
2. Scenario „Heterog_NoBeh”
3. Scenario „Homog_LimBeh”
4. Scenario „Heterog_DivBeh”



Disutility costs held constant!

Results

Vehicle-km distribution until 2100



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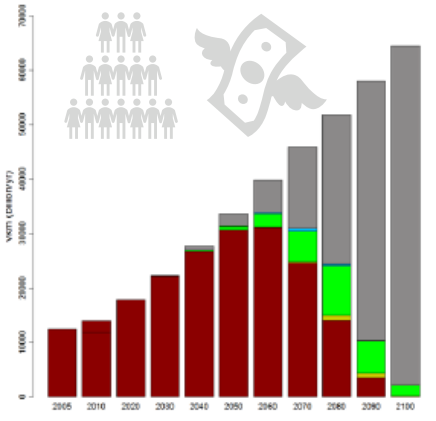
Vehicle-km distribution until 2100

- Fossil_ICE
- Fossil_HEV
- NGA_ICE
- NGA_HEV
- Biofuel_ICE
- Biofuel_HEV
- Synfuel_ICE
- Synfuel_HEV
- H2_FCV
- Electric
- PHEV

Homog_NoBeh



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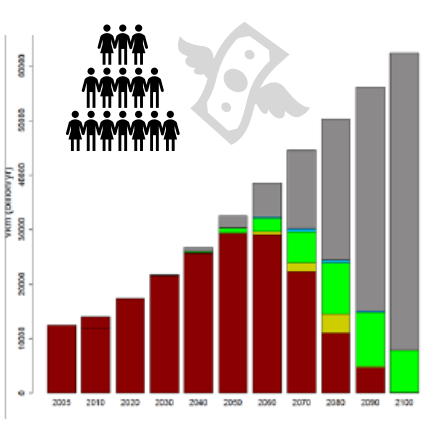
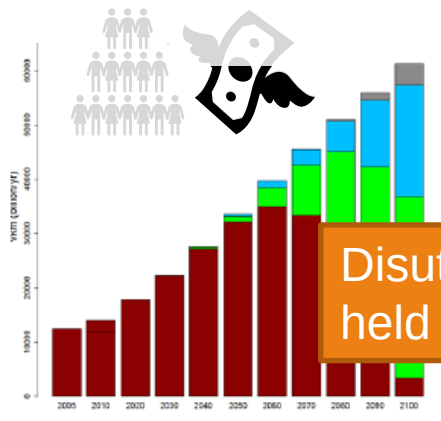


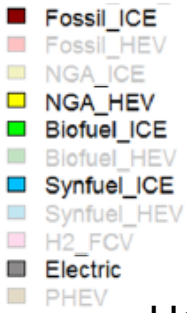
Homog_LimBeh



Heterog_DivBeh

Disutility costs held constant!

Vehicle-km distribution until 2100



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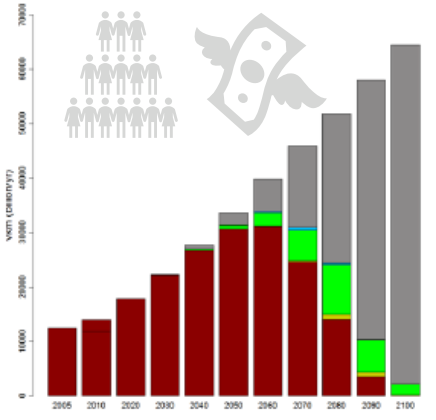

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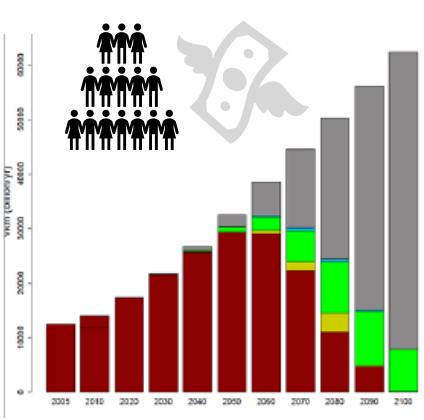

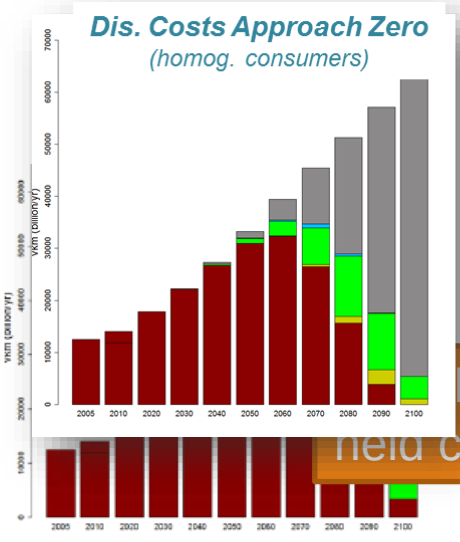

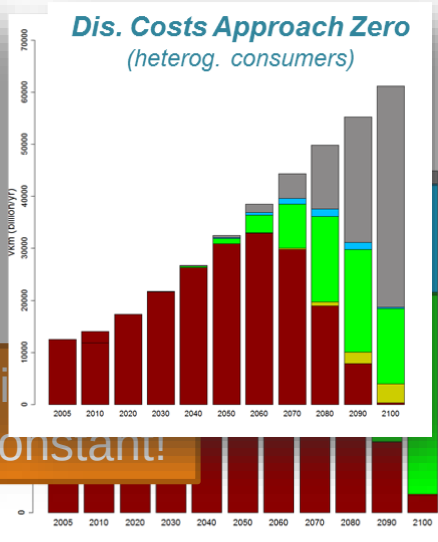

held constant!

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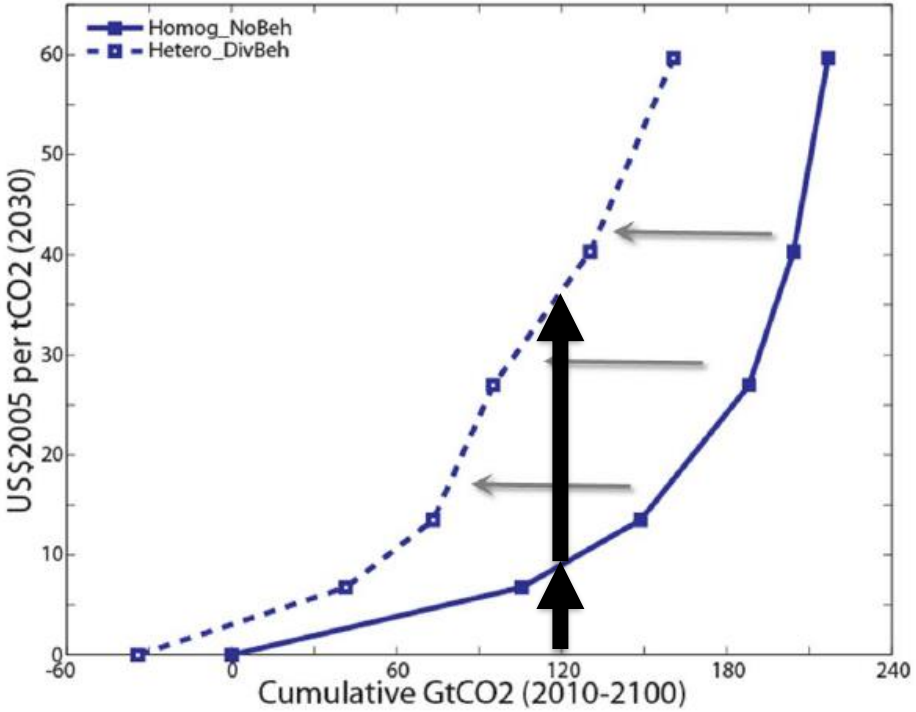
Carbon price increases



Conclusions

Behavior matters

- Including behavioral realism in IAMs:
  - Frontier of research for IAMs
  - Strongly alters results!
  - Allows to evaluate a wider set of policies
  - (price vs. non-price-based policy instruments)
- Disutility costs could decrease in time
- More „quantifiable” data needed