

# Ideas for Incorporating Longer Term Behavioral Dynamics in Activity-Based Travel Demand Models

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# Questions addressed...

What are “longer term behavioral dynamics”?

Why do we need them in our models?

Why aren't they in our models yet?

How can we incorporate them in advanced models?

# Questions addressed...

**What are “longer term behavioral dynamics”?**

Why should we want them in our models?

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## Time scales of travel behavior and modeling domains

Time Scale	Relevant Behavior	Modeling Domain
Seconds	Driving behavior	Traffic
	Route choice	Microsimulation
Minutes	Trip departure time choice	
Hours	Tour/trip mode choice	Activity-Based
	Tour/trip destination choice	Travel Demand
Days	Day's activity schedule	Microsimulation
Weeks	Activity scheduling "habits"	
	Location choice "habits"	
Months	Mode choice "habits"	
	Buying/selling vehicles	
Years	Choice of school	
	Choice of workplace	
	Household transitions	
Decades	Choice of residence	Land
	Business location	Use
	Land development	Microsimulation

## Time scales of travel behavior and modeling domains (very short term)

<b>Time Scale</b>	<b>Relevant Behavior</b>	<b>Modeling Domain</b>
Seconds	Driving behavior	Traffic
	Route choice	Microsimulation
Minutes	Trip departure time choice	

## Time scales of travel behavior and modeling domains (very long term)

Time Scale	Relevant Behavior	Modeling Domain
Years	Buying/selling vehicles	
	Choice of school	
	Choice of workplace	
	Household transitions	
Decades	Choice of residence	Land
	Business location	Use
	Land development	Microsimulation

## Time scales of travel behavior and modeling domains (medium – longer term)

Time Scale	Relevant Behavior	Modeling Domain
Hours	Tour/trip mode choice	Activity-Based
	Tour/trip destination choice	Travel Demand
Days	Day's activity schedule	Microsimulation
Weeks	Activity scheduling "habits"	
	Location choice "habits"	
Months	Mode choice "habits"	
	Buying/selling vehicles	
Years	Choice of school	
	Choice of workplace	
	Household transitions	

# Examples of dynamic effects

- Time lags, delayed responses
  - Can be due to changes in constraints or information
- Asymmetric responses
  - Can be due to budget effects, attitudes towards risk
- Responses related to rates of change
  - Influences perception, expectations about future
- Threshold effects
  - Discrete shifts as opposed to continuous adjustment



# Questions addressed...

What are “longer term behavioral dynamics”?

**Why do we need them in our models?**

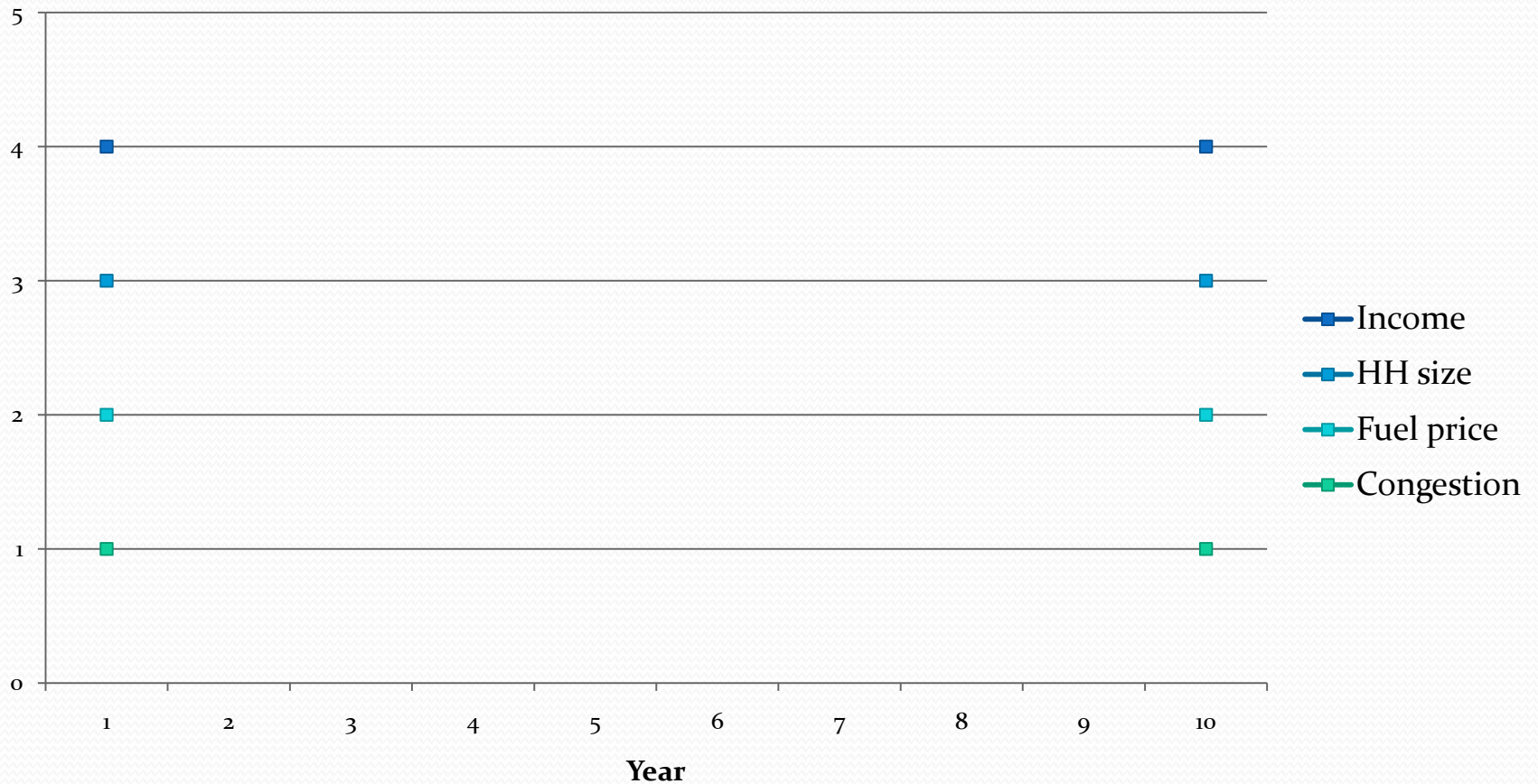
Why aren't they in our models yet?

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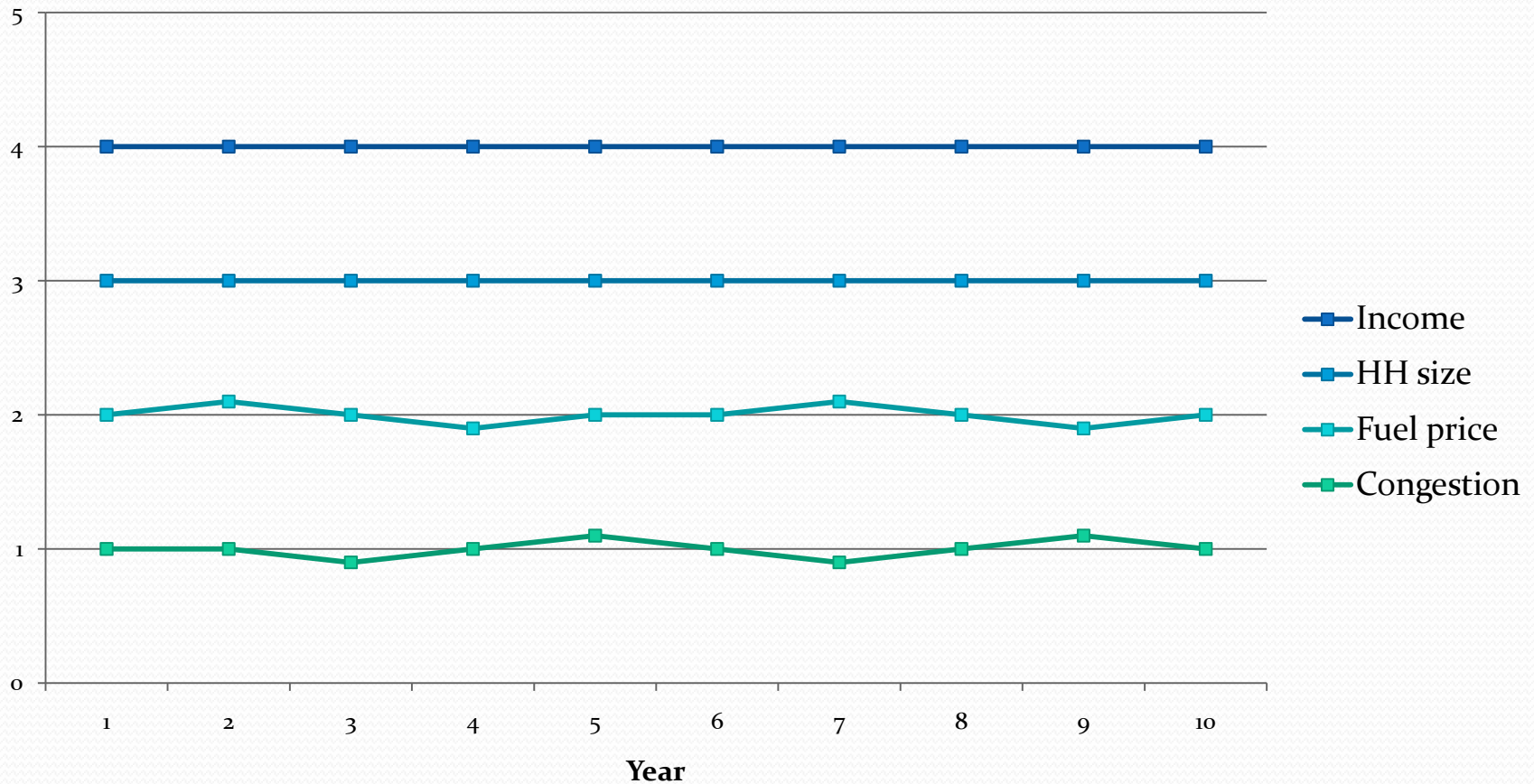
# Why do we need to add dynamics to travel choice models?

- The historical view
- The systems theory view
- The econometrics view
- The philosophical view

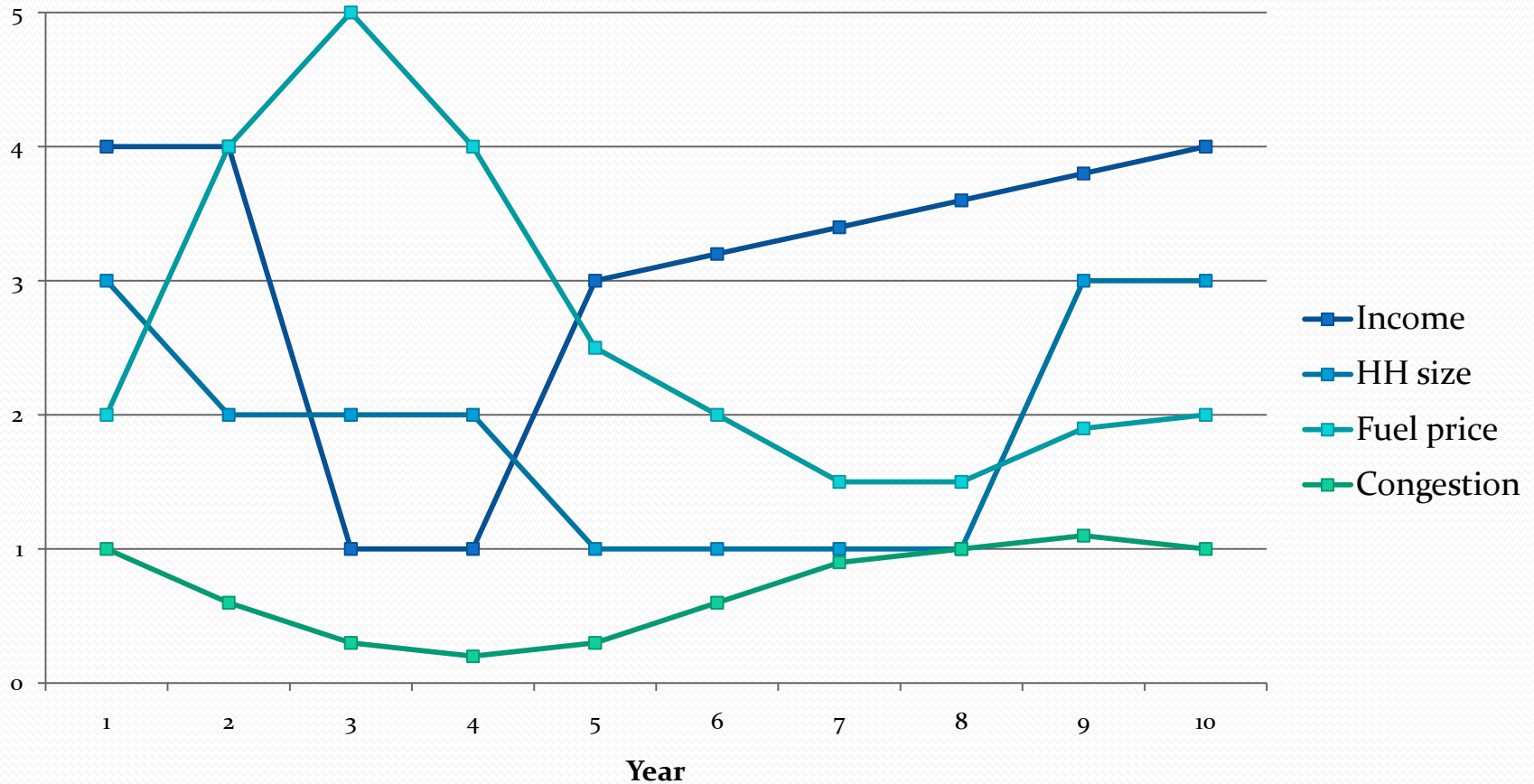
# Hypothetical example



# Hypothetical example- path 1



# Hypothetical example – path 2



# The historical view

- History matters (path-dependence)
- Changes trigger changes > we need models that explicitly predict change over time
- Cross-sectional snapshots don't provide enough information

# The systems theory view

- In non-linear feedback systems with time delays, different timing and rates of changes can lead to different “equilibrium” outcomes
- Need to know the path to predict the outcome
- Often, the structure is more important than the parameters

# The econometrics view

Model specification <<< >>> Model estimation  
(Judgment <<< >>> Statistics)

- Need to strike a balance – even the best estimation methods cannot fix a misspecified model



# Sources of heterogeneity

“Nature versus nurture”

- Exogenous
  - Personality, demographics, economic circumstances
- Endogenous
  - Habits, “inertia”, constraints related to previous choices

Need longitudinal data and dynamic variables to distinguish the two.

# Dynamic variables

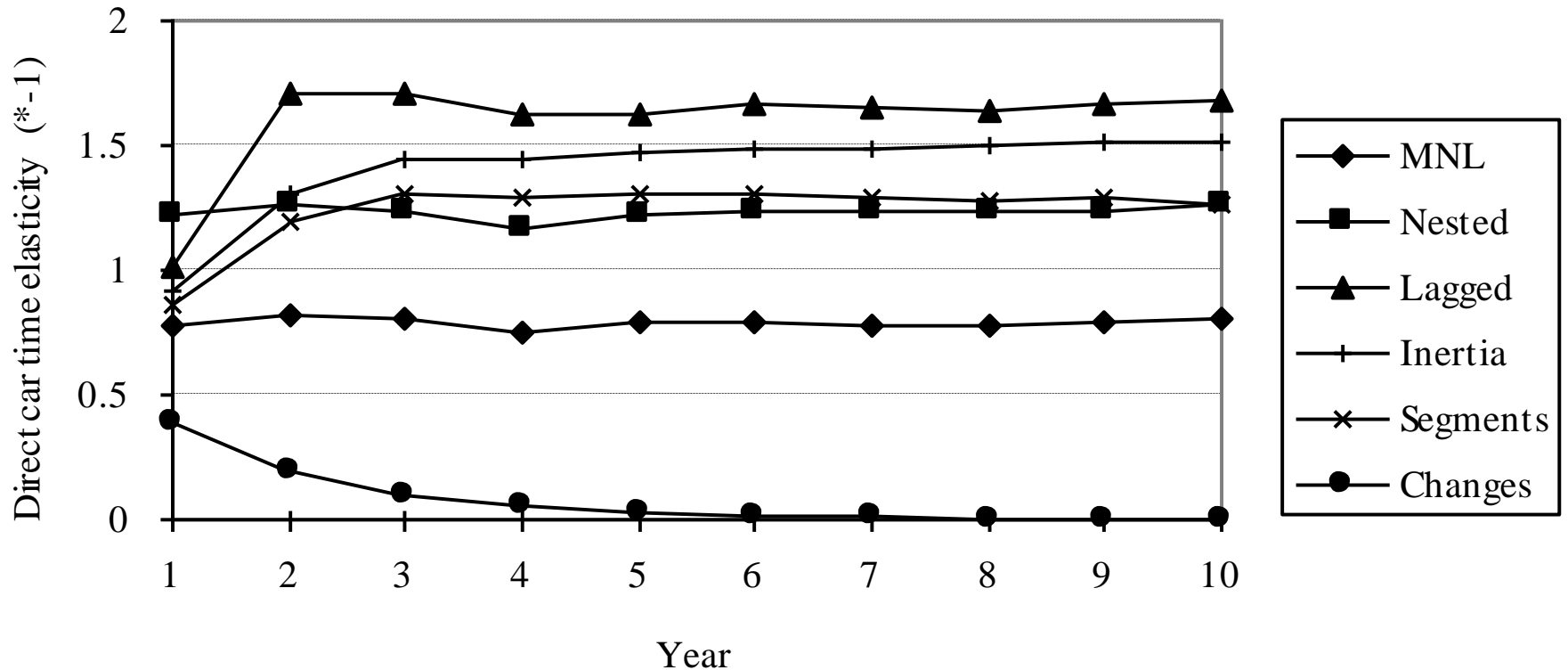
- **Lagged variables:** Delay in information or response to the situation in previous periods
- **State dependence:** “Inertia” or “habit” related to choices made in previous periods
- **Rate of change variables:** Response related to size and/or direction of change between periods

# Dynamic models can give...

- **Asymmetric responses:** Different elasticities for increases versus decreases
- **Delayed responses:** Different short-term and longer-term elasticities
- **Oscillating / non-equilibrium behavior**

# Summary of elasticities from example model specifications from Bradley (1997)

Changes in exog.var. and partial state-dependence



# The philosophical view

- “Models don’t provide answers, they provide insight”
- Models that include important dynamic behavioral processes can provide greater insight  
(even if we can’t estimate those models precisely)

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# Barriers to dynamic travel demand models

- Lack of appropriate longitudinal data
- Complexity of estimation methods
- Model application frameworks

# Panel surveys- history

- Dutch Mobility Panel, late 1980's
  - 10 waves, 6 months apart, 7-day travel diaries
  - MIDAS model (Kitamura, Goulias)
  - car ownership (Kitamura, Bunch); mode choice (Meurs)
- Puget Sound Panel, early 1990's
  - 10 waves, 6 months apart, some missing waves, fewer diary days per wave
  - Not used for applied forecasting models
- First (and last) Conference on Panel Surveys for Transportation, Lake Arrowhead, 1992
- German Mobipanel: 1995-present



# Panel surveys- issues

- Requires multiple days of travel data to measure year-to-year changes in behavior
- High respondent burden
- Attrition between waves- more complex sampling and weighting
- Conditioning... “professional respondents”
- Requires long-term, steady funding stream

# Panel surveys- Opportunities

- Shift towards passive data collection – GPS, cell phones, ?
  - Multi-day data capture
  - Lower respondent burden >> multiple waves or continuous(?)
  - Higher accuracy
  - Data has important side-benefits (network “probes”)
- Can supplement with short questionnaire

# Model estimation

- Mixed logit, GEV methods allow estimation of serial correlation in panel models
- Now commonly used in practice, several different estimation packages

# Model application

- Model application requires the past history of predicted choices to be stored for each individual
- Not easily possible in the aggregate 4-step framework
- Easily accommodated in disaggregate, agent-based microsimulation models, such as most ABM

# Questions addressed...

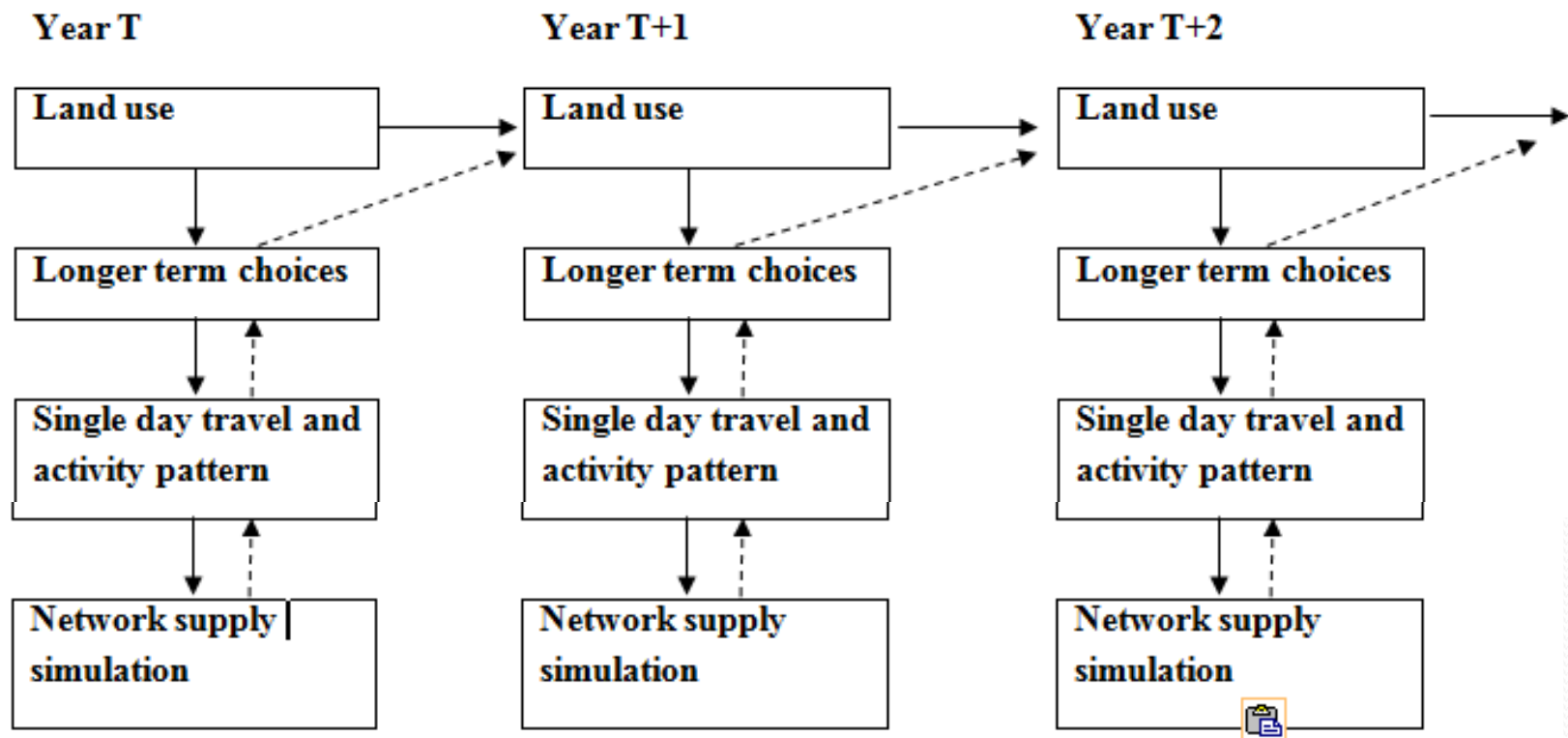
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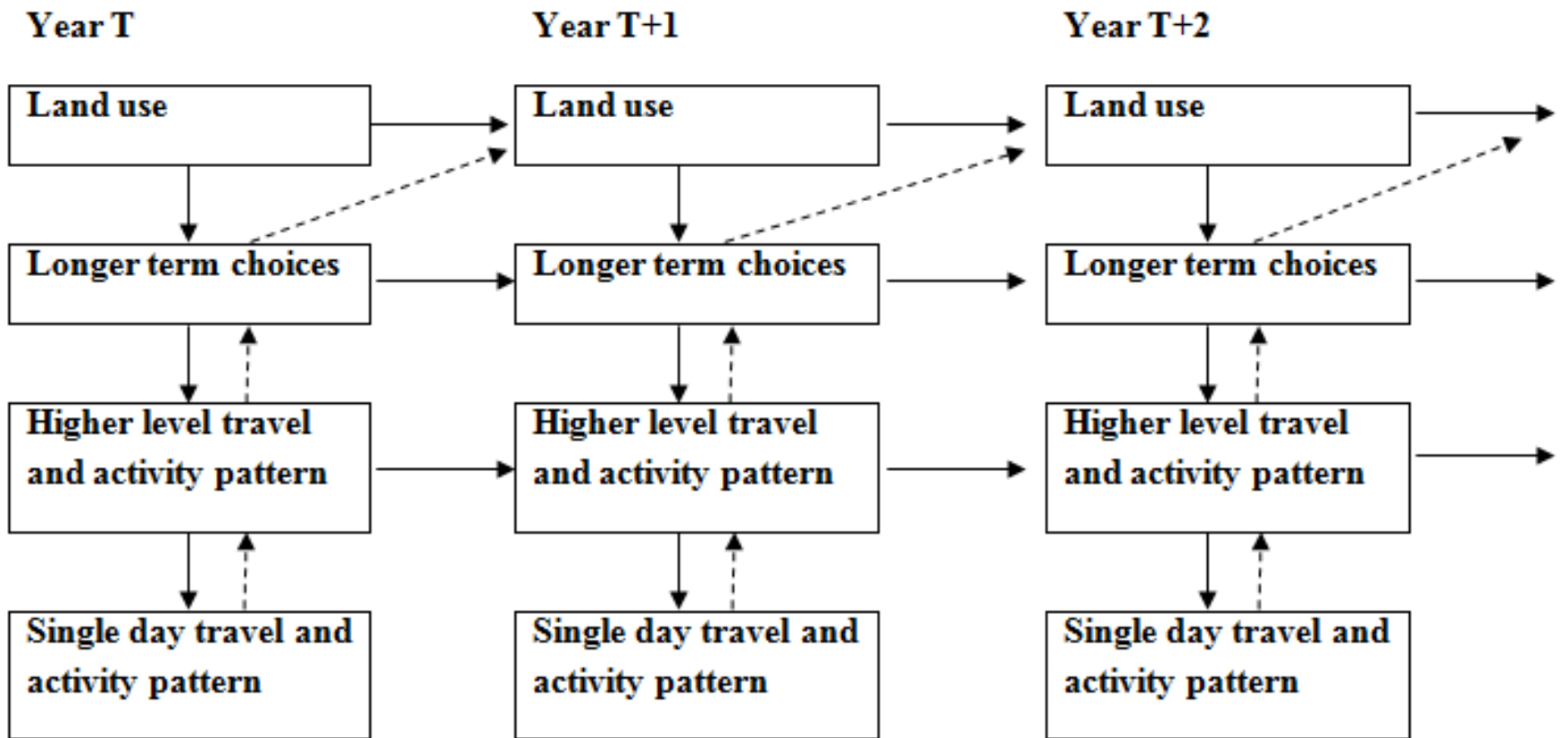
**How can we incorporate them in advanced models?**

# Integrated ABM / LU structure



↓ = conditional linkage between choices

↑ = accessibility (logsum) linkage



# What defines a “higher level travel and activity pattern”? Examples...

- The frequency of participating in specific types of activities
- The regularity with which specific destinations are visited
- The typical mode used and average distance for specific purposes
- The average number of trips per day and trips per tour (trip chaining)
- The average amount of out-of-home activity time versus in-home activity time
- The regularity of trip departure times and scheduling for specific purposes



# What should a typology do?

- Capture a high percentage of the variation in weekly or monthly travel and activity patterns
- Help distinguish different choice hierarchies and utility functions in the lower level (single day) models, such as different hierarchies across mode choice, destination choice and time of day choices
- Increase the model's realism and policy-relevance



Thank you!

Questions?