# Incorporating Activity-Based Accessibility Measures in Longer Term Life-Style Decisions

## TEL-AVIV AUTO ONWERSHIP MODEL CASE

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# Outline

- Daily activity travel behavior and longer term decisions
- Activity Base Accessibility Measures
- Behavioral realism vs. computational complexity
- Tel-Aviv Metropolitan Model Structure
- Car Availability Model
- Simplification of Car Availability Model
- Main results

# Land Use Policies

- Mixed land use
- Concentration schemes
- Urban design
- New urbanism and smart growth

- Assuming residents of “New Urbanism” drive less
- Will lead to less congestion and air pollution

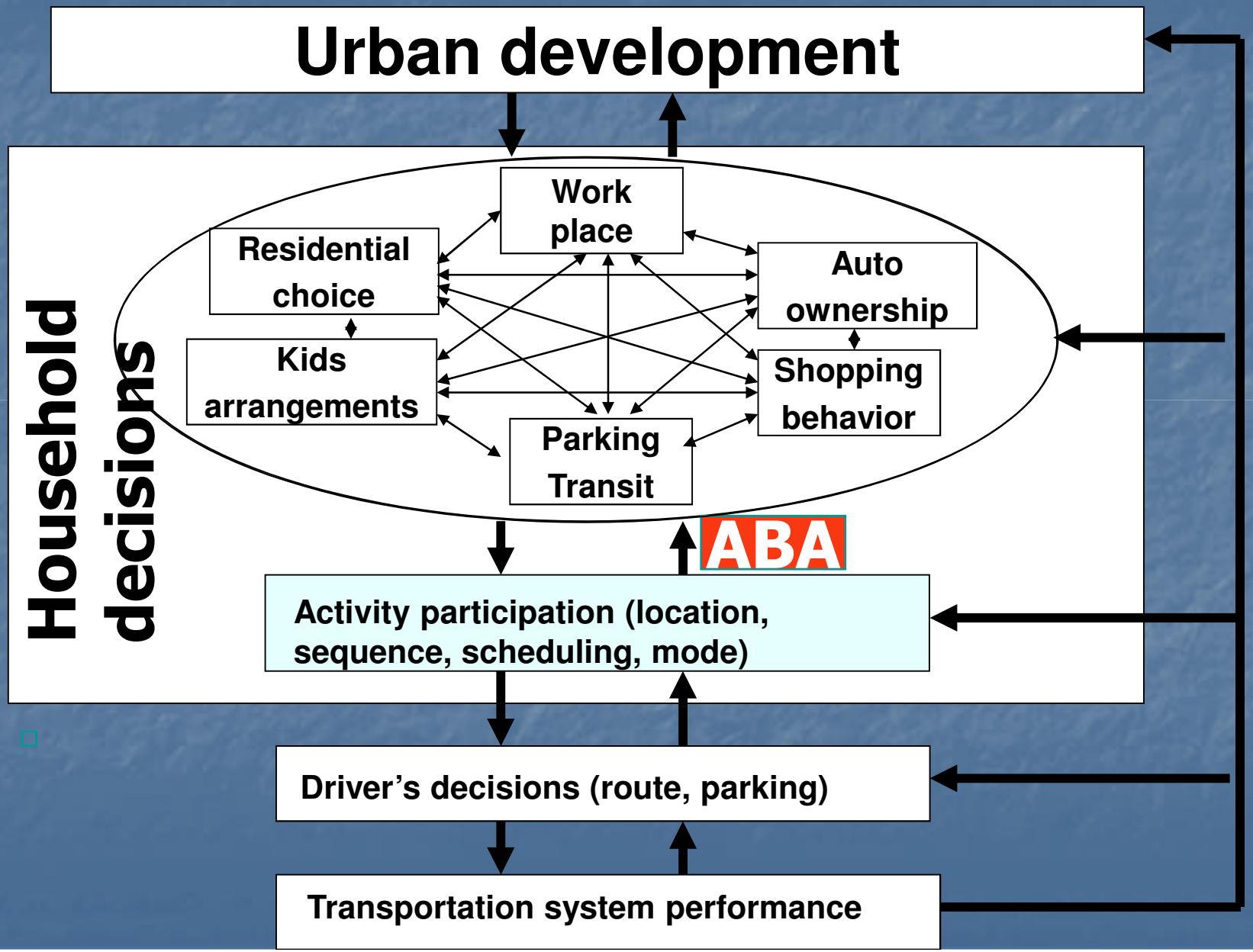
# Land Use Effects on Travel Behavior

- The research of the build environment on travel behavior is non-conclusive (selectivity bias)
- The effect of improved accessibility: shorter travel time and more access to activities, may induce more travel
- Mixed results in the literature
- Not much can be said about the effectiveness of urban design and land use planning in reducing traffic.

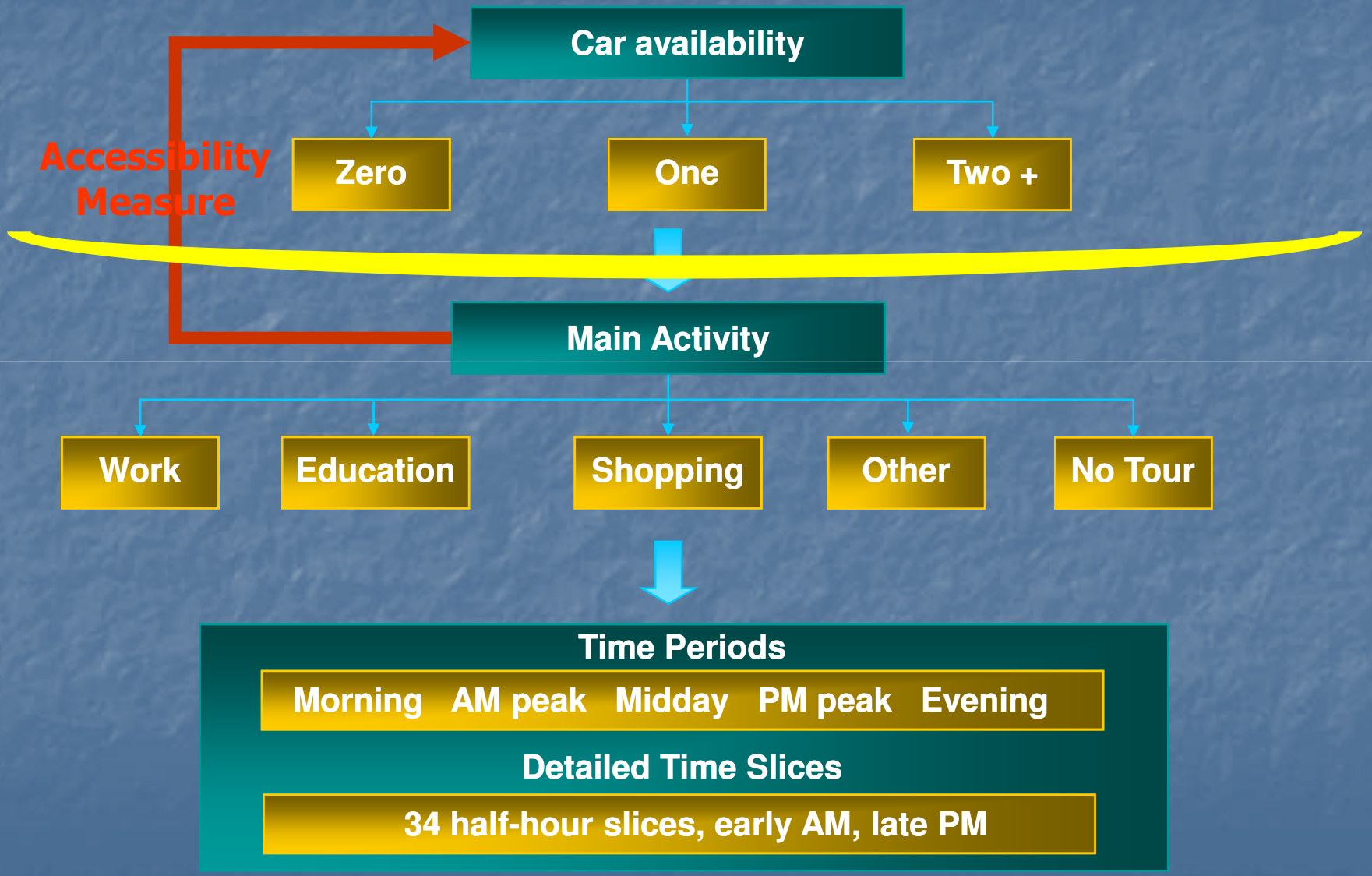
# Exogenous Activity Based Accessibility Measures

- Accessibility as space-time feasibility to better understand individual's accessibility experience (Miller, 1991/2, Kwan, 1998/9)
- However, they treat important attributes of the activity pattern as exogenous, the measures of accessibility depending on the activity opportunities that can be attained.

# Overall Framework



# Tel-Aviv Metropolitan Model



# Accessibility Measure

- Logsum variables represent the expected utility value from lower level models
  - Calculated As:

$$Logsum = \ln\left(\sum_{d} \exp(V_d)\right)$$

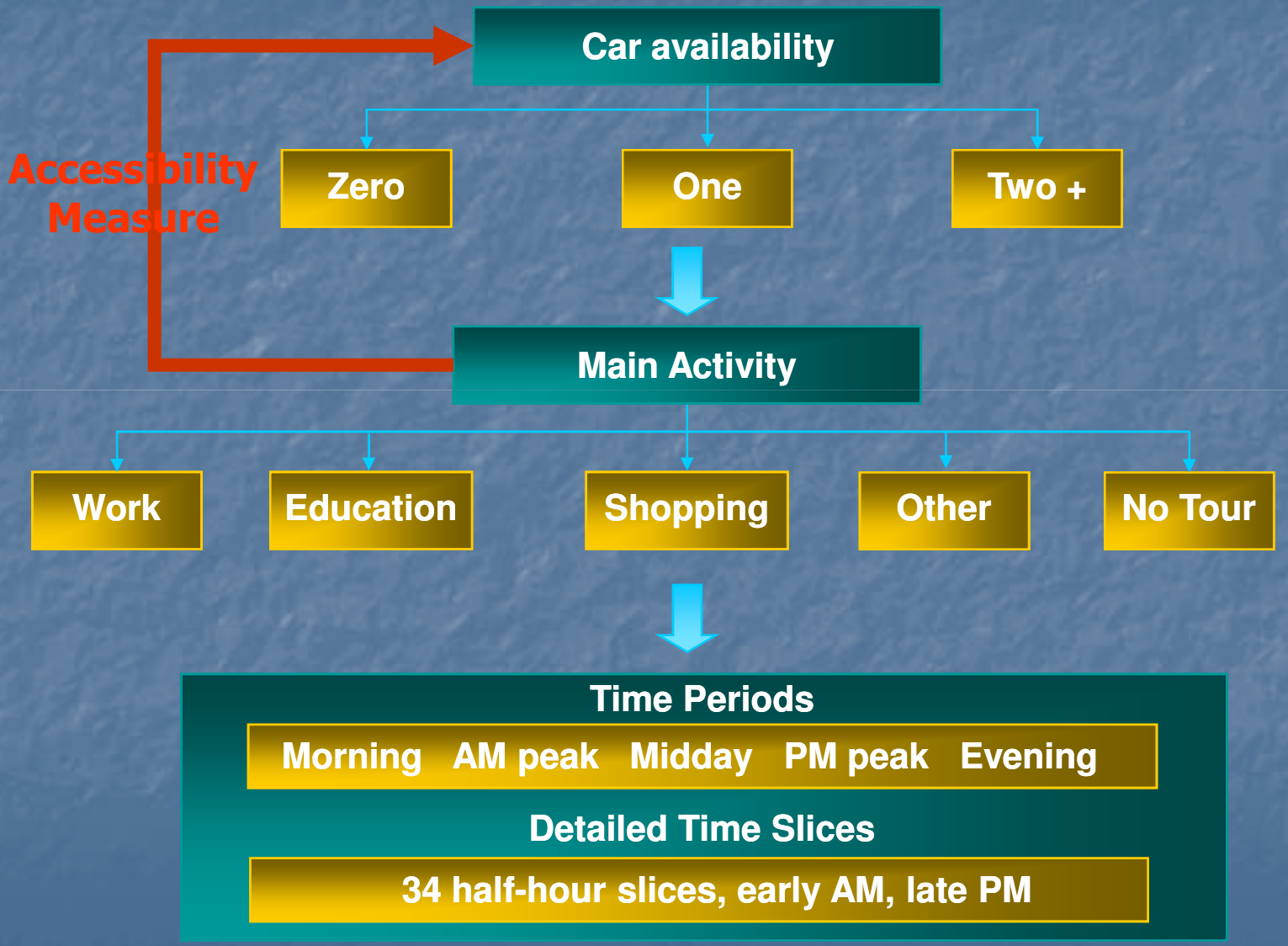
  - Activity Logsum Case:

$$Logsum = \ln\left[\left(V_{NO\ TRIP}\right) + \alpha \times \ln\left(V_{WORK} + V_{EDUCATION} + V_{SHOPPING} + V_{OTHER}\right)\right]$$

# Activity Based Accessibility Measures

- Ben-Akiva and Bowman (1998) - accessibility as the expected value of the individual maximum utility among the activity schedule available.
- Allow one residential location to have different accessibilities for different people
- Can take the information from the activity-based model of person's access to various activities in order to study how its affect long-term decisions.
- Can reflects  travel time and costs of all travel modes to all destination from all trips during the day.
- The ABA treats activities endogenously through a micro-economic approach based on specifying utilities of activity participation.
- Dong et al (2006) used it to analyze various policies.
- Ben-Akiva and Bowman estimate residential choice model

# Tel-Aviv Metropolitan Model



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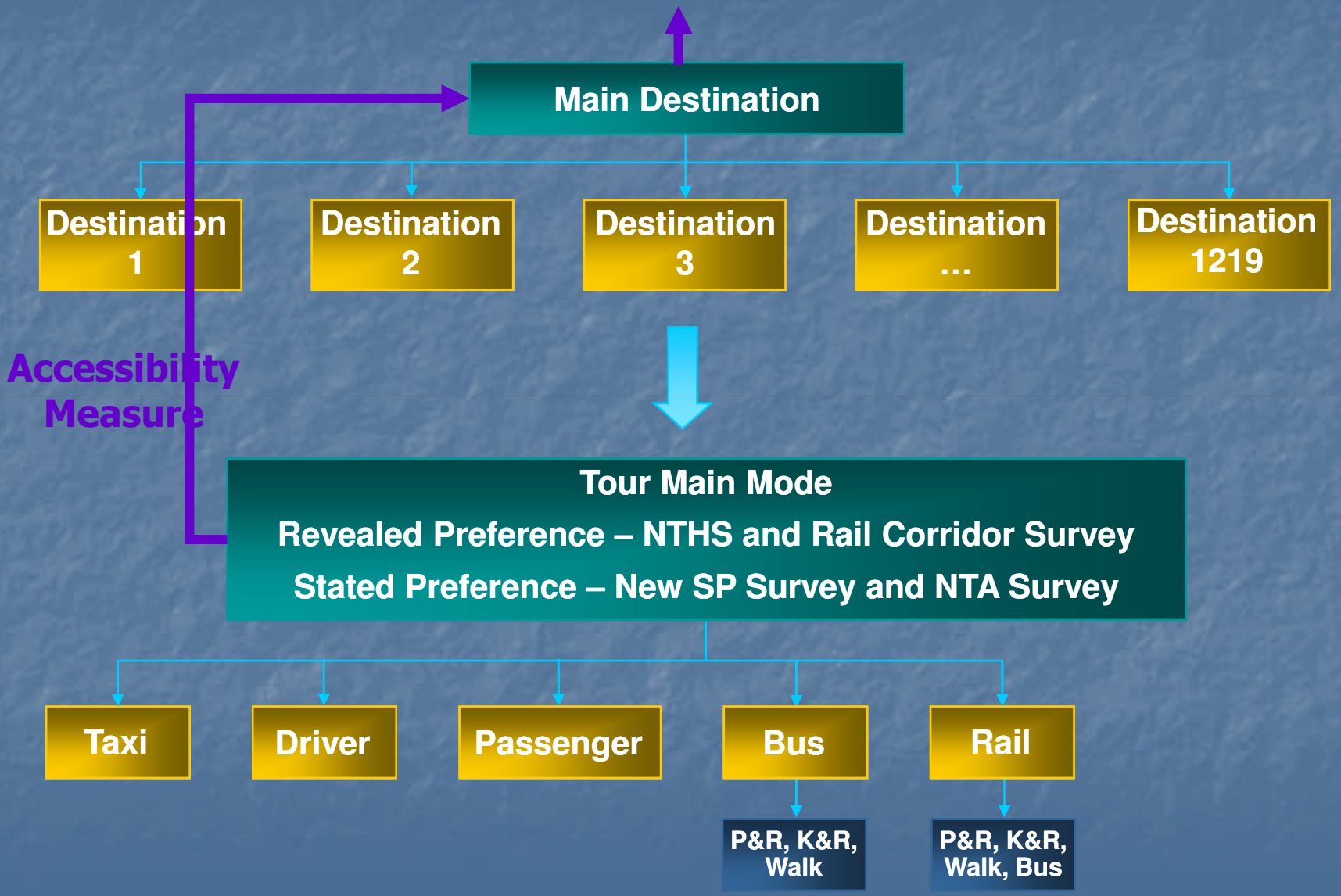
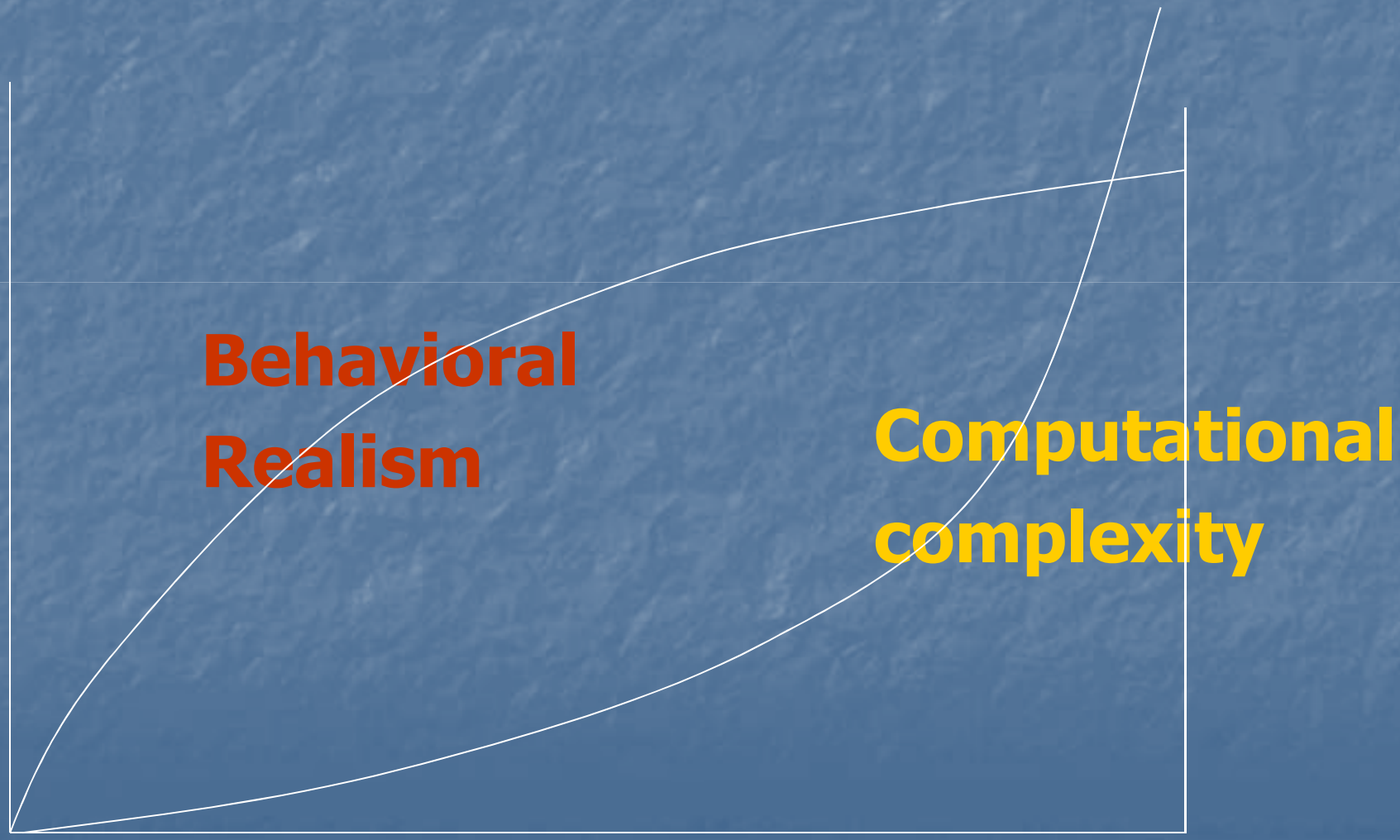


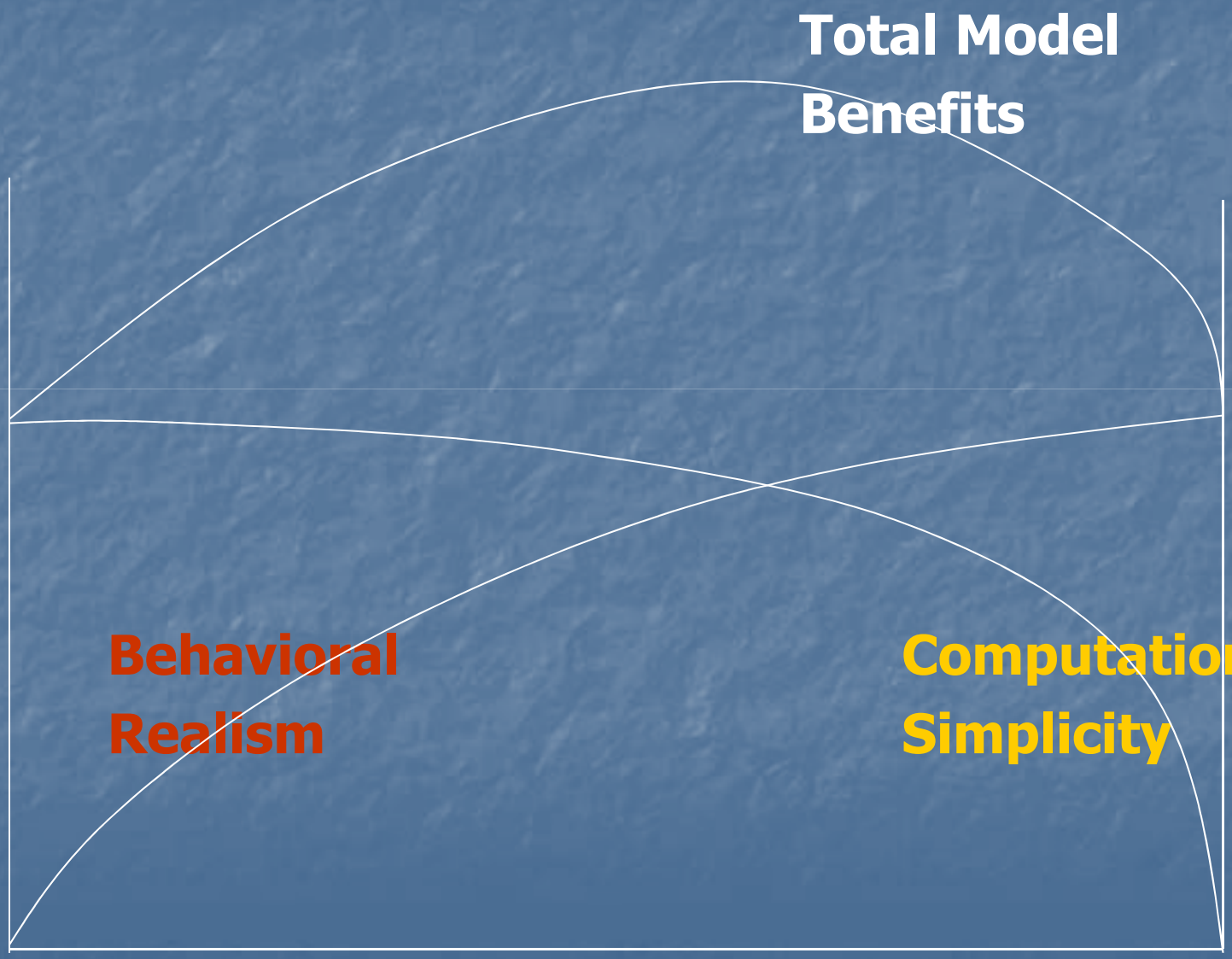
# ABA Measures are complicated
# They add significant running time in applying ABM

- The need to calculate the utility of every combination of the many alternatives
- Can be in the scale of millions for an entire AB model
- Start from the bottom of the model structure going up the tree and then calculating probabilities back down the tree structure

# Behavioral Realism and Computational Complexity



# Benefits from Behavioural Realism and Computational Simplicity



# Simplifications/Short Cuts in ABA measures:

- Capture the most important accessibility effects
- Approximate the expected utility logsum:
  - Aggregate logsums – ignoring some differences among individuals
  - Use logsums for a carefully chosen subset or aggregation of the available alternatives
  - Simulate a conditional outcome using a probability weighted Monte Carlo draw

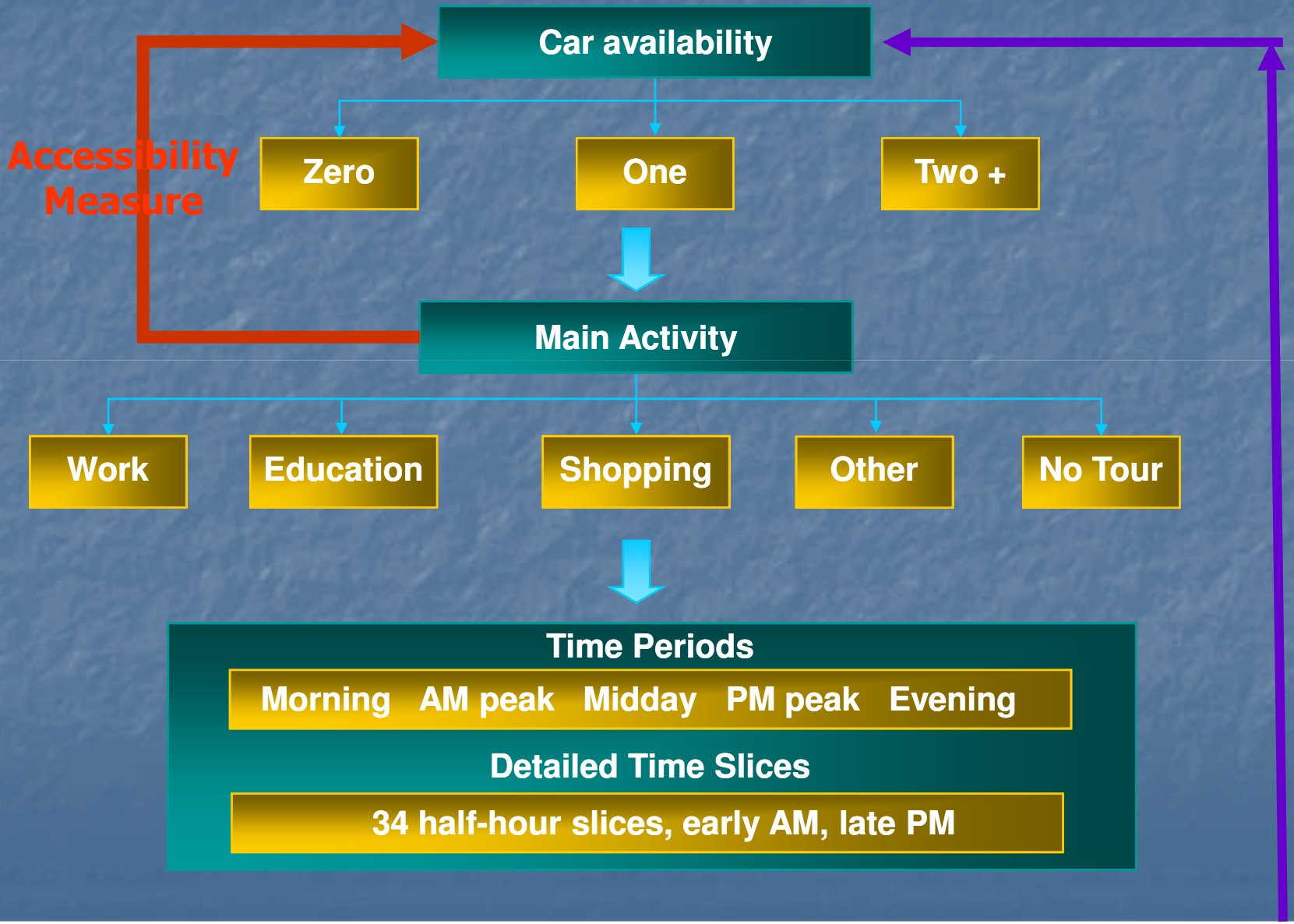
# Examples

- San Francisco
  - Work mode choice accessibility logusms (to be fed into work location model) are calculated assuming AM Peak - PM Peak tour with no intermediate stops
- Sacramento
  - The assumed conditional outcome is selected by Monte Carlo draw using approximate probabilities
  - Aggregate logsums
- However, these simplifications results in unknown biases

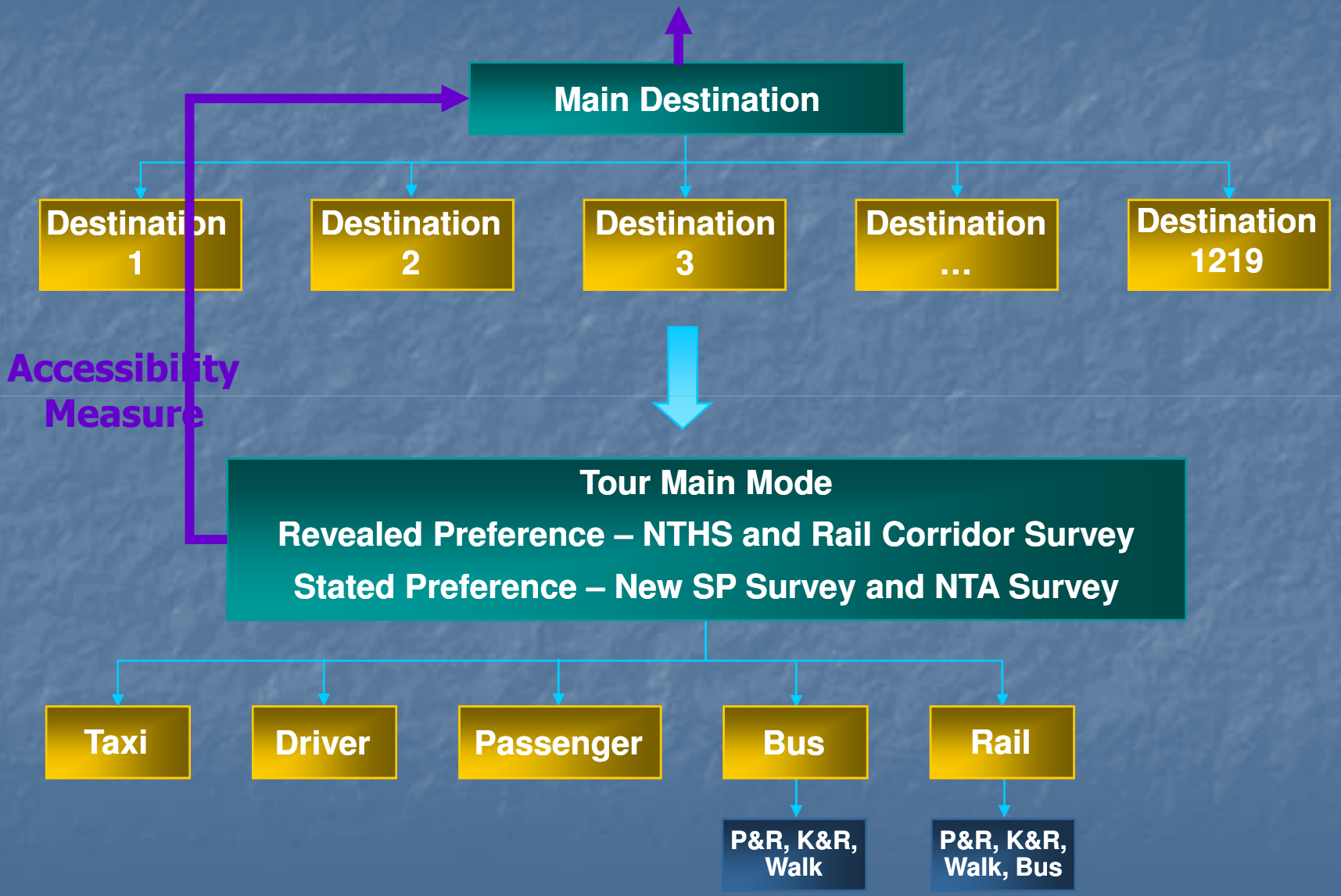
# Accessibility Measures in the Tel Aviv Car Availability Model

- **Two Accessibility Measures:**
  - Main Activity Accessibility Measure
  - Main Mode-Destination Accessibility Measure

# Tel-Aviv Metropolitan Model



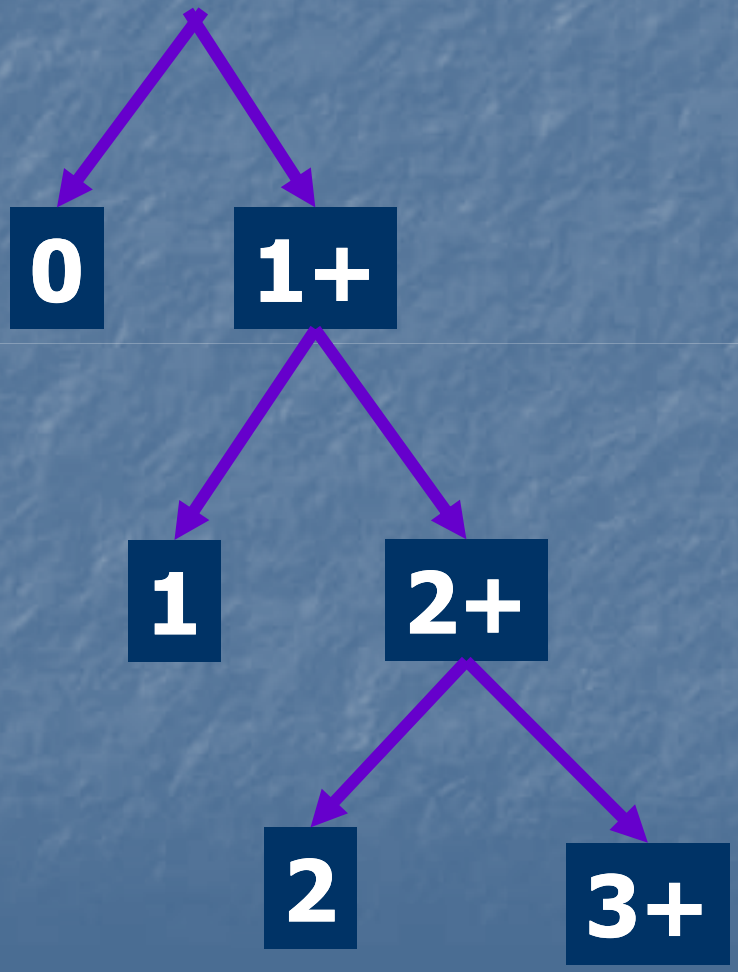
# Tel-Aviv Metropolitan Model



# Accessibility Measures Simplifications

- Main Activity logsum with no feedback from lower models
- Mode-Destination logsum was incorporated directly.
  - only for work purpose at the AM peak period
  - The mode choice logsums are varied only by time variables and aggregated for individual characteristics
- 6 Times longer to run the model with the simplified Logsum

# Car Availability Model Structure



# Full Model Estimation

| *Variable* | *Utility 1 Car* | *Utility 2 Cars* | *Utility 3 Cars* | *Utility 0 Cars* |
|---|---|---|---|---|
| Activity Logsum for Car Y- Activity Logsum for CAR N | 1.170 *[2.00]* | | | |
| Constant | -2.380 *[-8.26]* | -4.430 *[-8.59]* | -6.040 *[-7.13]* | |
| Destination Logsum for 1 Car | 0.542 *[4.170]* | | | |
| Destination Logsum for 2 Car | | 0.682 *[4.450]* | | |
| Destination Logsum for 3 Car | | | 0.740 *[4.440]* | |
| Destination Logsum for 0 Car | | | | 0.479 *[3.950]* |
| Educated Dummy (1 of Person has 15 or more years of study) | 0.367 *[5.880]* | 0.625 *[8.810]* | | |
| Number of Fulltime Workers in a Household | 0.075 *[2.200]* | 0.177 *[4.153]* | 0.213 *[4.392]* | |

# Full Model Estimation

| *Variable* | *Utility 1 Car* | *Utility 2 Cars* | *Utility 3 Cars* | *Utility 0 Cars* |
|---|---|---|---|---|
| Number of Part time Workers in a Household | 0.051<br>*[0.970]* | 0.177<br>*[2.810]* | | |
| Number of Men havig license in a Household | 2.004<br>*[33.690]* | 2.296<br>*[39.110]* | 2.537<br>*[27.510]* | |
| Population Density (Population/Area in km2) | -0.0000089560<br>*[-3.410]* | -0.0000306836<br>*[-6.590]* | -0.0000390280<br>*[-6.090]* | |
| Number of Women havig license in a Household | 1.495<br>*[26.420]* | 1.866<br>*[30.230]* | 2.075<br>*[21.57]* | |
| | ***Estimator*** | ***t-test0*** | ***t-test1*** | |
| NESTA | 0.478 | 5.08 | 2.65 | |
| NESTB | 0.335 | 4.12 | 2.74 | |
| ***Onservation Number*** | ***15866*** | | | |
| ***Init log-likelihood*** | ***-21994.9*** | | | |
| ***Final log-likelihood*** | ***-13723.4*** | | | |
| ***Rho-square*** | ***0.376066*** | | | |

# Estimation Results

## Choice Between 0 and 1+ Vehicles

| 0 CARS VS. 1 CAR | | |
|---|---|---|
| ***Variable*** | ***Utility 1 Car*** | ***Utility 0 Cars*** |
| **Constant** | -2.770<br>*[-9.75]* | |
| **Destination Logsum for 1 Car** | 1.340<br>*[12.36]* | |
| **Destination Logsum for 0 Car** | | 1.17<br>*[11.53]* |
| **Educated Dummy (1 of Person has 15 or more years of study)** | 0.395<br>*[6.61]* | |
| **Number of Workers in a Household ( Full time +Part Time )** | 0.143<br>*[5.07]* | |
| **Number of Men havig license in a Household** | 1.950<br>*[38.31]* | |
| **Number of Women havig license in a Household** | 1.500<br>*[32.78]* | |
| **Population Density (Population/Area in km2)** | | -1.32E-05<br>[-5.11] |
| | ***Estimator*** | |
| ***Onservation Number*** | ***15866*** | |
| ***Init log-likelihood*** | ***-10997.473*** | |
| ***Final log-likelihood*** | ***-5540.853*** | |
| ***Rho-square*** | ***0.496*** | |

# Estimation Results

## Choice Between 1 and 2+ Vehicles

| *Variable* | *Utility 2 Car* | *Utility 1 Cars* |
|---|---|---|
| **Constant** | -4.910<br>*[-17.24]* | |
| **Destination Logsum for 2 Car** | 1.470<br>*[11.36]* | |
| **Destination Logsum for 1 Car** | | 1.12<br>*[8.37]* |
| **Educated Dummy (1 of Person has 15 or more years of study)** | 0.557<br>*[11.36]* | |
| **Number of Workers in a Household ( Full time +Part Time )** | 0.256<br>*[9.64]* | |
| **Number of Men and Women havig license in a Household** | 0.784<br>*[28.96]* | |
| **Population Density (Population/Area in km2)** | | -4.90E-05<br>[-18.34] |
| | ***Estimator*** | |
| ***Onservation Number*** | ***11465*** | |
| ***Init log-likelihood*** | ***-7946.932*** | |
| ***Final log-likelihood*** | ***-6308.727*** | |
| ***Rho-square*** | ***0.206*** | |

# Estimation Results

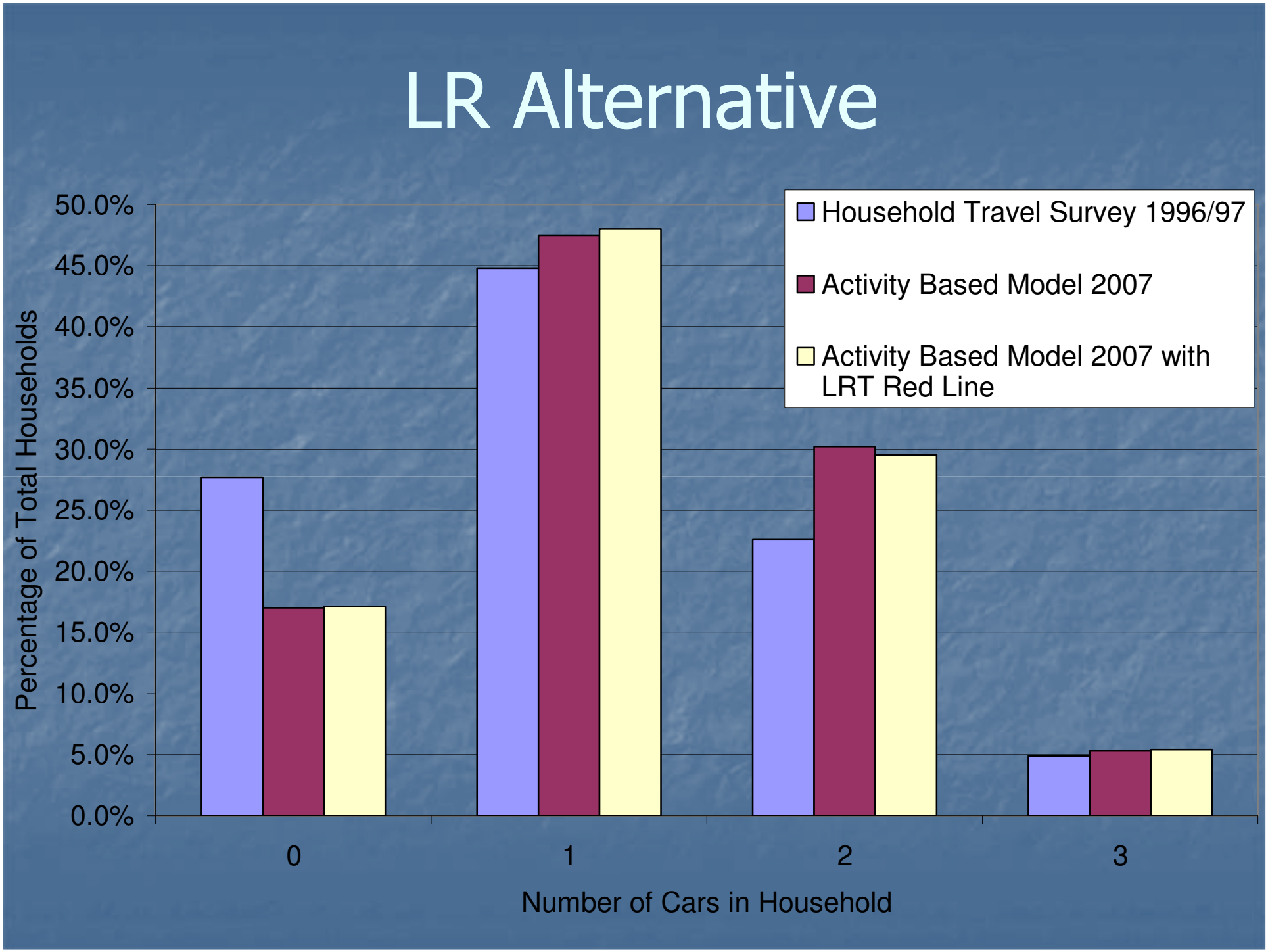
## Choice Between 2 and 3+ Vehicles

| *Variable* | *Utility 2 Car* | *Utility 1 Cars* |
|---|---|---|
| **Constant** | -3.950<br>*[-25.79]* | |
| **Number of Workers in a Household ( Full time +Part Time )** | 0.044<br>*[2.89]* | |
| **Number of Men and Women havig license in a Household** | 0.825<br>*[17.59]* | |
| **Population Density (Population/Area in km2)** | | -1.93E-05<br>*[-3.9]* |
| | ***Estimator*** | |
| ***Onservation Number*** | ***4359*** | |
| ***Init log-likelihood*** | ***-3021.429*** | |
| ***Final log-likelihood*** | ***-1775.78*** | |
| ***Rho-square*** | ***0.412*** | |

# Summary of Main Model Results

- Driver license by gender has the most explanatory power
- Number of full time and part time workers in the household
- Population density
- Education
- Activity logsum was significant only in the full model estimation
- Mode-Destination logsum was significant

# LR Alternative



# Other Hypothetical Scenarios

| Scenario | Motorization Rate (Cars/1000 Residents) | |
|---|---|---|
| | Metropolitan | Tel Aviv Only |
| *Basic Scenario 2007* | 295 | 505 |
| *Triple the Parking Cost for Tel-Aviv Only* | 295 | 508 |
| *Triple the Parking Cost for Tel-Aviv Metropolitan* | 295 | 510 |
| *Double the Parking Cost and Walk Time for Tel-Aviv Only* | 297 | 511 |
| *Triple the Parking Cost and Walk Time for Tel-Aviv Only* | 296 | 508 |
| *With 20% increase in transit speeds* | 296 | 509 |
| *Basic Scenario 2007 with Light Rail Line* | 296 | 507 |

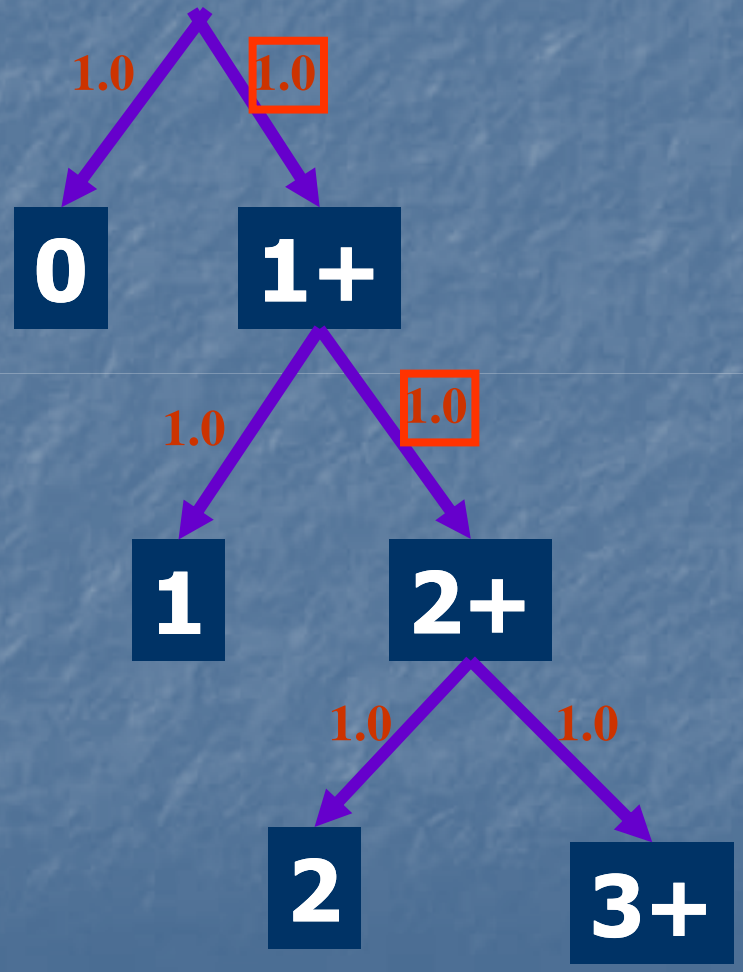
# Conclusions

- ABA measures are important elements in integrating short-term and long-term choices
- Need to carefully consider behavioral realism vs. computational complexity
- Low impact of accessibility on auto ownership in our case
- More work is needed to improve computational issues and to identify the best estimates of ABA measures

# Thanks you for your attention

# Model Simplification

- **Destination Logsum Only**



# Other Scenarios

- **Basic Scenario 2007**
- **Triple Parking Cost for Tel Aviv Only**
- **Triple Parking Cost for Tel Aviv Metropolitan**
- **Double Parking Cost & Walk time (TA only)**
- **Triple Parking Cost & Walk time (TA only)**
- **Enhanced Public Transit (Increase Speeds by 20%**
- **Run with Light Rail Transit in TA**

# The Tel Aviv Auto Ownership/Activity Based Model

- Based on the NTHS data
- Additional data include:

# Mode Destination Accessibility Coefficients

- 0 cars: 0.479
- 1 car: 0.542
- 2 cars: 0.662
- 3+ cars: 0.740