Metropolitan Model Temporal Calibration

Oregon Symposium on Integrated Land Use and Transport Models

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Context

- ODOT TLUMIP
- Model Integration
  - Land Use and Transport
  - State, Sub-state, and Metropolitan Scales
- Focus on Metropolitan Land Use Model
- Longitudinal Calibration

Longitudinal Calibration

- Work to Date Focused on Calibrating Cross-sectional Components
- Current Effort Focuses on Calibrating Dynamics of Model System
- Necessitates Historical Analysis (80-94)
- Represents Research and Development

Objectives of Presentation

- Outline Calibration Process
- Tasks
  - Designing the details of the process
  - Developing goodness-of-fit measures
  - Developing calibration targets
  - Search for functional forms and parameters
  - Evaluation of results
- Progress, Constraints, and Expectations

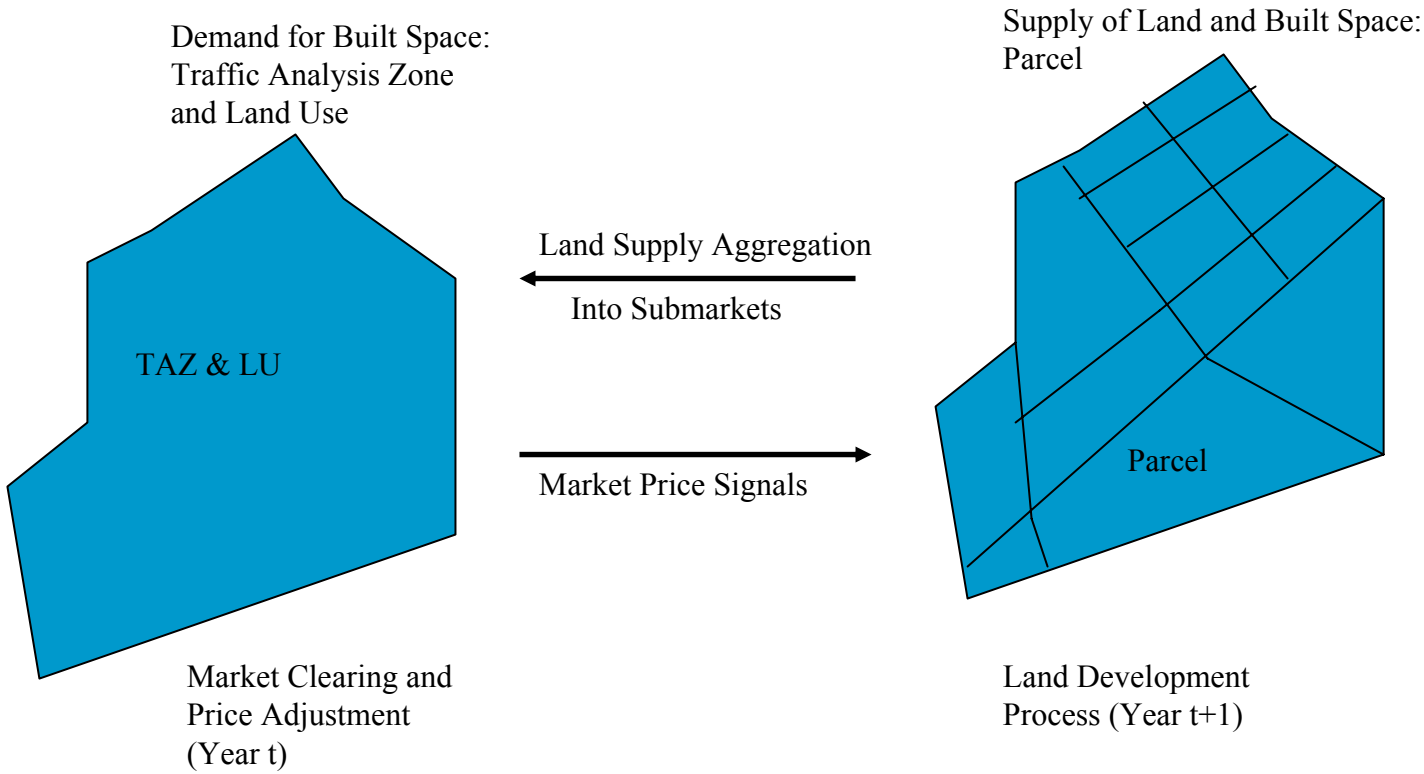
Organization of Presentation

- Review Key Aspects of Model
- Calibration Approach
- Practical Issues in Application
- Conclusions

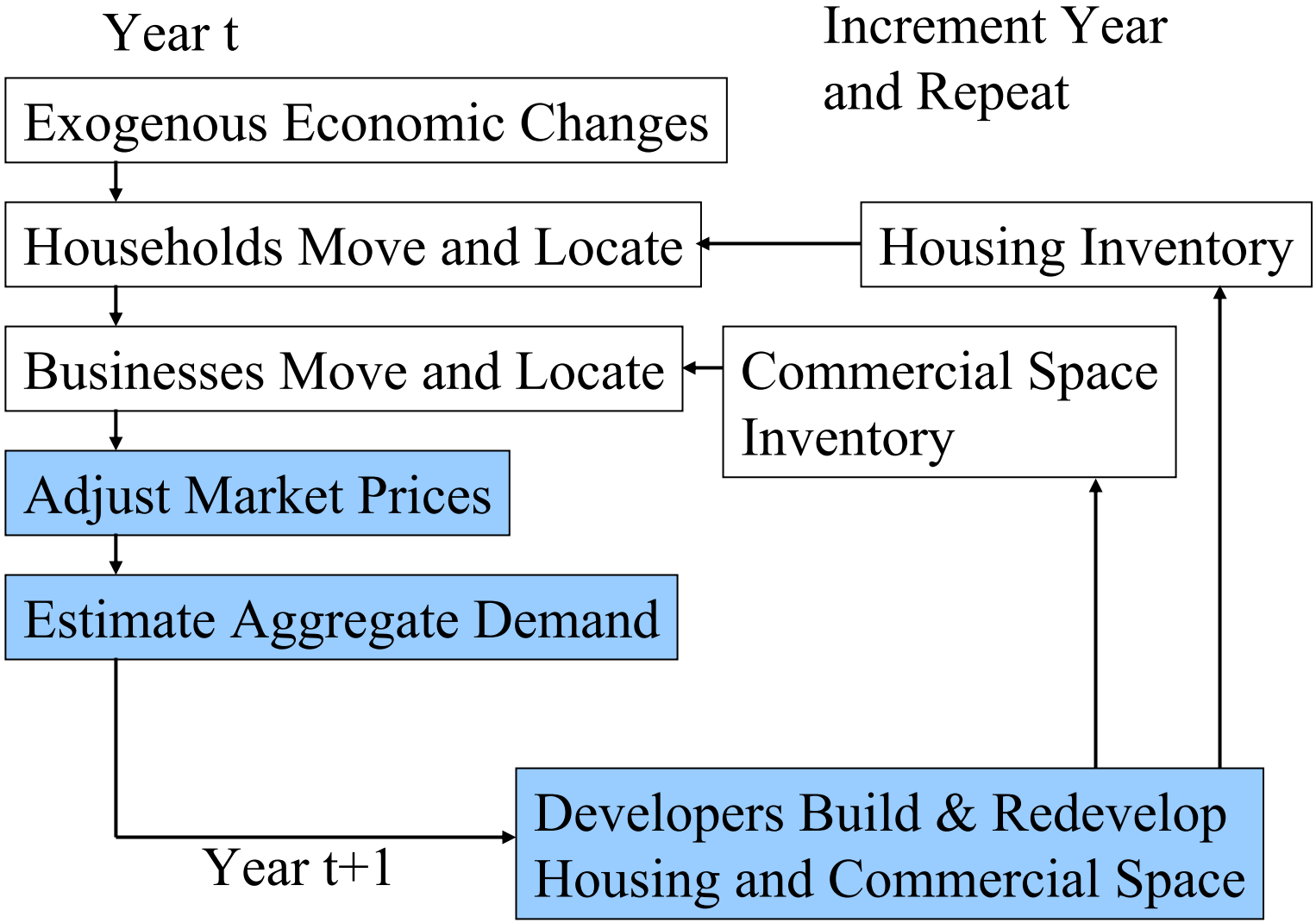
Key Points Related to Development

- Development Supply at Parcel Level
- Demand at Submarket Level
- Simulates Market Processes Annually
- Regional Vacancy Rate > Regional Development Quantity
- Parcel Profit > Development Location
- No Land Market Equilibrium Assumed

Demand and Supply of Land



UrbanSim Dynamics



Key Points Related to Prices

- Zonal price adjustment function for each land type, influenced by:
  - Regional Vacancy Rate
  - Local Vacancy Rate
  - Normal Market Vacancy Rate
- Land price Adjustment in special cases:
  - Vacant land
  - No Existing Development of Type in Zone

Additional Considerations

- Birth and Death Rates of Businesses and Households
- Phasing of large projects
- Treatment of major events
- Treatment of planning policy changes
- Still under development

Overview of Calibration Process

- Develop Cross-sectional Elements
- Identify Longitudinal Calibration Elements
  - One-time Parameters
  - Heuristic Parameters
  - Alternate Specifications
- Develop One-time components

Overview of Calibration Process

- Develop Model Run 1980-1994
  - Input Data
  - One-time Parameters
  - Starting Values for Heuristic Parameters
  - Land Use-Transport Model Interaction
- Establish Calibration Targets
- Search for Heuristic Parameters
- Sensitivity Runs

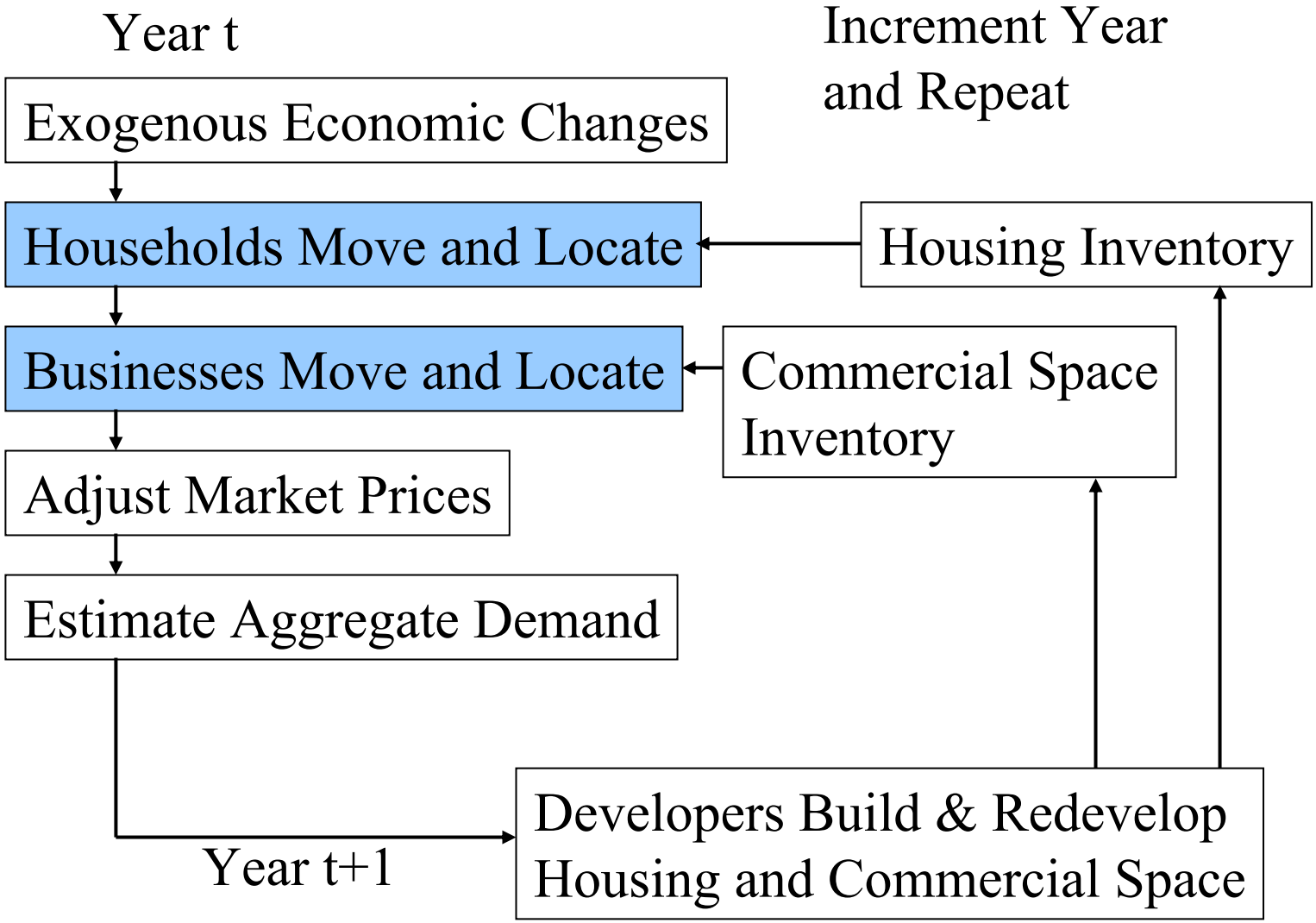
Elements of Calibration Process

- One-time Parameters
  - business birth rates
  - household birth rates
  - business death rates
  - household death rates
  - business mobility rates
  - household mobility rates
- Adjust to Longitudinal Aggregate Trends

Elements of Calibration Process

- Heuristic Parameters
  - Bid Functions - Space Type Coefficients
  - Density Functions
  - Aggregate Demand Equation
  - Price Adjustment Equation

UrbanSim Dynamics



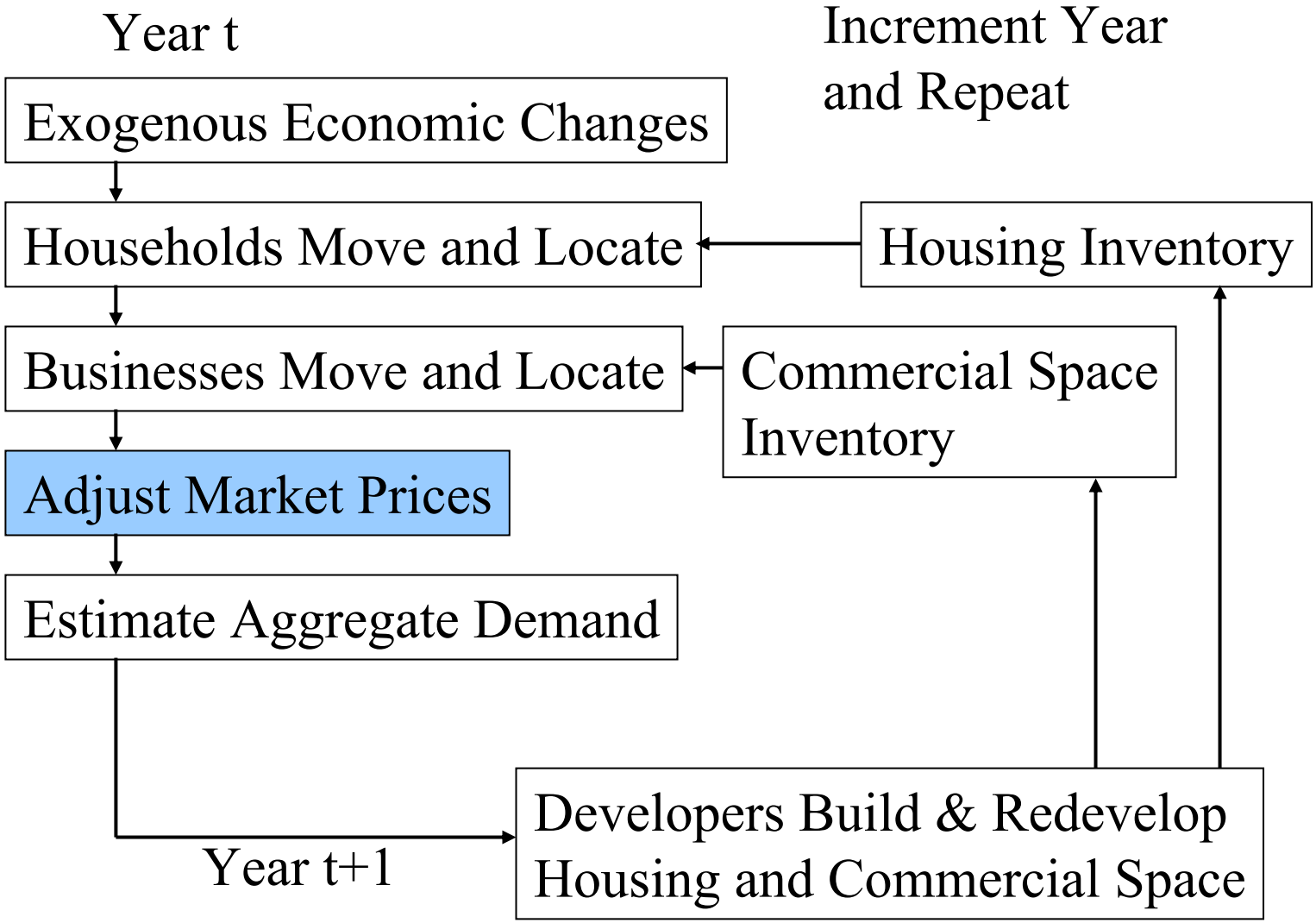
Market Price Adjustment

in Beta Version

$$P_{lbt} = P_{lbt-1}\left(\frac{1+\alpha_b - V_{lbt} + \lambda\left(1+\alpha_b - V_{bt}\right)}{1+\lambda}\right)^{\beta}$$

P_{lbt} is the land price of building type b in location l in year t
P_{lbt-1} is the previous year closing land price for the same building and location
α_b is the Normal, or threshold vacancy rate for building type b
V_{lbt} is the current vacancy rate for building type b in location l
V_{bt} is the current vacancy rate for building type b across the region
λ is a regional weighting parameter
β is a scaling parameter for the price adjustment, initially set to 1

UrbanSim Dynamics



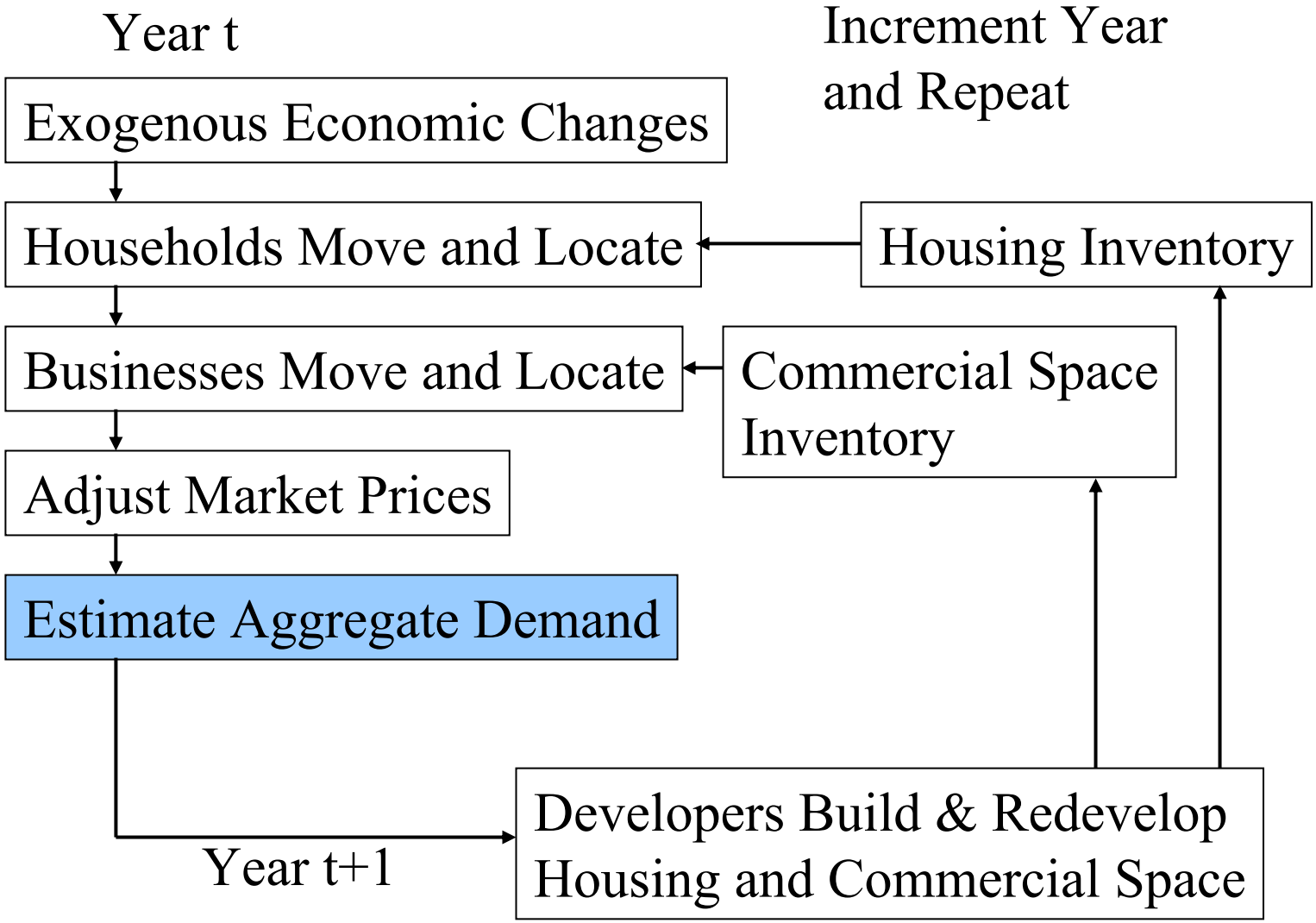
Aggregate Demand
in Beta Version

$$D_{bt} = D_{bt-1} + \left(\alpha_b - V_{bt-1}\right) S_{bt-1} \beta$$

where

D_{bt} is the aggregate demand for building type b in year t
D_{bt-1} is the aggregate demand for building type b in t-1
α_b is the normal market vacancy rate for building type b
V_{bt-1} is the actual vacancy rate in t-1 for building type b
S_{bt-1} is the total supply of space in building type b in t-1
β is a scaling parameter

UrbanSim Dynamics



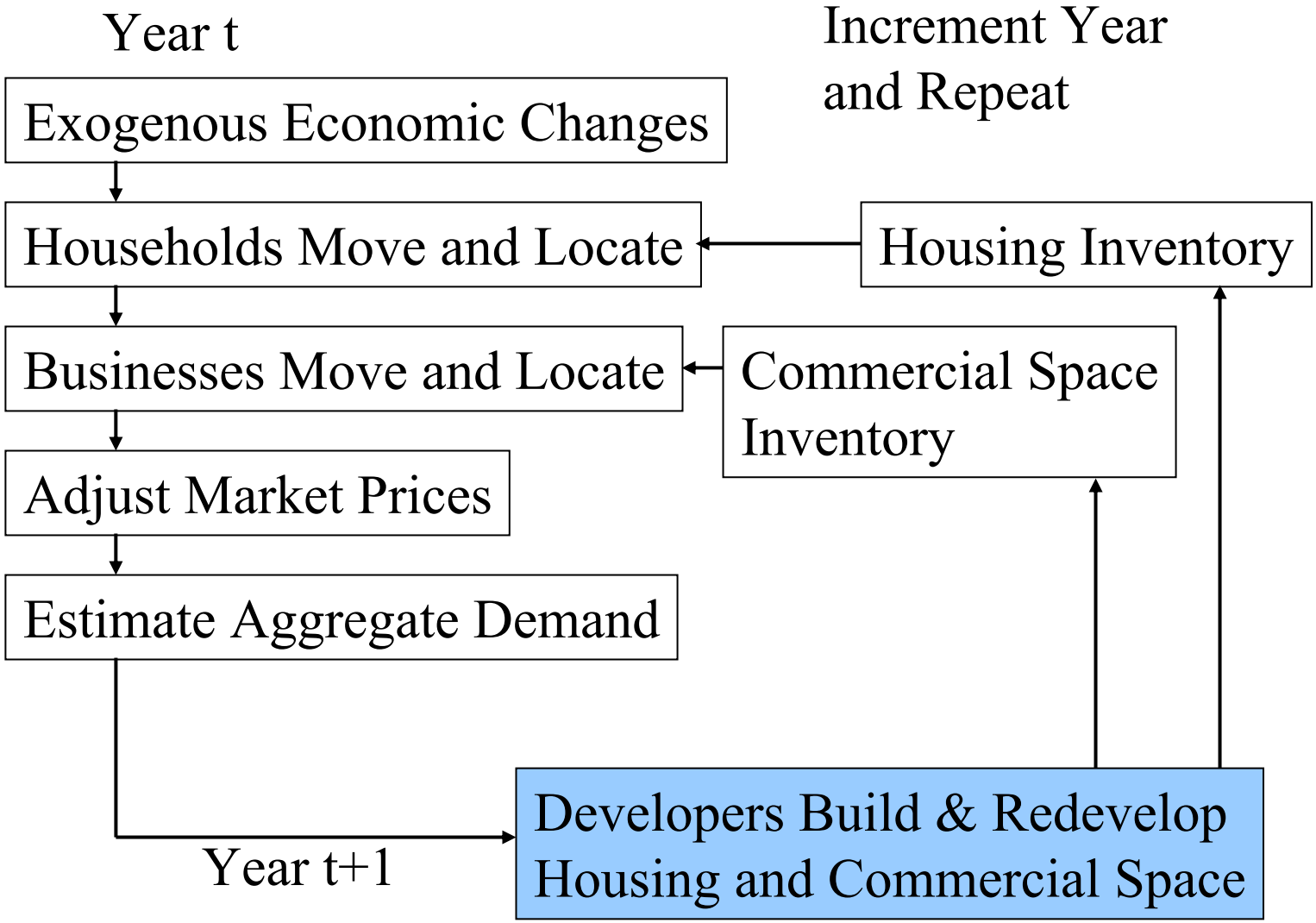
Density

$$\Phi_{lb} = \alpha_b + \beta_b \ln(P_{lb})$$

Φ_{ib} is the density for parcels in location l and building type b

P_{lb} is the land price per acre in location l for building type b

UrbanSim Dynamics



Functional Form Considerations

- Price Adjustment Formulation
  - Spatial Definition of Submarkets
  - Cross-effects of Other Building Types
- Large Scale Land Development
  - Maximum Project Size; Subdivide Parcels
  - Phasing of Large Scale Development
- Economies/Diseconomies of Scale

Functional Form Considerations

- New Development Improvement Values
  - Distribution vs Static Estimate
  - Function of Land Value; Improvement Values of Proximate Development
  - Temporal Trends
- Depreciation and Maintenance Effects
  - Current: Static Improvement Values
  - Fixed Depreciation Rate
  - Function of Age; Land Value

Functional Form Considerations

- Price Initialization for New Development
  - Currently:
    - Use Average of Zones within 5 Minutes
    - Or Regional Average if None within Range
  - Alternatives:
    - Keep Enlarging Search
    - Use Area Type Average

Managing Anticipated Events

- Major Business Events
  - Corporate Relocation
  - Closure; Upsize or Downsize
- Major Development Events
  - Projects ‘In the Pipeline’
  - Potential Differentiation by Commitment
- Major Policy Events
  - Change of Urban Growth Boundary

Calibration Targets

- Land Use Targets
  - Business Establishment Inventories for Even Years 1980-1994
  - Housing and Commercial Space Data From Current Parcel File, via Year Built
  - 1980 and 1990 Census

Calibration Targets

- Transportation Targets
  - Traffic Counts 1977 Forward; Somewhat Ad Hoc
  - Transit On Board Surveys in 1990 and 1994
  - Household Travel Survey in 1994
  - Census Journey to Work: 1980 UTPS, 1990 CTPP

Goodness of Fit Measures

- Assess Fit at All Targets Combined
- Scaled Least Squares Sum:
  - $SS = \sum_k W_k \sum_i [(m_{ki}-o_{ki})^2/o_{ki}]$
- Sensitive to Relative Weights of Components, W_k; Some Sensitivity Testing and Judgement

Heuristic Search

- Over Parameters and Functional Forms
- Orthogonal Treatment
- Seek to ‘Link’ Parameters and Functional Forms to Certain Targets
- Initial Searching Without Travel Model
- Search Process Limited by Schedule

Sensitivity Tests

- Alter Weights in Goodness of Fit
- Test Control Totals Constraints
- More Frequent Travel Model Interaction

Practical Application Issues

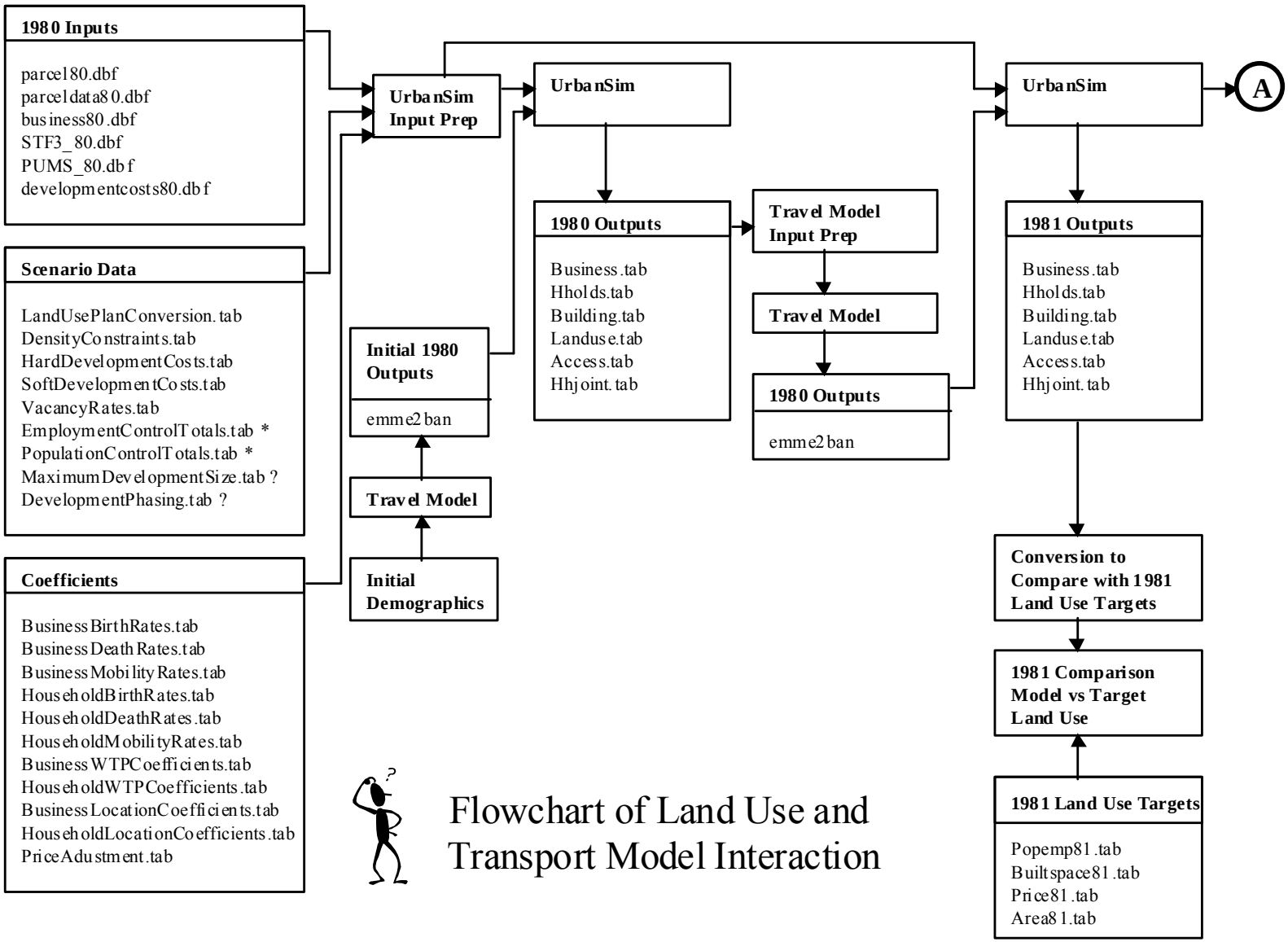
- Design of Transport Model Interaction
  - Interaction at Various Years is Essence of Land Use and Transport Model Integration
  - Years Selected for Travel Model Runs
    - 1980 for Consistency With Land Use Model
    - 1983 to Reflect Arterial Construction
    - 1988 to Reflect Chambers Connector
    - 1990 to Reflect Maxwell Connector Construction and to allow comparison with 1990 transit on-board survey

LCOG Travel Model

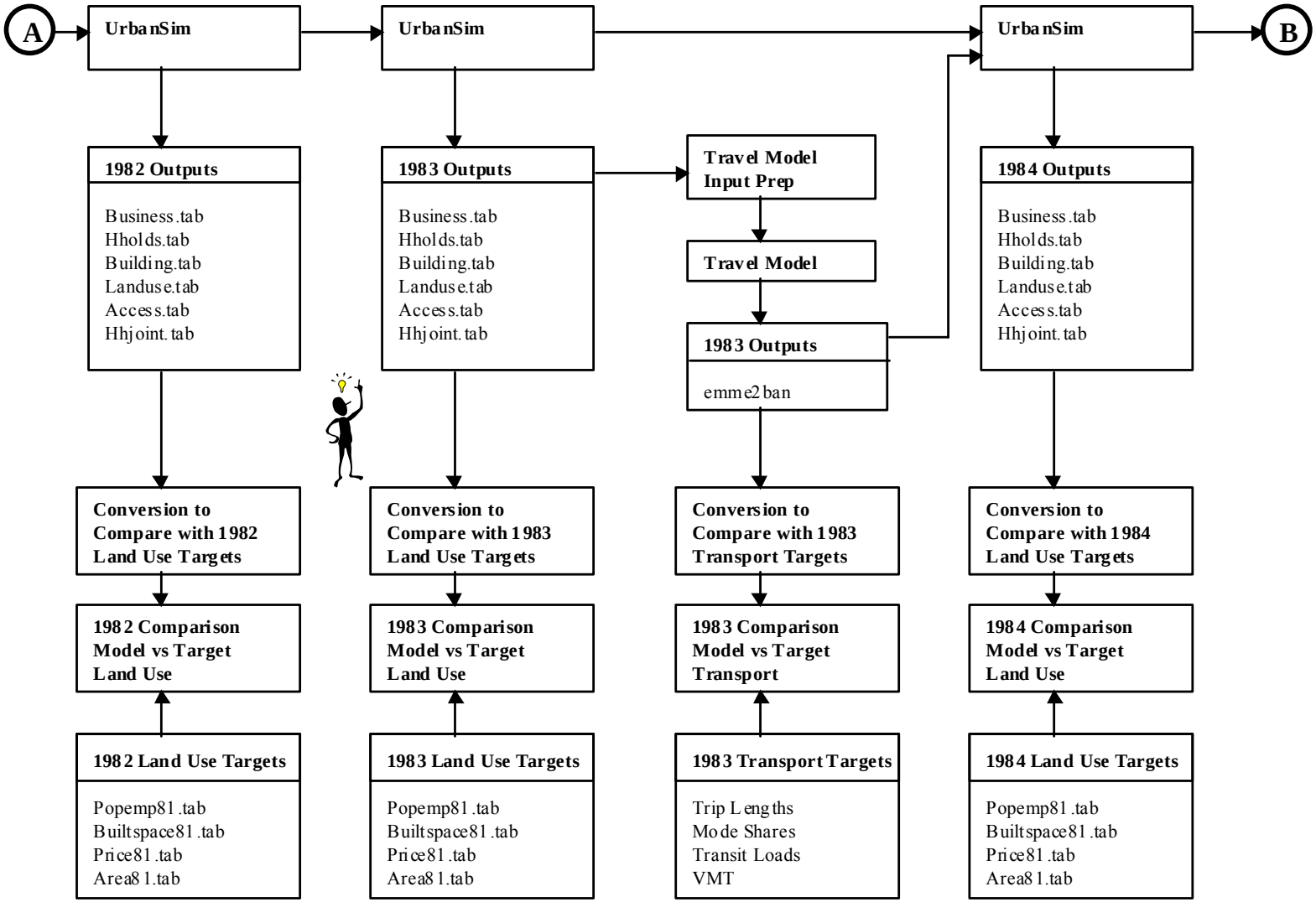
- Distribution, Mode Choice and Assignment in EMME/2
- Production and Attraction Models in EXCEL
  - Independent Variables
    - Include household size, and some housing type descriptors
    - NOT income
- Transport Run Takes About 4 Hours

Interface With LCOG Travel Model

- Need Interface/Data Prep Programs
  - Land Use to Transport
    - Reformat Outputs from UrbanSim to Trip Generation Format in Excel
    - Reconciliation of Differences in Definitions
    - Apply Sectoral Distribution to Employment
  - Land Use to Target Comparison
    - For Calibration Purposes
    - Depends on Availability & Format of Targets
  - Transport to Target Comparison



Flowchart of Land Use and Transport Model Interaction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1983 Outputs
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1983 Land Use Targets
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1983 Transport Targets
Trip Lengths
Mode Shares
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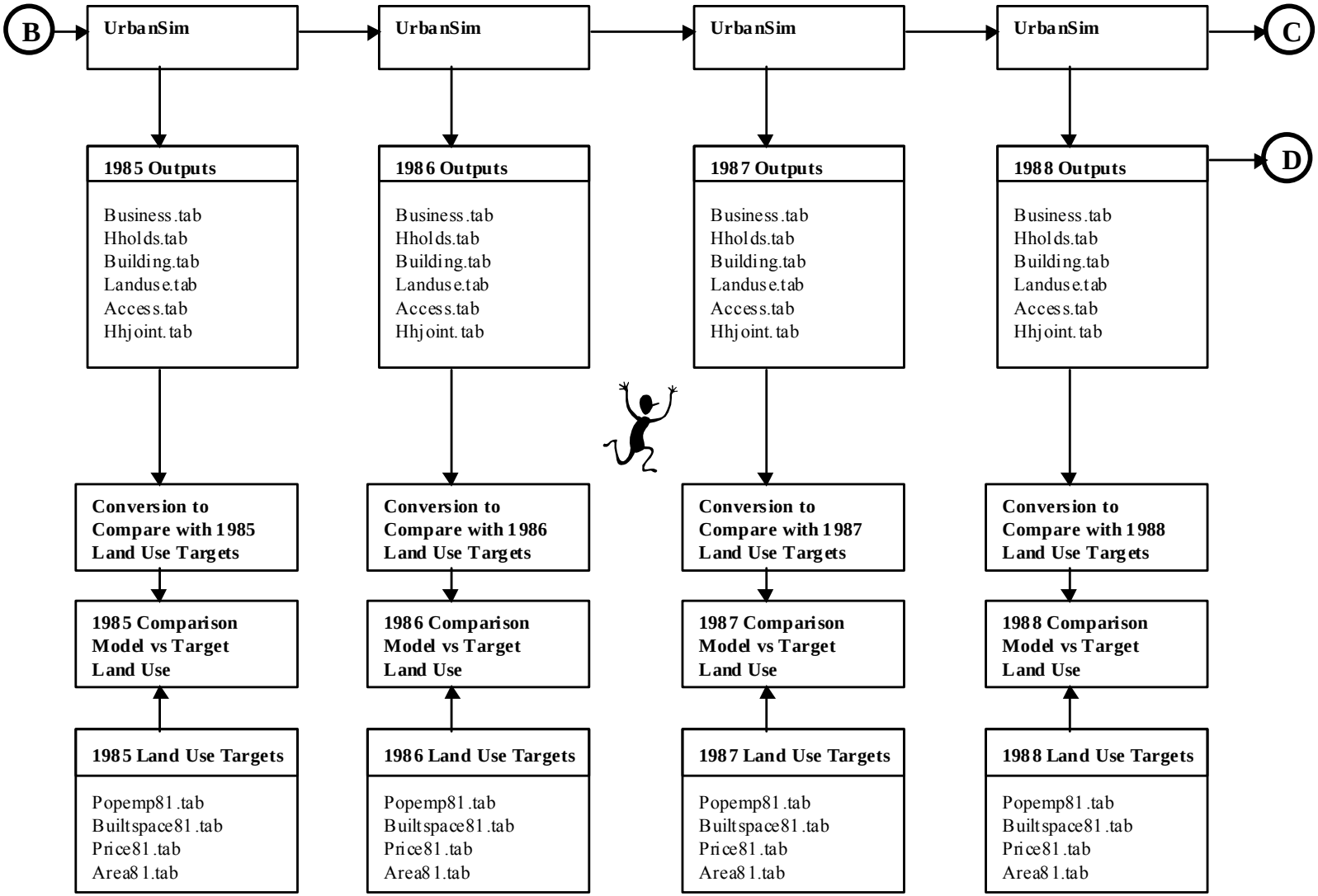
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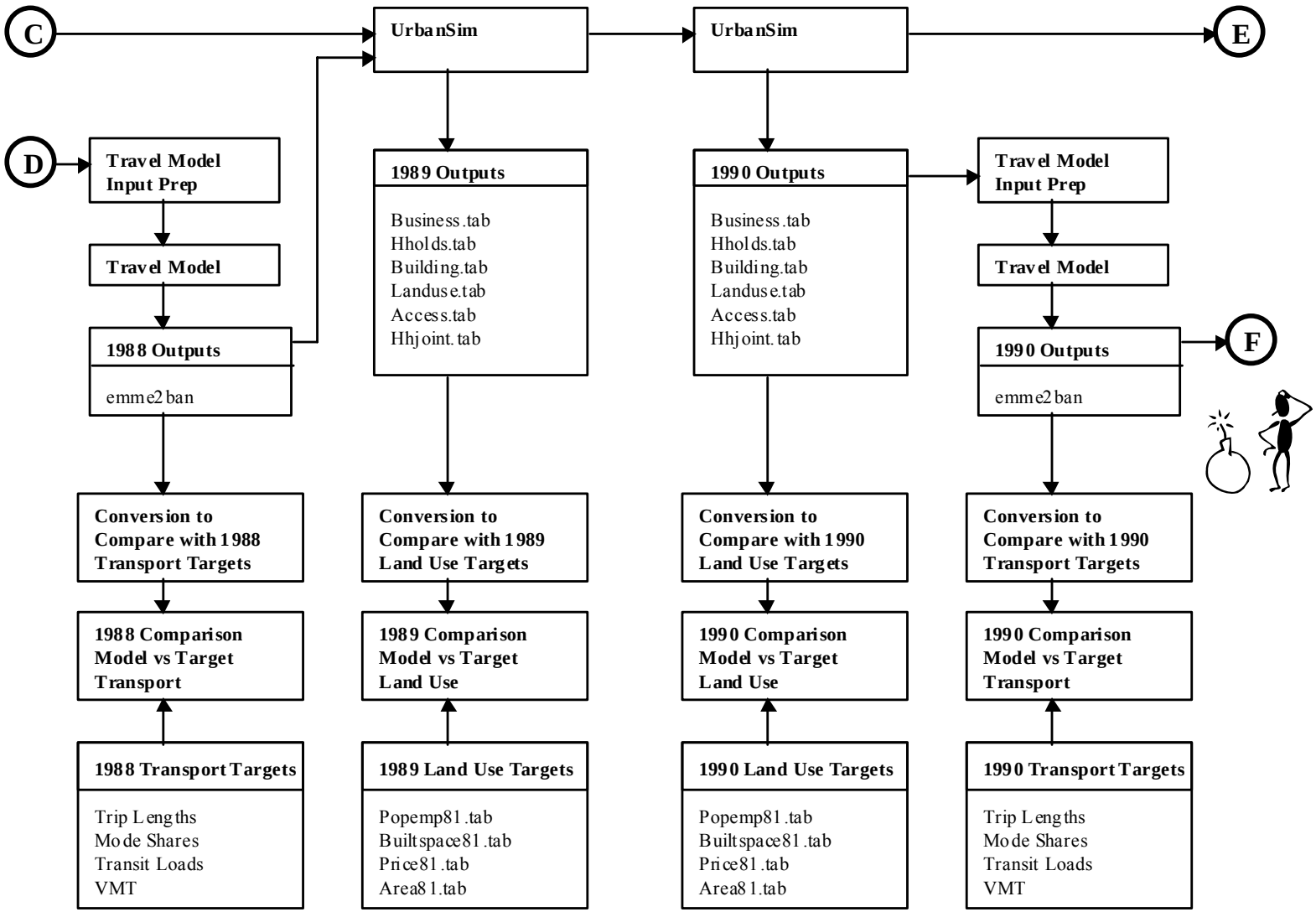
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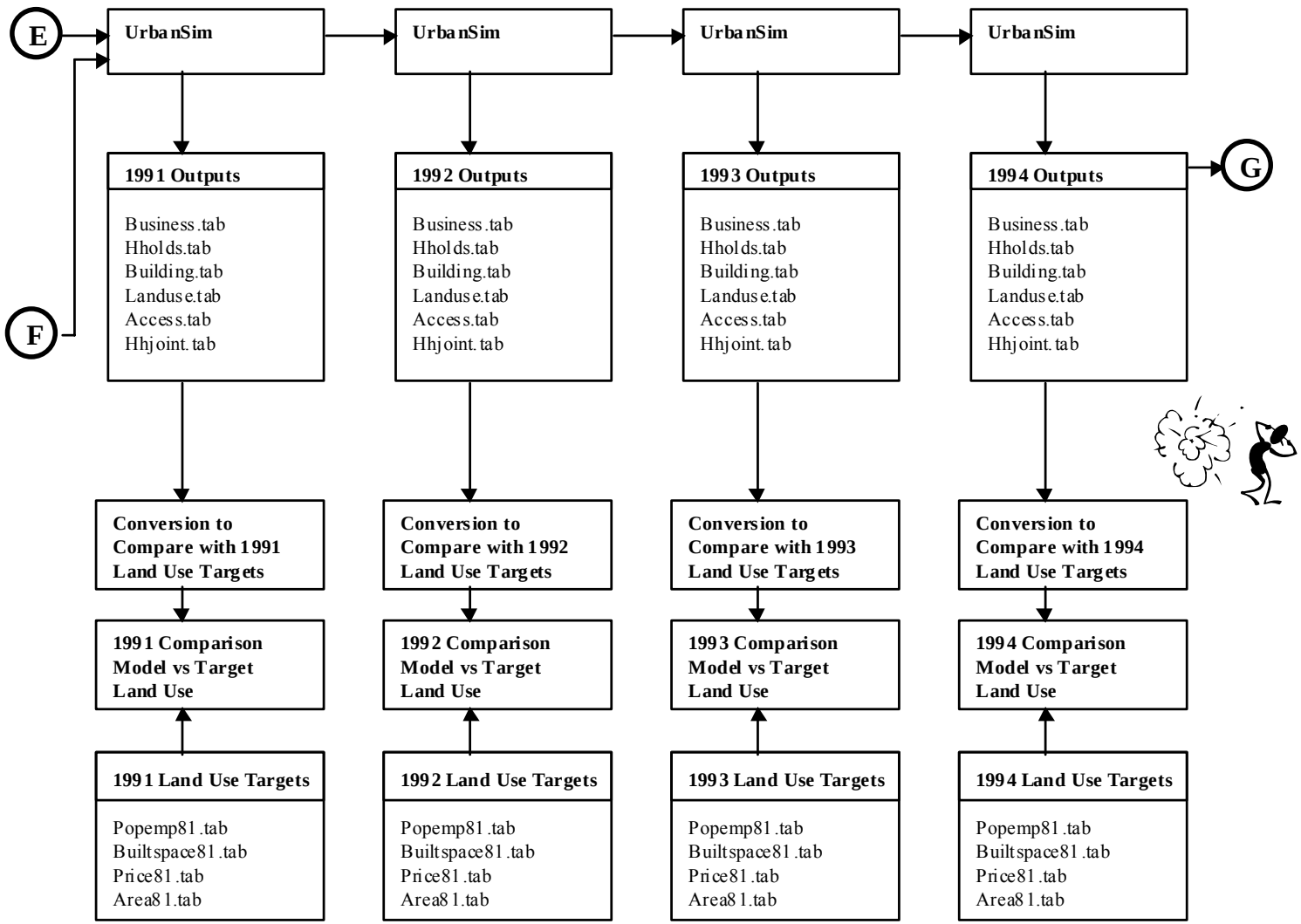
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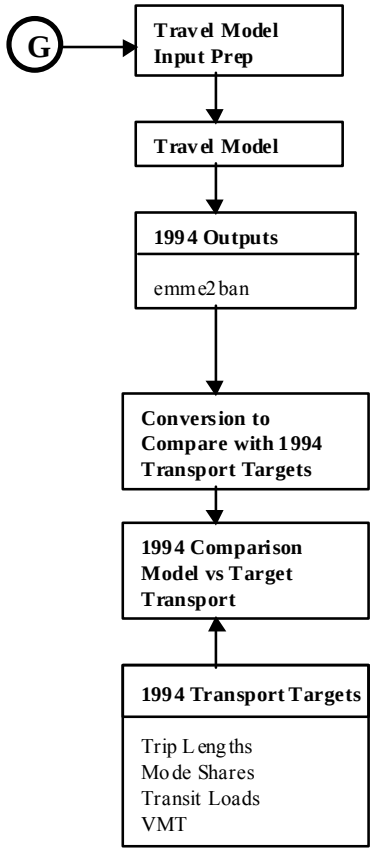
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Conclusions

- First Time to Calibrate Temporal Dynamics of UrbanSim; Still R&D
- Resource Constraints (especially time)
- Structured Approach to Manage Time
- Guaranteed to be Informative
- Should Become a Useful Planning Tool