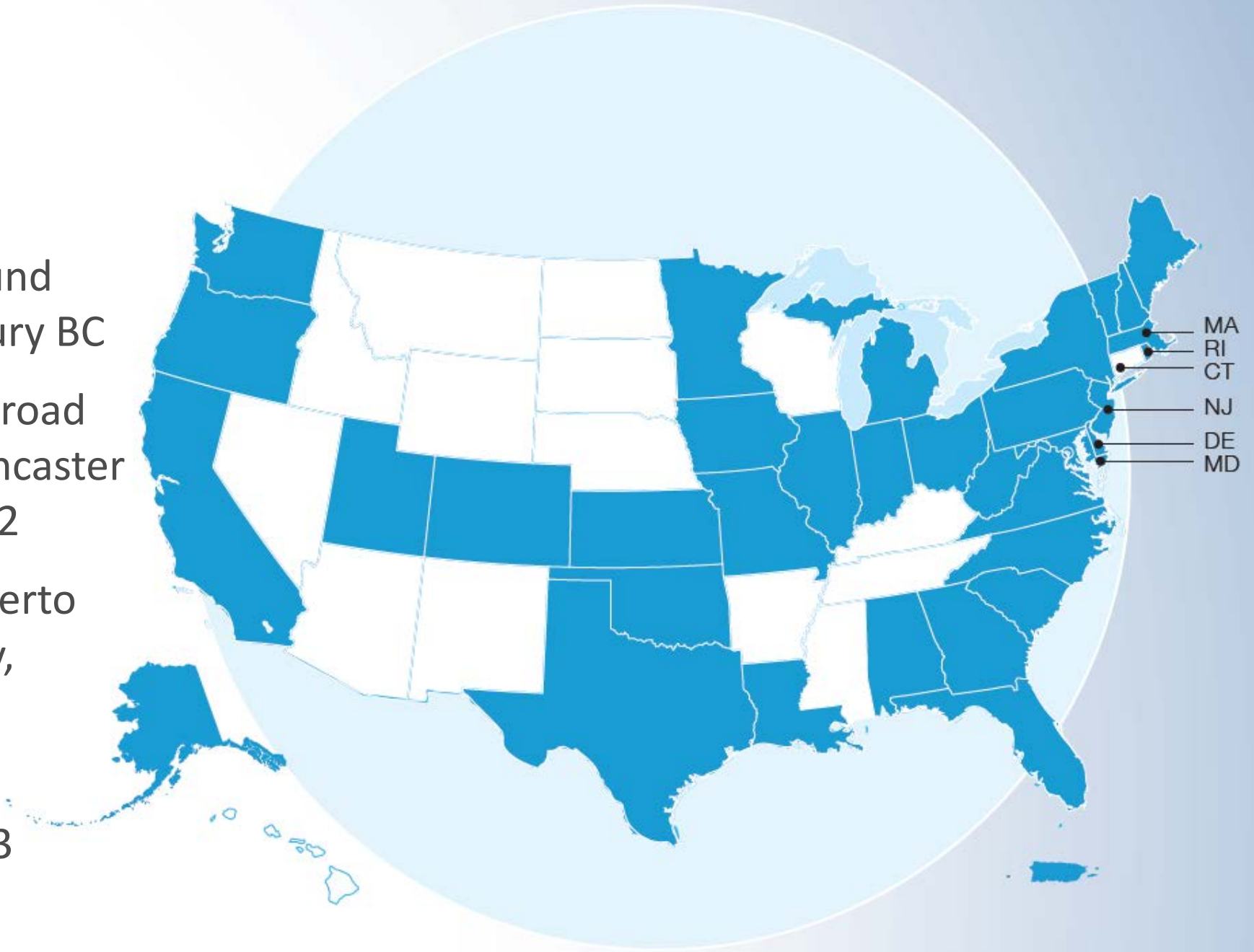
Penn State Transportation and Safety Conference

Public Perspective on Traffic and Revenue Forecasts for Public/Private Partnerships

December 7, 2017

Toll History

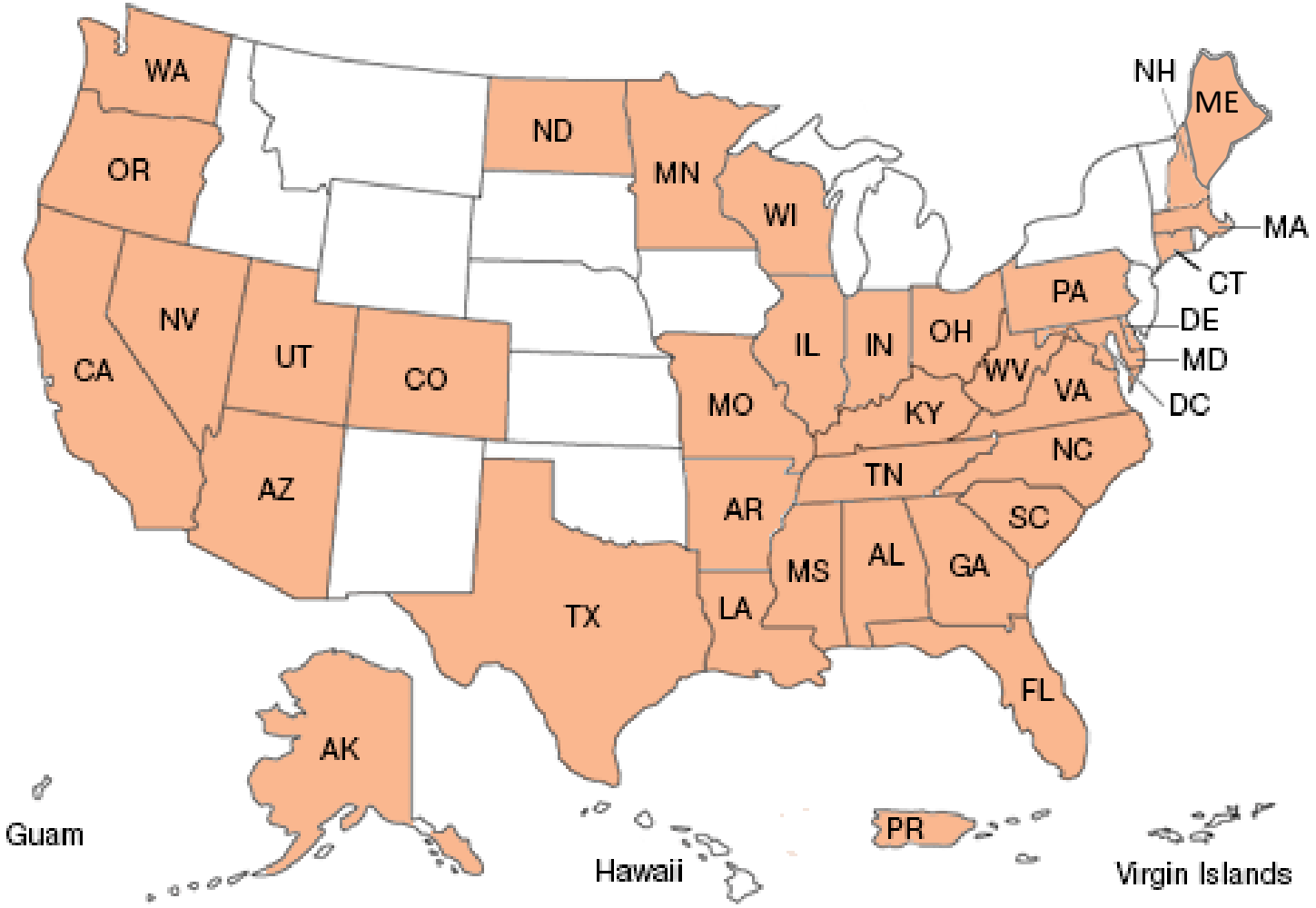
- Toll Roads have been around since at least the 7th century BC
- First major private US toll road was the Philadelphia – Lancaster Turnpike chartered in 1792
- In 2015, 34 states (and Puerto Rico) had a tolled highway, bridge or tunnel
- $13 Billion in toll revenue collected in the US in 2013



SOURCE: IBTTA

State Public Private Partnership Legislation

- 35 states, the District of Columbia, and Puerto Rico have enacted statutes that enable the use of various P3 approaches for the development of transportation infrastructure



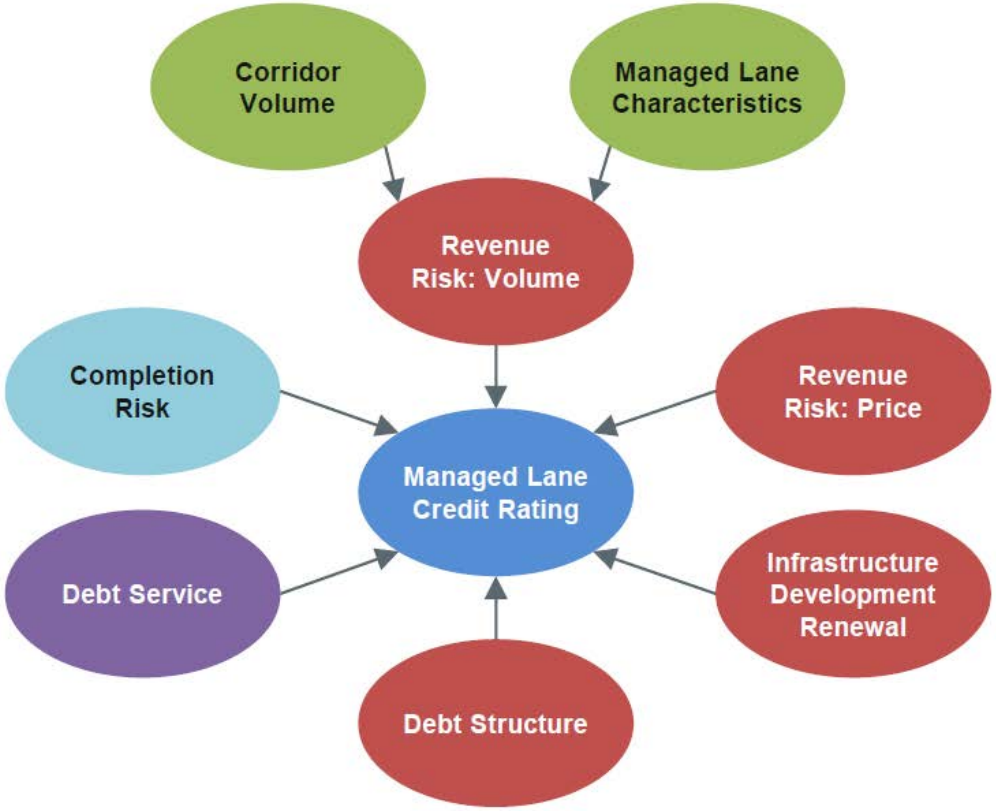
Source: FHWA Office for Innovating Program Delivery, Center for Innovative Finance Support

Public-Private Partnerships (P3)

- Agreement between one or more public sector agencies and a private party used for project development, financing, operation, maintenance, and/or project delivery. The agreements include specific language regarding transfer of risk, up-front financing, and revenue distribution. Often the payment or remuneration is linked to performance.
- Began in the late 1980s and early 1990s in the UK. SR 91 in Orange County CA, Dulles Greenway in Northern Virginia, and ETR 407 in Toronto early North American examples.
- P3 and innovative financing is not a way to “get something for nothing” - Private sector looking for a positive return on investment in the form of toll revenue or availability payments in the future

Fitch Ratings – Global PPP Lessons Learned 2013 Special Report

- Framework Provides Strength; Challenges Remain
- Value Garnered When Risks Anticipated
- Proper Risk Allocation Is Key
- Size and Complexity Affect Deliverability
- Forecasting Demand Sometimes a Key Vulnerability
- Macro and Industry Risks Remain
- Concession Renegotiation Risk Must Be Addressed



Source: Fitch Ratings, Peer Review of US Managed Lanes, 2017

Notable PPPs

- Fitch Ratings Project Risks:
  - Ownership and Sponsors
  - Debt Structure
  - Legal and Regulatory
  - Completion
  - Operations
  - Revenue

- South Bay Expressway (San Diego, CA) – Opened 2007. Actual traffic and revenue significantly below projections. Forecasting error further complicated by mortgage crisis and deep recession.
- Pocahontas Parkway (Richmond, VA) – Opened 2002. Actual traffic and revenue significantly below projections. Forecasting error further complicated by deep recession.
- Northwest Parkway (Denver, CO) – Opened 2003. Actual traffic and revenue significantly below projections. Forecasting error primarily.
- SH 130 Segments 5 and 6 (Austin, TX) – Opened 2008. Actual traffic and revenue significantly below projections. Forecasting error further complicated by deep recession.

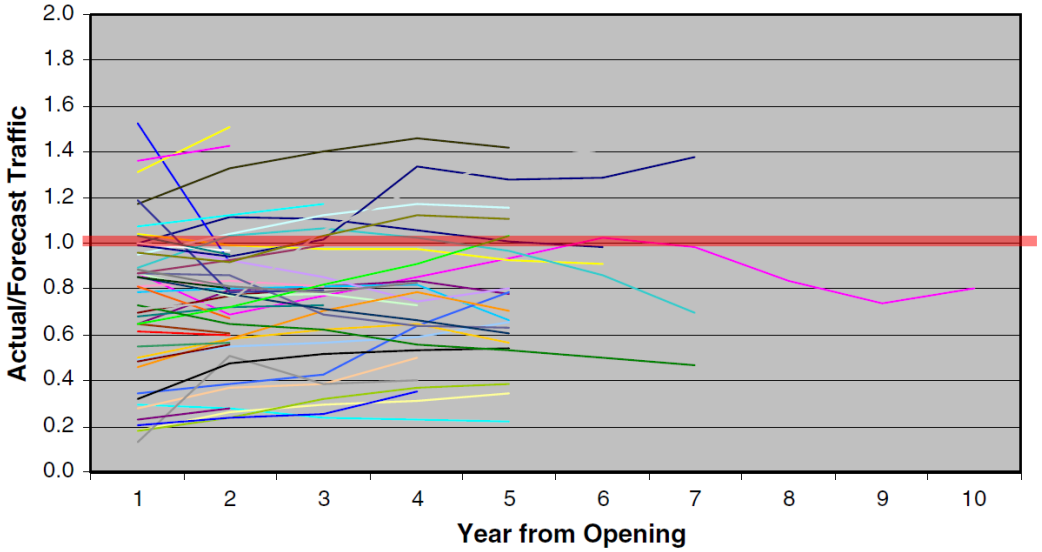
Notably PPPs

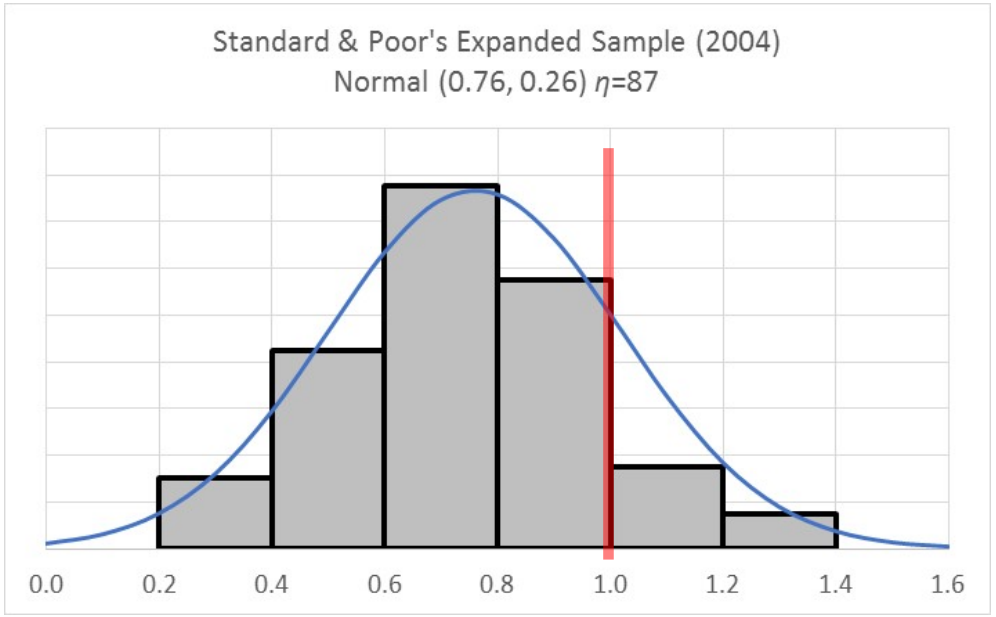
- Fitch Ratings Project Risks:
  - Ownership and Sponsors
  - Debt Structure
  - Legal and Regulatory
  - Completion
  - Operations
  - Revenue

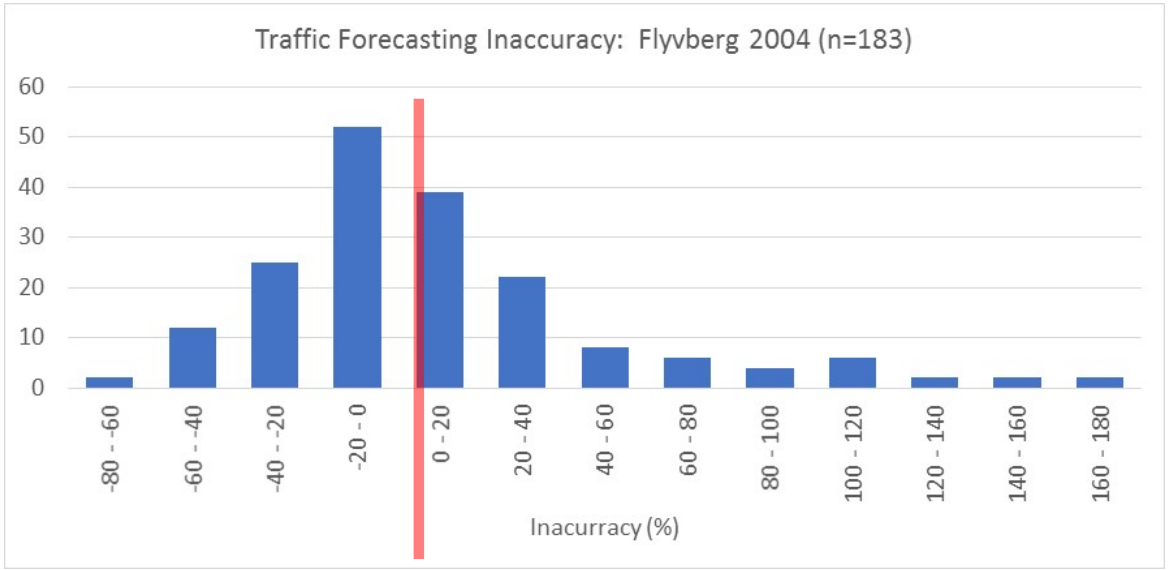
- Southern Connector (Greenville SC) – Opened 2001. 16-mile greenfield toll road, opened in 2001 and filed for bankruptcy in 2010. Traffic improving.
- Channel Tunnel (France/ UK) – Opened 1994. Actual traffic and revenue significantly below projections. Forecasting error further complicated by emergence of low-cost airlines and a ferry price war.
- M1 Toll Road (Hungary)- Opened in 1996. High toll rates for Hungarian standards while reasonable from a Western European standpoint. The project was constructed to a high standard, but failed financially due to overly optimistic traffic forecasts.

Historical Forecasting Accuracy of Toll Facilities

Bain's Error and optimism bias in toll road traffic forecasts. 2009.







Many factors determine the success or failure of a transportation investment or PPP.

This presentation focuses on the Traffic and Revenue Forecasting

Traffic and Revenue Forecast

- T&R Forecasts can be and are developed for all parties:
  - Project Sponsors
  - Government Agencies
  - Lenders
  - Concessionaries/ Bidders
- Each group may have its own perspective on the inputs and models

Key Questions and Methods

Key Questions:

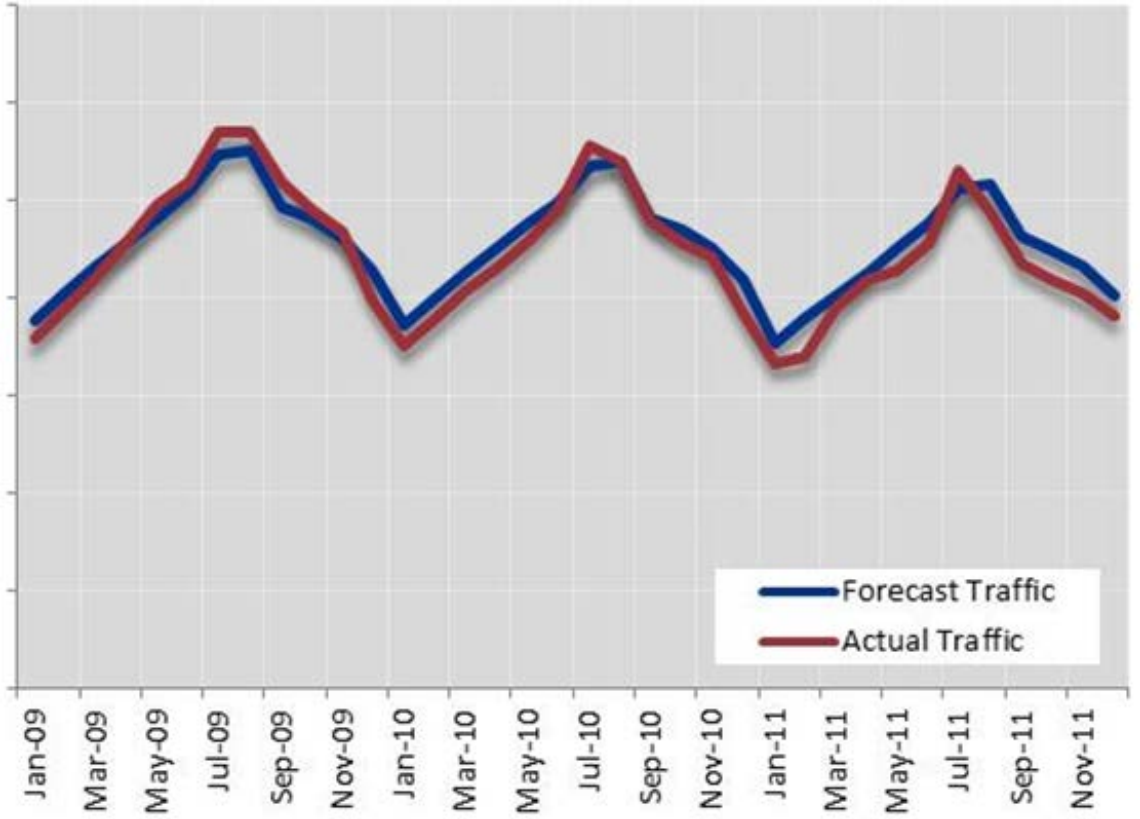
- What is the current travel in the corridor by all modes?
- How much of current demand will transfer to new facility or service?
- How will traffic grow in the future?
- What are the risks that predicted traffic and revenue will not be achieved?

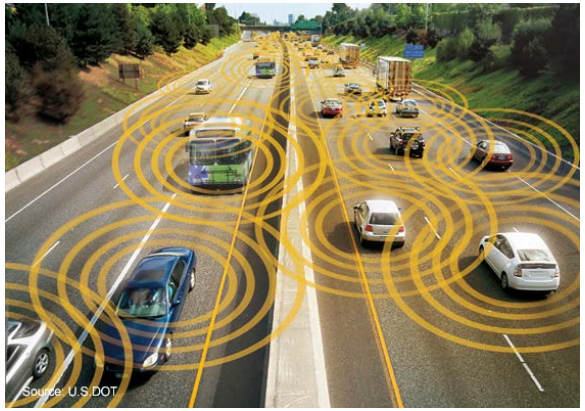
Methods:

- Apply conventional modelling techniques
- Conduct independent benchmarking against similar facilities with observed track records
- Perform sensitivity testing to help identify key risks
- Perform comprehensive risk analysis
- Utilize experienced & analytical staff

Traffic & Revenue Forecasting

- Models used for estimating future total travel demand, as well as mode and route choice and their associated impacts related due to tolling
- Models are calibrated and validated to current conditions to be able to reasonably forecast travel demand in the future
- If the future looks nothing like the past, assumptions need to be made to account for the changes for models to effectively forecast traffic

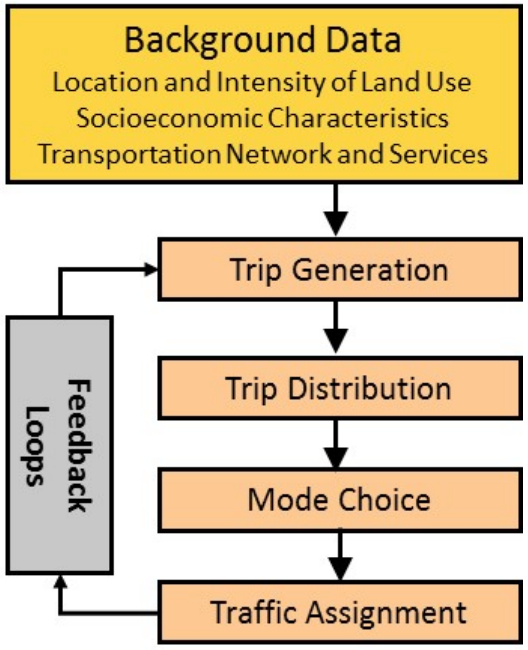




Traditional 4-Step Models versus Activity-Based Models

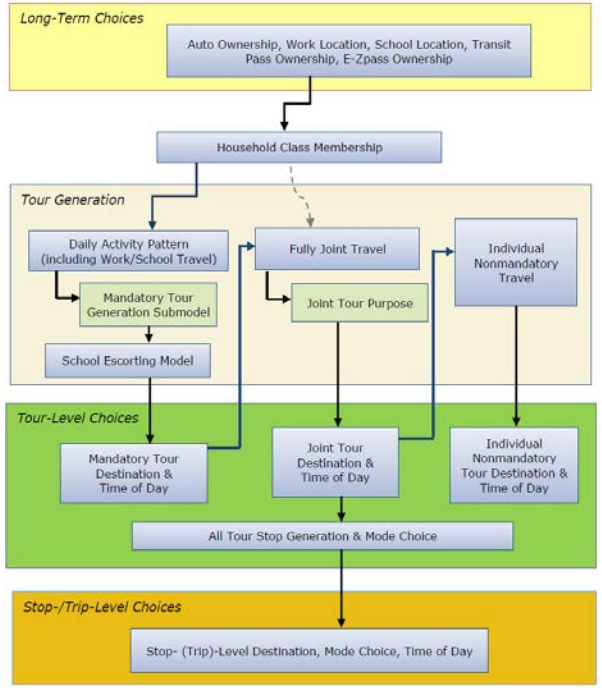
4-Step Model

- Trip Generation
- Trip Distribution
- Mode Choice
- Time of Day Distribution
- Assignment
  - Trips are determined by Productions and Attractions
  - Trips are aggregated by trip purpose and mode (aggregation bias)
  - Attributes averaged over a discrete number of classes
  - Segmented into time periods, usually by a time of day factor (insensitive to time of day)

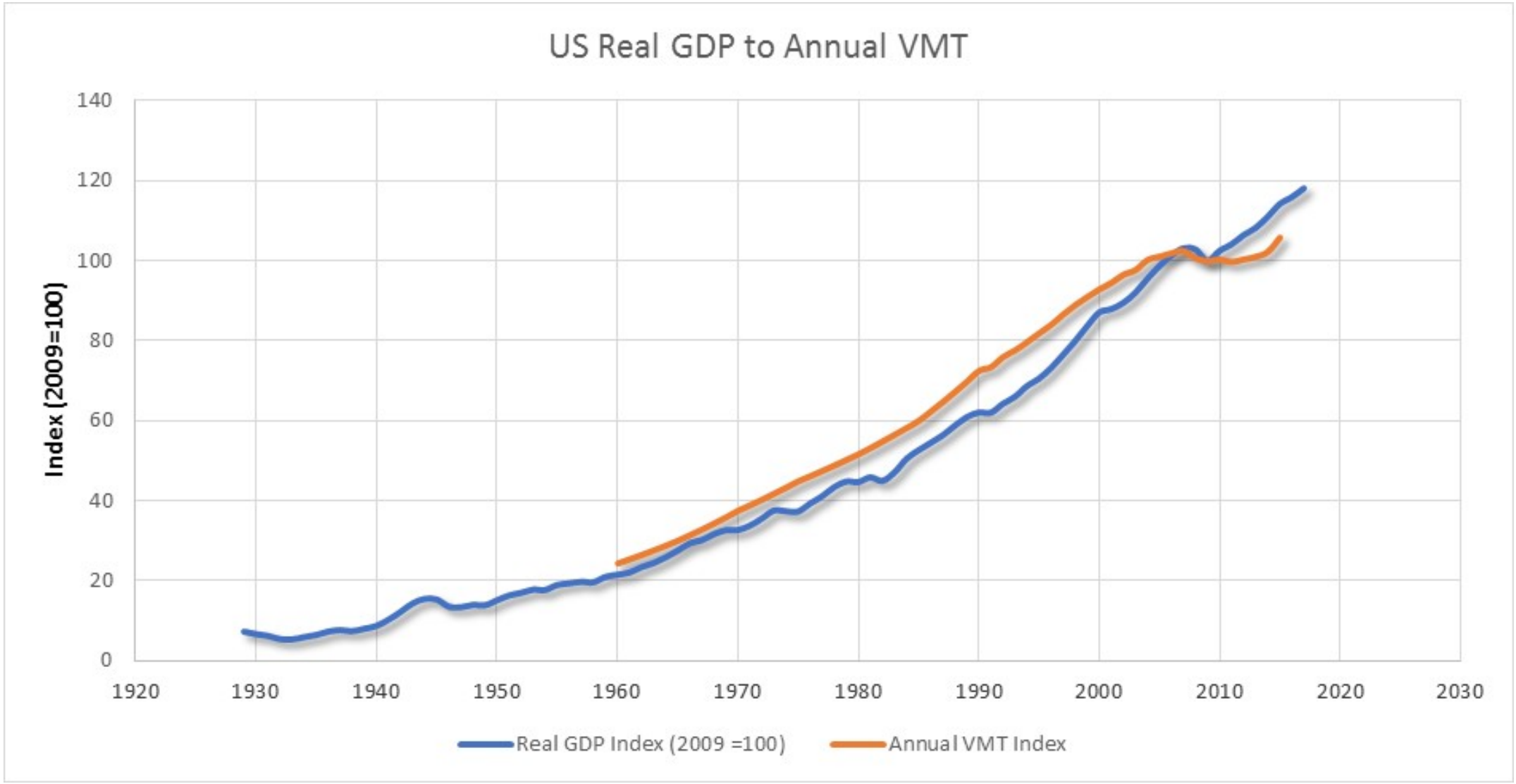


Activity-Based Model

- Population Synthesis
- Tour Generation
- Destination Choice
- Time of Day Choice
- Stop and Mode Choice
- Assignment
  - Trips are chained to start and end at home
  - Links activities for individual and households and inter trip dependence
  - Allows use of more detailed attributes for an individual and household
  - Ability to test a broader range of policies

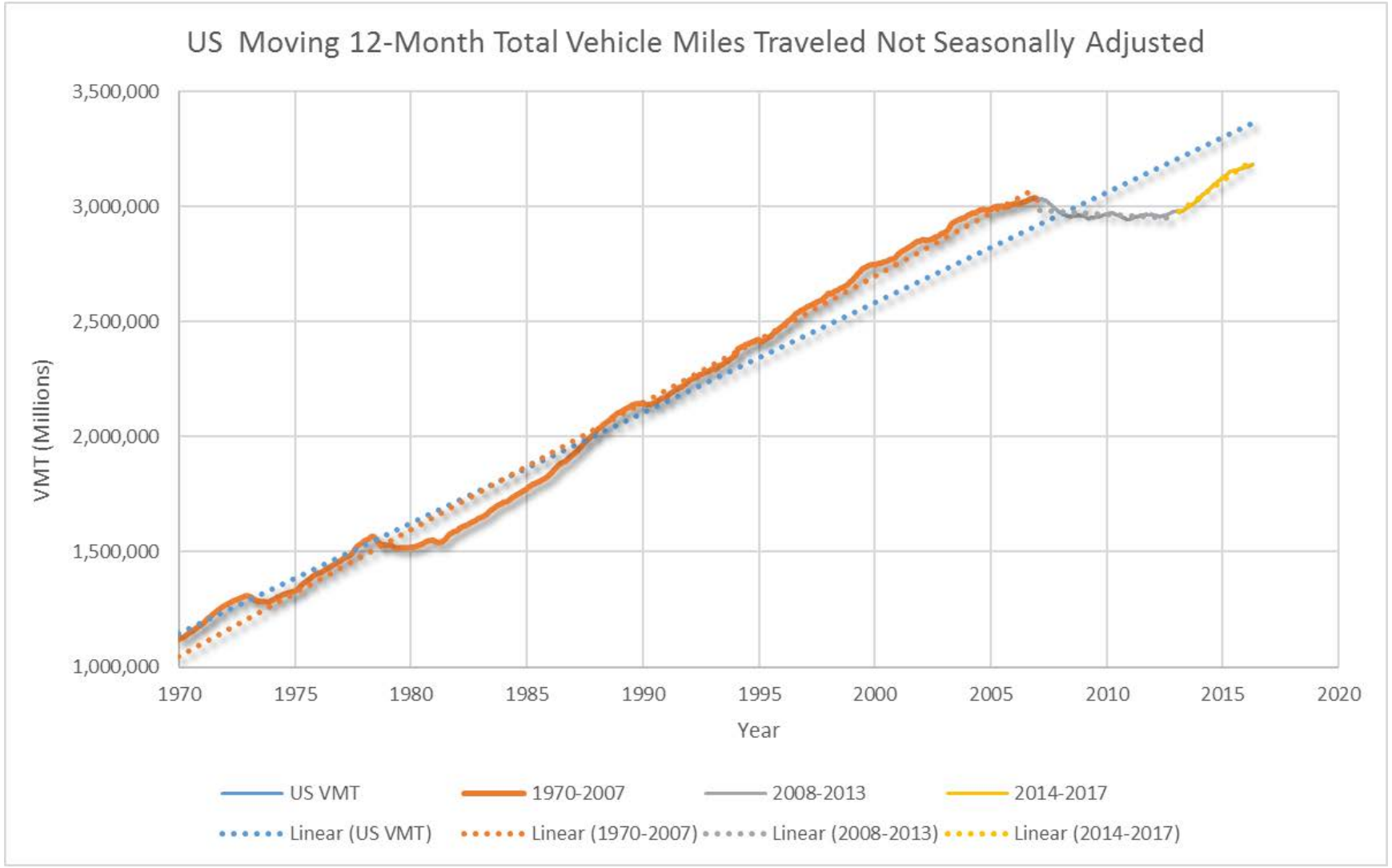


Relate Dependent Variables to Independent Variables



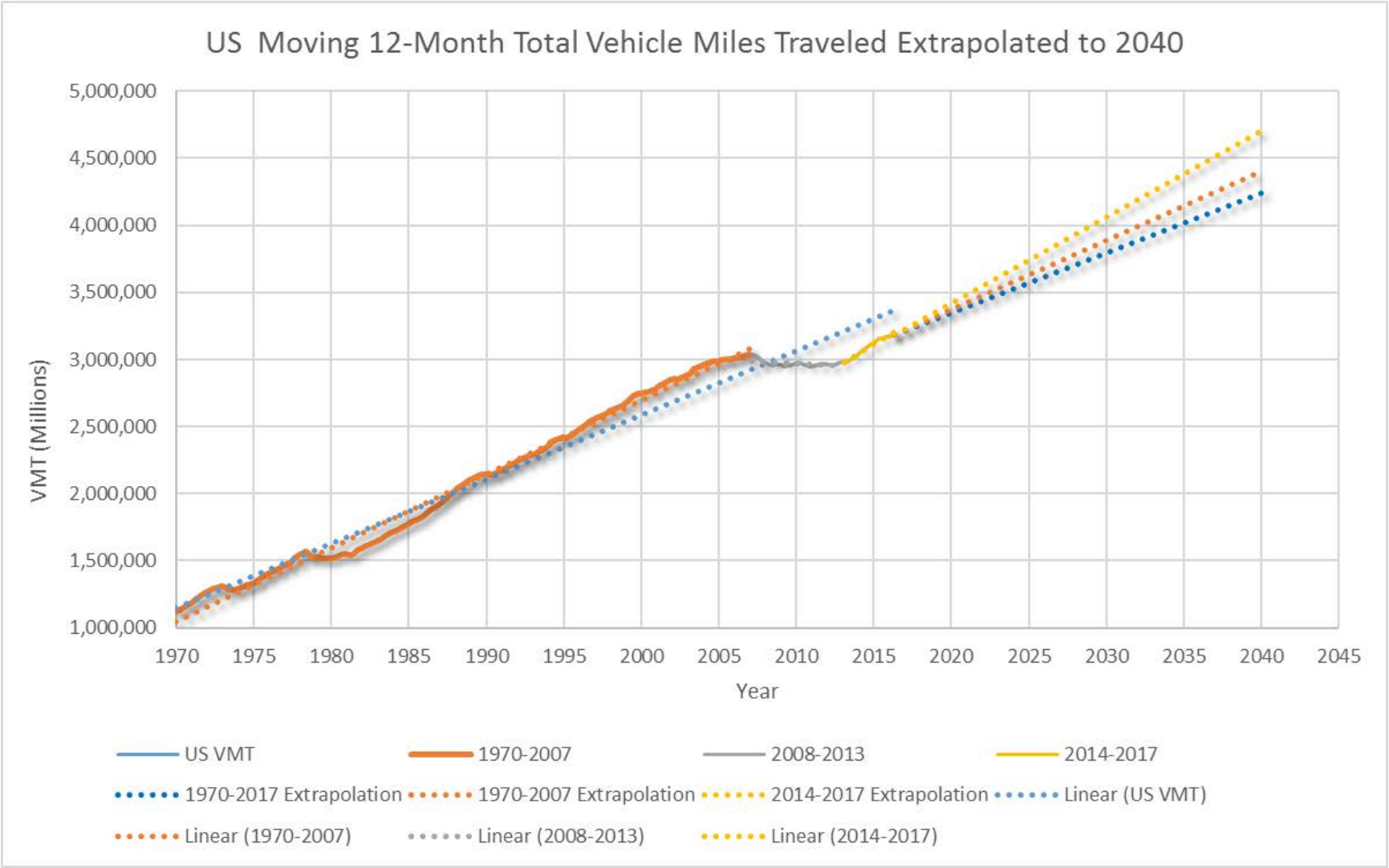
Recovery of US VMT Growth

- US VMT data showing recovery from Global Financial Crisis of 2007-2008
- Changing behaviors?
  - Are millennials driving less than previous generations
  - Impact of Uber, ride sharing, etc
  - Impact of aging population



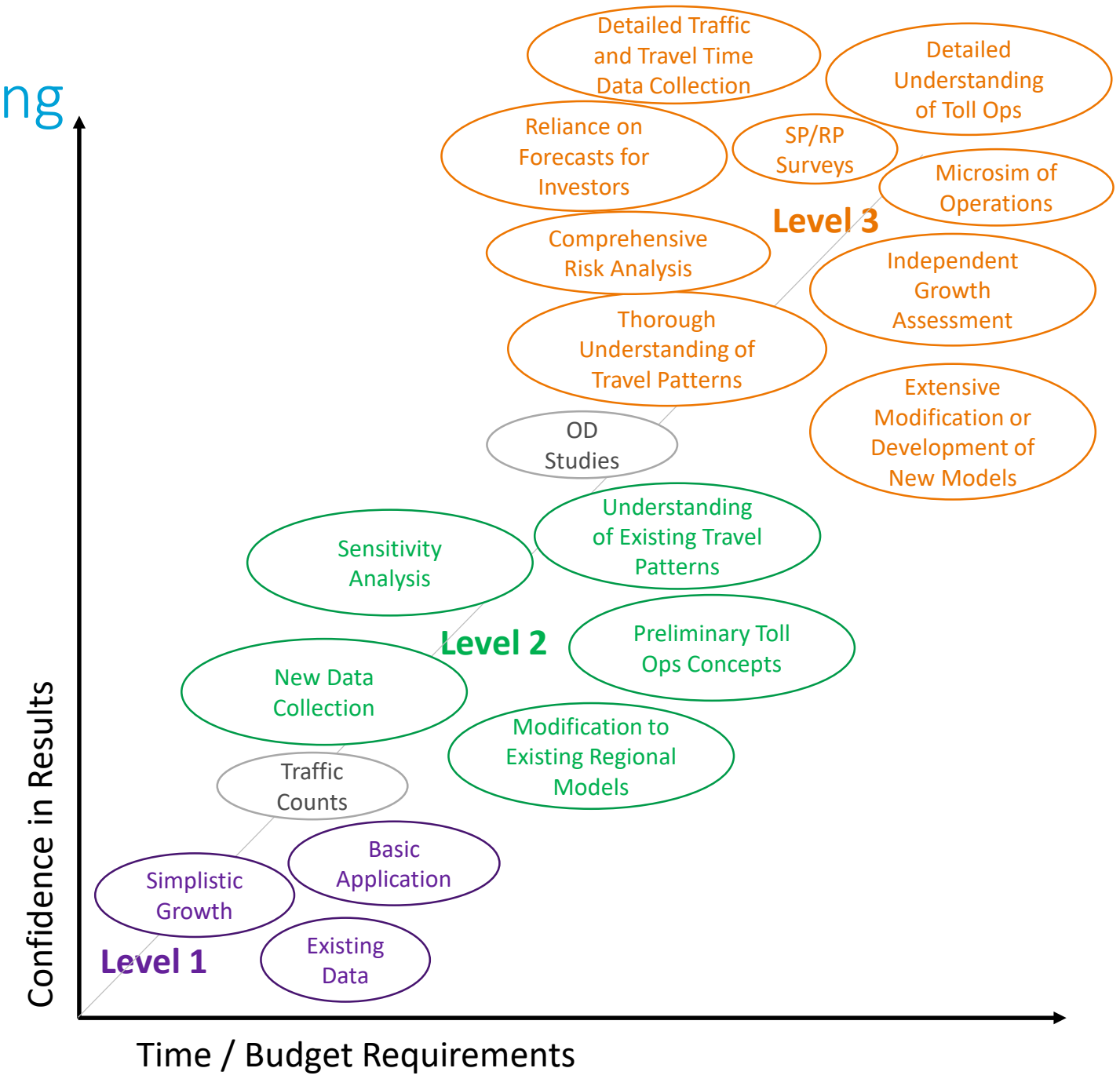
Extrapolating Growth Trends

- Using the most recent 3 years of data would result in 10% higher VMT forecasts than using the 1970-2017 growth rates



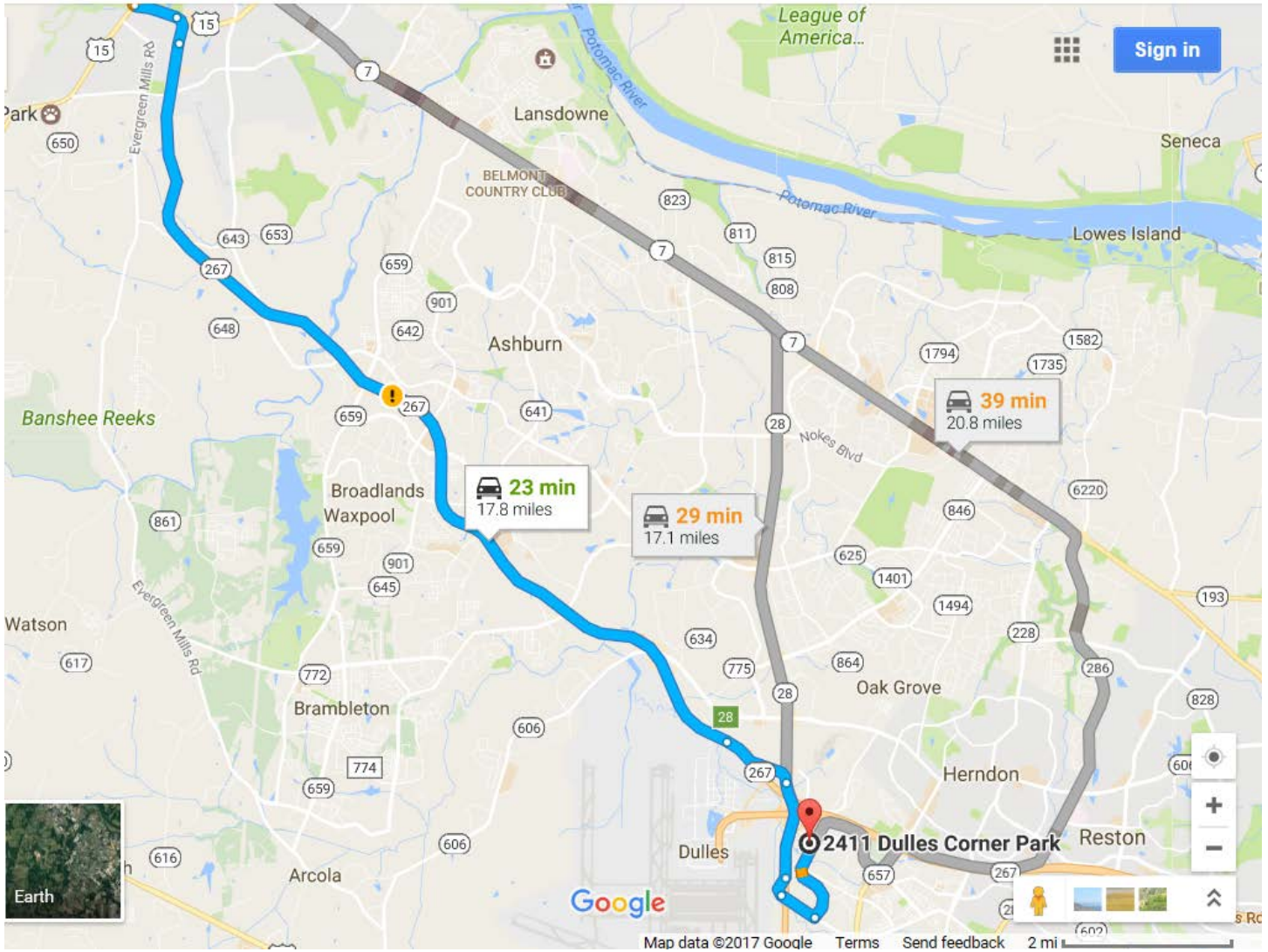
Traffic and Revenue Forecasting

- Level 1: Sketch or Exploratory Level
  - Typically spreadsheet or simplistic model. Typically uses all existing data
  - Level of Effort $20,000-100,000
- Level 2: Preliminary or Concept Analysis
  - Typically uses regional models with minor modifications
  - Level of Effort $100,000- $500,000
- Level 3: Investment Grade
  - Typically includes a lot of data collection (Origin-Destination, Stated Preference, new economic conditions analysis and forecasts – beyond accepted cooperative forecasts), sensitivity tests, risk analysis, detailed traffic and toll operational analysis
  - Level of Effort $200,000-$1 M+



Value of Travel Time

- Demand for travel is based on the activity, not the trip itself (travel time should be considered a negative or disutility)
- Value of Travel Time (VOT)– how much people are willing to pay to save time on a trip ($/hour). Typically 50-75% average wage rate. Can vary greatly by traveler, time of day, trip purpose, options and will often change by day for the same person. VOT does not include value of travel time reliability
  - GoogleMaps reports that the Greenway was 6 minutes faster than VA 7 to VA 28 to the CH2M office in Herndon. The Greenway toll is $5.35 so my value of time to use the Greenway would need to be greater than $53.5/hour



Revealed Preference Value of Time Calculation
$5.35/ 6 min savings = $.89/ min = $53.50/hour

Representation of Value of Travel Time

- All people do not have the same value of time… the same people have different VOT depending on the situation
- How can we represent this:
  - **Generalized Cost**
    - Turn the toll into time (or time into dollars)
  - **Segmented Value of Time**
    - Segment the trip tables into various markets (by purpose for example) or include a distribution of VOT across the trip table
  - **Toll Diversion Curves**
    - Estimate a binary logit model between toll and non-tolled paths
    - $P_{toll} = \frac{1}{(1+\exp(\alpha \times \Delta Time + \beta \times Cost + C)}$

      where α= time coefficient, β=cost coefficient, C = constant
    - $VOT = \frac{\alpha}{\beta} \times 60$

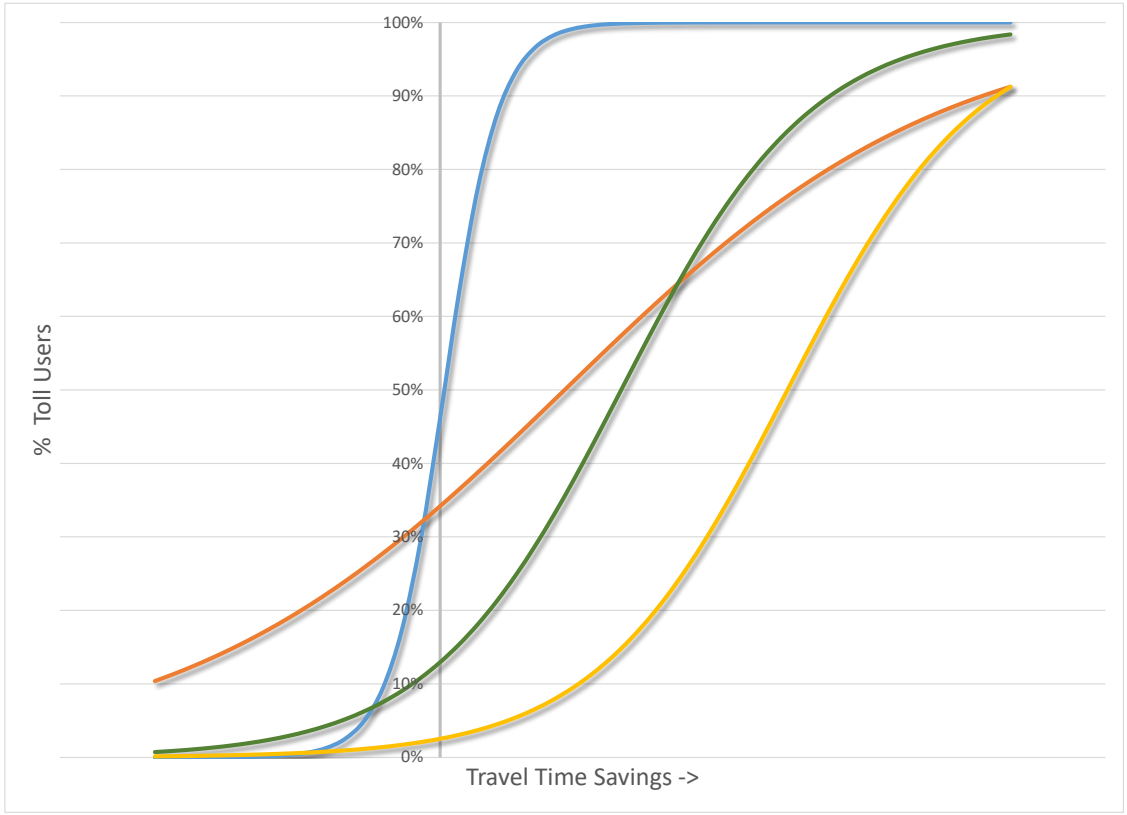
All users across all market segments

Assume a $2.00 Toll

6 min (assuming VOT=$20/hr)

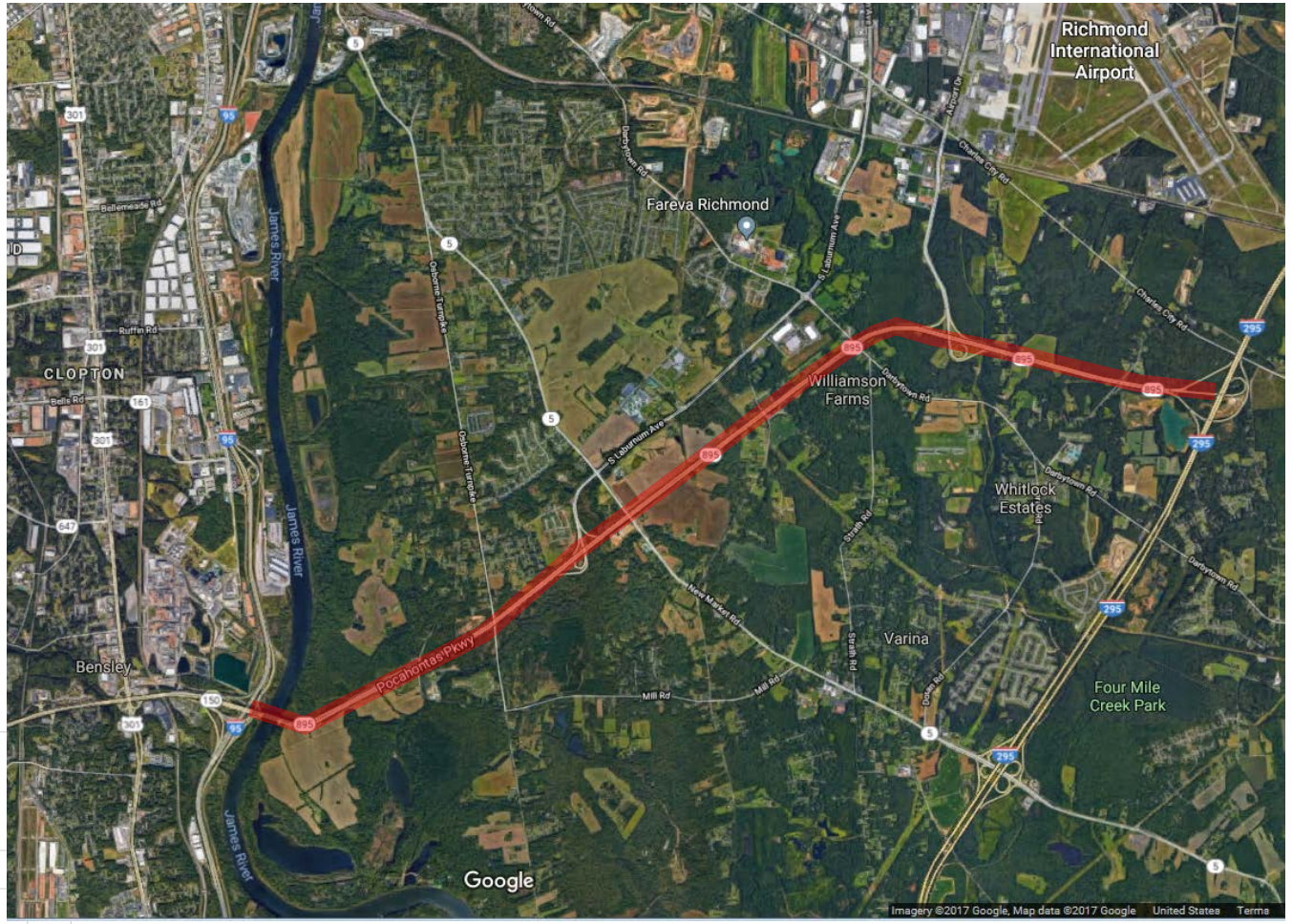
Toll ($2.00)/ VOT ($20/hr) * 60 min/hr

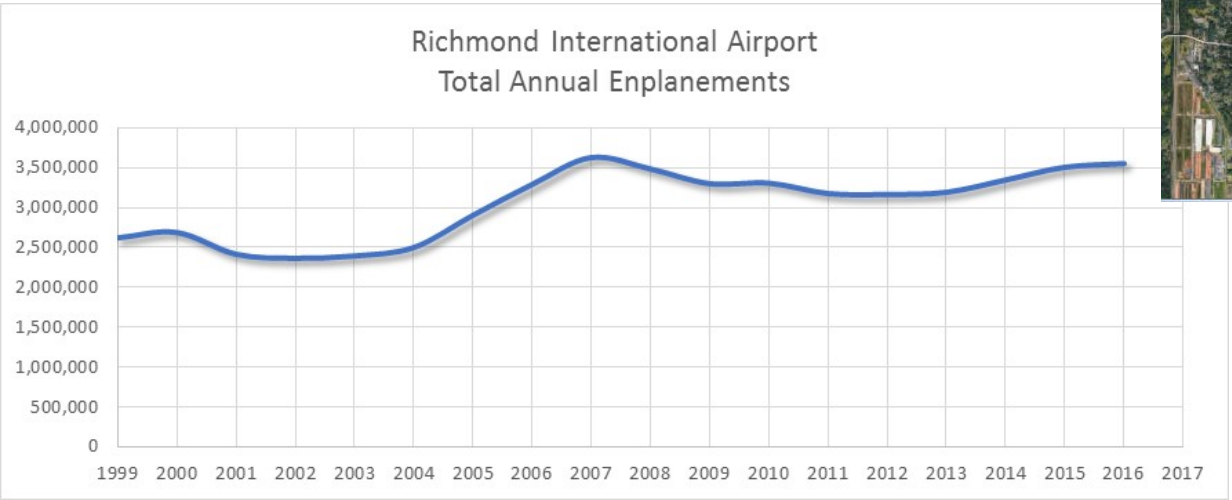
24 Min VOT = $5	8 Min VOT= $15	6 Min VOT= $20	4.8 Min VOT= $25	3.4 Min VOT= $35



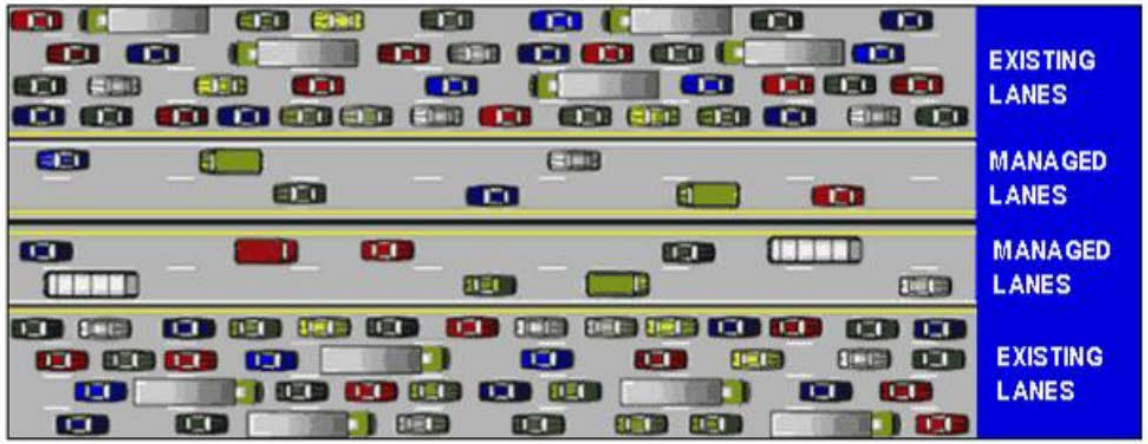
Overly Optimistic Land Use Growth

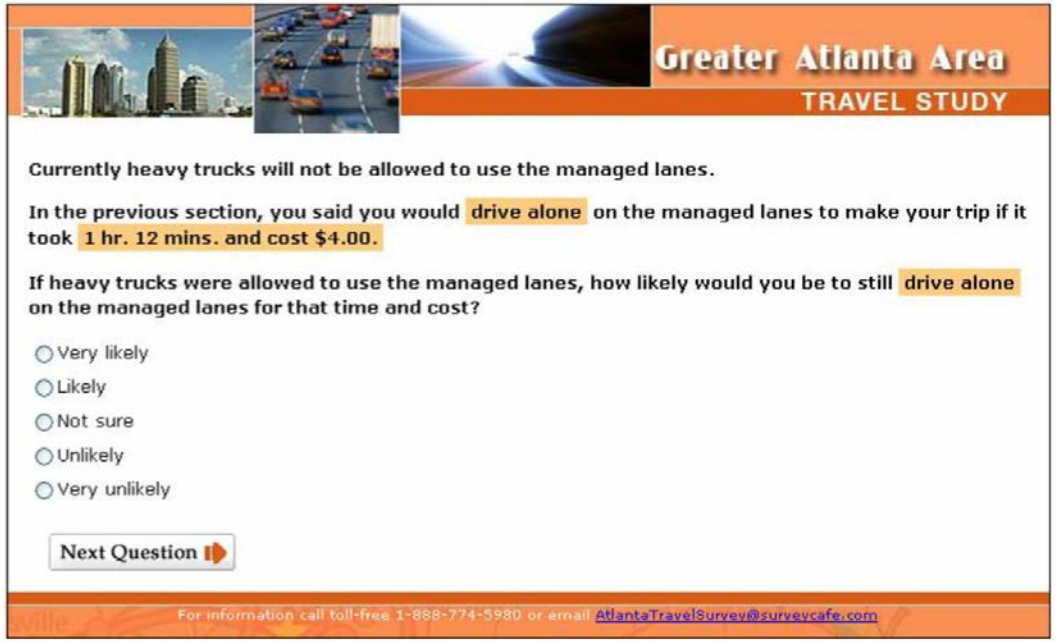
Traffic forecasts based on new suburban subdivisions southeast of Richmond (including 6,000 new homes, and due to increased passenger use of Richmond International Airport.





Stated Preference versus Revealed Preference





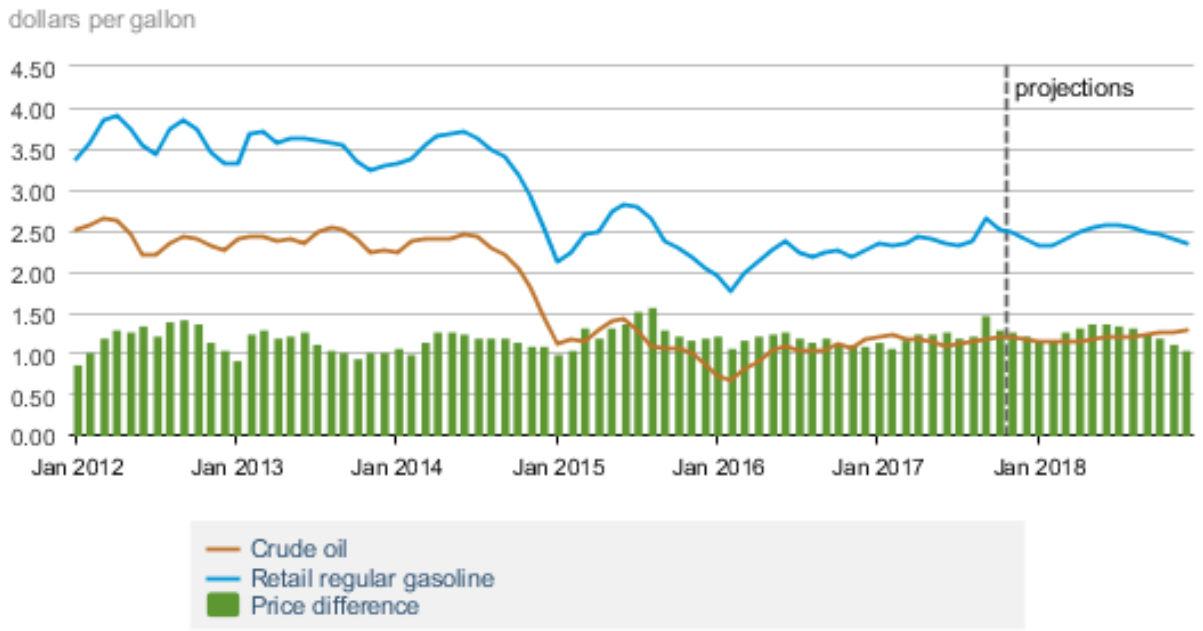
Source: Atlanta Regional Managed Lane System Plan, HNTB

Stated Preference - how travelers say they will respond to a future choice

Revealed Preference - how data shows travelers respond to existing choices

Future Estimates

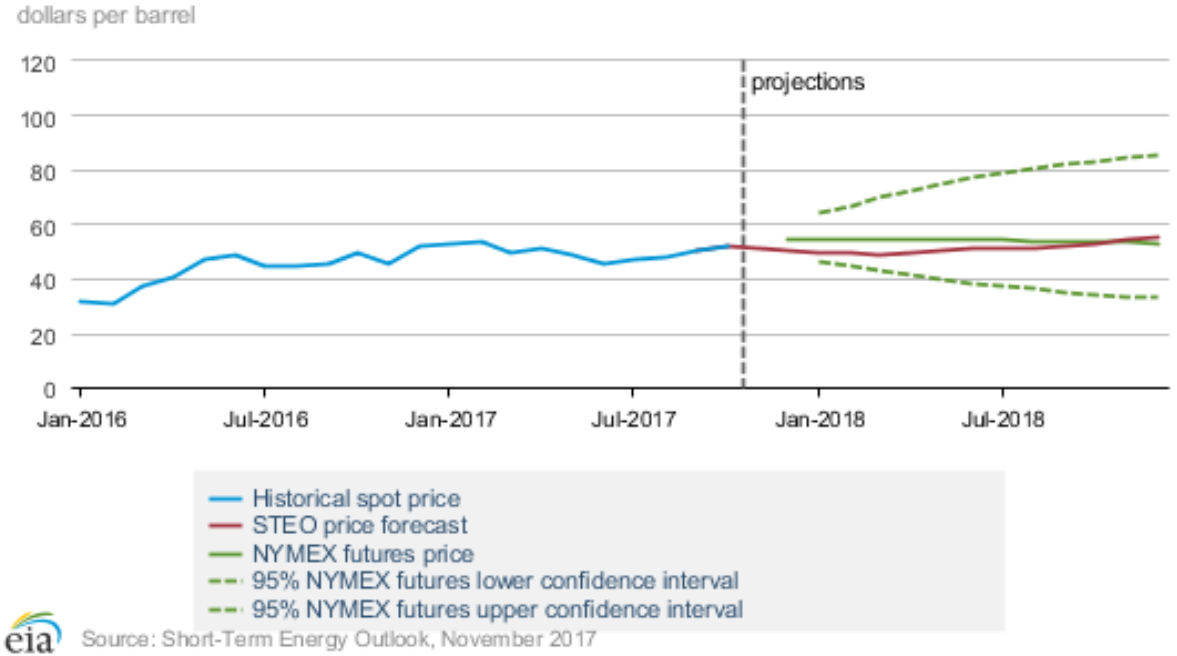
U.S. gasoline and crude oil prices



Source: Short-Term Energy Outlook, November 2017

Crude oil price is composite refiner acquisition cost. Retail prices include state and federal taxes.

West Texas intermediate (WTI) crude oil price



Source: Short-Term Energy Outlook, November 2017

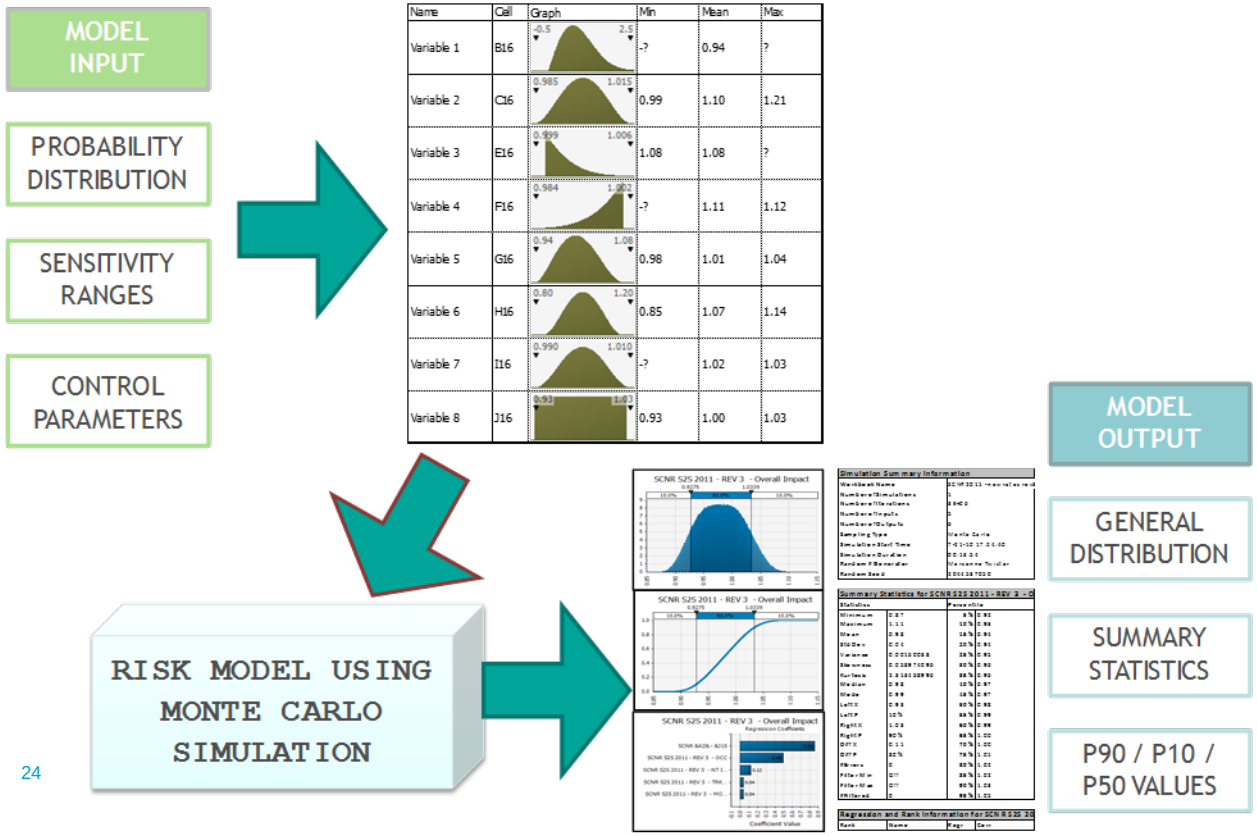
Note: Confidence interval derived from options market information for the 5 trading days ending Nov. 2 2017. Intervals not calculated for months with sparse trading in near-the-money options contracts.

Things to watch out for (an incomplete list)

- Access to facility and configuration
- Overly optimistic new land use growth in the corridor
- Stated Preference (SP) versus Revealed Preference (RP) data
- Applying behavior from other locations
- Value of small travel time savings
- Value of “toll road bias constants”
- Change in Value of Travel Time Savings
- Truck/Freight behavior
- Annualization Factors and days of the week and seasonal variation
- Ramp up
- Fuel prices and auto operating costs

Risk Analysis

- Identify key input variables that affect the baseline forecasts
- Define probability distributions around each key variable
- Define sensitivity functions for each variable
- Run the risk model (Monte Carlo simulation)



Conclusion

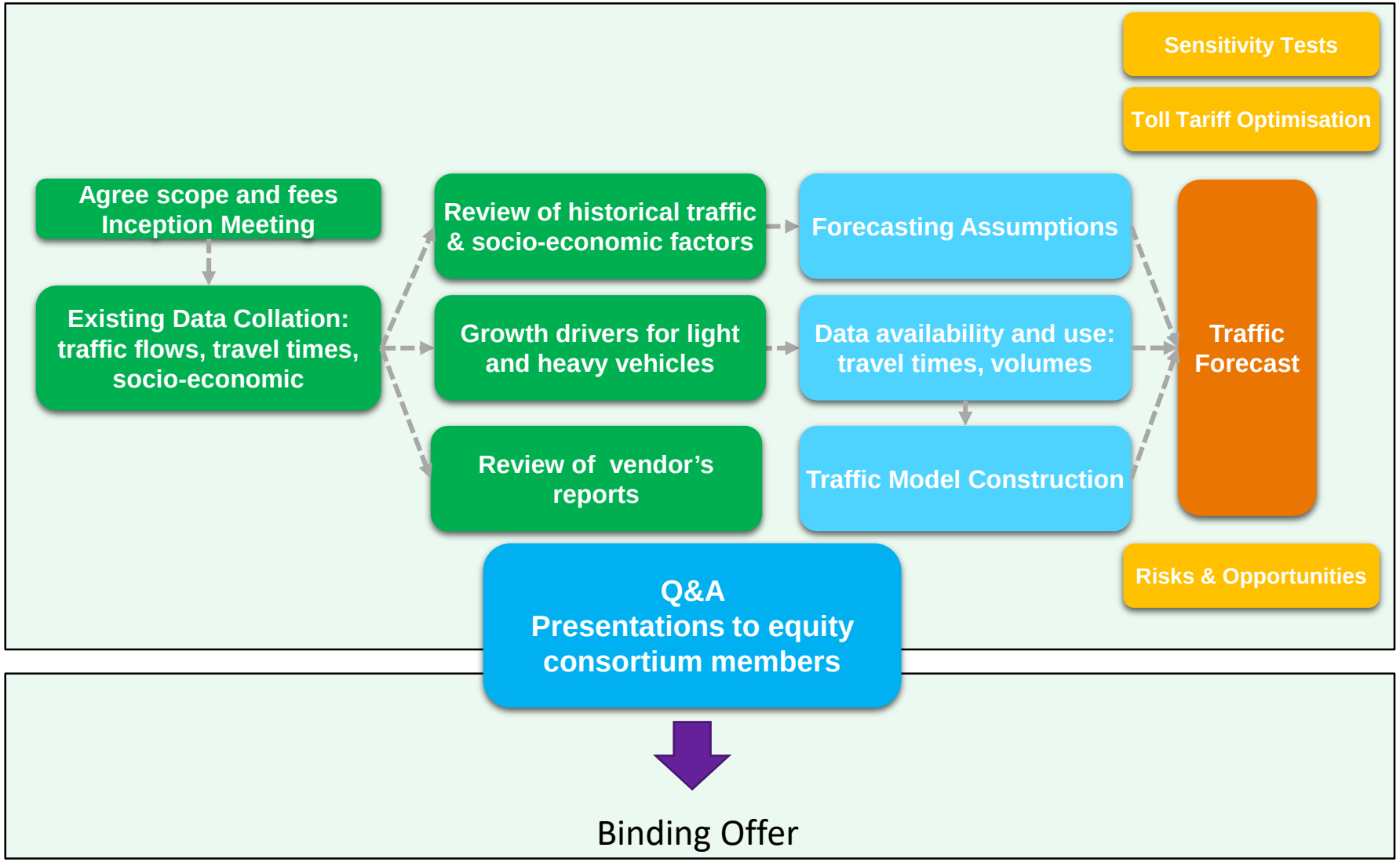
- Be skeptical of inputs and assumptions and understand the source and implications
- Benchmark forecasts to existing facilities
- Understand the perspective of each group involved and how it may guide their view of the forecasts
  - Sponsor may be overly aggressive
  - Lenders and rating agencies may be overly conservative
  - Forecasters should develop the most accurate and appropriate independent traffic and revenue projections

Thank You

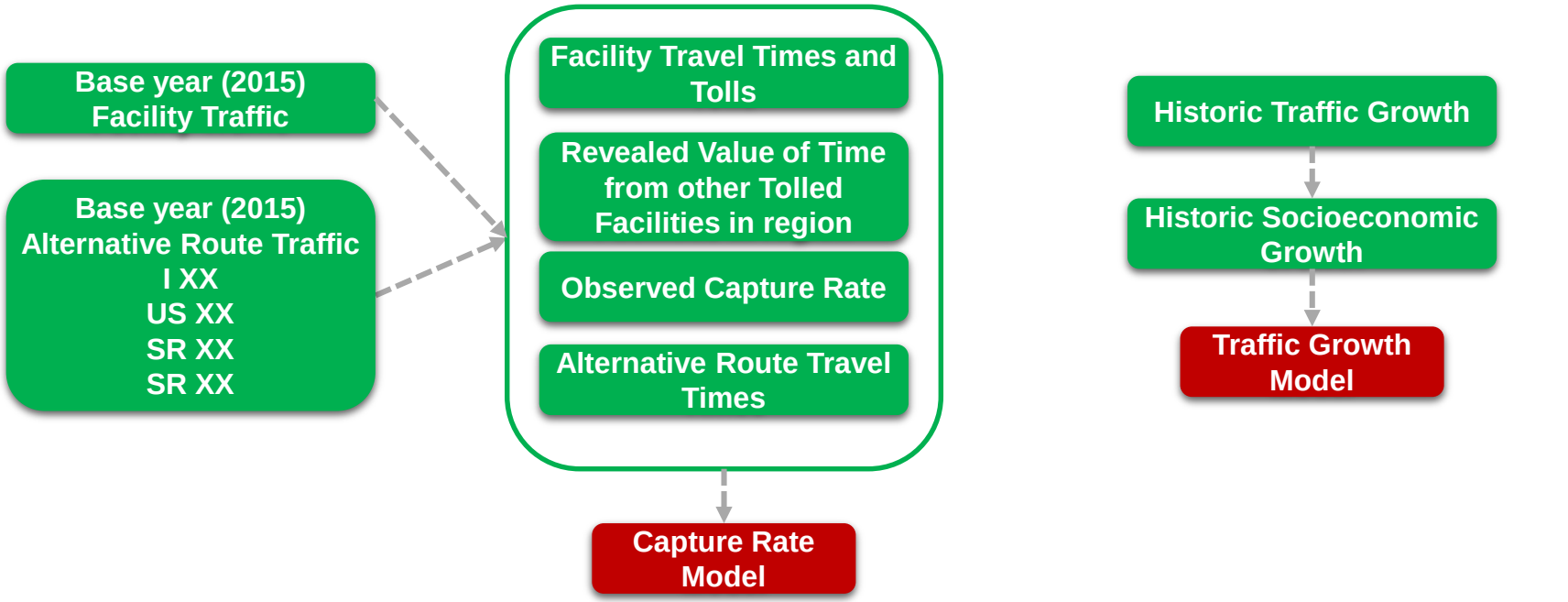
Questions?

2. Traffic and Revenue

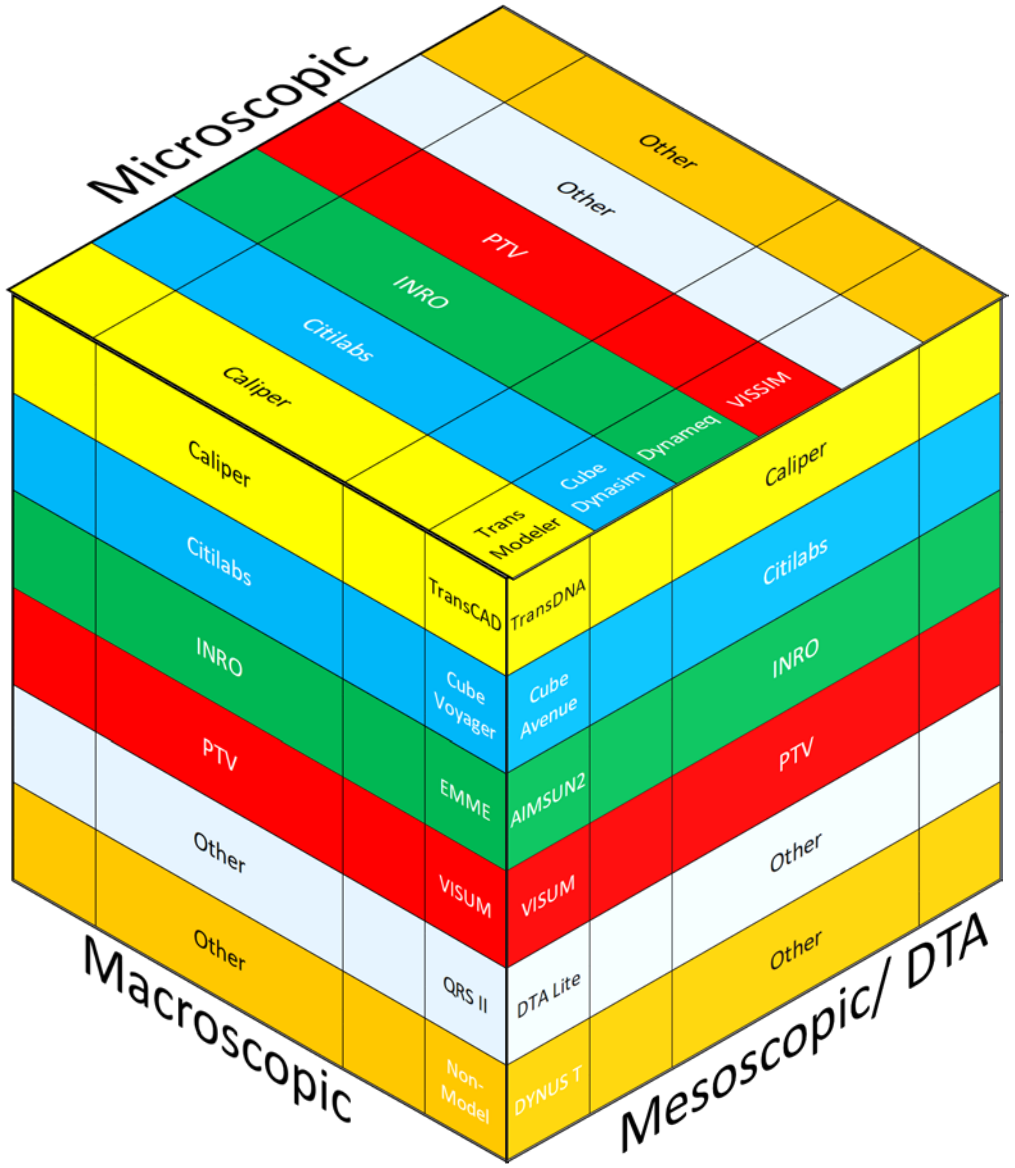
Sample methodology for developing new forecasts:



Typical Traffic Model Structure



Matrix of Platforms vs. Resolutions



Caliper

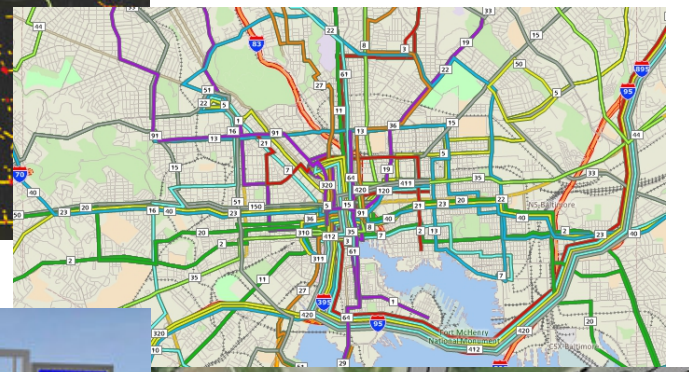
PTV GROUP
the mind of movement

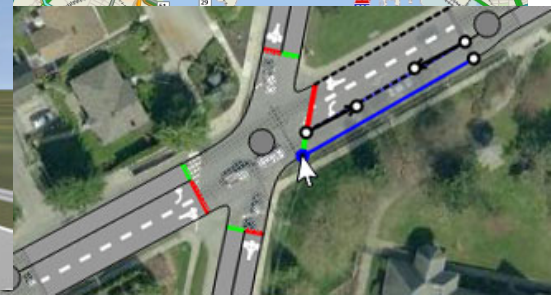
CITILABS

DTALite

INRO

DynusT





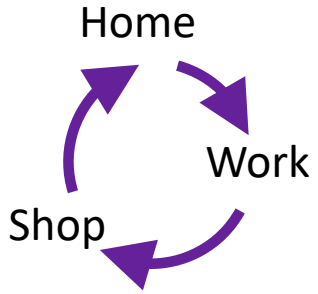
Benefits and Drawbacks of Activity-Based Models

Benefit

- Modeling individual behavior and activities, not just trip making
- Links activities for individual and households and inter trip dependence
- Allows use of more detailed attributes for an individual and household
- Ability to test a broader range of policies
- Better time representation (allows for analysis of peak spreading)
- Similar data input to the model as 4 step models

Drawback

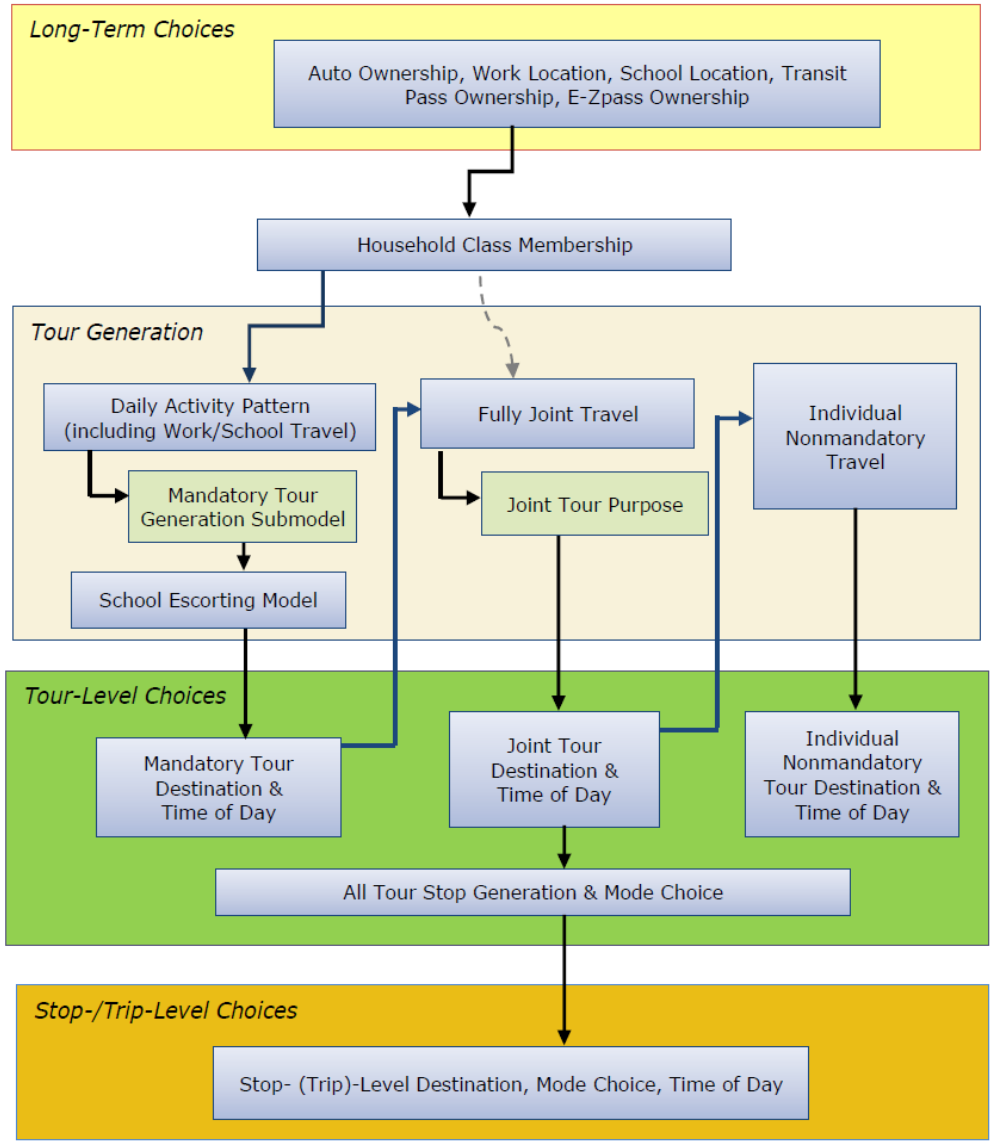
- More complex and therefore likely more difficult to develop and apply
- Longer run times
- More difficult to trace causes and effects of model results
- More complex data required for model estimation and model development



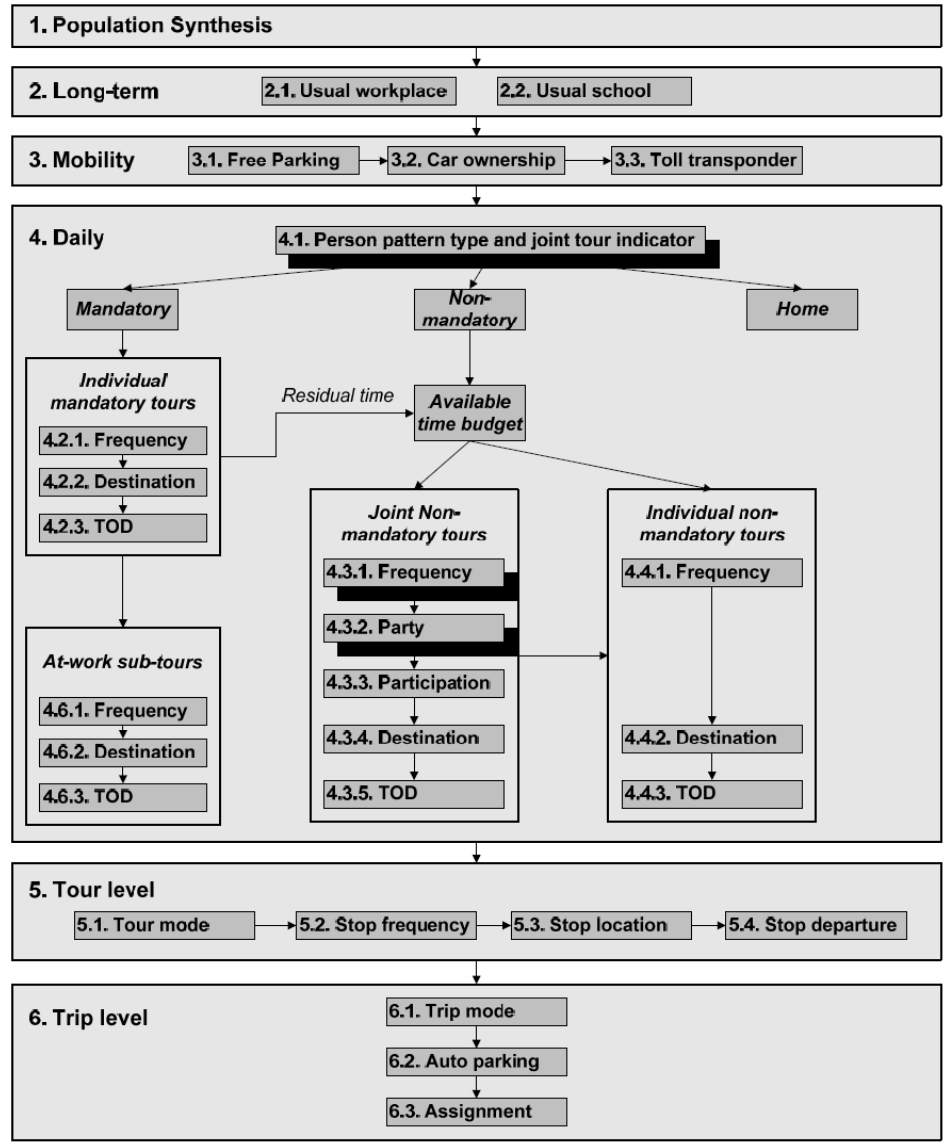
1 tour is 3 trips
HBW – trip from home to work
NHB – trip from work to shop
HBS – trip from shop to home

Activity-Based Models Process Flow Chart

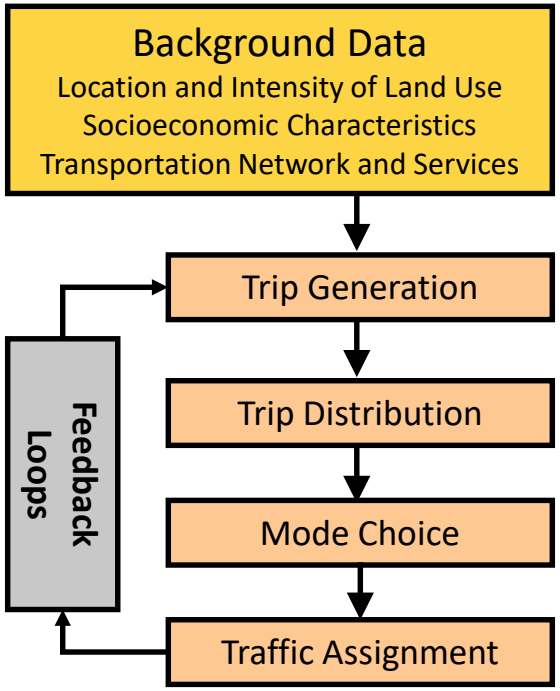
Baltimore InSITE Activity-Base Model

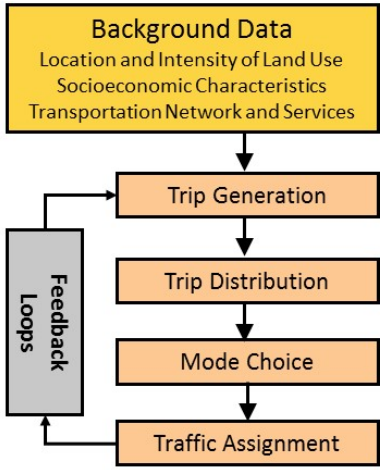


Southeast Florida Activity-Base Model



Source: Status of Activity-Based Models and Dynamic Traffic Assignment at Peer MPOs, CSI 10/15/16


Background Data
Location and Intensity of Land Use
Socioeconomic Characteristics
Transportation Network and Services
Trip Generation
Trip Distribution
Mode Choice
Traffic Assignment
Feedback Loops


Background Data
Location and Intensity of Land Use
Socioeconomic Characteristics
Transportation Network and Services
Trip Generation
Trip Distribution
Mode Choice
Traffic Assignment
Feedback Loops

Abstract

- The history of tolling and the introduction of P3 in the US
- A review of the good bad and ugly of toll forecasts
- The basics of a T& R Study: the accepted “levels” of the study, when and why they are used, characteristics of the study, level of effort, and limitations
- Basics of investment grade modeling methodology:
  - An Investment Grade Forecast is one that can form the basis for credit ratings, financial approval, and the sale of capital markets debt
  - Data collection needs and methods
  - Adjustments of base regional modeling tools including the importance of calibrating to time period volumes and travel times;
  - Value of time/ Willingness to Pay (VOT/WTP) variability, and model representation of cost and time (generalized cost versus diversion curves)
  - Ramp up
  - Toll setting (max revenue versus max throughput, toll rates by occupancy, vehicle class, etc)
  - Annualization and incorporation of weekends and holidays to average day forecasts
  - Benchmarking to similar facilities
  - Sensitivity testing and risk analysis
- Things to look out for - Common causes of inaccurate forecasts
  - Input socio economic growth assumptions, especially the impact of new development
  - Travel time savings not achieved
  - Value of Time changes over time
  - Gas Prices/ vehicle operating cost
  - Design changes to the facility
  - Network changes in the future (free alternatives to the facility, transit expansion)
- Future concerns issues
  - Impact of freight delivery changes
  - Ridesharing growth
  - Millennials driving less
  - Connected/ Autonomous vehicle impacts
- Toll Financing (Gross versus Net Revenue, basics of the loan and bond review process)

Important Factors & Common Sources of Error in Toll & Managed Lanes

- Access – Does the system provide a route for the desired origins and destinations
- Ramp up – How long does it take for facility to get to normal usage
- Toll setting policy (maximizing revenue versus maximizing throughput; differing toll rates by occupancy, vehicle class, etc)
- Annualization and incorporation of weekends and holidays forecasts
- Input socioeconomic growth assumptions, especially the impact of new development
- Value of time (VOT) changes over time
- Gas prices/ vehicle operating cost
- Design changes to the facility and/or network changes in the future (free alternatives to the facility, transit expansion) resulting in unrealized travel time savings
- Sensitivity testing and risk analysis