Demand Forecast Uncertainty

Dr. Antonio Trani (Virginia Tech)

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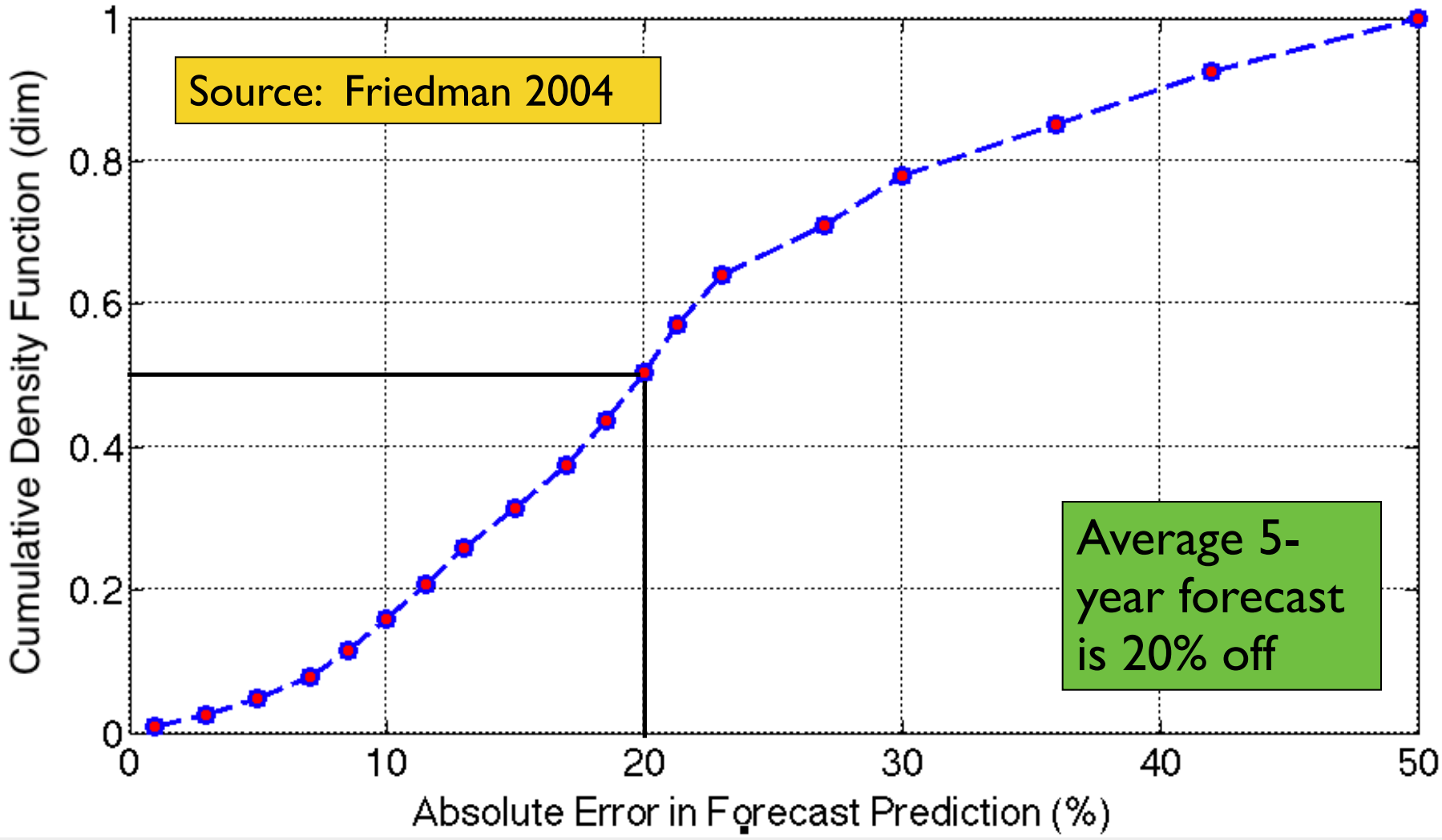
Introduction to Airport Demand Uncertainty

- Airport demand cannot be predicted with accuracy
- Multiple factors make such prediction uncertain:
  - Passenger demand forecast usually rely on socio-economic factors that in turn are uncertain (i.e., future GDP forecasts)
  - Passenger demand forecast rely on service level variables that cannot be predicted accurately (i.e. air fares)
  - Predicting people's behavior is more difficult than predicting atomic particle dynamics
  - Many exogenous variables that are impossible to predict (i.e., terrorism, financial crises, etc.)

Goodness of Airport Aviation Forecasts

- Percent Absolute Error of FAA Terminal Area Forecast (Five year forecast)



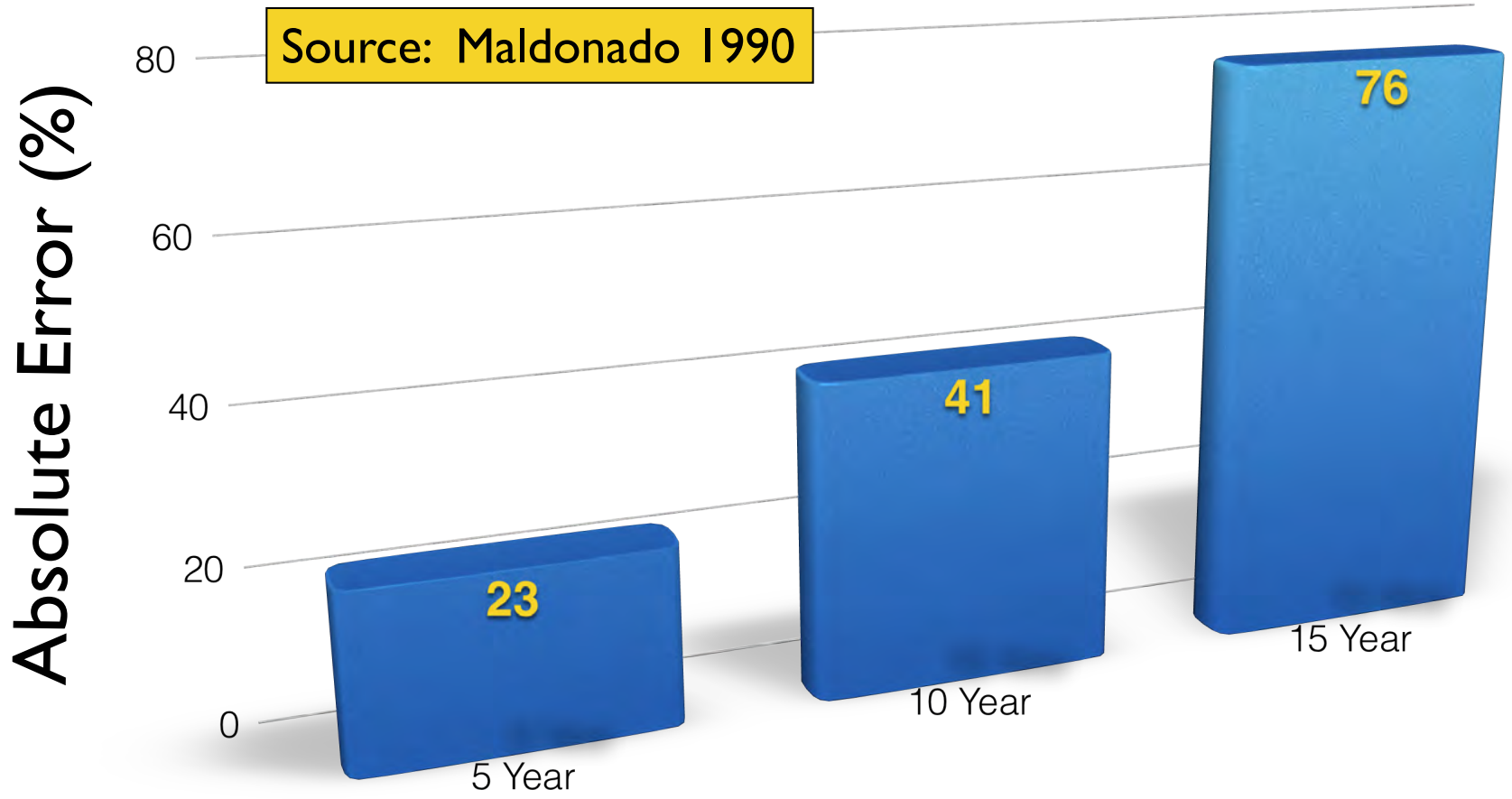
Uncertainty in Aviation Forecasts Applies to Many Markets

- Average difference between a 5-year forecasts and actual international passenger demand was 22%
- Average difference between a 10-year forecasts and actual international passenger demand was 40% (Nishimura, 1999)

Source:of map
http://www.yadyad.com

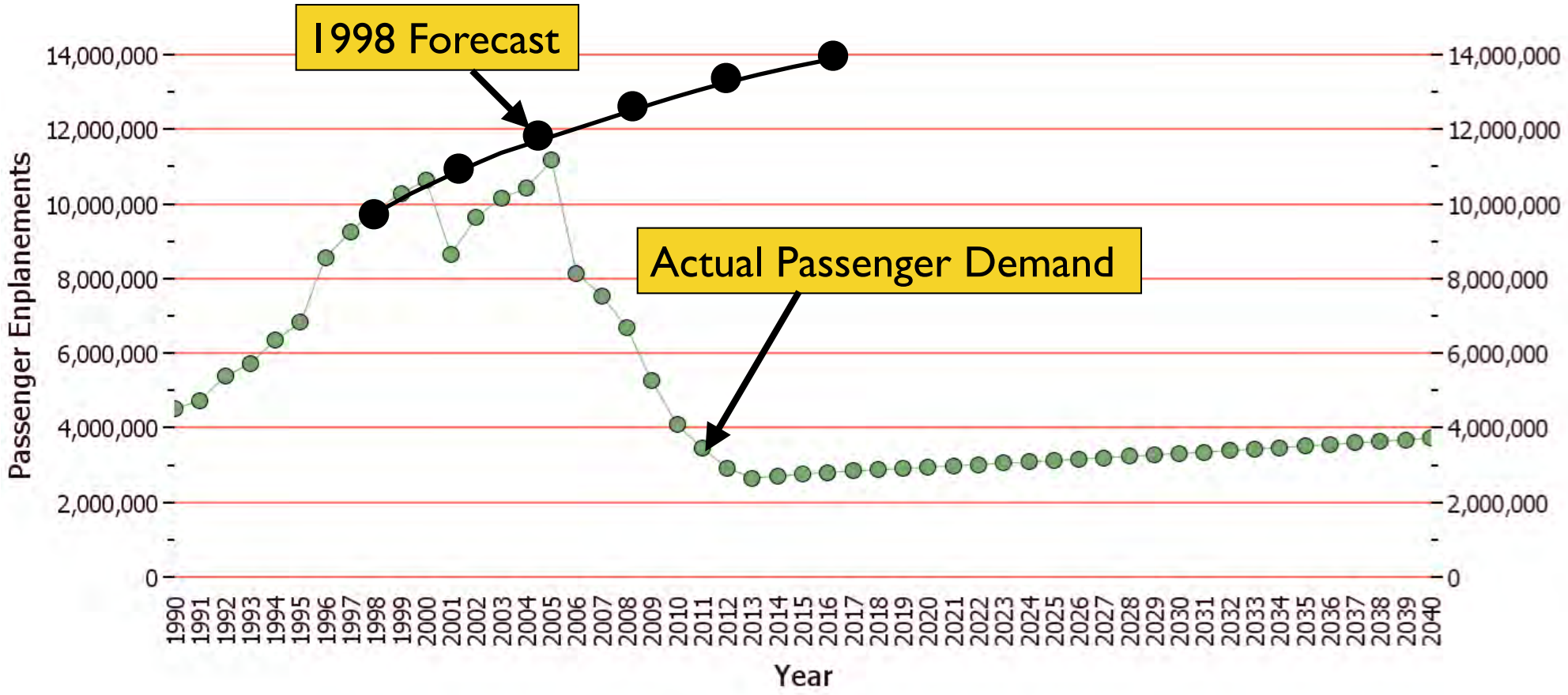
United States Airport Master Plan Forecasting Experience

- Longer term forecasts have higher inaccuracies than short-term forecasts



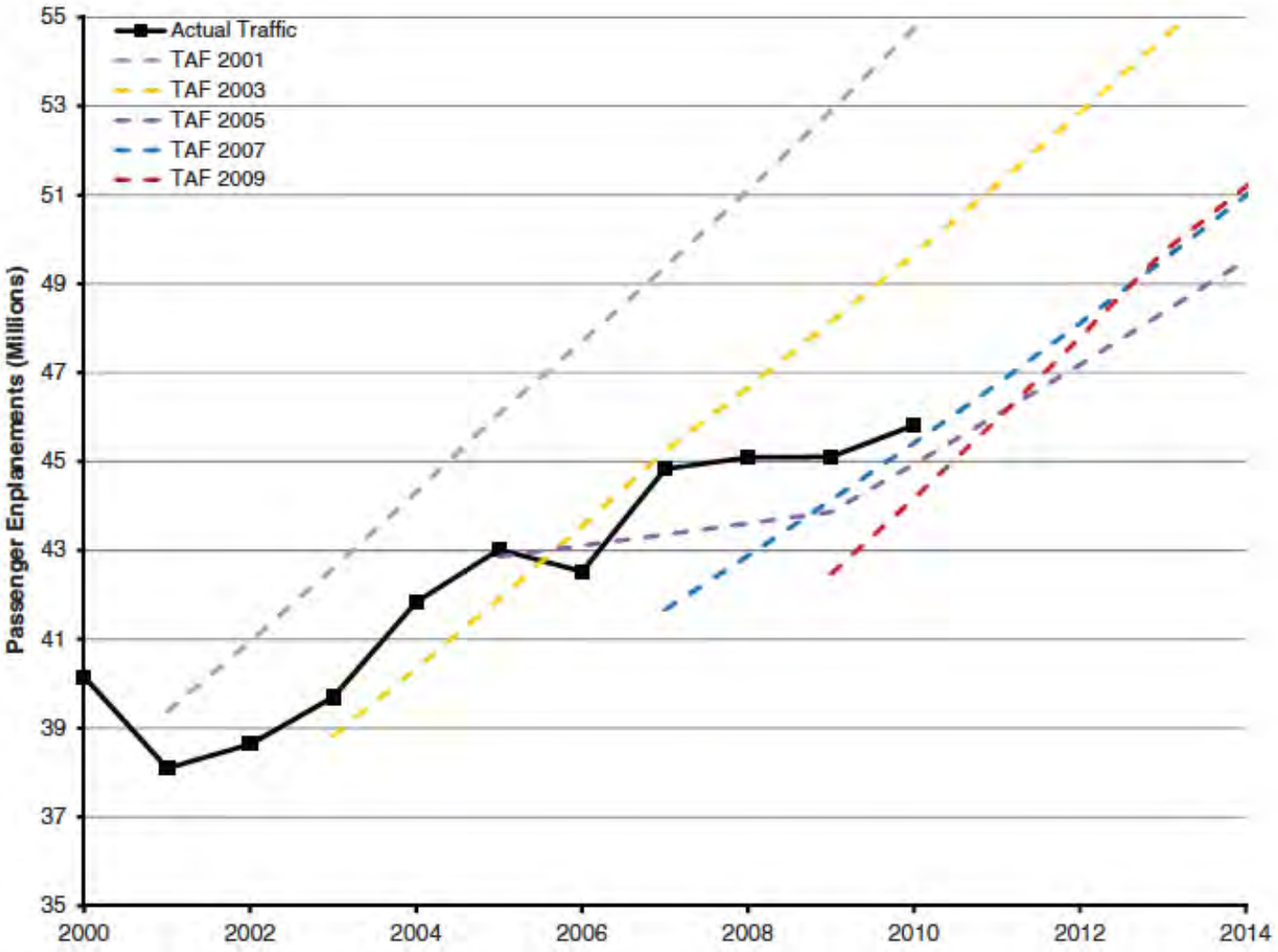
Example Volatility in Airport Demand (Cincinnati International Airport - CVG)

- Cincinnati was a hub for Delta Airlines
- Delta moved its hub operations from CVG in 2005



Source: FAA Terminal Area Forecast 2013

Example: Passenger Enplanement Forecasts for Atlanta International Airport

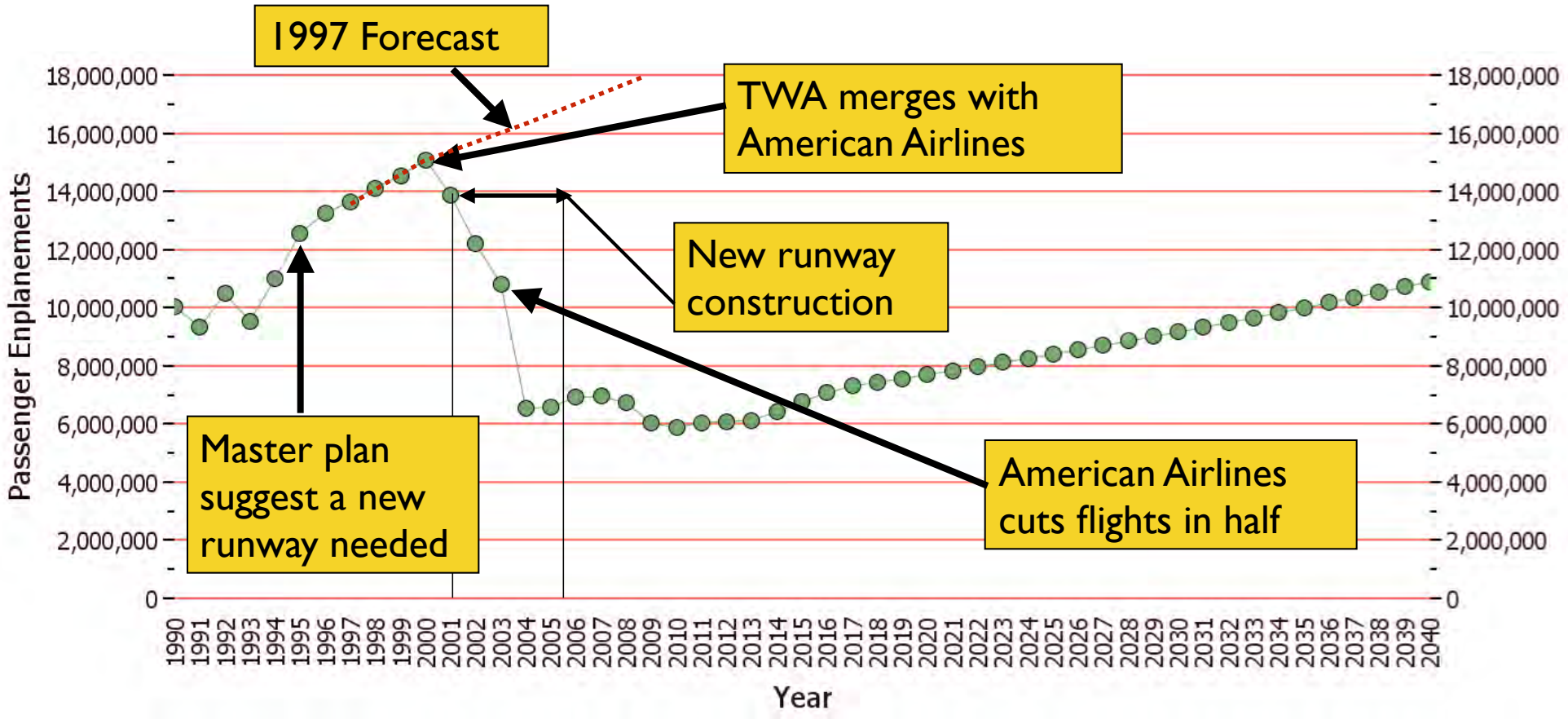


Source: Hartsfield-Jackson Atlanta International Airport operational statistics and FAA TAFs.

Source: ACRP 76

Example Volatility in Airport Demand (Saint Louis International Airport)

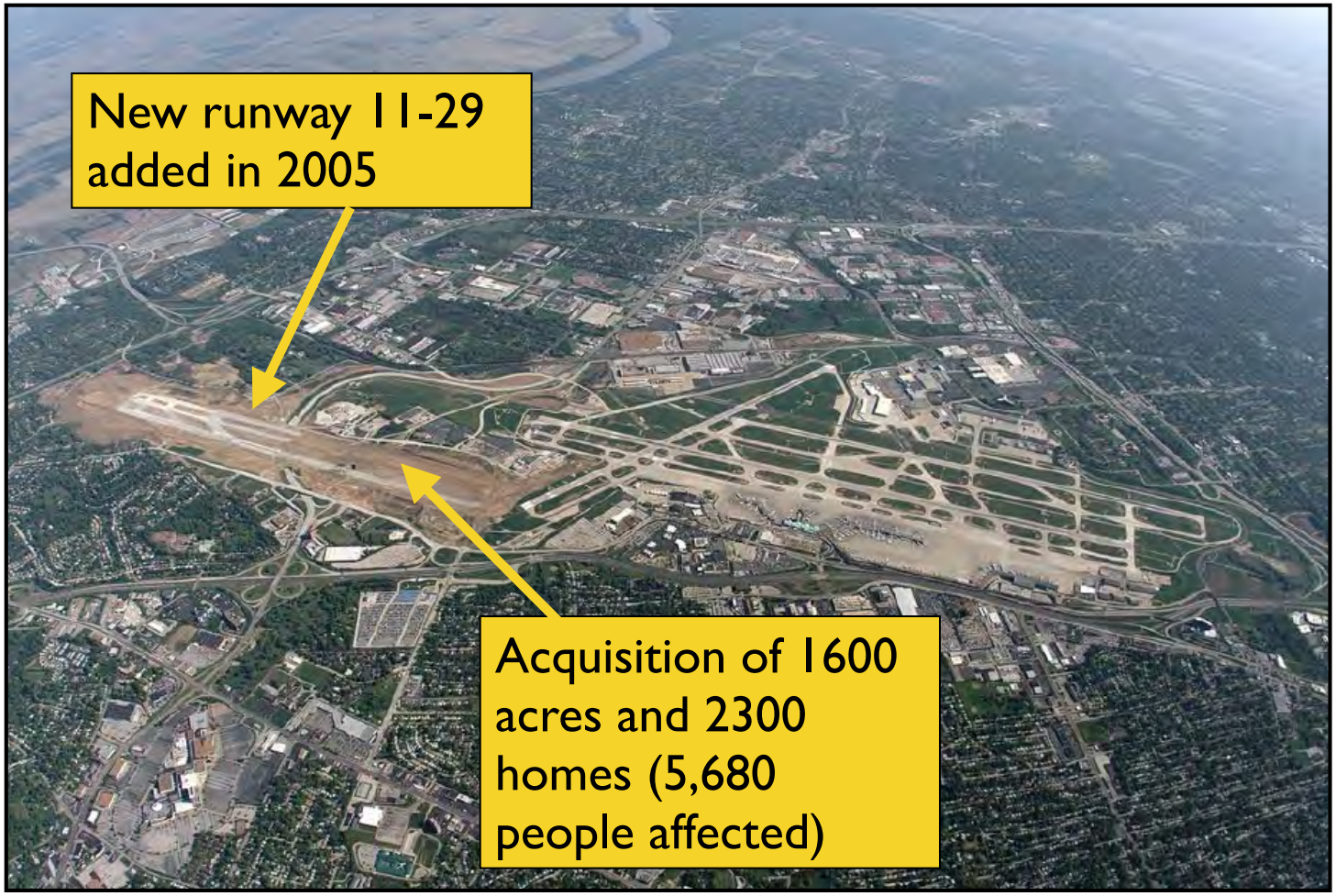
- St. Louis was a hub for Trans World Airlines (TWA)
- TWA merged with American Airlines in 2001



Source: FAA Terminal Area Forecast 2013

Saint Louis International Airport

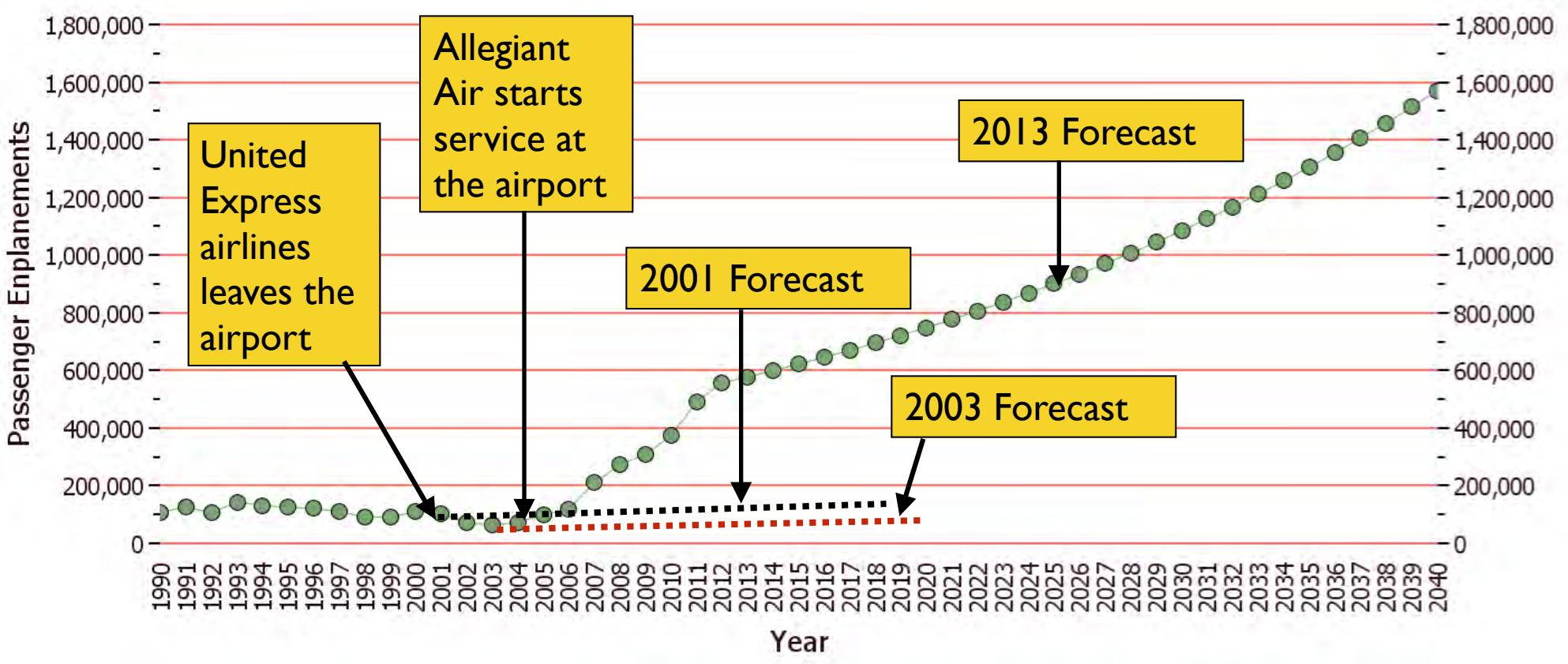
- Saint Louis International added a new runway (at the cost of 1.02 billion dollars ~ 1 trillion Korean Won in 2005)



Source: http://www.thebhc.org/publications/BEHonline/2011/rust.pdf

Example Volatility in Airport Demand (Bellingham International Airport - US)

- Demand at Bellingham has developed more rapidly than anticipated due to flight by a Low Cost Airline (Allegiant Air)



Source: FAA Terminal Area Forecasts and BLI Data

Summary of Airport Forecast Accuracy

- Previous studies suggest airport forecasts are off by an average 20-23% in five years
- Longer-term forecasts (15 years) can be off by an average absolute error of 76%
- For this reason, airport planning should rely on careful examination of various alternatives
- Short-term forecasts can favor mathematical models
- Long-term forecasts require both modeling and also common sense (i.e., expert opinion)

Dealing with Airport Forecast Uncertainty

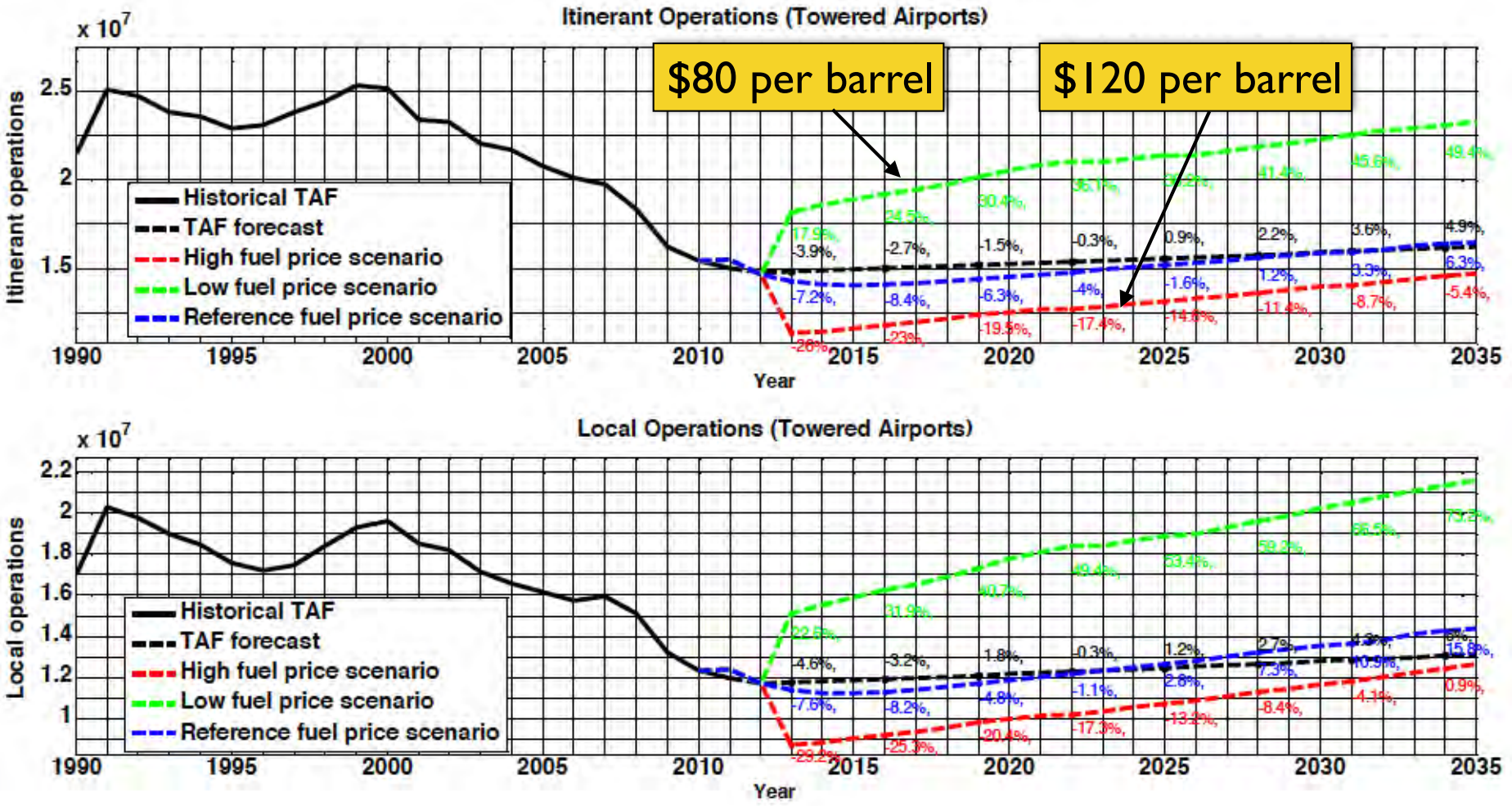
- Airport master planning is not a linear process: Risk assessment is key in today's airport planning environment
- Strategic thinking requires a solid understanding of the airport/airline industry in the context of the airport development
- Airport are connected systems and thus affected by other airports in a national and international environment
- National government directed plans are rare in today's competitive airport environment
- Flexible or dynamic strategic airport planning requires an assessment of risk and financial planning simultaneously

Techniques to Deal with Airport Demand Uncertainty

- Data-driven approaches
  - Low-High forecast
  - What-if analysis
  - Sensitivity analysis
  - Prediction intervals in Time-Series methods
  - Extrapolation of empirically observed errors
  - Distribution fitting and Monte Carlo simulation
- Judgement procedures
  - Delphi techniques

Example of Sensitivity Analysis Applied to a Forecast of General Aviation Demand in the US

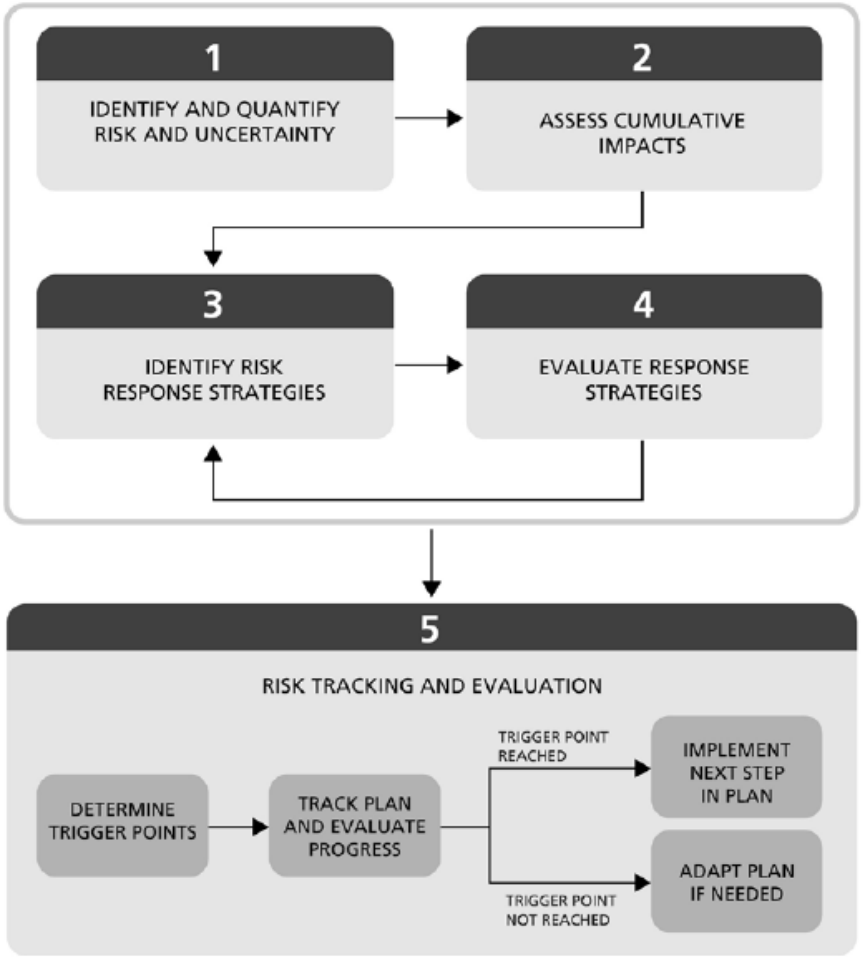
Li and Trani, 2013



Airport Cooperative Research Program
Method to Address Airport Demand Uncertainty

- Multi-step process to deal with airport demand uncertainty

- Step # 1 - Identify risk and uncertainty
- Step # 2 - Quantify cumulative impacts
- Step # 3 - Identify risk response strategies
- Step # 4 - Evaluate response strategies
- Step # 5 - Risk tracking and evaluation



Source: Airport Cooperative Research Program Report 76

Methodology and Its Variations to Deal with Airport Demand Uncertainty

Step	Track A Mostly Qualitative	Track B Some Quantification	Track C Quantitative, with Limited Stakeholder Involvement	Track D Quantitative, with Peer Review and Structured Elicitation
1. Identify and quantify risk and uncertainty	Development of the risk register based largely on the guidebook combined with qualitative analysis, visual aids, and informa elicitation within the airport.	Development of the risk register based largely on the guidebook combined with qualitative analysis, visual aids, and formal elicitation (e.g., Delphi) within the airport.	Development of the risk register based on quantitative analysis, where possible, combined with formal elicitation (e.g., Delphi) within the airport and with key stakeholders.	Development of the risk register based on quantitative analysis, where possible, combined with formal elicitation (e.g., Delphi and structured workshops) with airport management/planners, subject matter experts, and a wide range of stakeholder groups.
2. Assess cumulative impacts	Based on basic scenario analysis and qualitative approaches.	Based on basic scenario analysis and other simple modeling approaches.	Use of more advanced modeling procedures such as Monte Carlo simulation.	Use of more advanced modeling procedures such as structure and logic diagrams and Monte Carlo simulation.
3. Identify risk response strategies	Based largely on the information provided in the guidebook with informal elicitation within the airport.	Based on the guidebook and research on examples and best practice at other airports with informal elicitation within the airport.	Based on research of examples and best practice at other airports and informal elicitation within the airport and with key stakeholders.	Based on research of examples and best practice at other airports and formal elicitation within the airport and with stakeholders.
4. Evaluate risk response strategies	Largely qualitative and basic quantitative assessment.	Largely qualitative and basic quantitative assessment.	Quantitative analysis such as expected net present value.	Quantitative analysis such as expected net present value.
5. Risk tracking and evaluation	Tracking of traffic against forecasts and trigger points and annual review of risk register.	Tracking of traffic against forecasts and trigger points and annual review of risk register.	The risk register is updated continuously (possibly using a database system) whenever new pieces of information come in. Full periodic reviews of the risk register.	Major risks may be assigned to specific airport staff (risk managers) for tracking and updates. The risk register is updated continuously (possibly using a database system) whenever new pieces of information come in. Full periodic reviews of the risk register.

Source: Airport Cooperative Research Program Report 76

Step # 1: Sources of Airport Forecast Uncertainty

- Global, regional or local economic conditions
- Airline strategy changes
- Low cost carrier market share growth
- Multi-airport systems competition
- Technology changes
- Social and cultural factors
- Exogenous shock events

Outside Government or analyst control

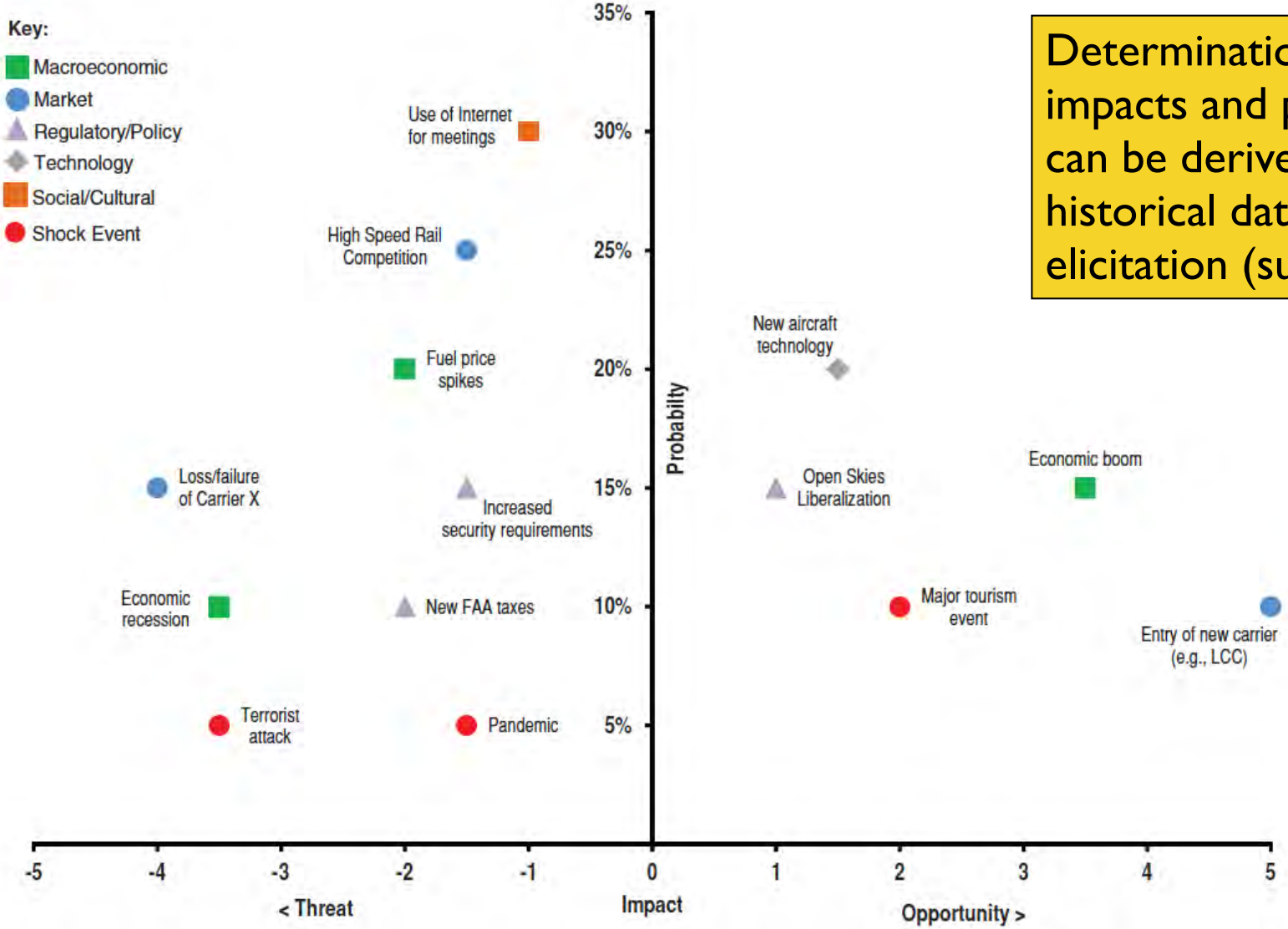
- Regulatory and government policies

Within Government control

- Statistical model errors

Within analyst control

Step # 1: Summary Plot of Risks and Uncertainties

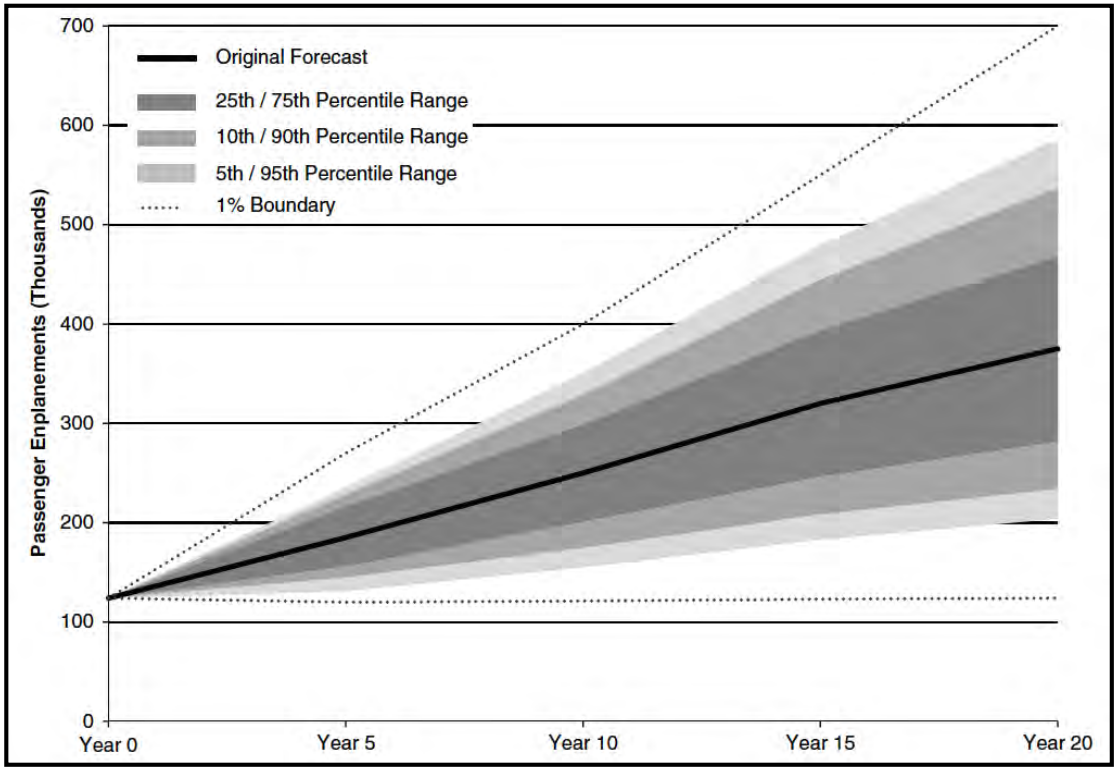


Determination of impacts and probabilities can be derived from historical data or though elicitation (survey)

Source: Airport Cooperative Research Program Report 76

Step # 2: Assess Cumulative Impacts

- This steps *"integrates the risks identified in Step 1 into a structural model of uncertainty" (ACRP 76)*
- Structured, logic or causal diagrams can be used to explain the causality between model variables
- Quantifying the cumulative impacts requires:
  - Monte Carlo simulation
  - Scenario analysis



Source: Airport Cooperative Research Program Report 76

Step # 3: Risk Response Strategies

- This steps identifies *"risk and uncertainties facing the airport as threats and opportunities."*
- Quantifying threats and opportunities requires:
  - Anecdotal evidence
  - Judgement

This step establishes trigger points

This step can be included in the feasibility study for Jeju Island Airport

Field Name	Example of Content
Risk ID	M1
Status	Active, Dormant, Retired
Risk Type	Market
Date Identified	01-01-2011
Risk Name	Loss of major carrier
Description	Carrier X removes the majority of its operations from the airport either through financial failure or change in strategy.
...	...
Risk response strategies	Linked to the following files: RR1; RR8

Field Name	Example of Content
Risk Response ID	RR1
Risk Strategy	Air service development
Description	Air service development program to attract additional carrier to the airport
Current Status	Targeting airlines Y and Z
...	...

Source: Airport Cooperative Research Program Report 76

Step # 4: Evaluate Risk Response Strategies

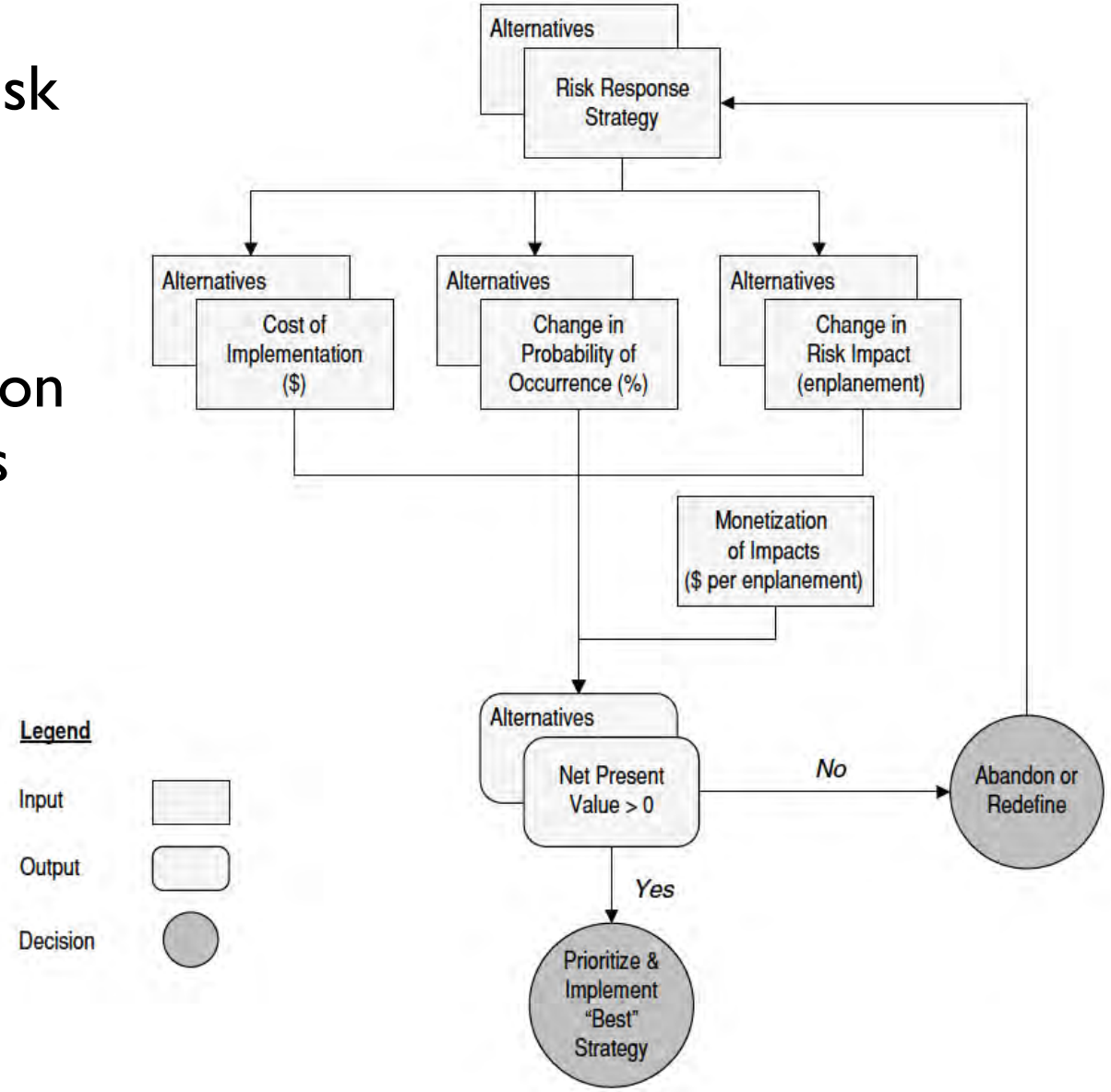
- This steps quantifies "*threats and opportunities facing the airport.*" *(ACRP 76)*
- *Specific goals are:*
  - *Identify the highest value risk response strategy*
  - *Demonstrate robustness over a wide range of outcomes*
  - *Determine value for money*

Source: Airport Cooperative Research Program Report 76

Step # 4: Evaluate Risk Response Strategies

Approaches to evaluate risk response strategies:

- Judgement
- Monte Carlo simulation
- Decision tree analysis
- Economic techniques (NPV, CBA, etc.)



Source: Airport Cooperative Research Program Report 76

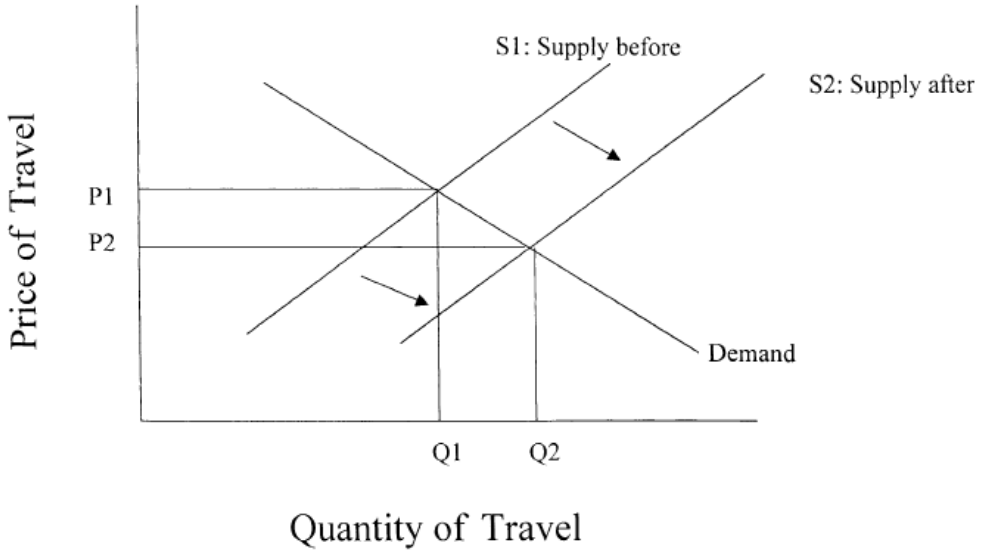
Step # 5: Risk Tracking

- This steps *"is an ongoing process of review, revision, and engagement." (ACRP 76)*
- *Specific goals are:*
  - *Continually assess the risk environment facing the airport*
  - *Identify new or changing risks, and*
  - *Take action where necessary*
- Actions
  - Periodic updates
  - Airport benchmarking

Source: Airport Cooperative Research Program Report 76

Air Transportation Induced Demand

- Induced demand arises when airlines add capacity to an air transportation system and potentially reduce the cost of travel (i.e., manifested by a reduction of fares)
- Induced demand is generally accepted as a consequence of airline industry dynamics
- In air transportation, the induced demand manifests itself as the difference between the historical underlying demand and the observed demand

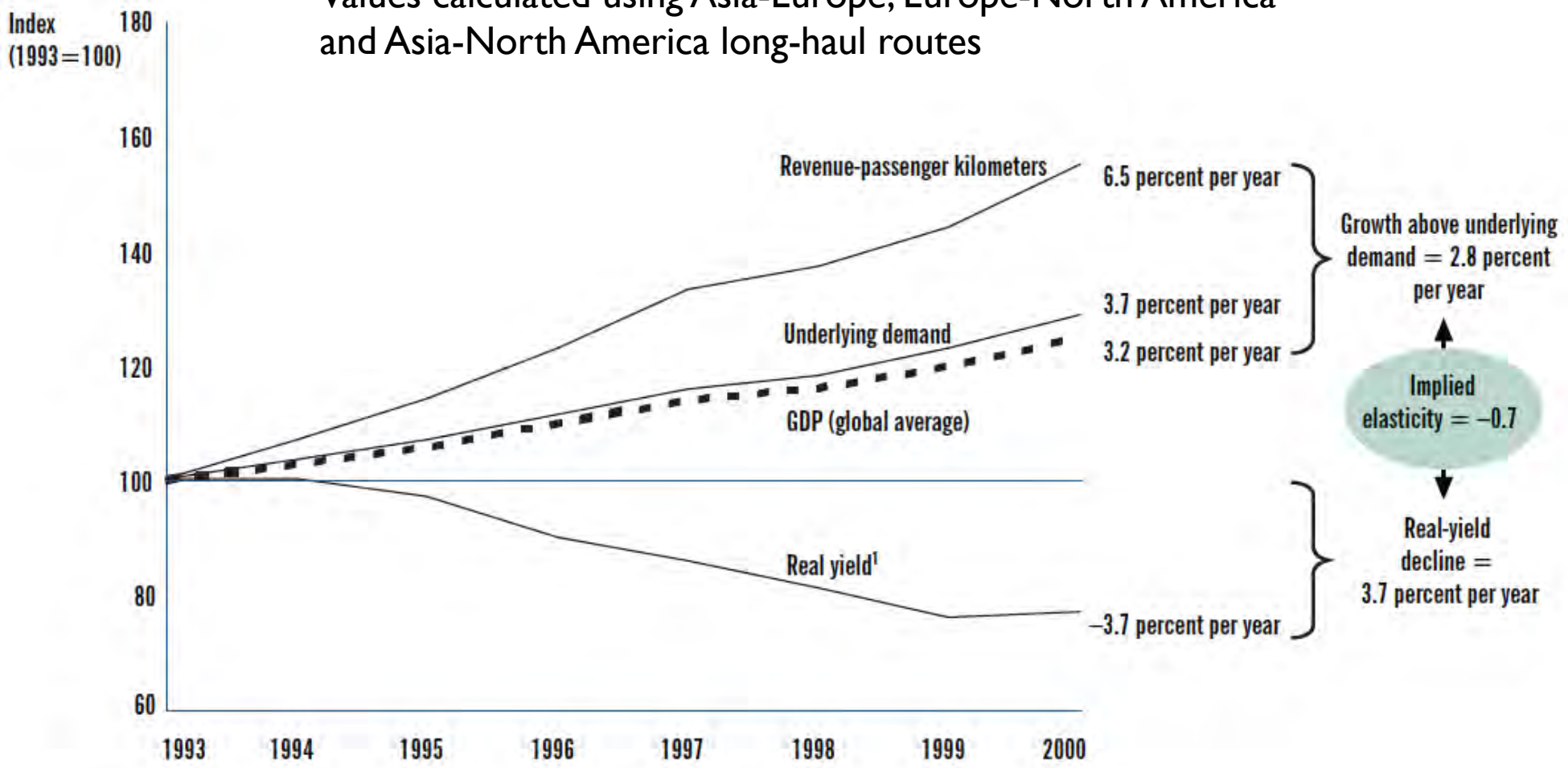


Sources: Nolam and Lem (2002)

- Most airport demand forecast models do not consider induced demand because airline dynamics over the long-term are not easily predictable

Air Transportation Induced Demand

Values calculated using Asia-Europe, Europe-North America and Asia-North America long-haul routes



Year

Sources: IATA and BCG Consulting

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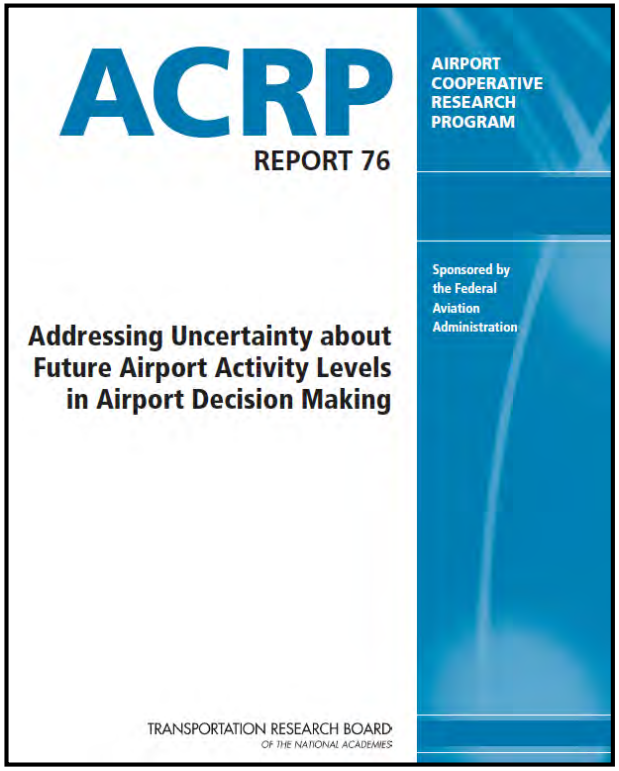

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