Airport Forecasting

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Forecasting In Practice

- **Objective: To present procedure.**
- **Topics:**
  1. **Premises**
  2. **Forecasts rely on Many Assumptions**
  3. **Basic mechanics of forecast methods**
  4. **Principles for Practice**
  5. **Recommended Procedure**
  6. **Mexico City Example**
  7. **Summary**

Premises

- **Forecasting is an Art,**

  not a Science -- too many assumptions

  not a statistical exercise -- too many solutions

- **Forecasts are Inherently Risky**

Assumptions behind any forecasting exercise

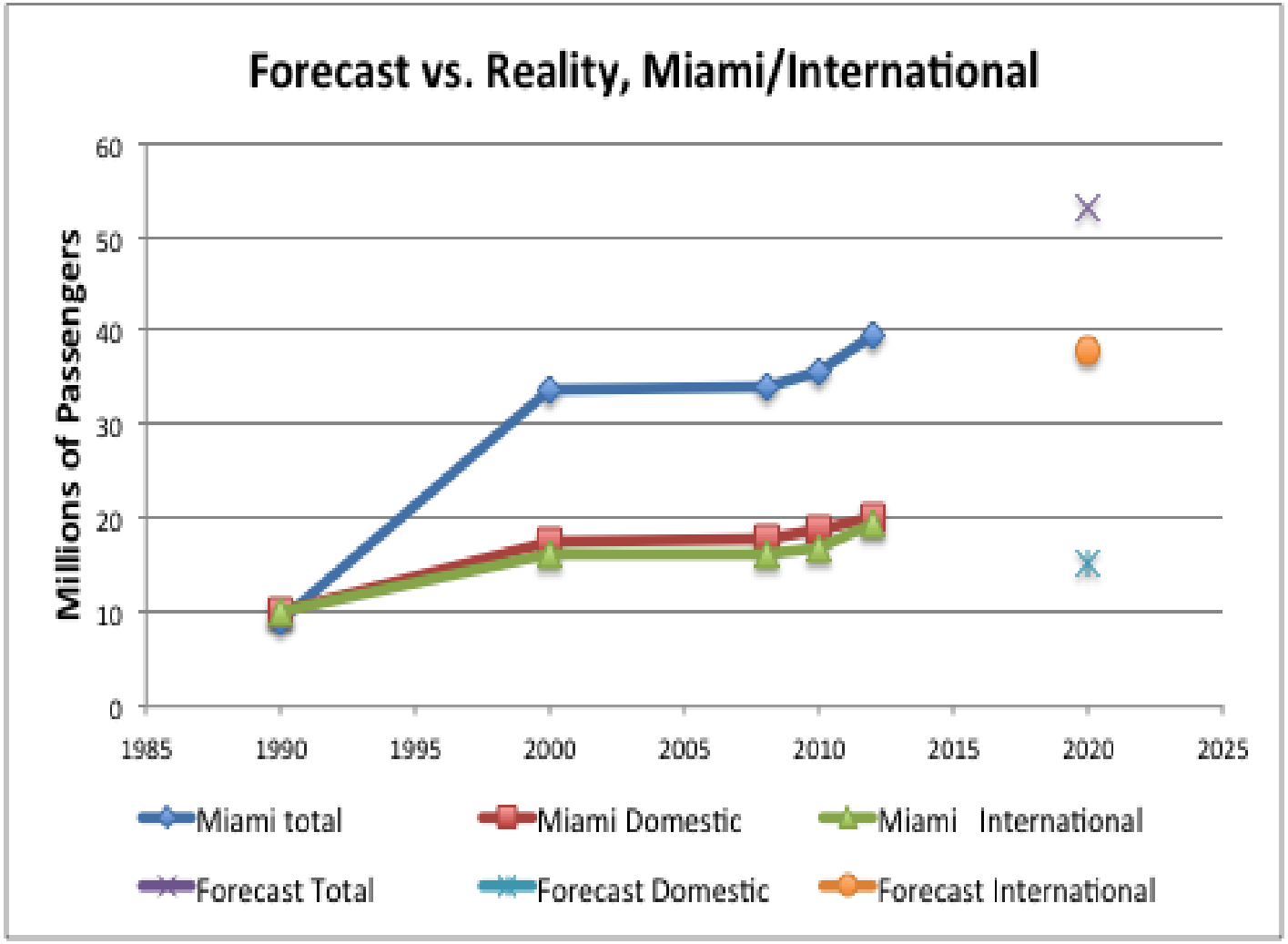
- Span of data -- number of periods or situations (10 years? 20? 30?)
- Variables -- which ones in formula (price? income? employment? etc)
- Form of variables -- total price? price relative to air? To ground?
- Form of equation -- linear? log-linear? translog? Logit?

Logical House of Cards

Assumptions behind any forecasting exercise

- **Span of data -- number of periods or situations (10 years? 20? 30?)**
- **Consider the Miami case…**

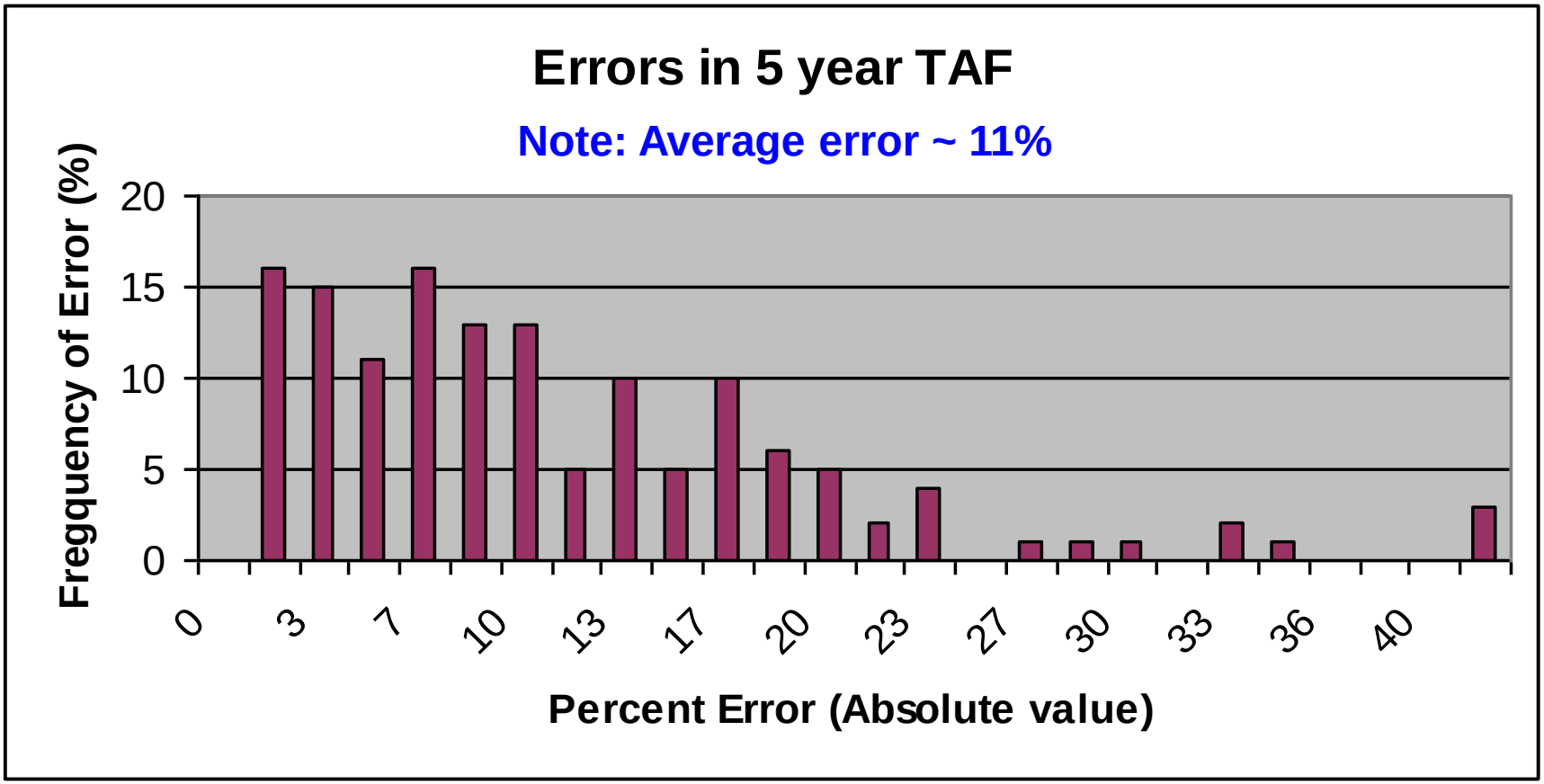
Forecast vs. Actual Miami/International



Consider making a forecast now:

How may years of data would you include in statistical analysis?

Results of a study of TAF



Adapted from: Terminal Area Forecast (TAF) Accuracy Assessment Results Jerome Friedman, MITRE CAASD. Study dated Sept. 30, 2004, but data until 2000. Deliberate omission of 2001, 2002 – when traffic dropped enormously

Choice of variables

- **Note first: The more variables you include, the better the statistics in model, the better the fit!**
- **Why is that?**
- **Because procedure for creating statistical model only includes variables to extent they improve**

Common forms of forecasting equations

- **Linear**
  - Pax = Population[a +b(Income)+c(Yield)…]
- **Exponential**
  - Pax = {a [Yield]^{b}}{c [population] ^{d}} {etc…}
- **Exponential in Time**
  - Pax = a [e]^{rt}
    where r =rate per period
    and t = number of periods
- **Benefits of each?**

Fundamental Mathematics of Regression Analysis

- **Linear equations**
  - Logarithm of exponential form => linear
- **Define "fit"**
  - = sum of squared differences of equation and data, $\Sigma (y_1-y_2)^2$
  - => absolute terms, bell-shaped distribution
- **Optimize fit**
  - differentiate fit, solve for parameters
  - R-squared measures fit ($0 < R^2 < 1.0$)

Let's talk about meaning of correlation for a moment

- **There is well-established good correlation between:**
  (Damage at Fire) and (Number of Firemen)
- **What do I conclude about how Firemen cause damage?**
  - ✈ Should I send less firemen to fire?
- **The correlation is "spurious":**

Big fires => damage, firemen sent

Good Statistics ≠ Good Model !!!

Ambiguity of Results: Many 'good' results possible

- **Common variables (employment, population, income, etc) usually grow exponentially ~ $a(e)^{rt}$**
- **They are thus direct functions of each other**
  - ✈ $a(e)^{rt} = [(a/b)(e)^{(r/p)t}]b(e)^{pt}$
- **Easy to get 'good' fit**
  - ✈ See Miami example (next)

Forecasts of International Passengers (Millions per Year) for Miami Int'l Airport

Forecast Method	Case	Forecast 2020	Actual 1990
Population	Dade Co.	16.00	10.01
	Dade/Broward	16.61	
	Dade/Broward (Non-Linear)	21.89	
Yield and Per Capita Personal Income	Dade Co.	19.25	
	Dade/Broward	22.25	
	Dade/Broward (Non-Linear)	20.31	
Time Series	Dade Co.	19.84	
	Dade/Broward	20.16	
	Dade/Broward (Non-Linear)	57.61	
Per Capita Personal Income	Dade Co.	28.38	
	Dade/Broward	25.57	
	Dade/Broward (Non-Linear)	53.79	
Share (US Int'l Pax)		37.76	
Share (US Reg'l Rev.)		25.45	
Source: Landrum and Brown (Feb. 5, 1992)	Maximum	57.61	576 %
	Average	27.49	275 %
	Median	21.20	212 %
	Minimum	16.60	166 %
	Preferred	37.76	377 %

Forecasts of Domestic Passengers (Millions per year) for Miami Int'l Airport

Forecast		Forecast	Actual
Method	Case	2020	1990
Population	Dade Co.	13.96	9.92
	Dade/Broward	15.35	
	Dade/Broward (Non-Linear)	17.74	
Yield and Per Capita Personal Income	Dade Co.	19.87	
	Dade/Broward	19.69	
	Dade/Broward (Non-Linear)	19.13	
Time Series	Dade Co.	17.41	
	Dade/Broward	18.67	
	Dade/Broward (Non-Linear)	40.05	
Per Capita Personal Income	Dade Co.	26.58	
	Dade/Broward	24.34	
	Dade/Broward (Non-Linear)	42.40	
Share of US Traffic		23.48	
	Maximum	42.40	427 %
	Average	22.97	232 %
	Median	19.69	198 %
	Minimum	13.96	141 %
	Preferred	15.35	155 %

Source: Landrum and Brown (Feb. 5, 1992)

Note Use of "preferred" forecast

- Forecasts obtained statistically often "don't make sense"
- Forecasters thus typically disregard these results substituting intuition (cheap) for statistics (very expensive)
- E.g.: NE Systems Study (SH&E, 2005)

  "The long-term forecast growth… was inconsistent with…expectations…[and] were revised to… more reasonable levels"

Domestic Pax for Miami update for 2010, 2014

Forecast Method and Variant		Forecast	Actual	
Method	**Data Used (form)**	**2020**	**1990**	**2000**
Population	Dade Country	13.96	9.92	17.4
	Dade and Broward	15.35		
	Dade and Broward (non-linear)	17.74		
Yield and Per Capita Personal Income	Dade County	19.87		
	Dade and Broward	19.69		
	Dade and Broward (non-linear)	19.13		
Time Series	Dade County	17.41		
	Dade and Broward	18.67		
	Dade and Broward (non-linear)	40.05		
Per Capita Personal Income	Dade County	26.58		
	Dade and Broward	24.34		
	Dade and Broward (non-linear)	42.40		
Share of US		23.48		
	Maximum	42.40		
	Average	22.97		
	Medium	19.69		
	Minimum	13.96		
	Preferred	**15.35**		

Actual 2010 =18.8

Actual 2014 =20.4

Miami press release, Jan 2011

- **“Miami set a new all-time record for annual passenger traffic in 2011 with 35.7 million passengers”**
- **BUT:**
- **“The previous record was set in 1997 when the airport welcomed 34.5 million passengers.”**
- **Source: http://blogs.sun-sentinel.com/south-florida-travel/2011**

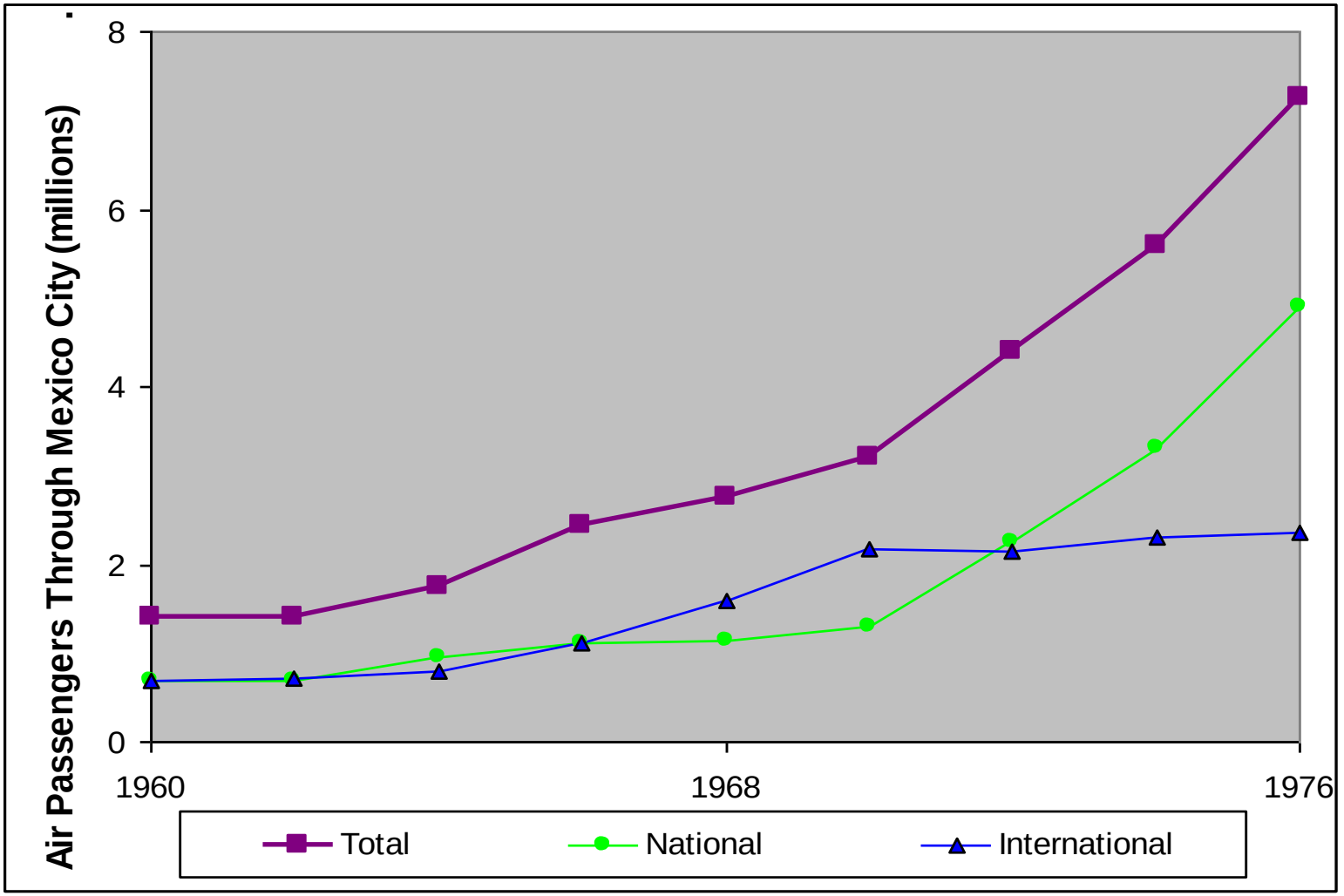
Principles for forecasting in practice

- **Detailed Examination of Data**
  - Statistics are often inconsistent, wrong, or otherwise inappropriate for extrapolation
- **Extrapolation for Short Term,**
  - About five years
- **Scenarios for Long Term,**
  - Allowing for basic changes
- **Ranges on Forecasts,**
  - Wide as experience indicates is appropriate

Recommended Procedure

1. **Examine Data**
   - compare sources, check internal consistency
2. **Identify Possible Causal Factors**
   - relevant to site, period, activity
3. **Do regression, extrapolate for short term, apply historical ranges on forecasts**
4. **Identify future scenarios**
5. **Project ranges of possible consequences**
6. **Validate Plausibility**
   - compare with similar circumstances elsewhere

Passengers, Mexico City International Airport (AICM)

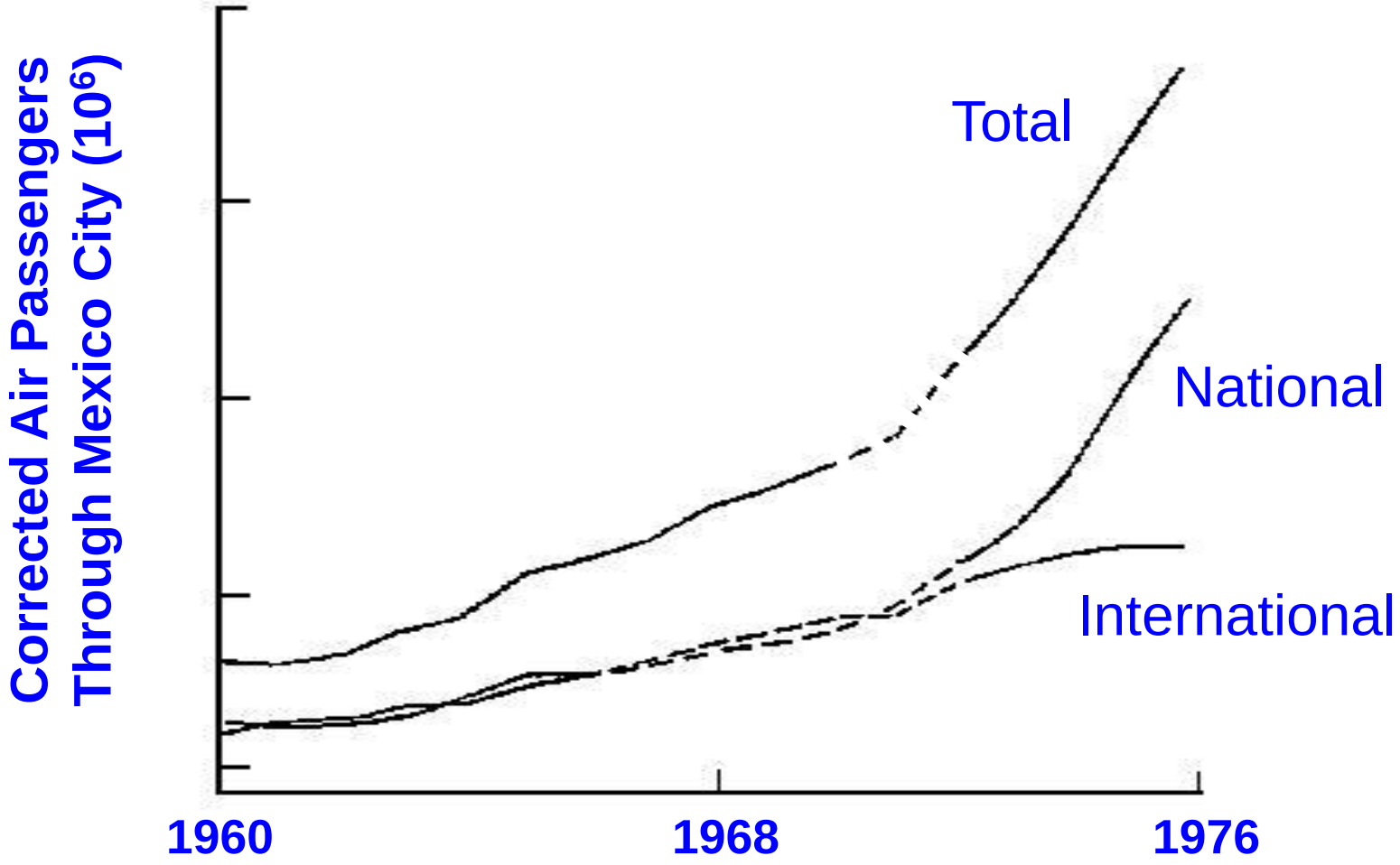


Mexico City -- Data Problems

- **Typographical Error**
  - Seen by examination of primary data (Comparable issue with Los Angeles)
- **Double Counting**
  - Introduced in series by a new category of data
- **New Definitions of Categories**
  - Detected by anomalies in airline performance (pax per aircraft) for national, internat'l traffic

These problems occur anywhere

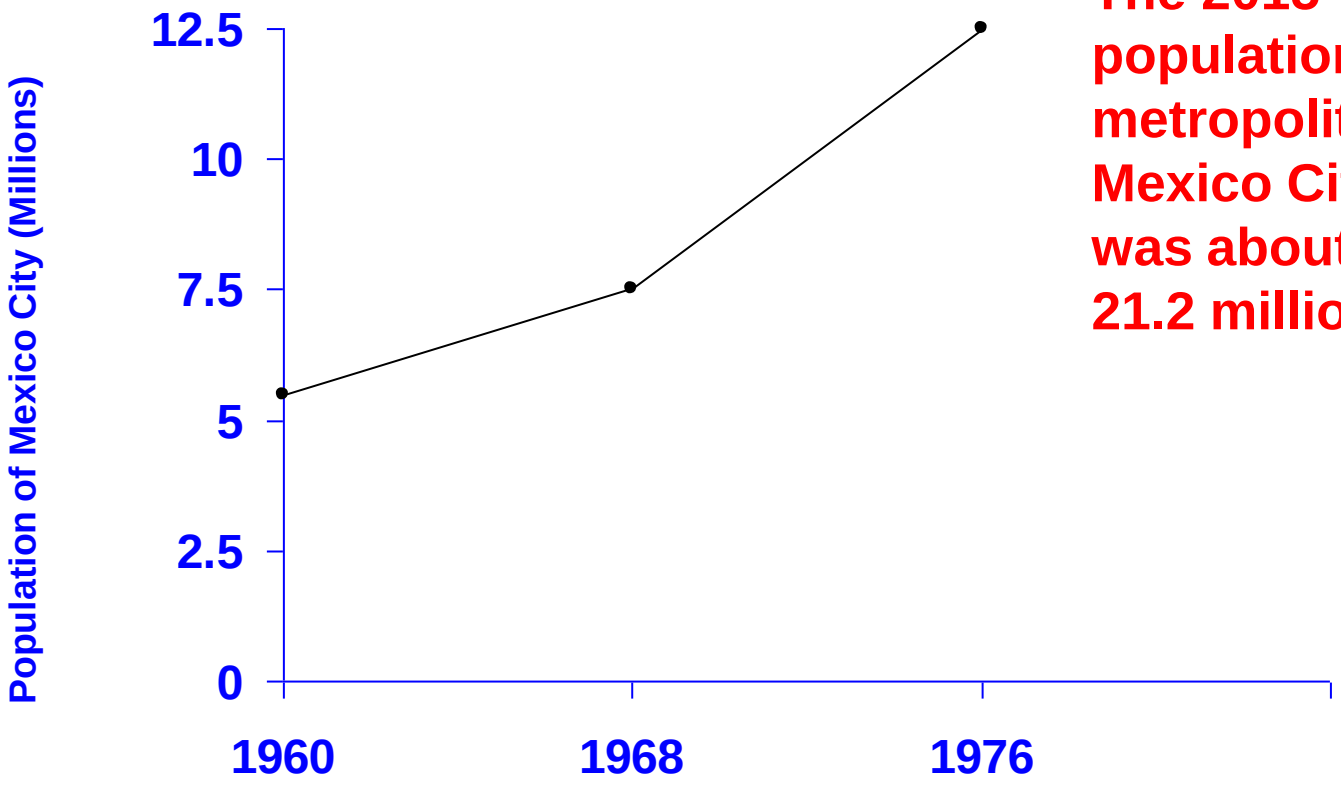
Passengers Through AICM (Corrected Version)



Mexico City
Causes of Trends

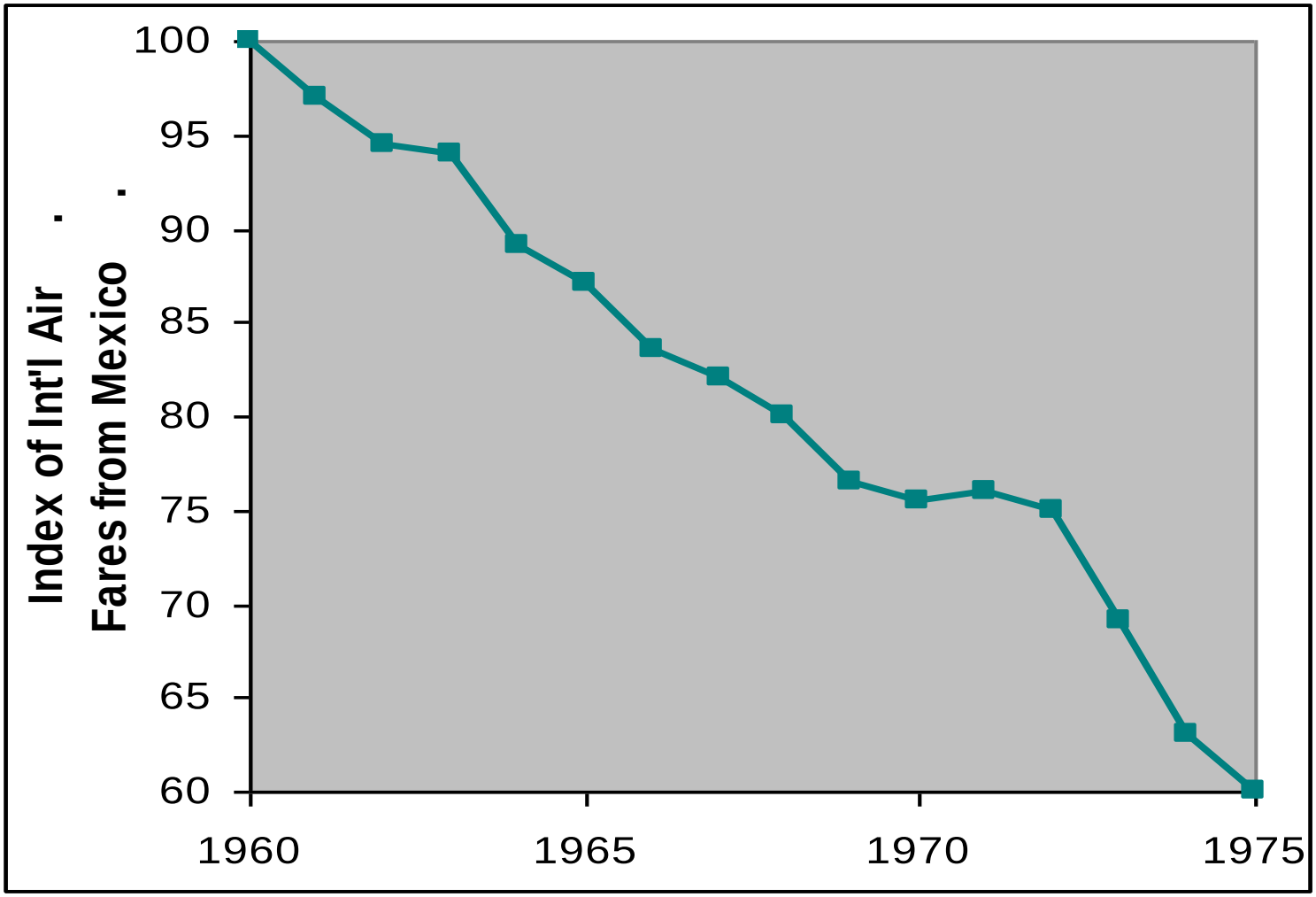
- **Economic Boom**
  Post 1973 oil prosperity
- **Recessions Elsewhere**
  Affecting international traffic
- **Population Growth**
- **Fare Cuts**
  Relative to other commodities

Population Increase of Mexico City's Metro Area



The 2015 population of metropolitan Mexico City was about 21.2 million!

Trend of International Air Fares at Constant Prices

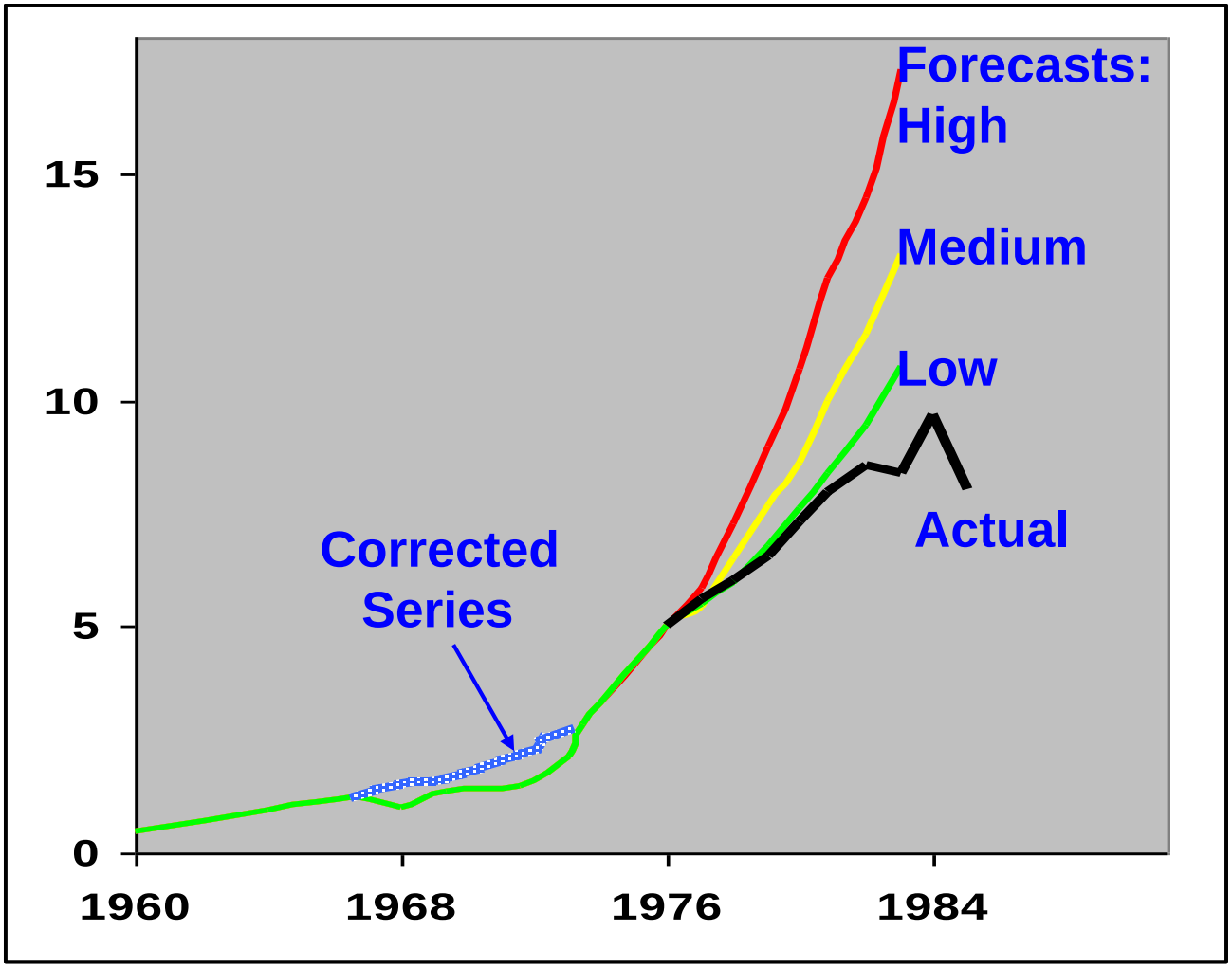


Mexico City -- Note

- Traffic formula based on these variables (or others) does not solve forecasting problem.
- Why?
- Formula displaces problem, from traffic to other variables.
- How do we forecast values of other variables?

Short-Range Forecasts, National Passengers, AICM

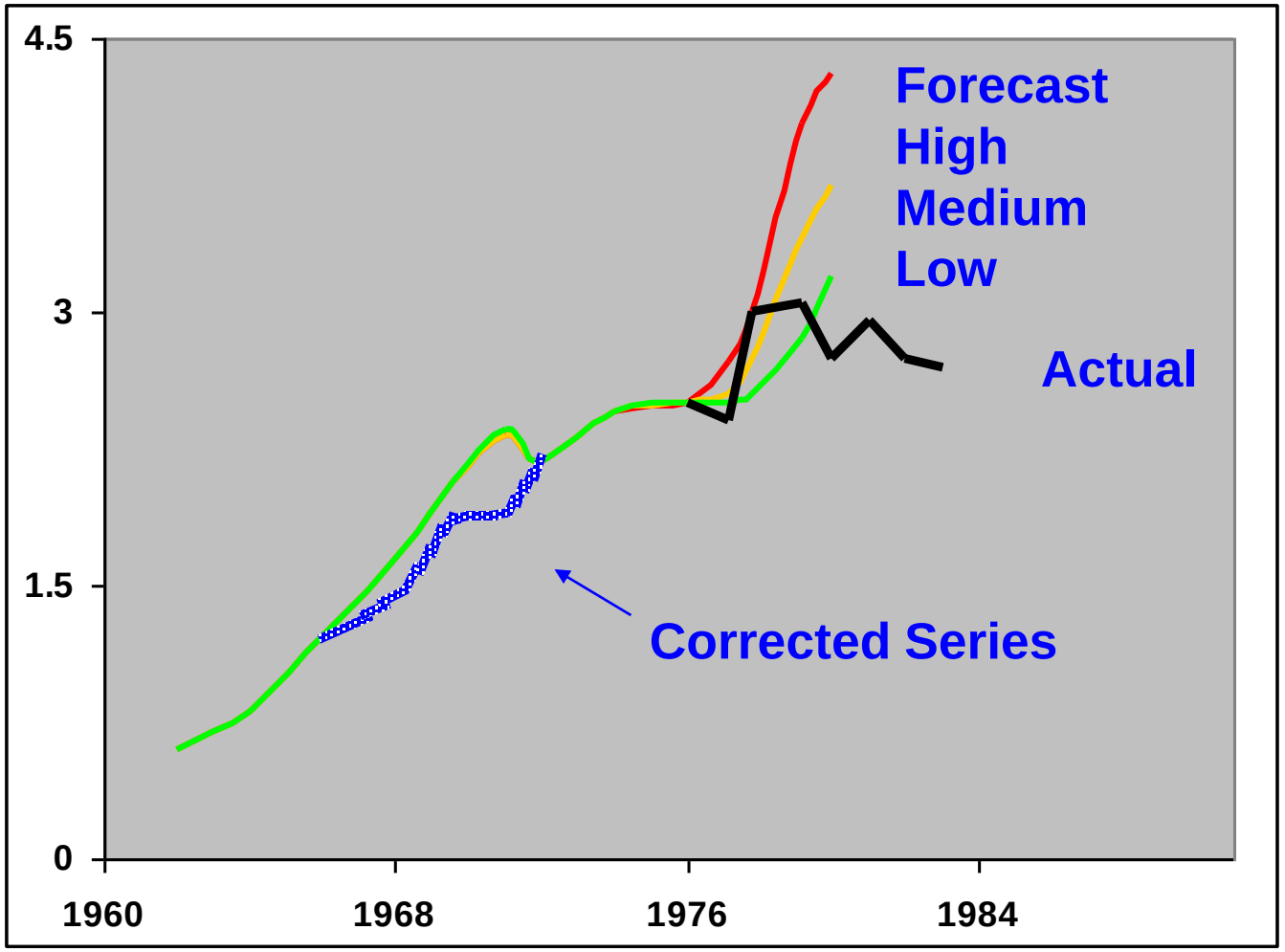
Forecast National Passengers for Mexico City (millions)



Actual 2010 = 15.6
Actual 2014 = 23.7

Short-Range Forecasts, International Pax. AICM

Forecast International Passengers for Mexico City (millions)



Actual 2010 = 8.5

Actual 2014 = 10.6

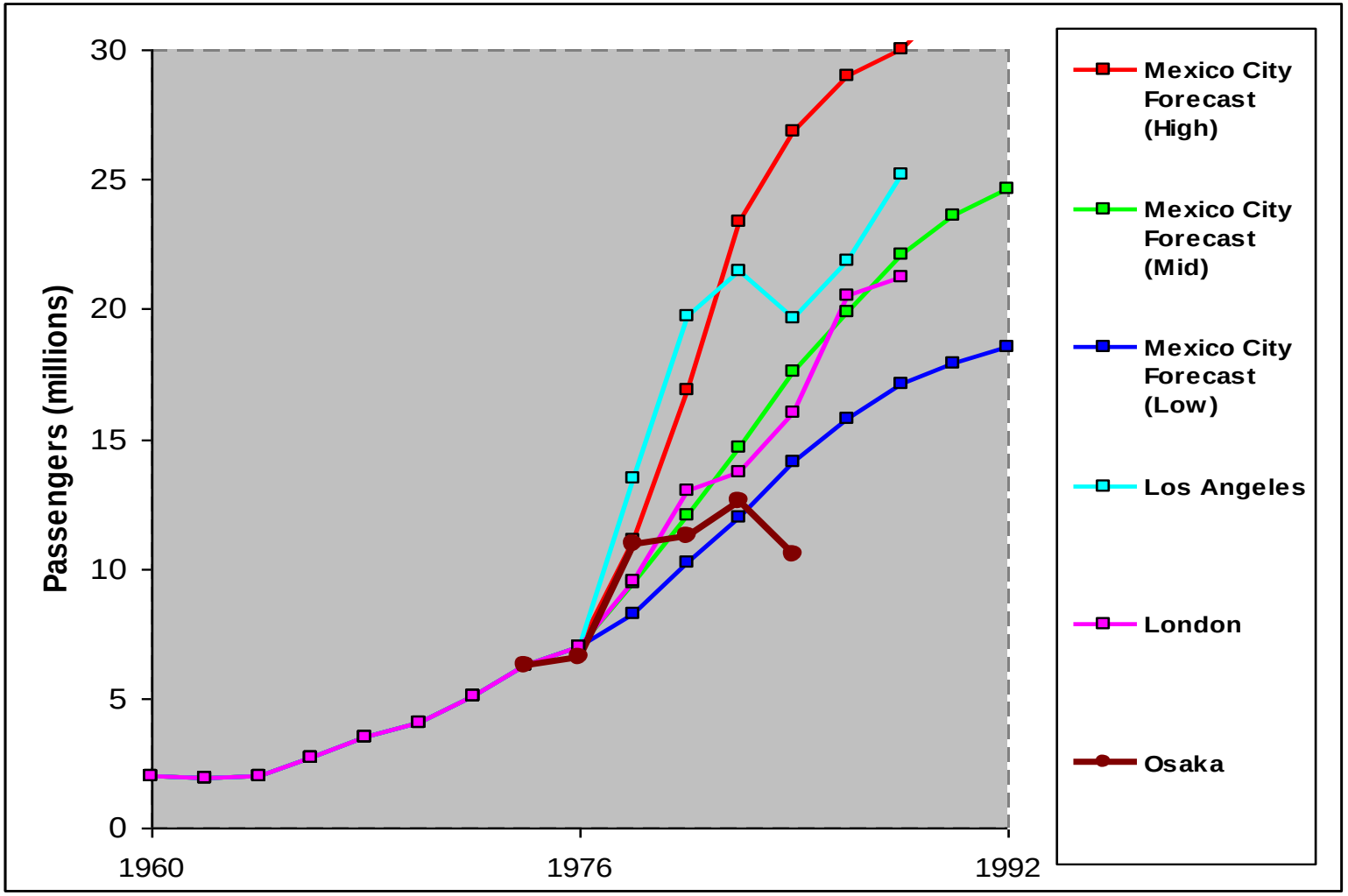
Mexico City: Elements of Long-range Scenarios

- **Demographics**
  - Rate of Population Increase
  - Relative Size of Metropolis
- **Economic Future**
- **Fuel Prices and General Costs**
- **Technological, Operational Changes**
- **Timing of Saturation**

Long-range Scenarios

- **New Markets**
  - ✈ Japan, Pacific Rim, United Europe (Frankfurt, etc.)
- **More Competition**
  - ✈ Deregulation, Privatization
  - ✈ Transnational Airlines, Airline Alliances
- **New Traffic Patterns**
  - ✈ Direct flights bypassing Mexico City to go directly to tourist areas (Los Cabos, Acapulco…)
  - ✈ More Hubs (Bangkok, Seoul?)
  - ✈ New Routes, such as over Russia

Long Term AICM Forecasts, validated by data elsewhere



Actual 2010 =24.1 M

Actual 2014 =34.3 M i

Summary

- **Forecasting is not a Science**
  - ✈ too many assumptions
  - ✈ too much ambiguity
- **Regression analysis for short term**
  - ✈ Apply historical ranges on projections
- **Scenarios for Long range**
  - ✈ compare with experience elsewhere
- **STRESS UNCERTAINTY**