Forecasting Issues Related to San Diego Airport

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San Diego’s Lindberg Airport

• A brief history
  – Busiest single runway airport in the country
  – Small in size (661 acres) relative to airports in similar cities with similar populations
• Over 30 studies and almost 50 years of formal discussion about what to do about Lindberg Field

San Diego Airport Authority

• Created by California Legislature in 2001
• Given charge to examine airport options
• Has spent 8+ million dollars on new studies
• Held extensive public hearings
• Is suppose to propose a ballot measure for November election

Current Options

• Do nothing
• Expand terminal facilities at Lindberg
• Alter runway capacity at Lindberg
  – Lengthen existing runway
  – Add runway
• Build new airport to replace Lindberg
• Take over Miramar MAS or North Island NAS
• Build/expand an auxiliary airport

Current View of San Diego Airport Authority

• Lindberg Field capacity may be exceeded by 2015 and for sure by 2030
• This will result in a loss of regional gross domestic product of $94 billion dollars
• Believes this implies a new airport with two 12,000 foot runways is needed
• Basis for this is two consultant reports by HR&A and SH&E

The Difficulty

• SD Airport Authority narrowed non-military new sites down to two locations:
  – Campo ($10.2 billion)
  – Imperial County ($13.2 billion)
• Military does not want to give up Miramar or North Island and does not want to allow joint use
A Second Look At Lindberg Runway Situation

• Reasons for wanting to replace/expand:
  – Ground operations/runway coordination
  – Emergency situations
  – Periodic reductions in capacity (weather)
  – Insufficient capacity for desired take-off and landing “slots”

Forecasting the Future

• Air Cargo
• Air Passengers

Air Cargo

• Accounts for roughly 80% of HR&A’s $94 billion dollar in gross regional domestic product
• HR&A’s Input-Output modeling approach effectively assumes that economic activity that generates air cargo moves out of San Diego

Problems with How Input-Output Approach Is Used in Analysis

• Ignores substitution
  – Other airports (Ontario, Yuma, LAX, TJ)
  – Other forms of transportation (Truck, Rail)
• Effectively assumes average and marginal effects are the same
• Incorrectly assumes that a gross output measure (rather than a net/surplus measure) is of policy interest

Air Passengers

Three Distinct Issues

• Forecasting passenger demand is distinct from forecasting demand by airlines for takeoff/landing slots
  – More passengers in the extreme case decrease the demand for runway slots
• Forecasting takeoff/landing slot demand
• Response to constraints on available slots

Demand for Slots

• Forecasted number of passengers (PAX)
  – Per capita demand
  – Projected increase in population
• Desired O-D schedule
  – Current non-stops
  – Potential non-stops
  – Mix of plane types
  – International flights
Trend in Slot Utilization
At Odds with SH&E Forecast
Comparison of Operations Forecasts for SDA

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Flight Operations by Category
January-June 2000-2005

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Airline Carriers</th>
<th>Airline Comm.</th>
<th>Civil</th>
<th>Military</th>
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<tbody>
<tr>
<td>1999</td>
<td>119,920</td>
<td>71,995</td>
<td>29,535</td>
<td>7,794</td>
<td>633</td>
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<tr>
<td>2000</td>
<td>100,897</td>
<td>76,404</td>
<td>16,310</td>
<td>7,863</td>
<td>320</td>
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<tr>
<td>2001</td>
<td>106,700</td>
<td>75,270</td>
<td>24,083</td>
<td>6,849</td>
<td>518</td>
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<tr>
<td>2002</td>
<td>99,251</td>
<td>70,650</td>
<td>20,418</td>
<td>7,592</td>
<td>636</td>
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<td>2003</td>
<td>99,600</td>
<td>69,151</td>
<td>22,874</td>
<td>6,963</td>
<td>612</td>
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<tr>
<td>2004</td>
<td>103,366</td>
<td>71,594</td>
<td>23,561</td>
<td>7,140</td>
<td>1,071</td>
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<tr>
<td>2005</td>
<td>107,482</td>
<td>74,300</td>
<td>26,278</td>
<td>6,645</td>
<td>259</td>
</tr>
</tbody>
</table>

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Relationship of Operations to San Diego Airline Passengers
- Statistically quite a weak relationship
- Forecast range for number of PAX may be less important than:
  - Examination of current/forecast OD preferences
  - Examination of current/potential non-stop routes
- Forecast of likely mix of airplane types in response to above

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Possible New Non-Stops With Regular Jet Service
- Orlando (only top 20 destination not served)
- Other Florida locations in top 50
  - Fort Lauderdale
  - Tampa
  - Miami
- San Antonio
- Washington (DCA)/La Guardia if allowed
Domestic Airport Pairs with Next Highest Traffic

- San Jose
- Sacramento
- Oakland
- Reno
- Phoenix
- Albuquerque
- Nashville
- New Orleans
- Denver
- Austin
- El Paso
- San Diego
- Minneapolis
- Kansas City
- Chicago
- Baltimore
- New York JFK
- Las Vegas
- Boston
- Newark
- Philadelphia
- Washington (Dulles)
- Charlotte
- Atlanta
- Cleveland
- Detroit
- Pittsburgh
- Cincinnati
- St. Louis
- Memphis
- Houston
- Dallas
- Salt Lake City
- Imperial
- Portland
- Seattle
- San Francisco
- Honolulu
- Maui
- Los Angeles
- Tucson
- San Antonio
- Miami
- Fort Lauderdale
- Orlando
- Tampa
- Spokane
- Indianapolis
- Columbus
- Raleigh-Durham
- Norfolk
- Providence
- Hartford
- Jacksonville
- Kauai
- Kona

International Destinations

- Current and likely to continue
  - Los Cabos (SJD)
  - Vancouver
- Marginal
  - Toronto (Air Canada gateway to Europe)
  - London (LHR)
  - Paris (CDG)
  - Some Mexican cities

Implications for Runway Specifications

- Canadian and Mexican locations can be supported by narrow-bodied aircraft
- European locations are marginal with a Boeing 777 and cannot support a 747-400
- Chance of needing two long runways to support simultaneous launch of two long haul wide-bodied aircraft effectively zero
- New perspective routes likely to be served by regional jets or narrow-bodied aircraft

Mix of Planes

- Passengers want
  - Non-stop flights
  - Distribution of "ideal" departure times
  - Regular jets over regional jets over prop jets
  - Low cost
- Airlines maximize profits subject to:
  - Actions of other airlines
  - Cost per PAX declines rapidly with aircraft size
  - Higher cost if connection via hub

Scaling Up Plane Capacity

<table>
<thead>
<tr>
<th>Plane Type</th>
<th>Examples</th>
<th>Seat Range</th>
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<tbody>
<tr>
<td>Turbo prop</td>
<td>EM2</td>
<td>30-40</td>
</tr>
<tr>
<td>Regional jet (small)</td>
<td>CRJ-200</td>
<td>40-50</td>
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<tr>
<td>Regional jet (large)</td>
<td>EMB-190</td>
<td>50-100</td>
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<tr>
<td>Narrow-bodied jet I</td>
<td>B373-3x/A318</td>
<td>100-150</td>
</tr>
<tr>
<td>Narrow-bodied jet II</td>
<td>B757/A321</td>
<td>150-250</td>
</tr>
<tr>
<td>Wide-bodied jet I</td>
<td>B777/A340</td>
<td>250-400</td>
</tr>
<tr>
<td>Wide-bodied jet II</td>
<td>B747-4x/A380</td>
<td>400+</td>
</tr>
</tbody>
</table>

SH&E Passenger Forecast Model

Exhibit 3-1: Domestic Passenger Demand Forecast Model

- Dependent Variable: DOMEN = log (Domestic Passenger Enplanements)
- Independent Variables:
  - Per Capita Personal Income
  - Non-Hispanic White Population
  - Total Employment
  - Average Household Income
  - Income Percentile

Source: SH&E
Problems with SH&E Model

- Very limited data (22 annual observations)
- Results dominated by high growth of 1980’s
- Fails to separate out factors determining per capita propensity to fly and population growth likely to mask true drivers
- Other basic econometric errors: (1) SH&E effectively regresses two trending variables on each other [results are thus potential spurious], (2) average fare is an endogenous regressor, (3) no testing was done of their model’s out-of-sample forecasting ability

Description of Data

- Quarterly number of passengers at each U.S. airport including San Diego from BTS
- Quarterly population estimates for each MSA
- Lower 48 crude petroleum price per barrel from US Energy Administration
- Quarterly BLS Unemployment Rate for each MSA
- Futures Price for crude (Brent) petroleum from Commodity Research Bureau
- Quarterly Coincident Economic activity indicator at state level for US from Philadelphia Fed

Forecasting Model

- The dependent variable is defined as the logit transformation of number of flights per capita,
\[ y_t = \ln \left( \frac{pax_t}{1 - \frac{pax_t}{pop_t}} \right) \]
- The model is estimated in the sample using quarterly data between 1990:Q1 and 2004:Q4:
\[ y_t = \beta_0 + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \beta_1 \text{trend}_t + \beta_2 \text{unemp}_t + \beta_3 \text{cpi}_t + \beta_4 \text{oilprice}_t + \beta_5 \text{unem}_t + \beta_6 \text{oilfutures}_t + \beta_7 \text{poppgr}_t + \beta_8 \text{sept} 11_t + \epsilon_t \]
- The pooled model is estimated for all U.S. airports with fixed effects for the 187 largest airports plus “other airports” model
- The coincident indicator forecasted using AR(2) model
- Per capita estimates multiplied San Diego pop. forecast
- Forecast error over short/moderate horizon (5 quarters) less than half of standard FAA approach

Pooled Estimation Results for San Diego

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Value</th>
<th>P-Value</th>
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<tr>
<td>TREND</td>
<td>0.01720</td>
<td>0.001952</td>
<td>1.37864</td>
<td>0.0900</td>
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<td>DECEMBER</td>
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<tr>
<td>SEPTEMBER</td>
<td>0.009509</td>
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<tr>
<td>COMMODITY</td>
<td>0.000265</td>
<td>0.000172</td>
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<tr>
<td>OILFUTURES</td>
<td>0.000265</td>
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<tr>
<td>INCOME</td>
<td>0.000313</td>
<td>0.000058</td>
<td>0.00946</td>
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<td>UNEMPLOYMENT</td>
<td>0.000151</td>
<td>0.000026</td>
<td>0.00946</td>
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<td>INTEREST</td>
<td>0.000121</td>
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<td>POPULATION</td>
<td>0.000121</td>
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<td>0.00000</td>
<td>0.0000</td>
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</tbody>
</table>

Forecasting Methodology

- Forecasting Explanatory Variables
  - Quarterly population estimates are formed by linear interpolation/extrapolation of long-term population forecasts from SANDAG
  - U.S Energy Administration quarterly oil price forecasts
  - Unemployment rate set to 5% long-term average
  - The change in oil futures price is set to zero
  - The coincident indicator forecasted using AR(2) model
- The pooled model is estimated for all U.S. airports with fixed effects for the 187 largest airports plus “other airports”
- Long-term (2004:Q1-2030:Q4) per capita forecasts used estimated model parameters with assumptions about exogenous variables to get per capita forecasts
- Per capita estimates multiplied San Diego pop. forecast
- Forecast error over short/moderate horizon (5 quarters) less than half of standard FAA approach
San Diego Annual Enplanement Forecast

![San Diego Annual Enplanement Forecast](chart.png)

**Airline Reactions to Slot Constraints**
- Increase price if possible
  - Empirical evidence consistent with 2%-10% higher prices
- Use larger planes
  - More PAX with same O-D preferences allows larger planes to be used
  - Reduce frequency of service allows route to be served by larger planes
  - Eliminating marginal non-stops in favor of hub service allows larger planes on hub routes

**Potential Problems With Slot Constraints**
- Allowing too much congestion
- Letting airlines gain market power through possession of slots
- Associating slots with particular routes
- Failing to recognize for planning purposes that the "marginal" use of a slot is likely to be for a regional jet
- Failing to "effectively" price the scarce slot resource so airlines respond appropriately

**Economic Losses From Slot Constraints**
- No loss if shift is simply to larger aircraft
- At the margin, economic loss to a region from a "lost" PAX must be essentially zero
- As long as number of lost PAX is not a large fraction of total unconstrained demand:
  - Losses must be much smaller than those based on "average" cost input/output models such as those used by HR&A:
    - Passengers who had lowest values for trip don't fly
    - Some of those trips still made via car/bus/train
    - Consumers/business utilize close substitutes

**Air Passenger Summary**
- Flight operations at SAN flat for a decade
- Relationship between PAX numbers and flight operations is not the almost linear one suggested by SH&E's analysis
- Few changes likely in current SAN non-stop pattern of flights
- Increases in number of PAX likely supported primarily by larger aircraft not more flights

**Summary Continued**
- SH&E’s forecast procedure not appropriate
  - At best, black box curve fitting with no insight into the demand generation process
    - Need to separate out changes in flights per capita from changes in population
  - SH&E’s high forecast is implausibly high
  - Alternative pooled model using data from airports across the United Stated suggest SAN PAX estimate below SH&E low estimate
Summary Continued

- Empirical evidence on slot constrained airports suggests:
  - Small to moderate price increases
  - Shift (when allowed) to larger aircraft
  - Small loss in PAX. Passengers lost are those with the lowest value for that trip via air