Air Transport Demand

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Air Transport Demand

- Demand for air transport between two cities or two regions depends on
  - Socio-economic characteristics of the regions
  - The characteristics of the transportation system that links them

Air Transport Demand

- Models to evaluate air transportation demand most often evaluate
  - The number of potential passengers
  - The number of passenger kilometers that can be achieved
  - The expected number of operations (take offs and landings)
  - A percentage share of the number of air passengers out of the total number of passengers

Air Transport Demand Estimation

- The process of forecasting transportation demand most often comprises the following steps:
  - Trip generation
  - Trip distribution
  - Modal split
  - Trip assignment

Classification: Competitive Mode

- Whether or not the model includes competitive modes of transportation
  - Models that are independent of the characteristics of alternative modes of transportation
  - Multimode models

Independent of Other Modes

- The airplane is the predominant mode of transportation on many long-distance traffic routes. Therefore, demand for air transportation on long-haul routes should be estimated independently of other modes of transportation.

Multimode

- Multimode models are primarily used to estimate demand for air transportation on short-haul routes.
- Air transportation demand on shorter routes is usually estimated simultaneously with the estimation of demand on other modes of transportation.

Classification: Macro vs. Micro

- Classification of air transportation demand model
  - Macroscopic models
  - Microscopic models

Classification: Macro vs. Micro

- Macroscopic models are used to estimate the development level of air transportation in a certain country or region
  - Estimate
    - The number of passengers
    - The number of airplane operations
    - The number of passenger kilometers

Classification: Macro vs. Micro

- Microscopic models estimate
  - Demand between two cities
  - The passenger traffic at an airport
  - The number of passengers along a specific route
  - The number of passengers in each class

Macroscopic Models

- Macroscopic Models : Demand is a function of time
  - Factors that affect the number of passengers are not taken into consideration

Macroscopic Models

t : time

y : the number of air passengers that changes over time

- Model 1

  k, m, ; parameters

  $$y = kt + m$$

  - Model calibration : can be the least squares method

Macroscopic Models

- Model 2

$$y = a \cdot b^t$$

  - logarithmic form

$$\log y = \log a + t \cdot \log b$$

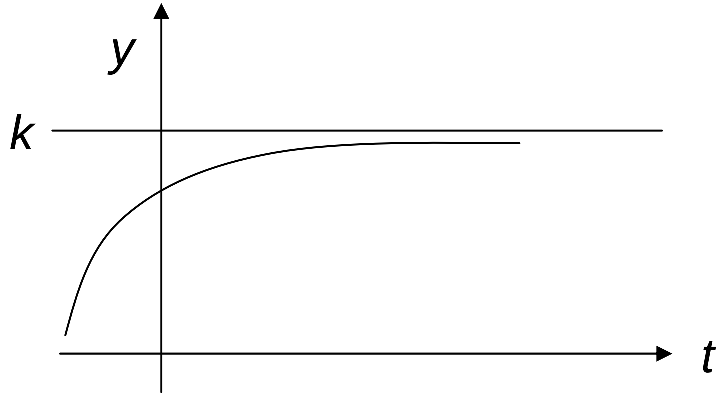
  - Advantage : *a*, *b* can be estimated using the least square method

Macroscopic Models

- Model 3 : modified exponential curve

$$y = k + a \cdot b^{t}$$

  - When $a<0$, $b<1$



  - k : fixed saturation level

Macroscopic Models

- Model 4 : Gompertz curve

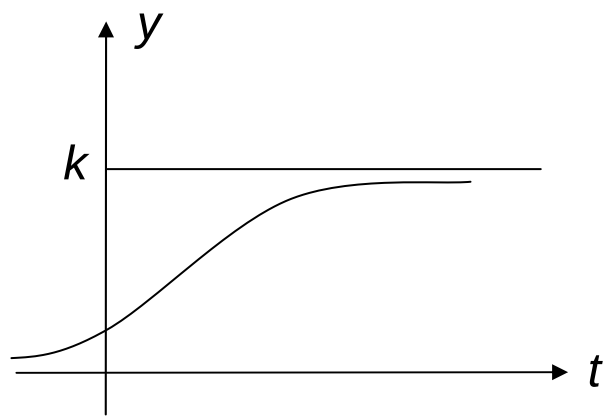
$$y = k \cdot a^{b^t}$$

  - Logarithmic form

$$\log y = \log k + b^t \cdot \log a$$

Macroscopic Models

- When $\log a < 0, b < 1$



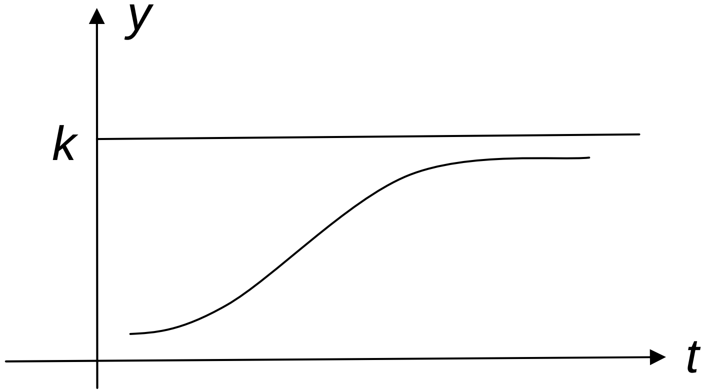
- k : saturation level

Macroscopic Models

- Model 5: Logistic curve
  - Logistic curve, or called Pearl-Reed curve

$$y = \frac{k}{1 + b \cdot e^{-at}}$$

  - Has a shape similar to the Gompertz curve



Macroscopic Models

- The lease squares method cannot be applied to estimate the parameters of :
  - Modified exponential carves
  - Pearl-Reed curve
  - Gompertz curve
- The three-point methods have proven very successful in estimation the parameters of these curves

Macroscopic Models

- Macroscopic models : Demand is a function of socio-economic characteristics
  - Dependent variables
    - The number of passengers
    - The number of operations
    - The number of passenger kilometers
  - Independent variables
    - Chosen from socio-economic characteristics and characteristics of the transportation system

Macroscopic Models

- Most often socio-economic
  - Population
  - National income
  - Personal consumption
  - Volume of trade
  - Number of tourist
- Most often transportation system
  - The cost of transportation
  - Speed / travel time

Macroscopic Models

Model :

m : the total number of socio-economic characteristics

n : the total number of transportation system characteristics

y_t : the number of air passengers in time t

S_{it} : the value of the i-th socio-economic characteristics in time t

T_{jt} : the value of the j-th transportation system characteristics in time t

a, b_i, c_j : parameter

$$y_t = a \prod_{i=1}^{m} S_{it}^{bi} \prod_{j=1}^{n} T_{jt}^{cj}$$

Macroscopic Models

- Logarithmic form

$$\log y_t = \log a + \sum_{i=1}^{m} b_i \cdot \log S_{it} + \sum_{j=1}^{n} C_j \cdot \log T_{jt}$$

  - a, b_i, c_j parameters estimation :
    - Multiple regression technique
    - Maximum likelihood function

Trip Distribution

- Trip distribution models
  - When the total number of trips that a region can generate has been established, the trips are then distributed.
  - Trip distribution : establishes the number of trips between individual zones.
- Commonly used models
  - Entropy model
  - Gravity model

Trip Distribution

- The Gravity model
  - an analogy to Newton's Law of Gravity

$$f_{ij} = k \frac{A_i \cdot B_j}{d_{ij}^{\;2}}$$

f_{ij} : the number of trips between city *i* and city *j*

k : constant

A_i : the "size" of city *i*

B_j : the "size" of city *j*

d_{ij} : the distance between city *i* and city *j*

Trip Distribution

- A_i, B_j is most often taken as the number of emitted or attracted trips , i.e. $A_i = a_i, B_j = b_j$
- Problems in the original gravity model : not satisfied by the following flow conservation equations

$$\sum_{j=1}^{n} f_{ij} = a_i \ , \sum_{i=1}^{m} f_{ij} = b_j$$

Trip Distribution

- Modified Gravity model

$$f_{ij} = k_i \cdot a_i \cdot k_j \cdot b_j \cdot f\left(d_{ij}\right)$$

k_i, k_j: coefficients associated with the number of trips emitted or attracted by the cities

$f\left(d_{ij}\right)$: distance function , can be distance, travel time…etc., or a combination of different variables

Trip Distribution

Since $$\sum_{j=1}^{n} f_{ij} = a_i$$

$$\sum_{j=1}^{n} k_i \cdot a_i \cdot k_j \cdot b_j \cdot f\left(d_{ij}\right) = a_i$$

$$k_i = \frac{1}{\sum_{j=1}^{n} k_j \cdot b_j \cdot f\left(d_{ij}\right)}$$

Similarly $$\sum_{i=1}^{m} f_{ij} = b_j$$

$$k_j = \frac{1}{\sum_{i=1}^{m} k_i \cdot a_i \cdot f\left(d_{ij}\right)}$$

Multimode Models

- Multimode models
  - Aggregated models
    - Aggregated models take certain socio-economic characteristics into consideration.
  - Disaggregated models
    - Disaggregated models start with the individual as the one making the decision to travel and therefore operate with certain socio-economic characteristics related to the individual, obtained by surveying passengers.
    - Disaggregated models can also quantify the effect of comfort or the feeling of safety.

Multimode Models

- Aggregated models : abstract mode model
- Disaggregated models : choice models