THE UNIVERSITY OF AUCKLAND
BUSINESS SCHOOL
THE ENERGY CENTRE

Transport Economics

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Transport Economics

- Transport demand
- Transport supply
- Congestion pricing
- Econometric modelling for demand forecast

Transport Demand

- Derived demand
  - An individual's demand for transport is instigated through their demand for something else.
  - Transport is not typically consumed because people like travelling, but because transport supports other activities (i.e. JTW commuting, the movement of freight)
- Time specific
  - When transport services are demand they are demanded NOW.
  - People generally travel to engage in activities at various locations at specific time period – demand for transport has a very short 'expiry date'.
- Follows peaks and troughs
  - The morning & afternoon rush hours – significant impact upon the way in which transport services are provided and indeed the whole 'economics' pf transport operations.

Microeconomic Theory

- What determines the demand for a particular journey or the demand for a particular mode of transport?
- What may happen to the level of congestion if a road pricing system is introduced?
- How can an airline operator charge passengers different prices for the same flight when schools are ‘in session’ or ‘on holidays’?
- What are the effects of a change in the price of petrol on private car usage?

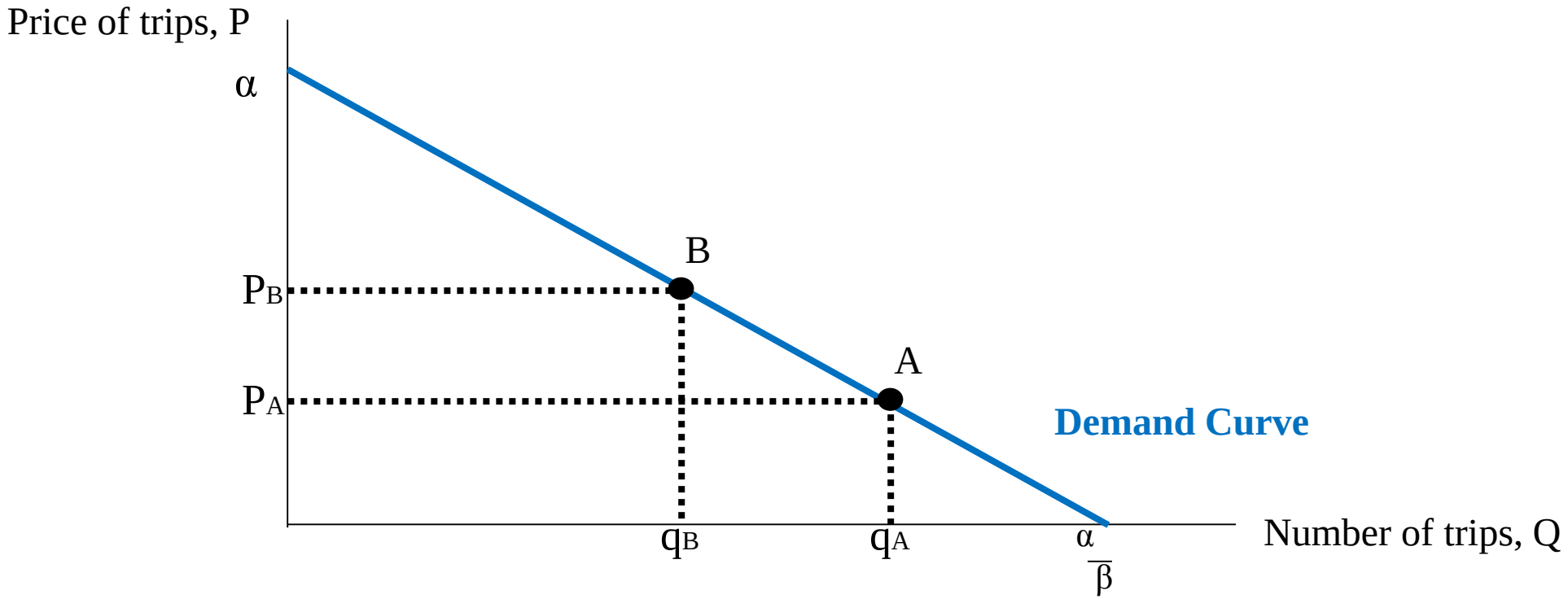
The Demand Function

- A key component of any form of economics
- The willingness of consumers to purchase the product at different prices (of different expenditures of resources)
- Relates price (cost to the consumer) and quantities demanded
- Can be expressed in terms of a number of “prices”
  - Fare
  - In-vehicle time
  - Overall generalised travel cost
- Assumptions:
  - Consumer utility maximisation
  - Rationality: as the price increases the quantity demanded reduces
  - Ceteris Paribus: a number of the other characteristics of the journey and of the traveller remain constant.

A Typical Linear Demand Curve

Equation: $p = \alpha - \beta\, q$

Where q is the quantity of trips demanded, p is the price and α and β are constant demand parameters



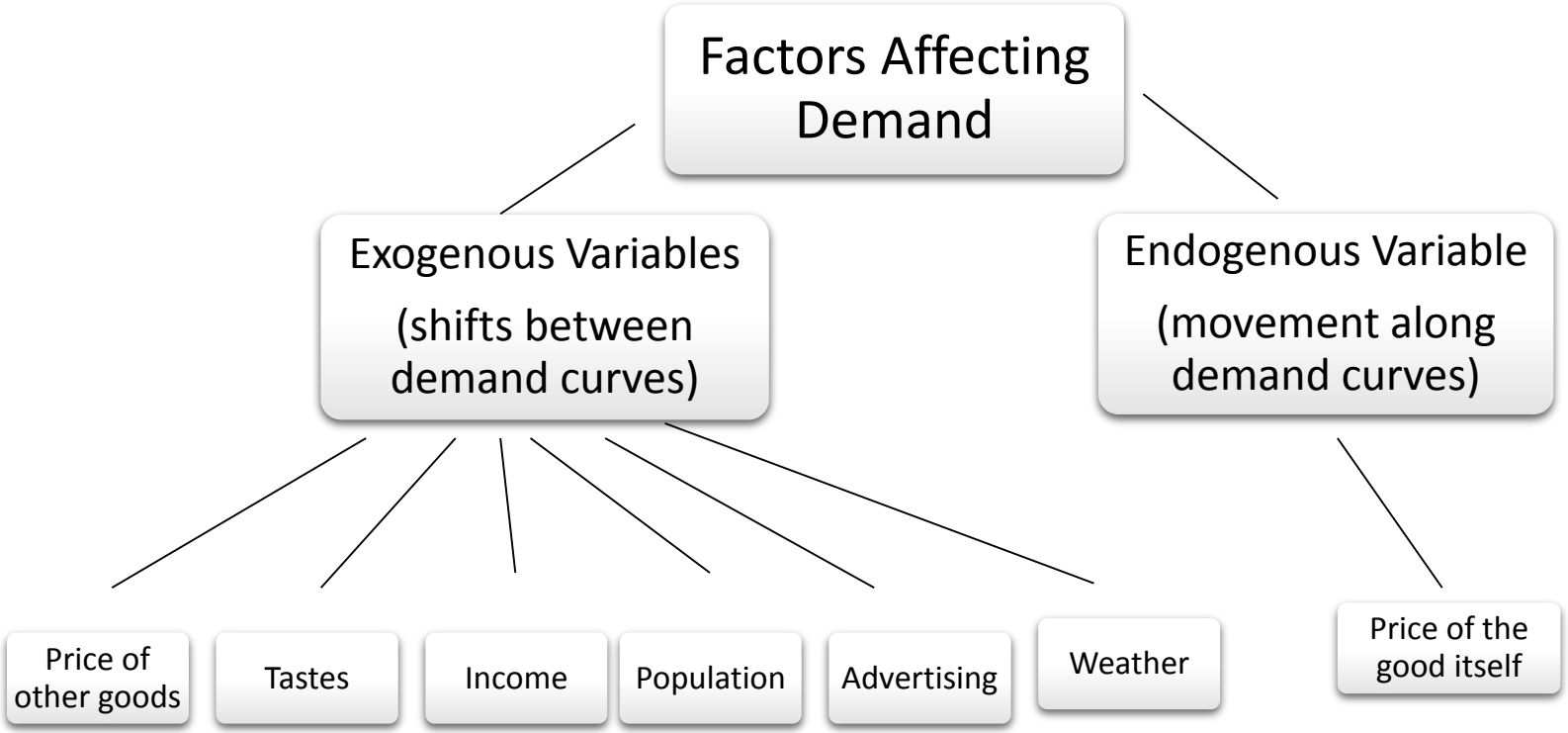
Characteristics of the Demand Curve

- Equation of form $p = \alpha - \beta\, q$
- When price = 0, quantity demanded q = α/β
- When price = α, quantity = 0
- Negative relationship with price means curve slopes downwards as prices increase

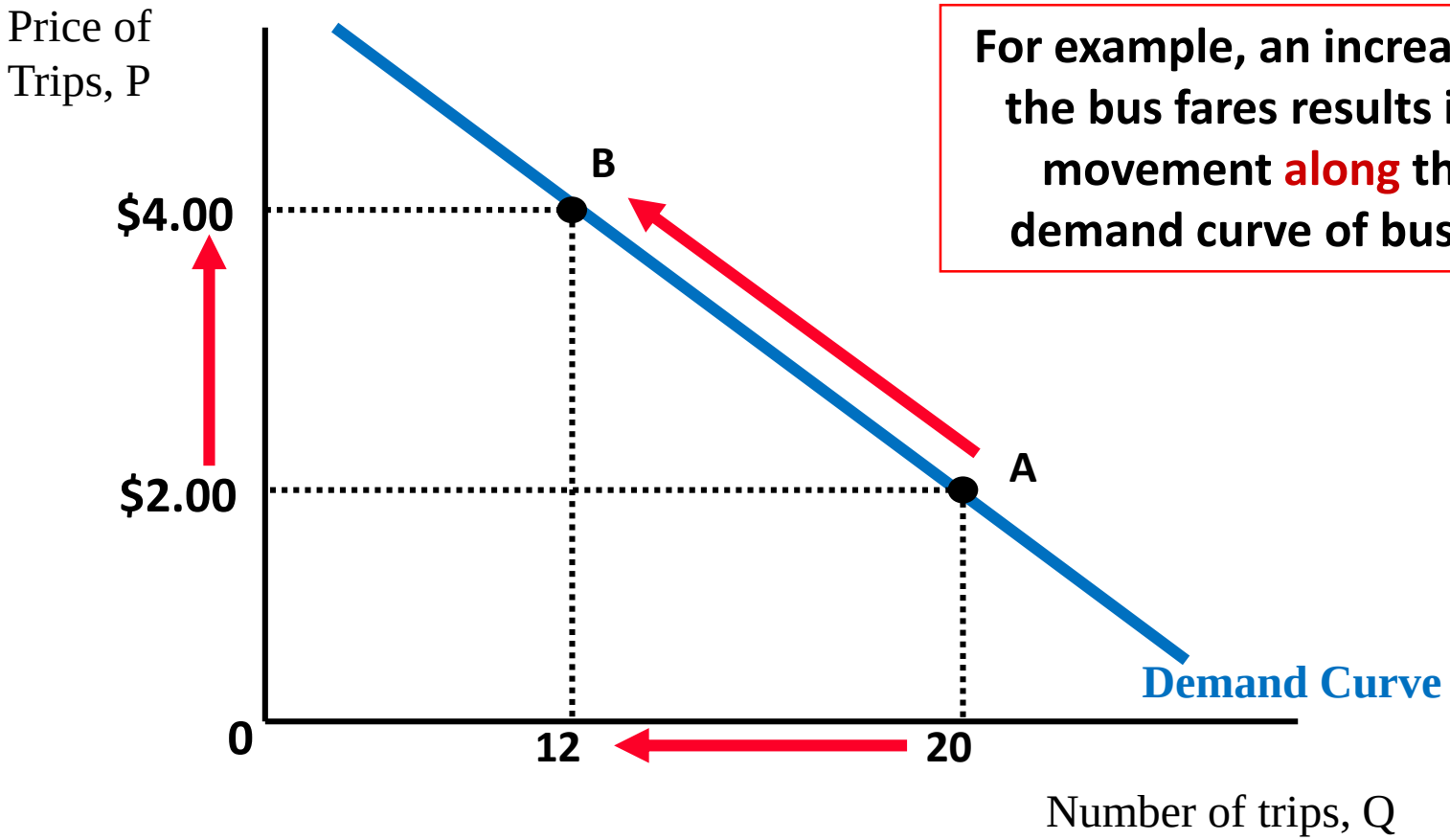
Shifts Along and Between Demand Curves

- **Along** demand curve possibly under control of operator
  - Short term changes
- **Between** demand curves more general changes or changes in other modes
  - Often longer term and may be outside control of transport operator

Factors Affecting Demand

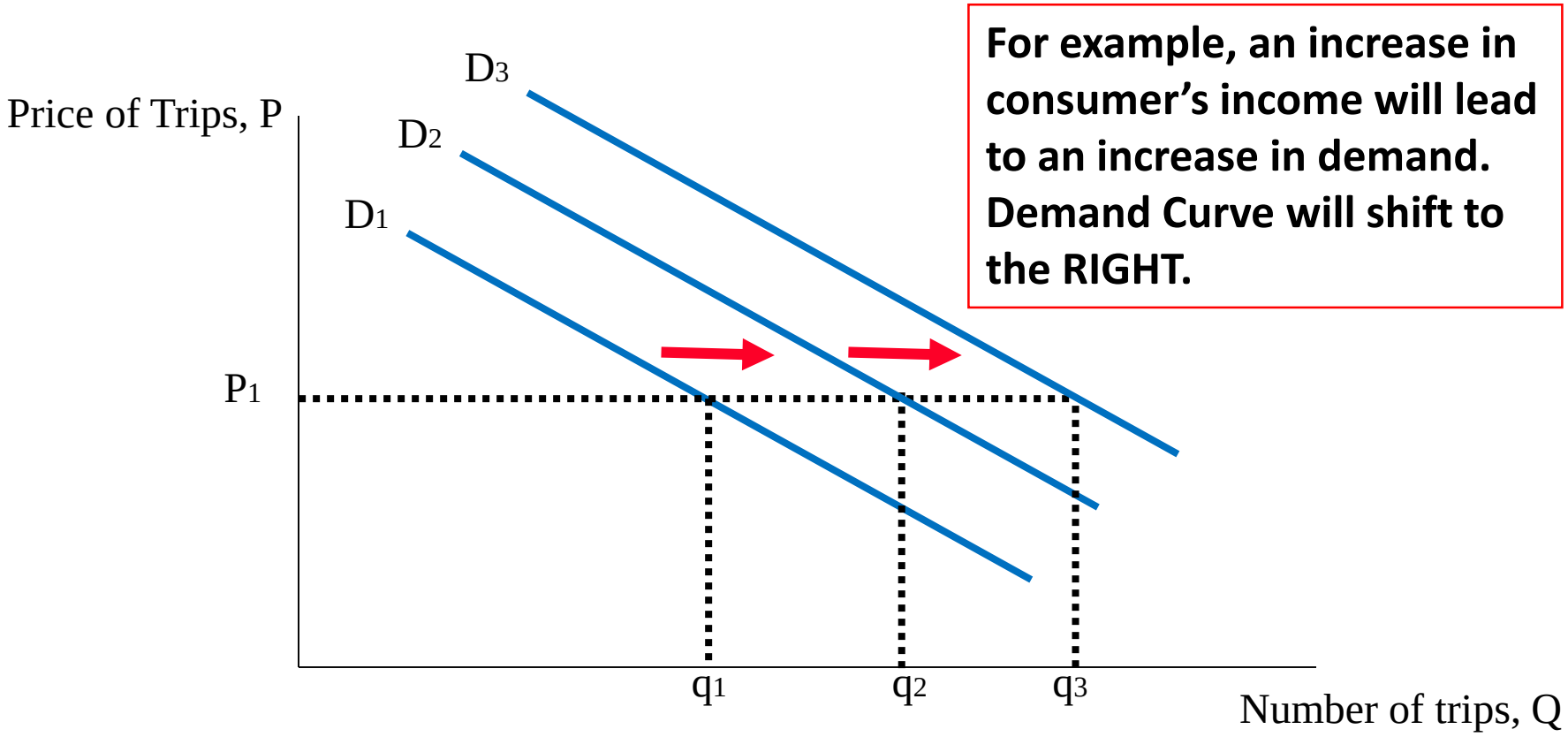


Movement along the Demand Curve



For example, an increase in the bus fares results in a movement along the demand curve of buses.

Shift between Demand Curves



For example, an increase in consumer's income will lead to an increase in demand. Demand Curve will shift to the RIGHT.

- Factors other than "price" changing

The Elasticity of Demand

- Need to understand how demand changes if we alter the cost to the traveller of a service
- Elasticity of demand
- Measures the change in demand in response to changes in the “price” of the service
- Proportional change in quantity divided by the proportional change in “price”

Elasticity Formula

- Price elasticity of demand; Or
- Elasticity of demand with respect to price

$$e_p = \frac{\delta q / q}{\delta p / p} = \frac{\delta q}{\delta p} \times \frac{p}{q}$$

where δq is the change in the number of trips that accompanies , the change in price δp

Calculating Elasticities

- If fare increases from $1.0 to $1.1
- Proportional increase in fare

  = (1.1-1.0)/1.0 = 0.1 or 10%
- Quantity demanded changes from 100 to 97
- Proportional decrease in quantity demanded

  = (97 – 100)/100 = -0.03 = -3%
- Elasticity therefore = -0.03/0.1 = **-0.3**

Transport Supply -1

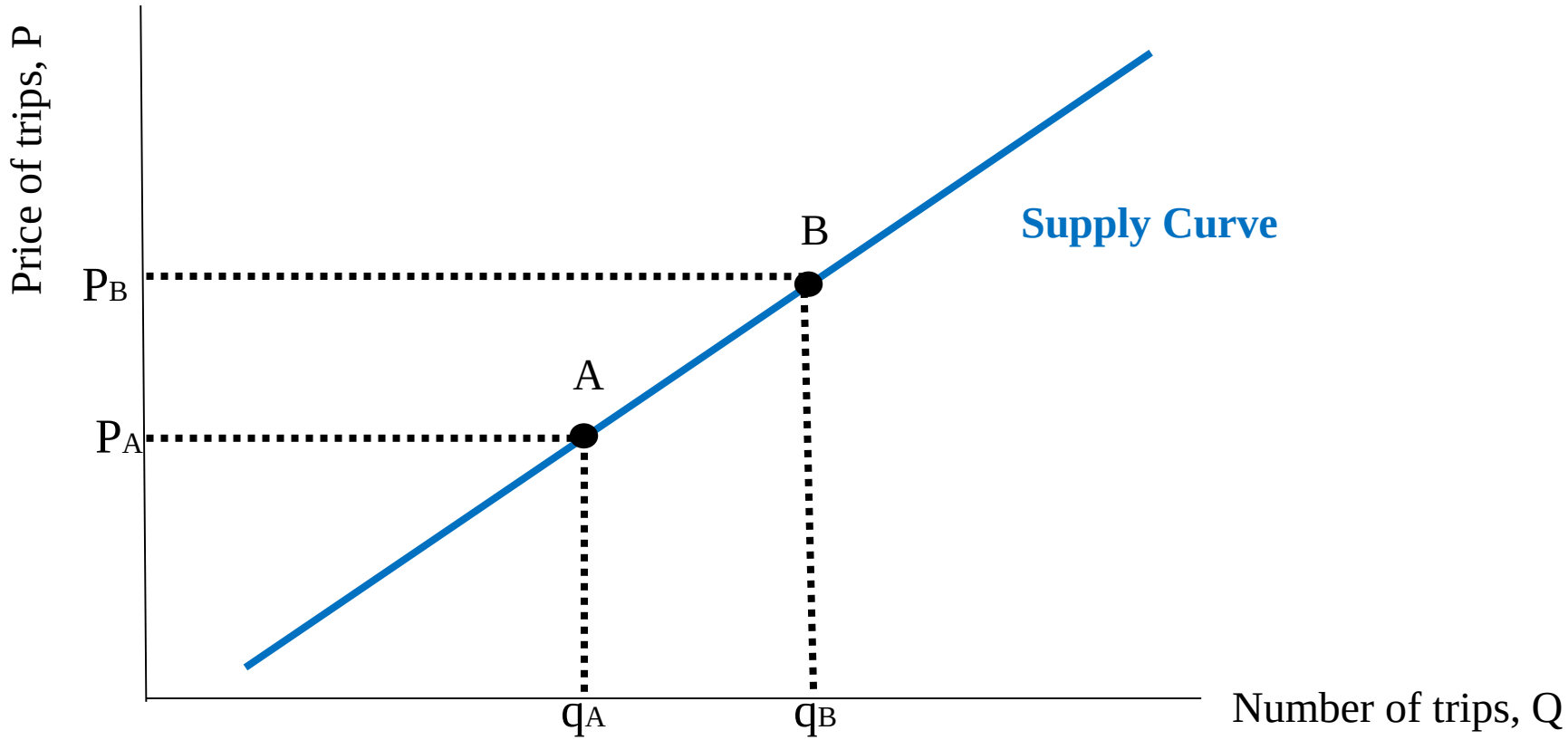
- Who supplies transport
  - Government
  - Private sector
- What is supplied
  - Infrastructure
  - Transport services

Transport Supply -2

- Private sector – financial criteria
    - Flow of funds to generate income
        - But may come from subsidy or similar source
    - Revenues greater than costs
    - Need for precise assessment
- Government – ideally social welfare criteria
    - Need to be sure that benefits > costs
    - Financial criteria is important in funding of schemes

Transport Supply -3

- As in case of transport demand, transport supply also reveals the relationship between market price and quantity supplied
- Quantity is based on what suppliers are prepared to offer



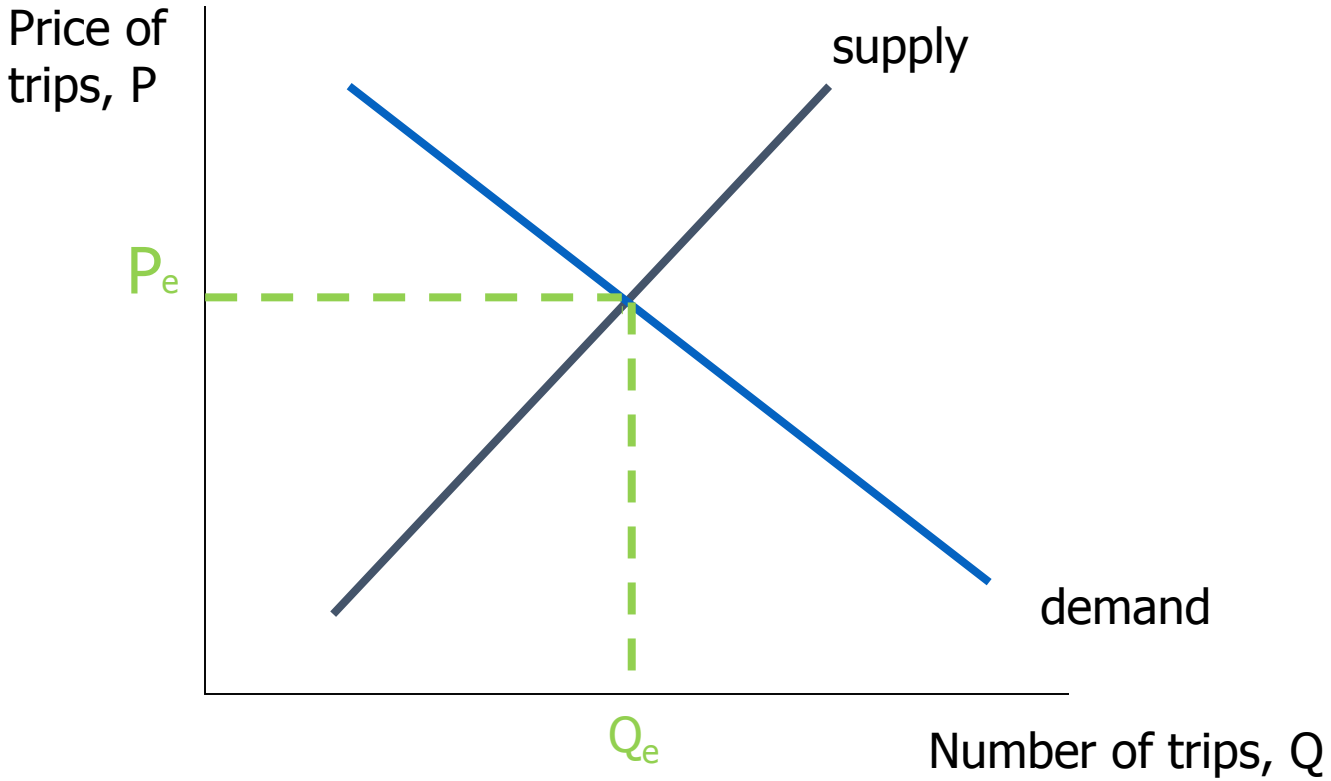
Costs of Production

- Costs of production is a major determinant of the level of supply
- Supplier needs revenues to cover costs (types costs will be examined later).
- Profit = Revenue – Cost
- All transport operators are assumed to be profit maximisers:
  - An increase in cost will decrease the supply: some operators will leave the market due to a loss in profit
  - A reduction in costs will increase in supply: existing operators will supply more to the market & new entrants will enter the market due to higher profit opportunities.

Market Equilibrium

- We drew the transport market demand curve on a graph with P on the vertical and Q on the horizontal
- We did the same for transport supply...
  - Hence we can actually show transport demand & supply on the **same graph**, with P on the vertical and Q on the horizontal
- What is happening at the point where they cross...?
- At this point we have an ‘equilibrium’

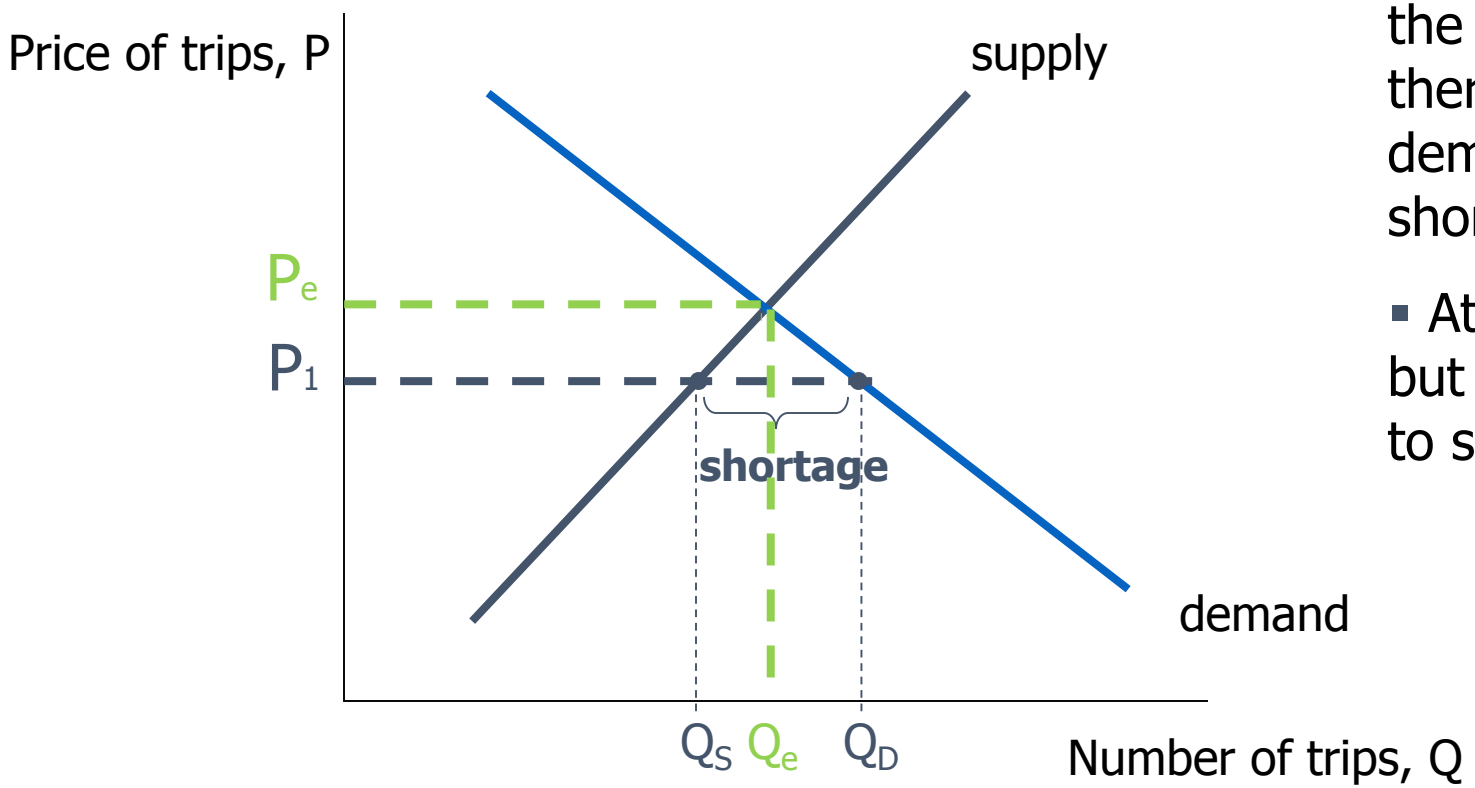
The Market at Equilibrium



What is Equilibrium?

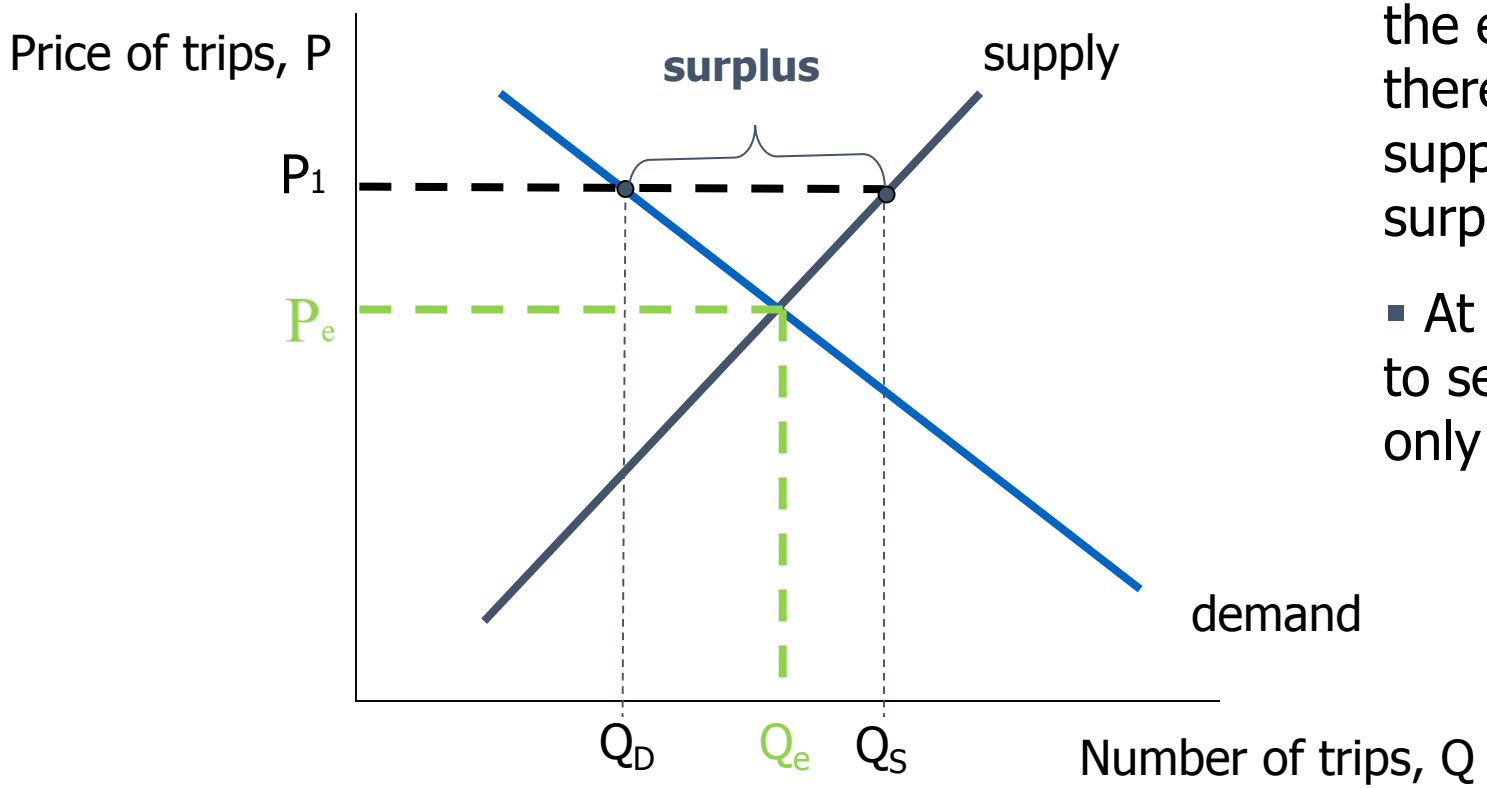
- **Equilibrium** is a stable situation that occurs in the market when quantity demanded in the market is equal to quantity supplied in the market
  - On the graph this appears as the intersection of the market demand curve and the market supply curve
  - This occurs at one unique (single) price and quantity
    - What is this price? What is this quantity?
  - At this point demand = supply → quantity demanded = quantity supplied (there is no over- or under-supply of the commodity)
  - We say the market 'clears' at equilibrium

Determination of Price in a Competitive Market -1



- If the price is set below the equilibrium price, there will be an excess demand, which leads to a shortage
- At P_1, buyers want Q_D but sellers are only willing to sell Q_S

Determination of Price in a Competitive Market -2



- If the price is set above the equilibrium price, there will be an excess supply, which leads to a surplus
- At P_1, sellers are willing to sell Q_S but buyers are only willing to buy Q_S

What are Externalities?

- An external cost is a cost that is *not borne by either the buyer or the seller of the service* - it is imposed on a third party
- Externalities occur whenever *someone other than the producer and user* of the transportation service are affected by the act of transportation
- Most prevalent external cost: **traffic congestion**
- Other external costs of transportation: noise, air vibration, glare, and water pollution

Traffic Congestion

- Travel demand is mainly a derived demand
- AM and PM peak – temporal
- Because the capacity of the road is limited, congestion externalities arise
- Some degree of congestion is desirable, excessive congestion is not
- *What is the optimal level of congestion??*

Congestion Pricing – 1

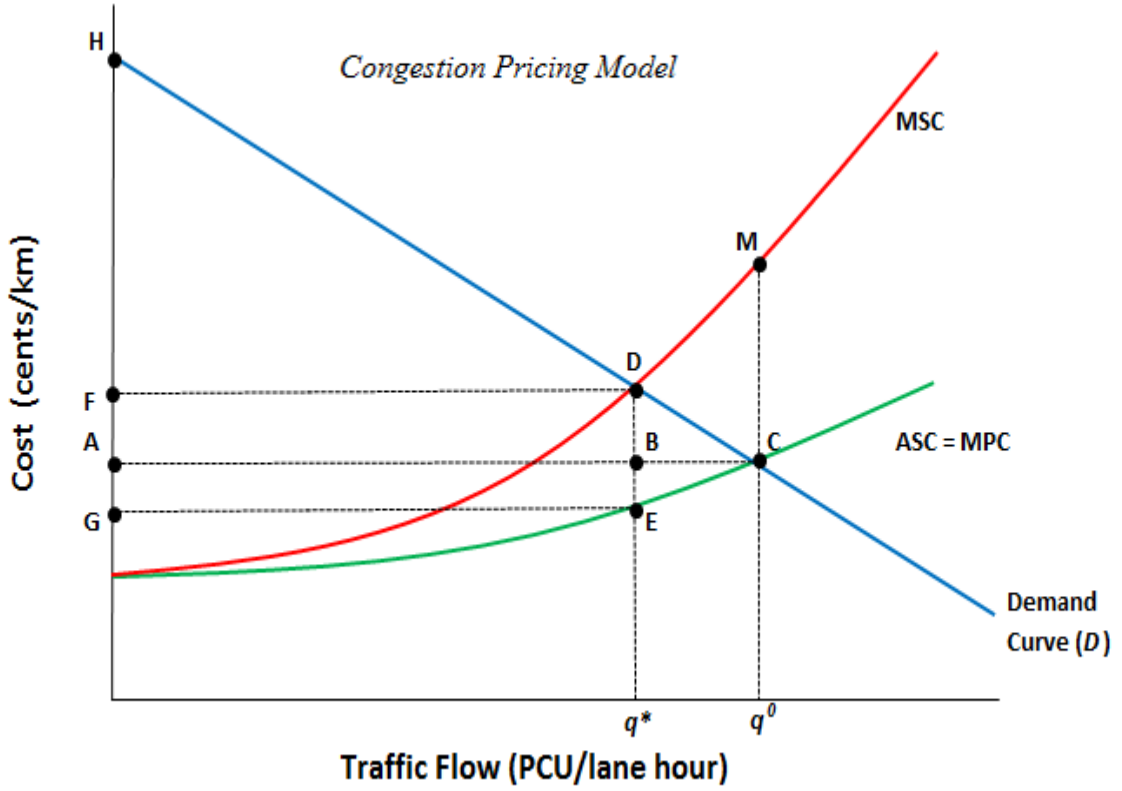
ASC = MPC

Users ignore the costs they impose on others

Actual Flow = $q0$

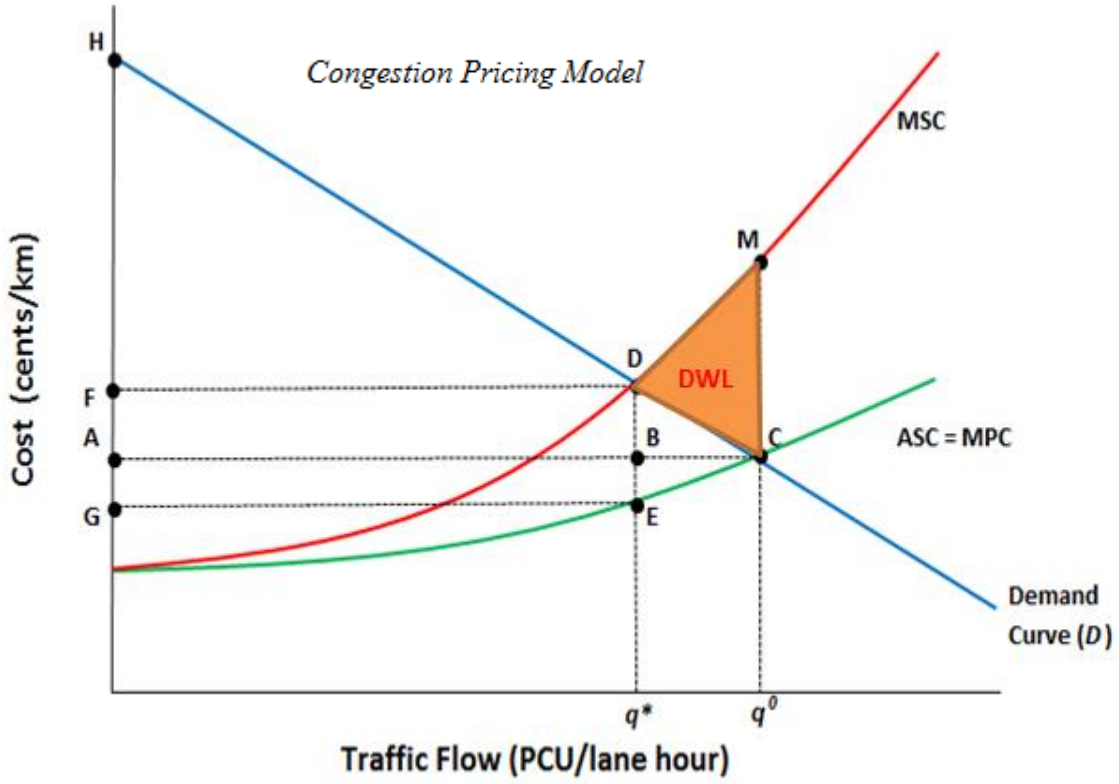
Marginal Congestion Cost = MSC - ASC

Optimal Flow = q^*



Congestion Pricing – 2

- Optimal Charge = *DE*
- Optimal Flow = *q**
- Deadweight loss = Welfare Gain = *DMC*



Econometric modelling for demand forecasting -1

- The objective of econometric methods is to try and identify the precise importance of each of the factor that broadly determine the demand for transport (income, price of the service, quality of the service, price and quality of alternatives, journey time and population size, etc.), in order that we can determine the effect on demand of changing these in the future.

Econometric modelling for demand forecasting -2

1. Understanding the problem:

   Identifying all the key factors and making preliminary estimates of the size and direction of the effect.

2. Obtaining the data:

   Data on ALL the factors has to be acquire.

   a) Time series: where the data, going back a significant number of years, relates to a single location
   b) Cross Section: where the data has been obtained from a series of locations (or individuals) at a specific point in time
   c) Panel data: where data has been obtained from the same series of locations over a period of years.

Econometric modelling for demand forecasting -2

3. Specifying the model:
   a) Selecting the functional form (i.e. linear, log-log)
   b) Selecting the variables and in time series any lagged effects
   c) Making reasonable assumptions about the error term
4. Estimating the specified model:

   Identifying values for the parameter estimates for each factor to be used in the forecast, that makes the predicted values lie as close as possible to the actual values. This normally involves minimising the sum of squares of the residuals.

Econometric modelling for demand forecasting -3

5. Validating the model:

a) The values of the coefficients (the elasticities in log-log) have the right signs (i.e. income +, price -) and are of the expected size.

b) The model fit is statistically significant (The R^2 in the output table)

c) The individual variables are statistically significant (the p value in the output table)

d) The residuals have no pattern over time or location (i.i.d)

6. Simulation/Forecasting:

Once we have the final model then it is a question of inserting expected future values of the factors into the equations. Sometimes we use suggested values obtained from expert groups, or use different sets of predictions to form scenarios, or simply use trend extrapolation of the external factors.

Econometric modelling for demand forecasting -4

$$\log Q_t = \alpha + \beta_1 \log Y_t + \beta_2 \log P_t + \beta_3 \log J_t + \beta_4 \log F_t + \varepsilon_t$$

where Q_t is the number of passengers, Y_t is income, P_t is relative price, J_t is relative journey time and F_t is relative frequency, at time t. The parameter estimates are the average relative impact (%) on demand of each of the factors included, taking into account the units in which each is measured.

References

1. Sheng, S. (2016). CIVIL770 Coursebook. Transport Systems Economics, Department of Civil and Environmental Engineering, UoA.
2. Cowie, J. (2010). The economics of transport: A theoretical and applied perspective. London; New York: Routledge.