1. TRANSPORT MARKETS

Readings for Lecture 1

Button, K. (2010) Transportation economics: Some developments over the past 30 years. *Journal of the Transportation Research Forum*

Learning Outcomes

- The law of demand and its main determinants
- The law of supply and its main determinants
- The market and economic principles that underpin the provision of transport services
- The important role of the price mechanism
- That even where transport markets are closely controlled and regulated by public authorities, underlying economic principles still apply

1.1 Basics

based on Cowie (2010): The Economics of Transport, chapter 3

Market analysis

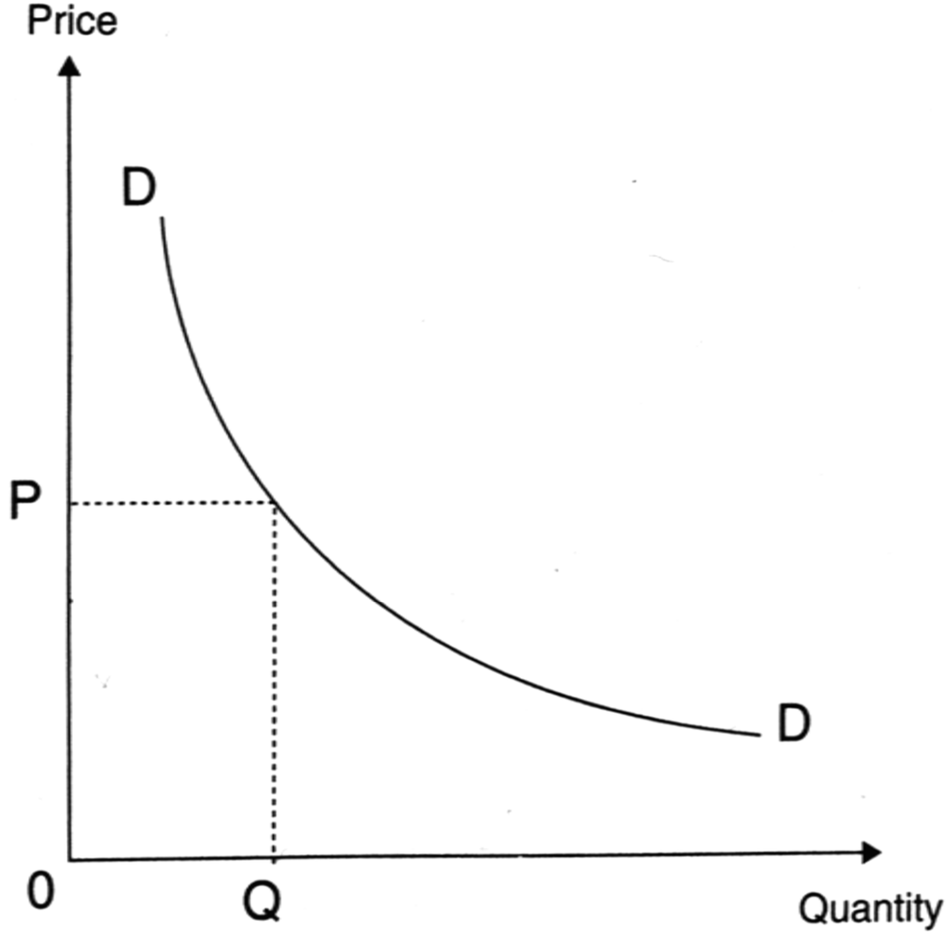
- Market demand and supply
- State regulation and intervention
- Ceteris paribus clause

The law of demand

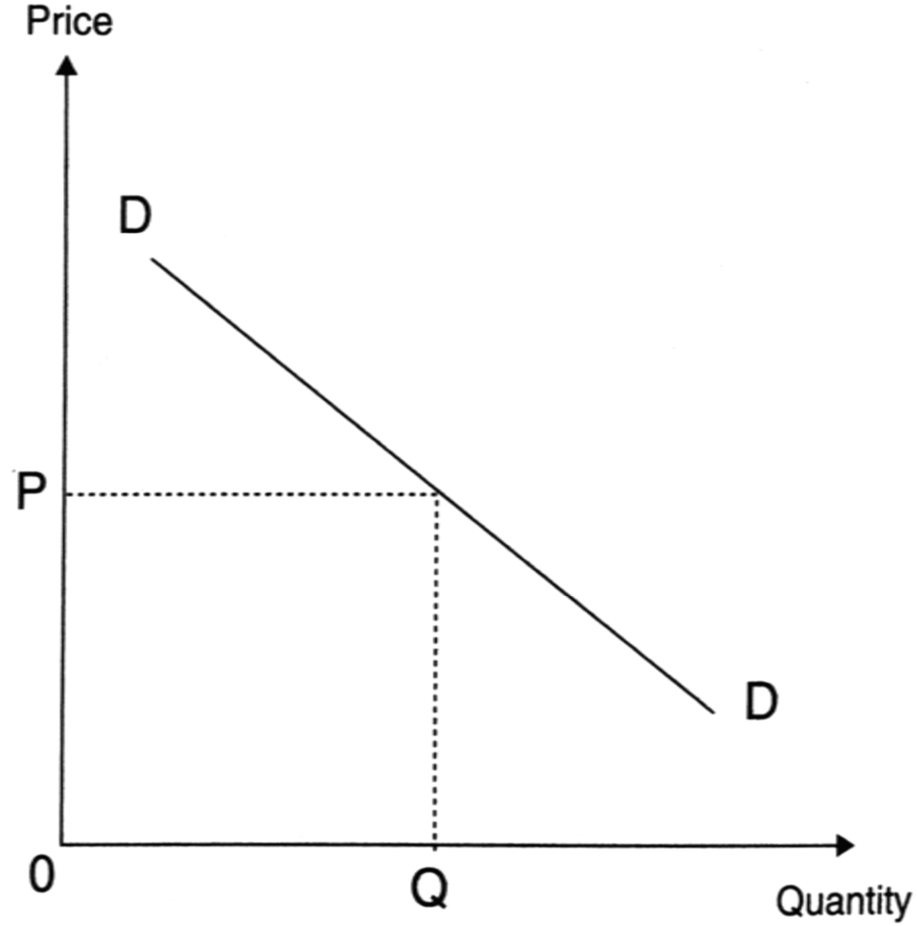
Law of demand states that, all else being constant, as the price of a product increases **(↑)**, quantity demanded falls **(↓)**

Demand curves

Theoretical



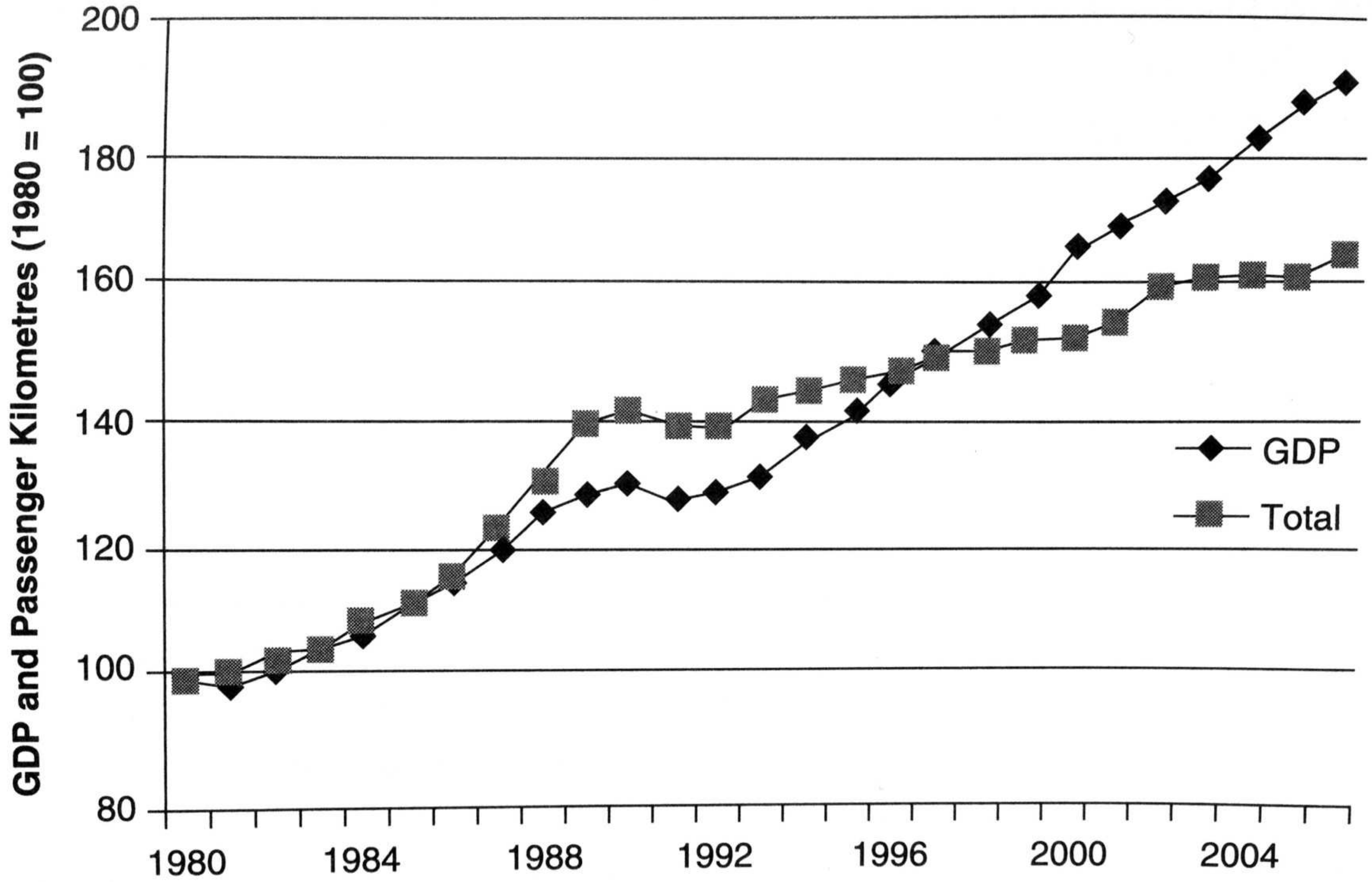
Simplified



Demand determinants

- Income ↑
- Price of substitutes ↑
- Price of complements ↓
- Fashion
- Expectations

Case 1: Impact of income on demand



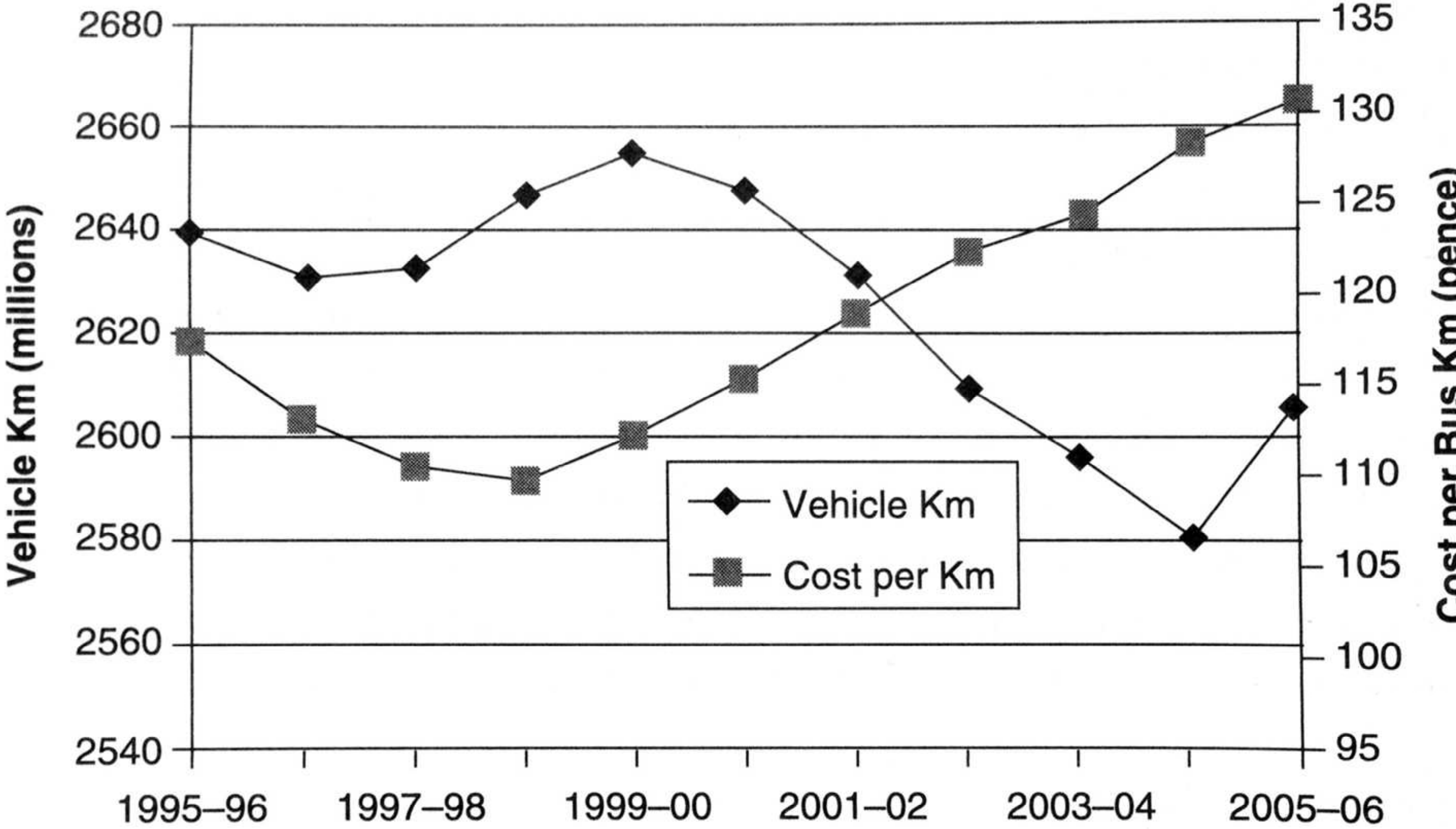
Theory of supply

The **law of supply** is a fundamental principle of economic theory which states that, all else equal, an increase in price results in an increase in quantity supplied

Supply determinants

- The cost of production
- Government policy
- The price of goods in joint supply
- Natural shocks
- Aims of producer

Case 2: British bus industry



Organization of Supply

- Integration or Fragmentation?
- Monopoly or Competition?
- Intervention or Liberalism?

See: Quinet – Vickermann (2004): Principles of Transport Economics.
Chapter 6: The Nature of Markets and Public Intervention

Market workings

- Putting together demand and supply
- Incorporate market imperfections
- Adding government intervention and regulation

1.2 Exercises

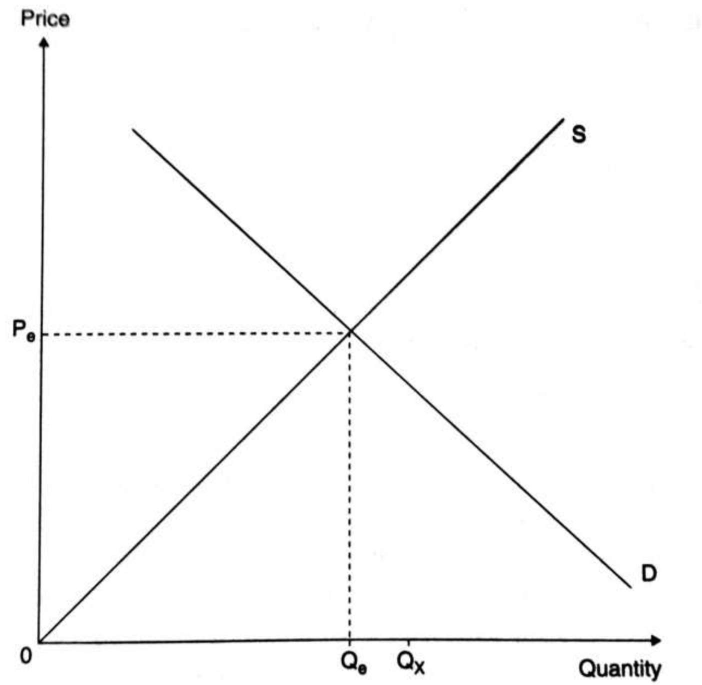
Transport economics problems?

Listed below are seven major transport related issues facing society today. Your task is to identify which ones are related to "the economics of transport":

1. The privatisation of the railways.
2. The negative impact on the natural environment of all transport related activities.
3. Increasing levels of traffic congestion in towns and cities.
4. The high levels of subsidy required to sustain public transport industries.
5. The increasing amounts of land that are being given over to support transport activities.
6. The role of transport in "unifying" the European Union.
7. The subsidisation of public transport services in rural and socially deprived areas.

Increasing the use of the railways

Almost without exception European governments have as one of their main transport policy objectives an increase in the use of passenger rail travel. The simple question is, how can these governments assist the market to achieve this aim? If we assume from attached figure that the government wished to see the quantity used of rail services increase from the current position of Q_e to the level indicated by Q_x, then you should use this diagram as a basis to outline the various options available



Public transport as an inferior good?

Public transportation is oftentimes argued to be the inferior good.

1. Identify why this might be so.
2. Is public transportation an inferior good at all levels of income? If so, why; and if not, why not?

Demand for air travel

Consider the following observations:

(1) between 2009 and 2017 real per capita income increased by 15%;

(2) during the same time span there was a decrease in the average number of hours spent working;

(3) there was an increase in the number of single households and households with unrelated members.

Why might you expect each of these factors to increase the demand for air travel?

The role of infrastructure

The US highway interstate system was started in 1950 and completed in 1973.

1. Use market demand and supply curves to characterize the effect that the completed interstate system had on the market for intercity motor vehicle passenger trips.
2. Similarly, illustrate with market demand and supply curves how the completed system affected shippers' transportation rates.
3. What effect, if any, would you expect the interstate system to have upon rail rates?

Monetary and time costs

Evaluate the following statement: “When transportation markets are functioning well, the opportunity cost of transportation will primarily reflect monetary costs. To the extent that time costs are present, they will be small.”

Economic and econometrics models

Suppose that we have a simple economic model that shipper demands for transportation services depend upon the transportation rate charged.

a) Identify the cause and effect relationship in this model.
b) Why is this model a qualitative model of shipper demands?
c) How would you transform this economic model into an econometric model of shipper demand?
d) In your econometric model, how would you test the hypothesis that demand depends upon transportation rate charged?

Basic econometrics

Consider the following econometric model of T individual bus demands:

$$(Bus\ Trips)_t = \alpha + \beta\ (Fare)_t + \gamma\ (Income)_t + \varepsilon_t$$

where $(\text{Fare})_t$ is the fare (in dollars) per bus trip paid by individual t and $(\text{Income})_t$ (in dollars) is individual t's income.

1. What sign would you expect β and γ, respectively, to have, and why?
2. From the econometric model, what impact will a 50-cent increase in bus fare have upon ridership? What impact will a \$1 increase in household income? What about a \$1000 increase in household income?

1.3 Readings

Button, K. (2010). Transportation economics: Some developments over the past 30 years. In *Journal of the Transportation Research Forum* (Vol. 45, No. 2).

Transport economics

- Why study Transport Economics?
- Is better to study Economics of Transport or Transport Economics?

Markets and interventions

- What are differences between Continental and Anglo-Saxon approaches to transport markets regulation?
- Are (transport) markets always delivering efficient solutions?

Further topics

- Regulation
- Costs and efficiency
- Congestions
- VOTT
- Demand modelling
- Future path

Further Readings

- Button, K. (1998). The good, the bad and the forgettable—or lessons the US can learn from European transport policy. *Journal of Transport Geography*, *6*(4), 285-294.

1.4 Summary

Summary (1)

- Demand and supply were combined in order to examine how the markets operate in practice
- Principally this is through the price mechanism. Market principles still apply even where heavy government intervention exists.

Summary (2)

- „Only the psychologically disturbed or inadequate want transport for its own sake" (Munby, 1968).
- The economist are often reluctant to work with those from other disciplines and are still frequently poor at stating their case in a way that business people and policy makers can appreciate (Button, 2010).

Summary (3)

- An economic model identifies the most important factors that explain the behavior of some underlying economic variable of interest. Economic models are explanatory, generally characterize average behavior, and identify the qualitative relationships between variables.
- An econometric model is a statistical model that enables one to quantify the casual relationships identified in an economic model. Econometric models are used to make statistical inferences on the importance of "explanatory variables" in explaining the variation in the "dependent" variable.

See: Appendix

Readings for Lecture 2

Paulley, N. et al. (2006). The demand for public transport: The effects of fares, quality of service, income and car ownership. *Transport Policy*, 13(4), 295-306.

Appendix: The statistical analysis of economic relations

Based on P. McCarthy (2001): Transportation Economics. Chapter 2

Economic model

- Economic model – simplified description of behavior which purports to identify primary cause and effect relationships between economic variables
- Economic models are:
  - Explanatory
  - Representative
  - Qualitative
- Models are useful in formulation of policy because they identify the important causal linkages between economic variables.

Econometric model

- An econometric model is a statistical specification of an economic model that enables the analyst to quantify the economic relationships identified in the theoretical framework.

An Econometric Model of Airline Demand

- To illustrate the relationship between an economic and econometric model, consider the following economic model of the demand for airline passenger miles:

Miles = f(Price per Mile, Per Capita Income)

$$= \beta_1 + \beta_2 \text{ Price Per Mile} + \beta_3 \text{ Per Capita Income} + \varepsilon$$

Least Squares Regression

- The method of obtaining parameter estimates by minimizing the sum of squared residuals is referred to as the method of least squares.
- The least squares estimator is the formula that is used to produce the least squares estimate.
- OLS estimator is unbiased, consistent and efficient

Estimating the Demand for Airline Travel

Hypotheses:

1. All else constant, an increase in Price per Mile is expected to reduce the quantity of passenger miles demanded
2. All else constant, an increase in Per Capita Income is expected to increase the demand for airline travel

OLS estimation:

$\widehat{\text{Miles}}$ = 15.7 - 8.7 Price Per Mile + 0.031 Per Capita Income

Confidence Intervals

- Each estimated coefficient is a random variable that has an associated probability distribution
- A standard method that is used for determing how close each coefficient estimate is to the true parameter values is to construct a confidence interval around our estimate

t statistics

- It can be shown that statistics $(\beta_i - \hat{\beta}_i)/s_{\beta i}$ has a t-distribution with degrees of freedom equal to the sample size minus the number of parameters estimated.
- $s_{\beta i}$ is the square root of the estimated sample variance and is referred to as the standard error of the estimate.
- If we want to construct a 95% confidence interval, than we want to identify lower and upper bound numbers for the true parameter value

Confidence Intervals for Airline Travel

$$\widehat{\text{Miles}} = \underset{}{15.7} - \underset{(1.0)}{8.7}\ \text{Price Per Mile} + \underset{(0.0013)}{0.031}\ \text{Per Capita Income}$$

<u>95% Confidence intervals:</u>

Price per Mile (-10.80; -6.60)

Per Capita Income (0.0284; 0.0337)

Hypothesis tests

- A major objective of many empirical studies is to test hypothesis regarding the relationship between the dependent and independent variables.
- The methodology for hypothesis testing first requires that we identify two hypotheses, a null hypothesis (H_o) and an alternative hypothesis (H_a)

H_o: $\beta = 0$
H_a: $\beta \neq 0$

Issues in hypotheses testing

- One tail and two tail tests
- Type I and Type II error
- Significance level (1%***; 5%**; 10%*)
- Reject x Not reject null hypothesis

Goodness of fit and R2

- In addition to examining whether our estimated model is consistent with the implications of economic theory, it is of interest to know how well model fits the data.
- R2 = goodness of fit = the statistics that gives the proportion of variation in the dependent variable that is due to all of the explanatory variables in the model

Cross section and time series data

- Cross section data reflect observation on individuals, households, firms, countries, or some other unit of analysis at a given point of time. Usual problem: heteroscedasticity → solution: robust standard errors.
- Time series data are different because each observation corresponds to a different time period. Problem (1): autocorrelation → solution: robust standard errors. Problem (2): unit roots → risk: spurious regression → solutions: trend inclusion; differencing, cointegration.

Model specification

- <u>A time trend </u>is a variable that is included in time series models to capture the influence of factors that are correlated with time but are excluded from the model because they are either unquantifiable or the data are unavailable. A time trend is often use to reflect technological change.
- <u>A dummy variable </u>is a variable that either has a value of 0 or a value of 1. It is often use for analysis of structural changes.

Functional Form

linear:
$\text{Miles} = \beta_1 + \beta_2(\text{Price per Mile}) + \beta_3(\text{Per Capita Income}) + \varepsilon$

log–linear:
$\log(\text{Miles}) = \beta + \beta_1(\text{Price per Mile}) + \beta_2(\text{Per Capita Income}) + \varepsilon$

linear–log:
$\text{Miles} = \beta + \beta_1[\log(\text{Price per Mile})] + \beta_2[\log(\text{Per Capita Income})] + \varepsilon$

double–log:
$\log(\text{Miles}) = \beta + \beta_1[\log(\text{Price per Mile})] + \beta_2[\log(\text{Per Capita Income})] + \varepsilon$

Marginal effects

Model	Marginal Effect*	Interpretation
Linear	$\frac{\Delta\text{Miles}}{\Delta\text{Price}} = \beta_2$	Change in the number of passenger miles from a unit increase in Price per Mile
Log–linear	$\frac{\Delta\log(\text{Miles})}{\Delta\text{Price}} = \frac{\Delta\text{Miles}/\text{Miles}}{\Delta\text{Price}} = \beta_2$	Percentage increase in passenger miles from unit increase in Price per Mile
Linear–log	$\frac{\Delta\text{Miles}}{\Delta\log(\text{Price})} = \frac{\Delta\text{Miles}}{\Delta\text{Price}/\text{Price}} = \beta_2$	Change in the number of passenger miles due to a 1% increase in Price per Mile
Double–log	$\frac{\Delta\log(\text{Miles})}{\Delta\log(\text{Price})} = \frac{\Delta\text{Miles}/\text{Miles}}{\Delta\text{Price}/\text{Price}} = \beta_2$	Percentage change in the number of passenger miles due to a 1% increase in Price per Mile

*Price is Price per Mile.

Elasticity measures

Model	Elasticity*
Linear	$\frac{\Delta\text{Miles}/\text{Miles}}{\Delta\text{Price}/\text{Price}} = \beta_2\left(\frac{\text{Price}}{\text{Miles}}\right)$
Log–linear	$\frac{\Delta\text{Miles}/\text{Miles}}{\Delta\text{Price}/\text{Price}} = \beta_2(\text{Price})$
Linear–log	$\frac{\Delta\text{Miles}/\text{Miles}}{\Delta\text{Price}/\text{Price}} = \beta_2\left(\frac{1}{\text{Miles}}\right)$
Double–log	$\frac{\Delta\text{Miles}/\text{Miles}}{\Delta\text{Price}/\text{Price}} = \beta_2$

*Price is Price per Mile.

The Airline Demand Model Revisited

Model 1 – linear model

$$\text{Miles} = 13.17 - \underset{(-10.4)}{9.74}\ \text{Price per Mile} + \underset{(10.9)}{0.034}\ \text{Per Capita Income} - \underset{(-1.1)}{2.06}\ \text{Time} + \underset{(2.9)}{13.95}\ \text{Deregulation}$$

$R^2 = 0.9963$

Model 2 – log–linear

$$\log(\text{Miles}) = 4.56 - \underset{(-6.23)}{0.032}\ \text{Price per Mile} + \underset{(2.31)}{0.000039}\ \text{Per Capita Income} - \underset{(-5.33)}{0.054}\ \text{Time}$$

$$+\underset{(4.68)}{0.124}\ \text{Deregulation}$$

$R^2 = 0.9957$

The Airline Demand Model Revisited

Model 3 – linear–log

$$\text{Miles} = 2.941 - \underset{(-9.35)}{115.8}\ \log(\text{Price per Mile}) + \underset{(2.56)}{386.3}\log(\text{Per Capita Income}) - \underset{(-5.88)}{39.1}\log(\text{Time})$$

$$-\underset{(-0.19)}{1.42}\ \text{Deregulation}$$

$R^2 = 0.9923$

Model 4 – double–log

$$\log(\text{Miles}) = 6.06 - \underset{(-8.67)}{0.40}\log(\text{Price per Mile}) + \underset{(17.9)}{1.36}\log(\text{Per Capita Income}) - \underset{(-1.76)}{0.043}\log(\text{Time})$$

$$-\underset{(2.46)}{0.070}\ \text{Deregulation}$$

$R^2 = 0.9958$

*t-statistics are in parenthesis below each explanatory variable's coefficient.

Elasticity measures

	Elasticity with respect to:	
Model	Price per Mile	Per Capita Income
1 Linear	−0.38	1.37
2 Log–linear	−0.25	0.32
3 Linear–log	−0.58	1.92
4 Double–log	−0.40	1.36