11. TRANSPORT FORECASTING

Transport and economic growth

- Transport has played a vital role in economic development → it enabled **separation** of production and consumption
- The **wealthy** society needs a lot of transport to move: Freight – all these goods; Passengers – to enable individual mobility
- **Why**? → Division of labour; consumer preferences, optimal matching …..
- There is a close **link** between transport levels and economic wealth (or income)

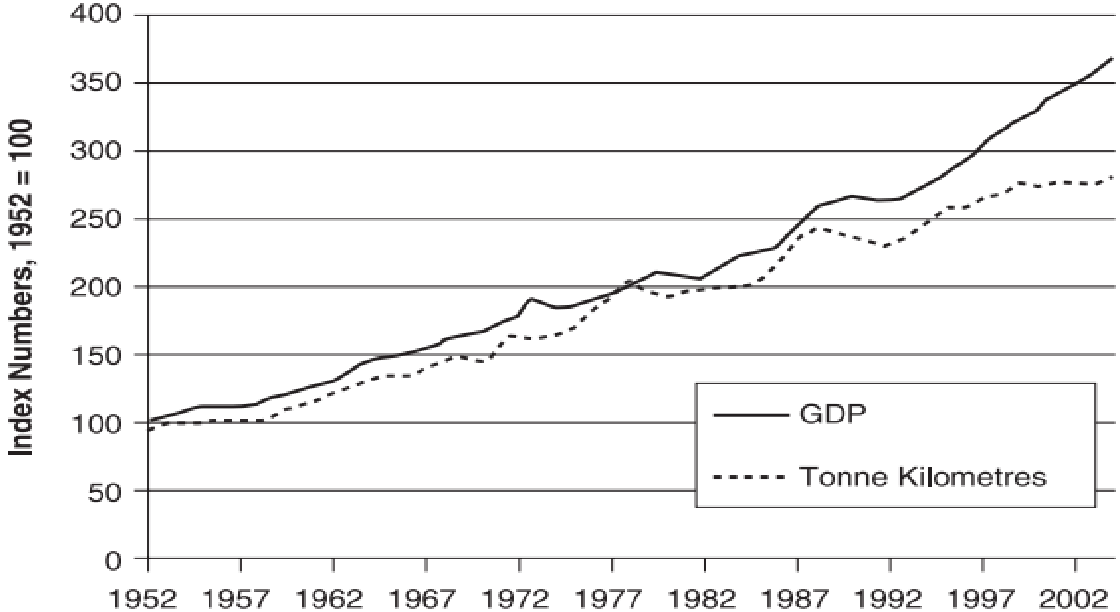


Figure 2.1 *Freight transport and real Gross Domestic Product, Great Britain, 1953 to 2004*

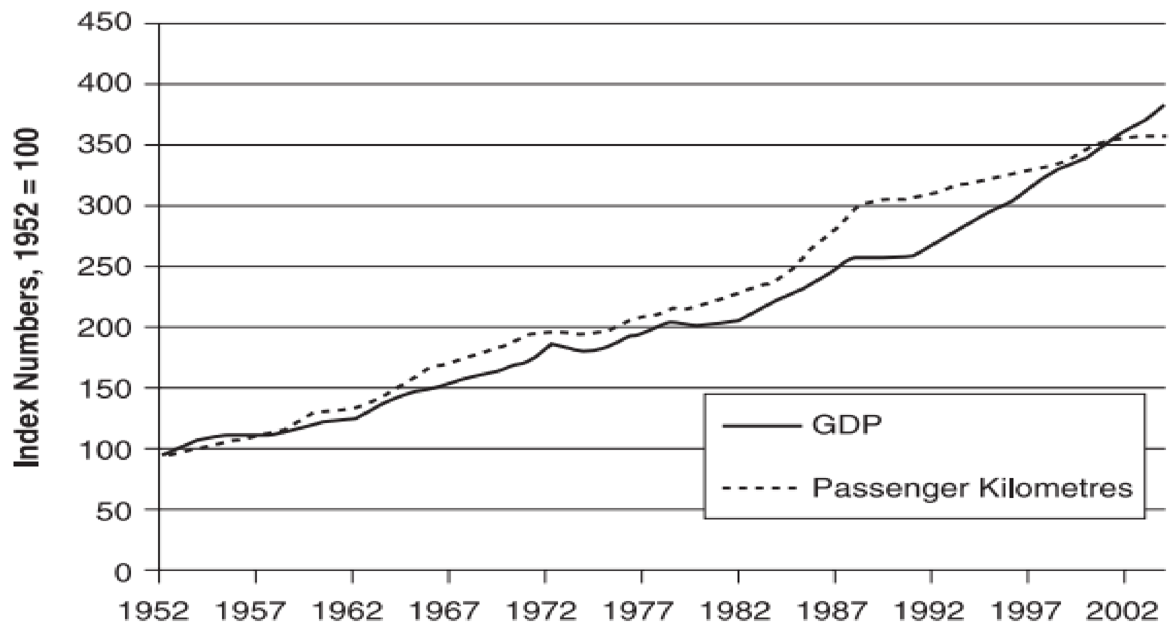


Figure 2.2 *Gross Domestic Product and passenger kilometres travelled, Great Britain,*

Questions

- What is the direction of **causation**?
- Is this pattern **sustainable** in the long run?
- Can we **decouple** economic and transport growth?
- Can we **change** our behaviour? (15 minutes city, electromobility)

Direction of causation?

- The association between **transport volumes** and GDP has long been recognized, there remains real question over the direction of causation
- Is it that as **income rise**, more goods are demanded and transported?
- The alternative hypothesis is that advances in freight transport will result in **reduced transport costs** and it will lead to more goods produced

Supply led view – transport leads to economic development

To adopt a **supply led** model is to suggest that the casual relationship is that improving the transport infrastructure of an area will automatically stimulate economic activity. This would occur for a number of reasons:

- **Widening of markets**, increased production and multiplier effects → the range of potential markets will be expanded
- **Indirect effects** on employment in construction and operation → huge infrastructure projects create an increase in demand

Examples: 1) Role of railways during Industrial Revolution → movement from agricultural to a manufacturing-based economy 2) Exploitation of Brazilian rainforest by better lines of communications

Demand led models – economic development drives demand for transport

- Contrasting with the supply led view is the alternative idea that transport provision is a invariably a **response to** a basic **demand** → hence the casual relationship is that economic development leads to a demand for better transport facilities
- **Without a basic demand** for an area's goods and services, then irrespective of the quality of the transport infrastructure this will never stimulate that demand
- The demand required can come from **revealed** (existing) or **latent** (potential) demand

Synthesis

- There is **no clear answer** to the direction of causation and the two are closely associated
- Under a supply led view improving transport services and/or upgrading the infrastructure is a **necessary and sufficient** condition for improved transport to lead to economic development
- Under a demand led view, however, it is a **necessary** but **not sufficient** condition, i.e. the only condition required. There has to also be a basic derived demand for transport services in order for transport developments to facilitate economic development.

Passenger transport and development

- When people travel more, do they become **better off**?
- **Supply effects**: upgrading existing transport links → will increase passenger travel → and thereby increase GDP. What about the emergence of commuter belt zones?
- **Demand effects** → e.g. Heavily used commuter routes with congested routes and overcrowded public transport → time is money → investing in new infrastructure → any problem with such approach?
- **Demand effects**: 1) High speed rail can create new (commuting) markets. 2) Increased wealth creates a demand for more leisure activities 3) Higher incomes tend to produce a modal switch away from public transport towards cars → creating multiple car households

What is the empirical evidence?

Fogel (1964) → **Railroads** and economic growth in the USA

Purvis (1985) → what is the impact of **highway construction** on the economic growth?

Aschauer (1989) → what is the **elasticity** of aggregated output with respect to infrastructure spending?

Harmatuck (1997) → return on **infrastructure investment** will decline as maintenance expenditure goes up

Rodriguez-Pose (2004) → impact of European **transport investment** on economic development (almost zero)

Prudhomme and Lee (1999) → how **time savings** affects the productivity increases?

Rice and Venables (2004) → the impact of transport on **economies of density and scale**

Supply or demand transport initiatives?

- **CrossRail** – this project is to build new railway connections under central London.
- **The Channel Tunnel** that was opened in 1995 and links Britain to France
- The opening of the **M6 Toll motorway** around Birmingham in December 2003, thus effectively providing a Birmingham by-pass and considerably reducing through journey times.
- The **Golden Gate Bridge** across the opening of San Francisco Bay completed in 1937, which provided the first fixed link northwards out of San Francisco.
- The opening of phase one of the high-speed train line (the **TGV Est**) from Paris to the west of Nancy in June 2007.
- The construction of a **container terminal** at the port of Mundra on the Gujarat coast in North West India. This will be the port's first container terminal.

Decoupling transport from GDP

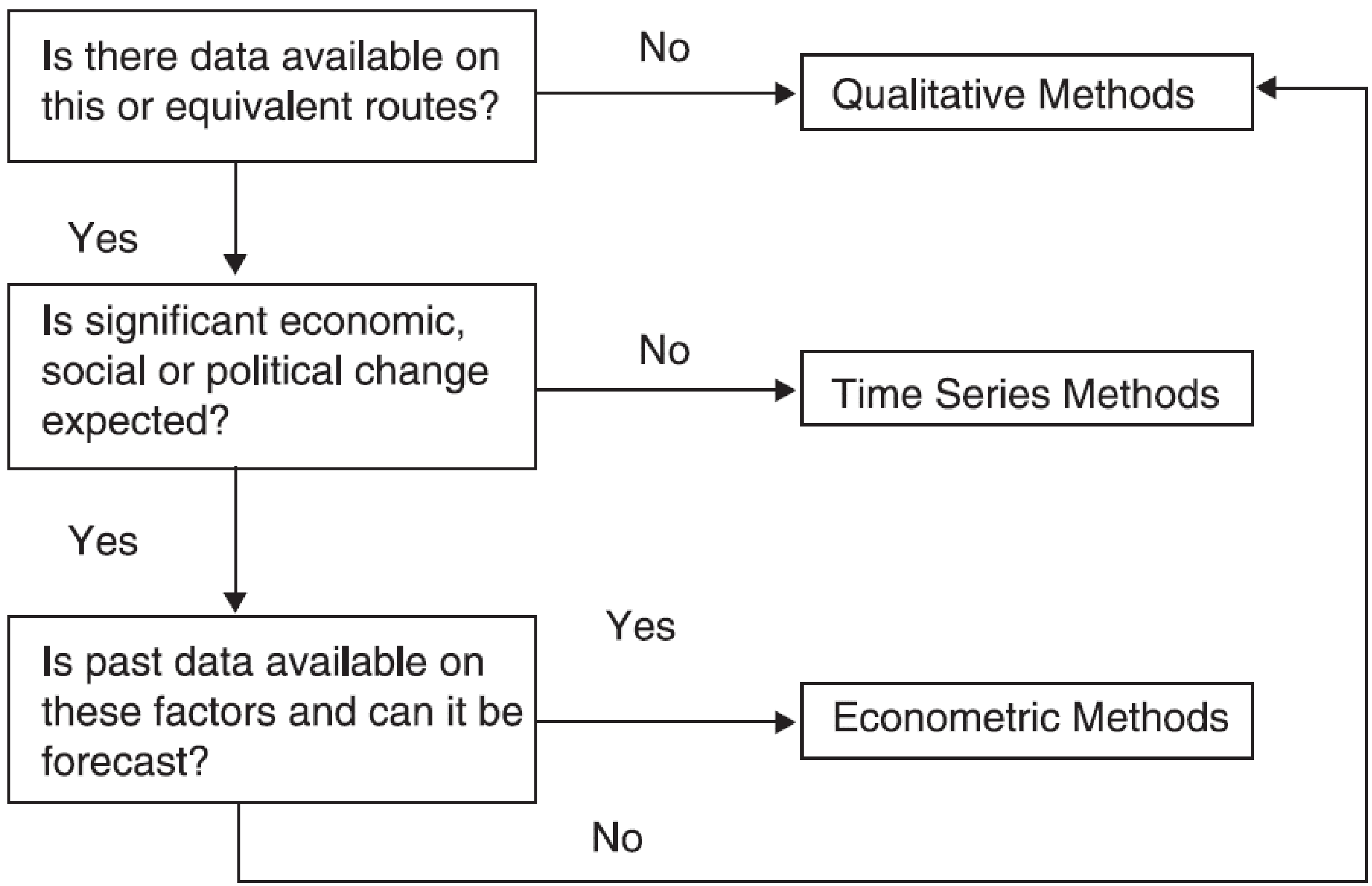
- There is a very **close association** between freight and passenger traffic and GDP
- This has now become a major problem, due to negative impact of transport on the **environment**
- **Decoupling** = GDP can continue to grow without being associated with the growth of traffic
- Is decoupling **achievable**?

TRANSPORT FORECASTING

Introduction

- In order to assess if the provision of a new or improved transport service makes economic sense, we need to have some **idea** of how public will respond, both immediately and in the far distant future
- Forecasting is about **collecting information** from all relevant sources and **analysing** it in a consistent structured fashion.
- When to use **economic modelling** and when to seek **experts' advice**?

Choosing between methods



QUALITATIVE Methods

- Qualitative Forecasting Methods are based on surveys of either potential **customers or „experts“**
- The major problem is identifying **who to ask**
- Small and contained **target group** x representative **sample**
- Problems: **over-estimation** of behavioural changes, **identification** of the target groups

Expert's opinions

- May be very **valuable** in forecasting future trends
- **Problems**: anchoring bias, group think and status deferral
- **Rules:** facilitation, interdisciplinarity, equality, reviews of previous forecasts
- **Delphi technique** = group of interdisciplinary experts discussing until consensus is reached

TIME SERIES analysis

In time series analysis we seek to identify the three elements:

1. The **Trend**
2. Seasonal or **Cyclical** Factors
3. The unusual (sometimes termed the stochastic factor or **noise**)

ECONOMETRIC methods

The modelling process involves **6 stages**:

1. Understanding the Problem
2. Obtaining the Data
3. Specifying the Model
4. Estimating the Specified Model
5. Validating the Model
6. Simulation/Forecasting

The gravity model

The model that predicts the level of transport between two locations to be dependent upon their respective population sizes and the distance between them

$$F_{ij} = \alpha O_i^{\beta} D_j^{\gamma} C_{ij}^{\delta} \varepsilon_{ij}$$

$$\log F_{ij} = \mathrm{A} + \beta \log O_i + \gamma \log D_j + \delta \log C_{ij} + \mathrm{E}_{ij}$$

F = the Flow between destinations
O = the size of the Origin
D = the size of the destination
C = the cost of travelling between them

Case: Border effect

- A traveller flying from **Hanover to Bologna** has to change at Munich airport, i.e. from a domestic to a border-crossing flight. For the first part of the trip, he may select between **eight** flights and will be carried by wide-bodied aircraft such as the Airbus 320 or the Boeing 737.
- For the second part, only **four** flights per day are available, and the typical aircraft is a narrow-bodied one with a capacity of less than 50 seats.
- Apparently, there is much **lower demand** for flights between Munich and Bologna than between Munich and Hanover, although distances are similar and economic activity in the Bologna region is about as high as in the Hanover region.
- The **border** between Germany and Italy seems to substantially suppress air traffic activity.

Klodt, H. (2004). Border effects in passenger air traffic. Kyklos, 57(4), 519-532.

Methodology: Gravity model

In accordance with previous studies, the following equation was estimated:

$$t_{ij} = c\ \beta_1\ y_{ij} + \beta_2\ dist_{ij} + \beta_3\ Border_{ij} + \varepsilon_{ij} \quad (1)$$

t is the logarithm of the number of persons traveling from i to j, c is a constant, y_{ij} is the logarithm of GDP of i multiplied by the GDP of j, $dist_{ij}$ is the geographical distance between i and j, $Border_{ij}$ takes the value of 1 for national flights and the value of 0 for international flights, and ε_{ij} is an error term.

Table 1

OLS-Estimates of Traveler Departures by Airport

	Frankfurt	Hamburg	Munich
c	–5.89***	–5.12**	–10.09***
	(2.02)	(2.16)	(2.99)
y	0.77***	0.78***	1.00***
	(0.10)	(0.10)	(0.10)
dist	–0.28**	–0.65***	–0.62***
	(0.13)	(0.10)	(0.09)
Border	1.60***	1.29***	1.56***
	(0.33)	(0.38)	(0.34)
Obs	106	112	110
Adjusted R^2	0.38	0.55	0.57
SEE	1.27	1.03	1.13

Notes: Heteroskedasticity-consistent standard errors in parentheses. *** and ** denote significance at one and five per cent levels.

Econometric demand models

The **demand for particular mode** (road, rail, air) will be determined by *income, price, journey, times, frequency and comparative quality*

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

CASE: The demand for ferry services

Short sea crossings

to and from the UK

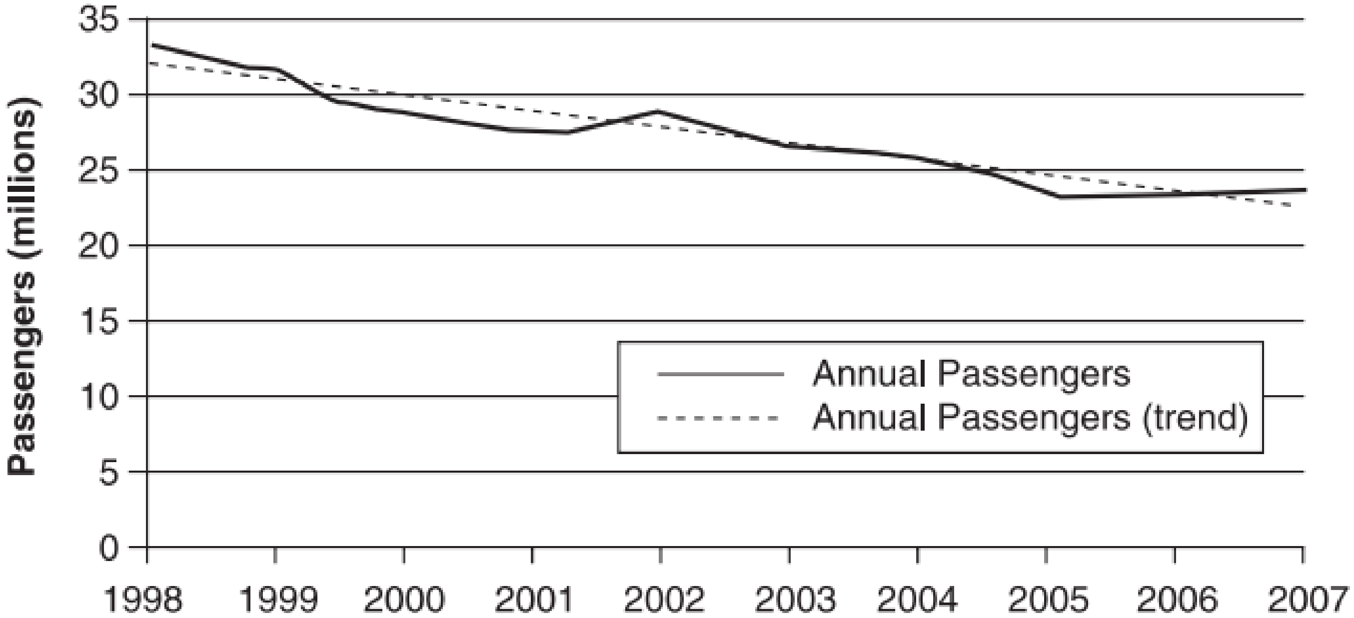


Figure 13.4 *Annual sea passengers, underlying trend*

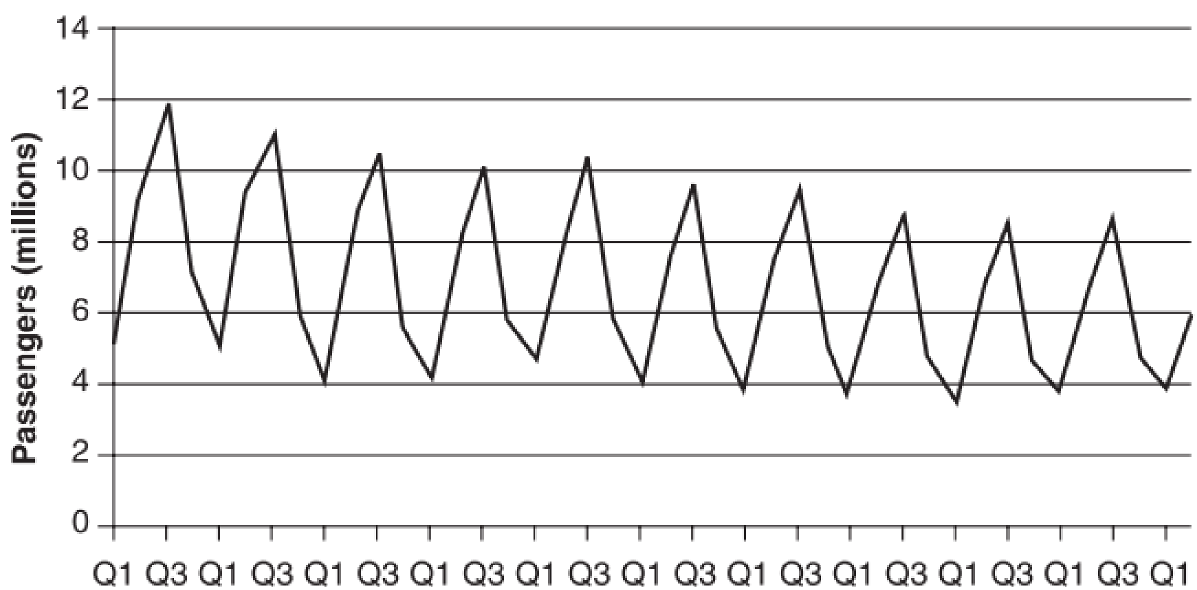


Figure 13.3 *Annual and quarterly short sea passengers, inward and outwards, 1998 to Q2 2008*

Interpretation

- There is a clear **seasonal pattern** when we may expect a higher demand in summer than in a winter
- There is also a clear **downward trend** → how to forecast it into the future?
- $\mathbf{Y = \alpha + \beta\ (YEAR) + \varepsilon}$ = 33,06 – 1,05 (YEAR) → the demand will be lower by 1,05 million passengers every year
- $\mathbf{Y = \alpha + e^{\beta\ (YEAR)} + \varepsilon}$ → growth rate of demand was found to be -3.8%

Seasonal fluctuations

- When **planning capacity** → if there is a marked seasonal fluctuation → then a seasonal forecast is required
- It is possible to **use weighted averages** of the seasonal differences (or ratios)
- A simple approach utilising the regression involves the use of **dummy variables** → four dummies for quarters without a constant OR three quarter dummies and a constant

Misspecification and demand for ferry services

- The number of ferry passengers is in **decline**
- Since foreign travel is a **luxury**, our economics suggests it is likely to grow with income, hence it should have a **positive income elasticity**
- We may also suspect that cheaper more available **air services** and the advent of the **Channel Tunnel** might influence demand for ferries

Table 13.3 UK international passengers by mode (million)

YEAR	AIR	SEA	TUNNEL	TOTAL	REAL GDP
1981	11.4	7.7	0.0	19.0	56.2
1991	20.4	10.4	0.0	30.8	73.0
1995	28.1	10.0	3.2	41.3	79.5
1996	27.9	10.7	3.5	42.1	81.7
1997	30.3	11.5	4.1	46.0	84.3
1998	34.3	10.5	6.1	50.9	87.1
1999	37.5	10.4	5.9	53.9	89.7
2000	41.4	9.6	5.8	56.8	93.1
2001	43.0	9.7	5.6	58.3	95.3
2002	44.0	10.0	5.3	59.4	97.3
2003	47.1	9.2	5.1	61.4	100.0
2004	50.4	9.0	4.8	64.2	103.3
2005	53.6	8.1	4.7	66.4	105.2
2006	56.5	8.4	4.7	69.5	108.2

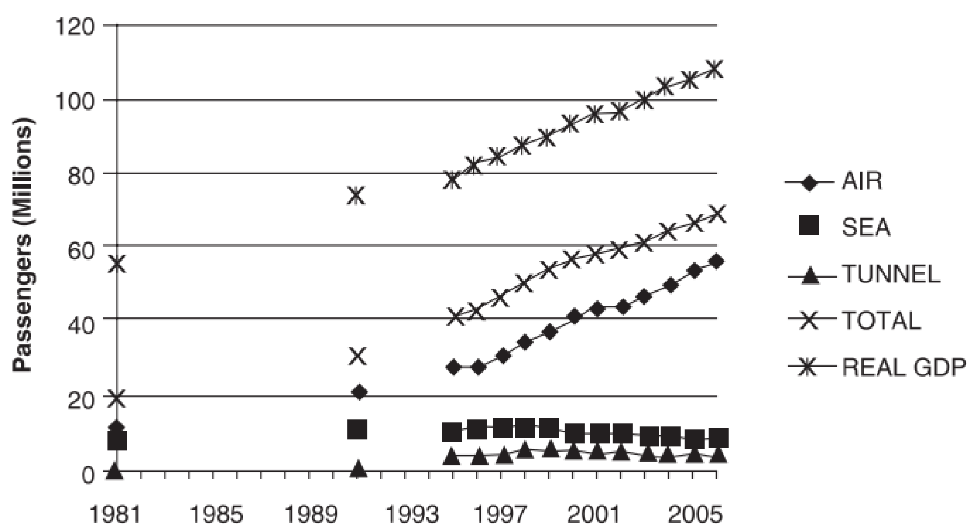


Figure 13.8 UK international passengers by mode

Table 13.4 *Correlation matrix. Passengers by mode from 1981*

	AIR	SEA	TUNNEL	TOTAL	REAL GDP
AIR	1.0000				
SEA	–0.2784	1.0000			
TUNNEL	0.7433	0.1755	1.0000		
TOTAL	0.9886	–0.1499	0.8270	1.0000	
REAL GDP	0.9900	–0.1485	0.7698	0.9933	1.0000

Table 13.5 *Correlation matrix. Passengers by mode from 1996*

	AIR	SEA	TUNNEL	TOTAL	REAL GDP
AIR	1.0000				
SEA	–0.9471	1.0000			
TUNNEL	0.1440	–0.0812	1.0000		
TOTAL	0.9939	–0.9226	0.2437	1.0000	
REAL GDP	0.9975	–0.9354	0.1044	0.9890	1.0000

Interpretation

- There is a significant **difference** between correlations values based on the first (1981-) and second (1995-) table → there is a strong negative correlation (**- 0.93**) between Sea Travel and Income in the period 1995 – 2007
- It may be that it reflects the fact that sea travel on holiday is an **inferior product** with a large negative income elasticity → i.e. as Britons get richer, they are, ceteris paribus, less likely to take their cars on to a ferry to Europe

The impact of air fares?

- **Conversely**, we may well believe that this is a short-term effect brought on by **rapidly declining air fares** in recent years and that the longer series with much weaker correlation (**-0.148**) is a better indication of what to expect in the future
- It is important to recognize that our **understanding** from economic theory of what underlies change is crucial to modelling and forecasting

The impact of competing modes

- To forecast demand for sea ferries we really require the **price** of ferry services, **price** of air services and **price** of tunnel services
- As discussed earlier obtaining „a price“ for a single route is extremely difficult, for a combination **virtually impossible**
- Since we expect price and demand to be quite strongly inversely related, we can sometimes use „demand numbers“ as **proxies** for prices
- I addition, the number of air passengers also reflects increases in **capacity**
- It seems **reasonable** to try to explain the number of sea passengers by numbers on the other modes and income

SUMMARY OUTPUT

Regression statisitics	
Multiple R	0.978422
R Square	0.957309
Adjusted R Square	0.944501
Standard Error	0.253175
Observations	14

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	14.37331	4.791102	74.74673	3.77E-07
Residual	10	0.640978	0.064098		
Total	13	15.01429			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	–10.5864	1.869482	–5.66274	0.000209	–14.7519	–6.42093
AIR	–0.51199	0.039174	–13.0696	1.3E-07	–0.59927	–0.4247
REAL GDP	0.429856	0.037769	11.38123	4.8E-07	0.345701	0.51401
TUNNEL	0.232451	0.05696	4.080982	0.002211	0.105537	0.359365

Figure 13.9 *Regression output from Excel*

Conclusions

- The **fit** of the model is good (95%) and more importantly, the coefficients have the right **signs**. **Income elasticity** of sea travel is almost 4
- The increases in **air travel** and not Channel Tunnel has been the most important factor in slowing down the demand for ferries
- **If** airline growth is **checked** because of higher fuel prices and carbon pricing than we would confidently **expect** significant **growth** in the ferry market well more than the growth of GDP
- It is important to note that if **data on prices** were available, it would be far better than using the proxy variables
- In addition, a **better modelling strategy** might well be to model the total market and relate that to GDP and model mode choice separately based on factors such as price and journey time

MODELLING CHOICE

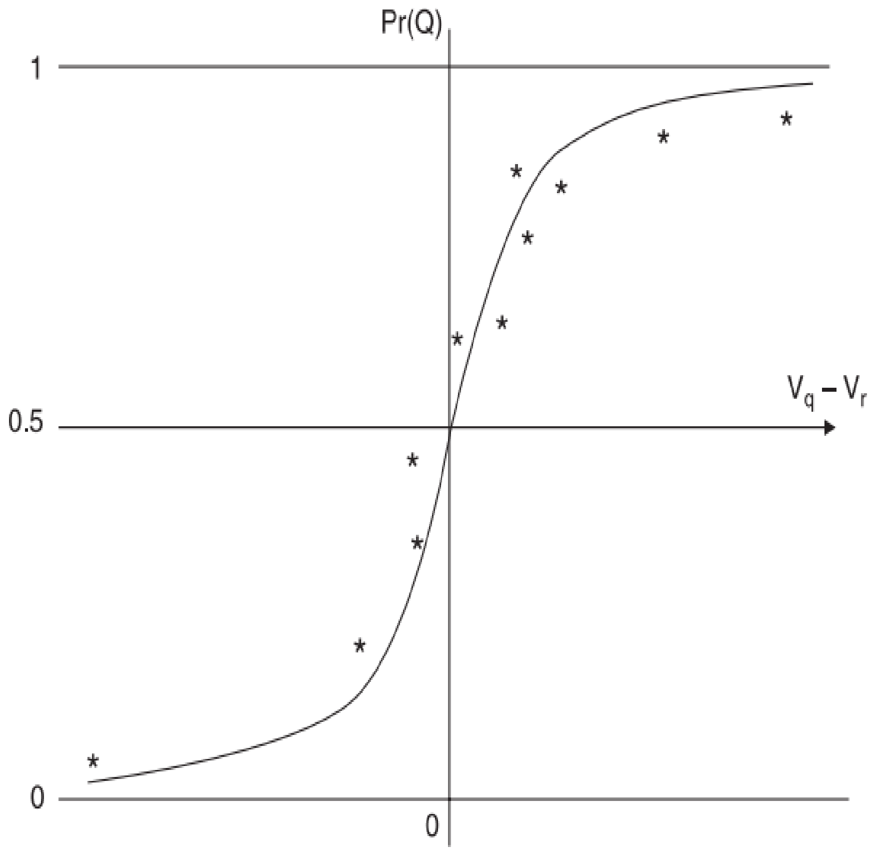
Background

- It is often the case that we are more concerned with forecasting the **share** of existing traffic than the growth of that traffic
- **Example:** Investing in a new toll motorway that runs parallel to an overcrowded existing motorway → the key question is how many vehicles we might expect at various levels of toll
- **Modelling** → gravity model → total traffic → choice model → shares of old and new motorway

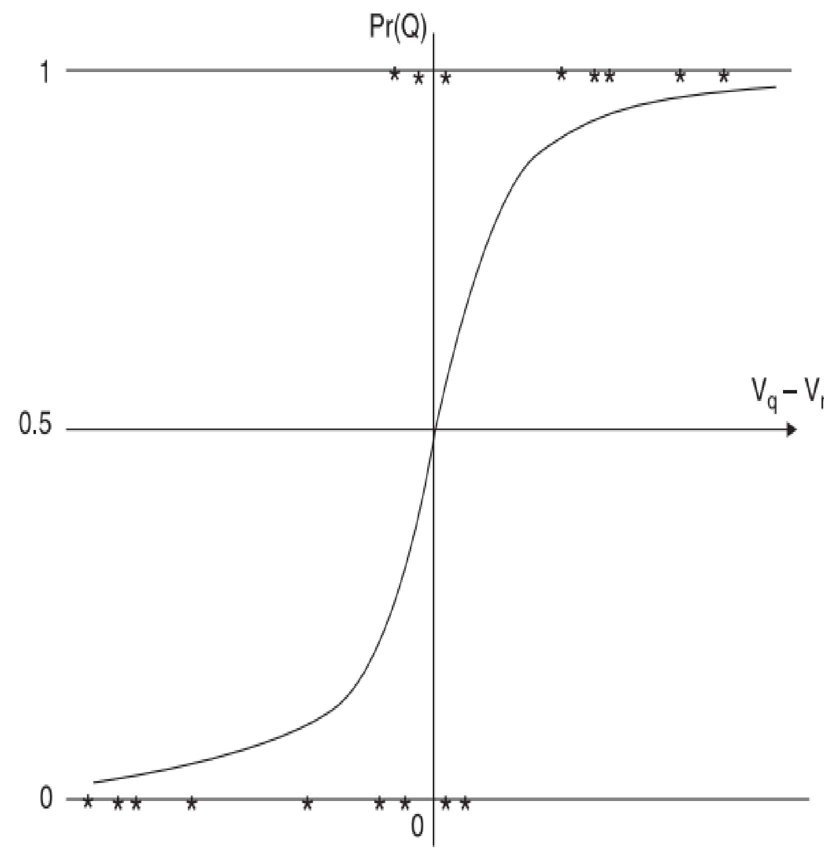
Data and Specifications

- Choice modelling data comes in two forms:
  a) **Individual** Data gathered within one time period
  b) **Market Share** Data which can be cross section, time series or panel
- Increasingly, when contemplating quality changes, a **survey** is undertaken where customers are presented with number of alternatives and asked to choose between them → **Choice Experiment**
- **Forecasting Shares**: The choices are made on the basis of differences between factors such as journey time and price → The specified model must consider the logical limits of proportions and the law of diminishing marginal utility → One common form is the **Logistic Curve**

Logistic curve



13.11 The Logistic curve with market share data



13.12 Logistic curve and individual data

Example: Following table gives data of mode shares between metropolitan area (some of which are on islands):

Table 13.6 Sample data on market shares and differences in systematic values

	Complete Journey Time (Mins)			Price (£)			Share	
Location	Land	Air	Difference	Train	Air	Difference	Train	Air
1	350	120	230	56	98	–42	0.0%	100.0%
2	280	280	0	98	98	0	50.0%	50.0%
3	35	120	–85	56	98	–42	99.1%	0.9%
4	90	80	10	88	78	10	33.2%	66.8%
5	620	134	486	25	231	–206	0.0%	100.0%
6	324	212	112	45	123	–78	10.5%	89.5%
7	350	220	130	56	98	–42	1.9%	98.1%

$\text{Log}_e(\text{Pr(Land)}/\text{Pr(Air)}) = -0.04 * (\text{Difference in Journey Times}) - 0.03 * (\text{Difference in Price})$

$\text{Pr(Land)} = \exp(-0.04 * (\text{Difference in Journey Times}) - 0.03 * (\text{Difference in Price})) / (1 + \exp(-0.04 * (\text{Difference in Journey Times}) - 0.03 * (\text{Difference in Price}))$

Suppose current differences are 60 minutes faster by air and £100 more expensive but increased security increases air journey times by 50 mins. The model forecasts that the current land market share will increase from 64.6 per cent to 93.1 per cent.

Developments in choice modelling

- **Extensions** to models with more than two choices
- **Multinominal logit** has a significant limitation → independence of irrelevant alternatives
- The preferred model is usually **nested model**

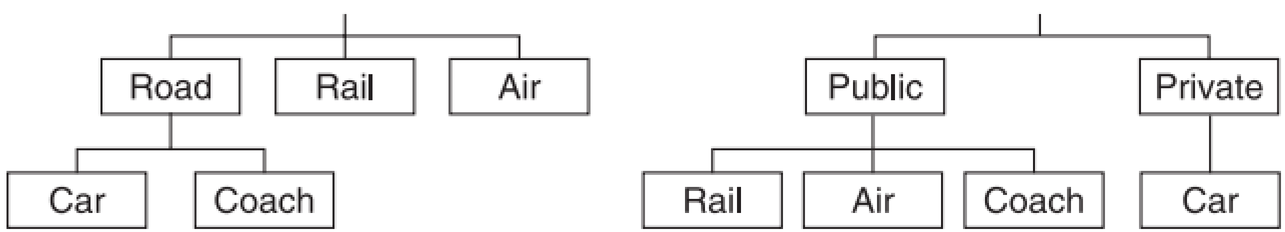


Figure 13.13 *Possible nesting structures for a four mode choice*

CASE: Forecasting a demand for a new ferry service

- **Islay and Jura** are two adjacent islands off the Southwest of Scotland
- **Populations**: Jura (461); Islay (6.500)
- Transport to Islay from mainland → 3 return services per day. Journey time: **2 hours**
- Proposed new service: Mainland → Jura → Islay. Journey time: **1 hour**. However **not suitable** for the heavy lorry traffic (distilleries) → old connection still needed
- What is the **economics**?
- **Initial survey** → considerable demand for a new service → road system would need to be improved
- **Re-examination in 1996** → demand and choice modelling

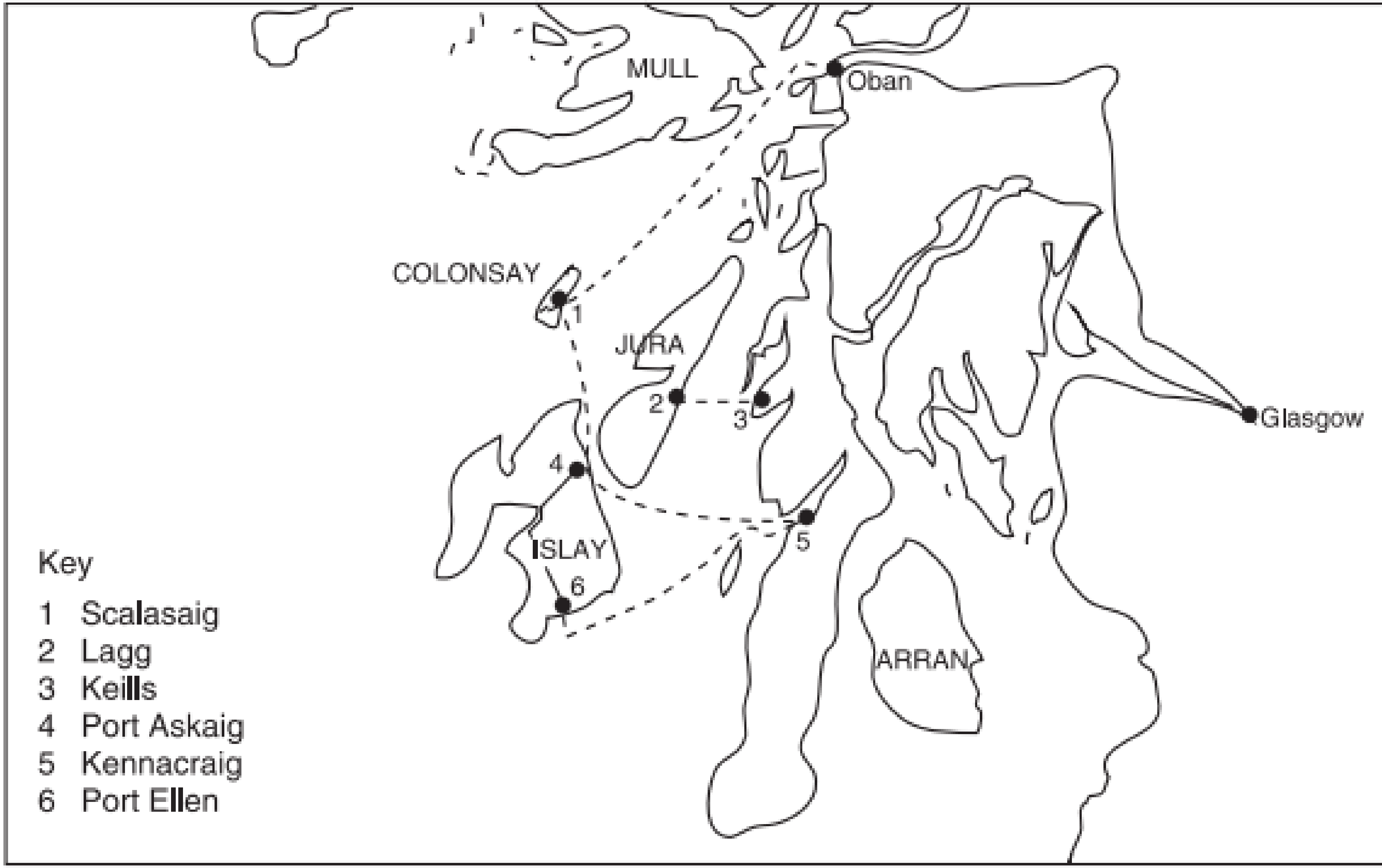


Figure 13.14 *The Islands of Argyll in South West Scotland*

Demand Model – to forecast the total traffic

$$Q_{it} = aP_{it}^{\beta 1}\ Y_t^{\beta 2}\ N_i^{\beta 3}\ J_{it}^{\beta 4}\ \varepsilon_{it}$$

Where:

Q_{it} represents the passenger or vehicle numbers going to island i in year t

P_{it} represents the charge for passenger or vehicles going to island i in year t

Y_t represents the income of passengers in year t

N_i represents the resident population of island i

J_{it} represents the total journey time from the central belt to island i in year t

α is a constant, $\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$ are demand elasticities and ε_{it} represents factors specific to island i in year t.

Results

Table 13.7 Passenger and vehicle elasticities

	Price	*Income*	*Population*	*Journey Time*
Passengers	–0.58	1.30	0.68	–0.86
Vehicles	–0.87	1.91	0.78	–0.41

Assuming real prices and populations are relatively **stable** → a **forecast** of demand for Islay/Jura was generated → **assuming** 3 different growth rates and a reduction in a journey time by an hour → this gave estimates of **demand growth** between 33% and 66% → the **numbers** travelling to islands would **increase** substantially → main problem was modelling **tourism**

Choice model – to forecast the shares of long and short sea routes

$$Log_e\left(\frac{\Pr(Q_{Sit})}{\Pr(Q_{Lit})}\right) = \beta_1\,(P_{Sit} - P_{Lit}) + \beta_2\,(F_{Sit} - F_{Lit}) + \beta_3\,(J_{Sit} - J_{Lit}) + \varepsilon_{it}$$

Where, for each island i in year t

$Pr(Q_{Sit})$ is the proportion of vehicles using the Short Sea route
$Pr(Q_{Lit})$ is the proportion of vehicles using the Long Sea route
P_{Sit} is the Price of using the Short Sea route
P_{Lit} is the Price of using the Long Sea route
F_{Sit} is the frequency of the Short Sea route
F_{Lit} is the frequency of the Long Sea route
J_{Sit} is the total journey time using the Short Sea route
J_{Lit} is the total journey time using the Long Sea route
$\beta_1, \beta_2, \beta_3$ are coefficients to be estimated and ε_{it} is the stochastic term

Conclusion

- Choice model explained 97% of variance and **coefficients** were highly **significant**
- It was supposed that the new connection would be only slightly **cheaper** than the long route, but would be substantially **faster** and more **frequent** → the result was that **80% of vehicles would switch** to the short crossing
- However, this would put into problems/**closure longer** route (essential for freight). Together with need to improve the road system (high costs) → the plan was **rejected** → to the **dismay** of many local groups

Forecasting demand for high speed rail

Börjesson, M. (2014). Forecasting demand for high speed rail. *Transportation Research Part A: Policy and Practice*, *70*, 81-92.

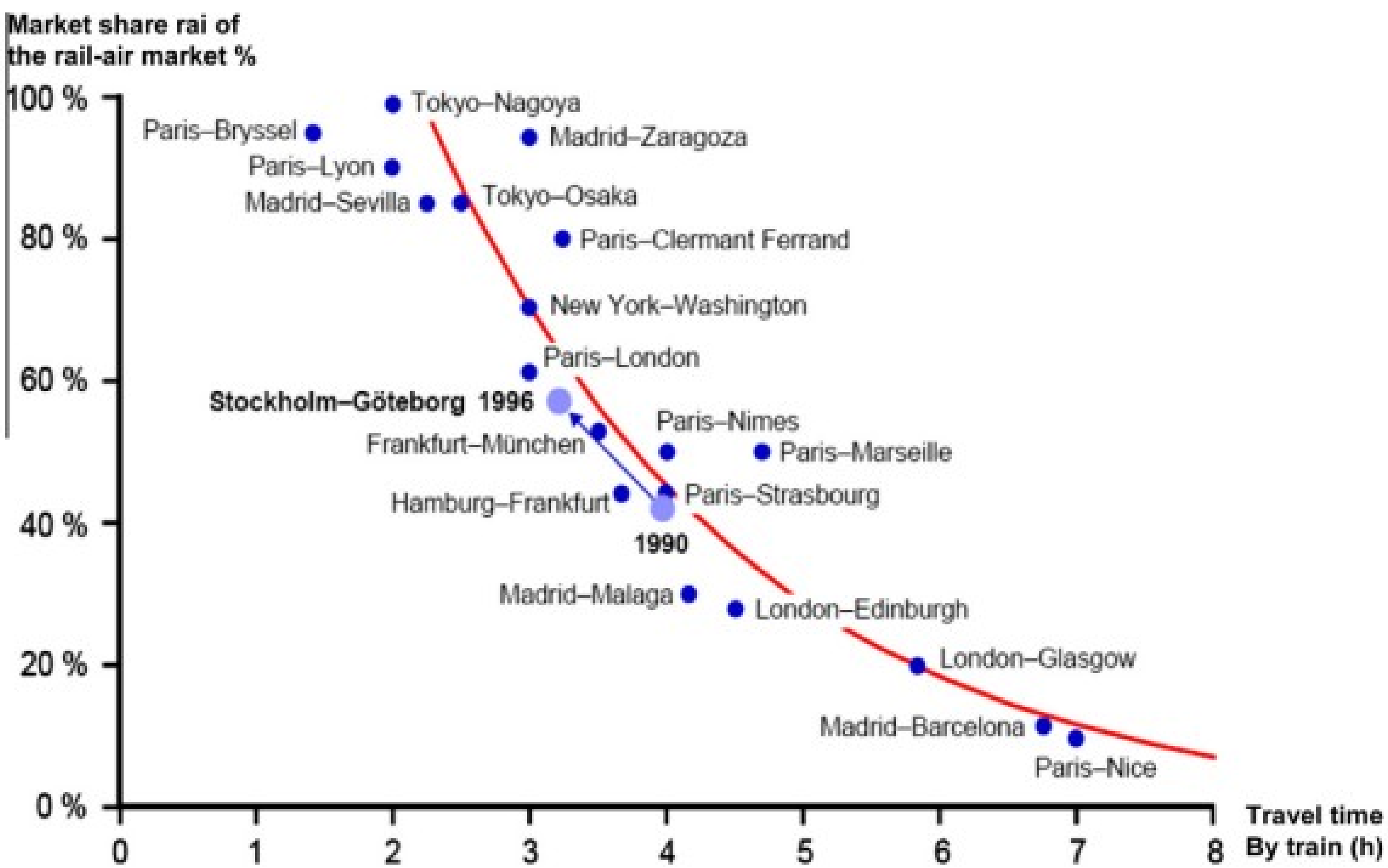
Summary

- It is sometimes argued that standard state-of-practice logit-based models cannot forecast the demand for **substantially reduced travel times**, for instance due to High Speed Rail (HSR).
- The present paper investigates this issue by **reviewing the literature** on travel time elasticities for long distance rail travel and comparing these with elasticities observed when new HSR lines have opened.
- This paper also **validates the Swedish long distance** model, Sampers, and its forecast demand for a proposed new HSR, Results indicate that the Sampers model is indeed able to predict the demand for HSR reasonably well.

Rail elasticities in the literature

Study	Elasticity	Comment
Model-based studies		
Román et al. (2010)	−0.4 (Madrid–Barcelona) −0.6 (Madrid–Zaragoza)	Cross-section RP/SP data. Spanish HSR corridors. In-vehicle travel time elasticity.
Cabanne (2003)[a]	0.3/0.45 −0.16 (air cross-elasticity)	Time series data models. Rail accessibility elasticity. French HSR corridor.
de Bok et al. (2010)	−0.6 (business) −0.5 (commute) −0.3 (other)	Average distance elasticity. Portugal. Cross-section RP data.
Rohr et al. (2010)	−0.9 (business) −0.4 (private)	Average distance elasticity. UK. Cross-section RP data.
Dargay (2010)	−0.49 to −3.04	Aggregate time series, UK. Different purposes and trip length segments.
Empirical studies		
Nash (2010)	−1.6 (Paris–Lyon, phase 1) −1.1 (Paris–Lyon, phase 2)	HSR line 1981–1983. In-vehicle travel time elasticity.
Sánchez-Borràs (2010)	−1.3 (Madrid–Barcelona)[b]	HSR line 2008. In-vehicle travel time elasticity.
Sánchez-Borràs (2010)	−1.2 (Madrid–Sevilla)[b]	HSR line 1992. In-vehicle travel time elasticity.

Estimated relationship between share of rail trips (air-rail mode split) and in-vehicle train travel time



HSR in Sweden

- The Swedish Transport Administration has used the Sampers long distance **model to forecast** the effects of a proposed HSR rail track in the Stockholm-Gothenburg corridor.
- The thick line on the map in Fig. 2 marks this **HSR track**
- The travel demand has been forecast in a **HSR scenario** and in a **baseline scenario**, the former with the new HSR investment and the latter without. Both scenarios refer to **year 2020**.
- In the baseline scenario the travel time of the X2000 trains is on average **3 h 5 min** and there are **18 return** trips a day. In the HSR scenario it is assumed that the travel time decreases to **2 h 14 min** and the frequency increases to **24 return** trips a day

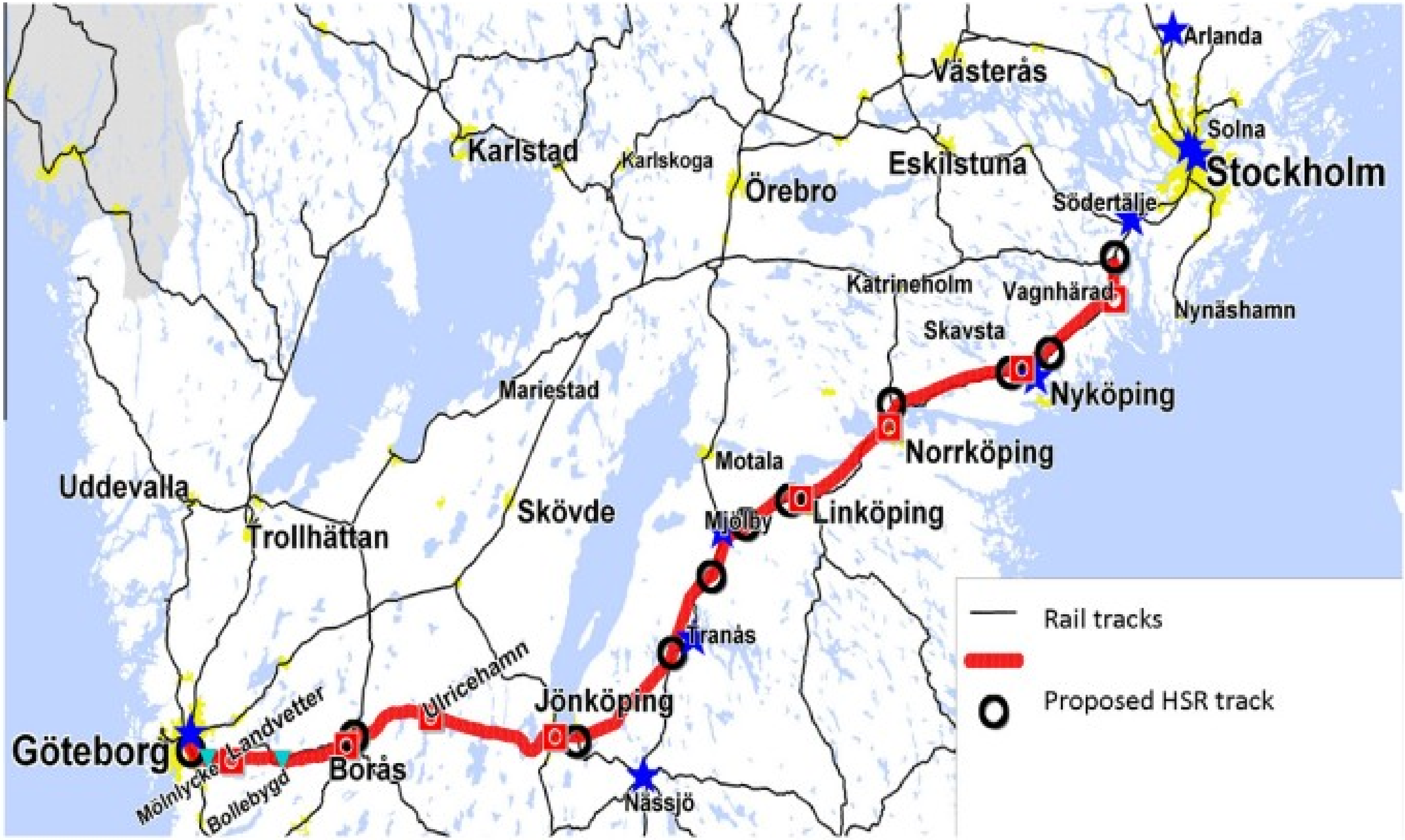


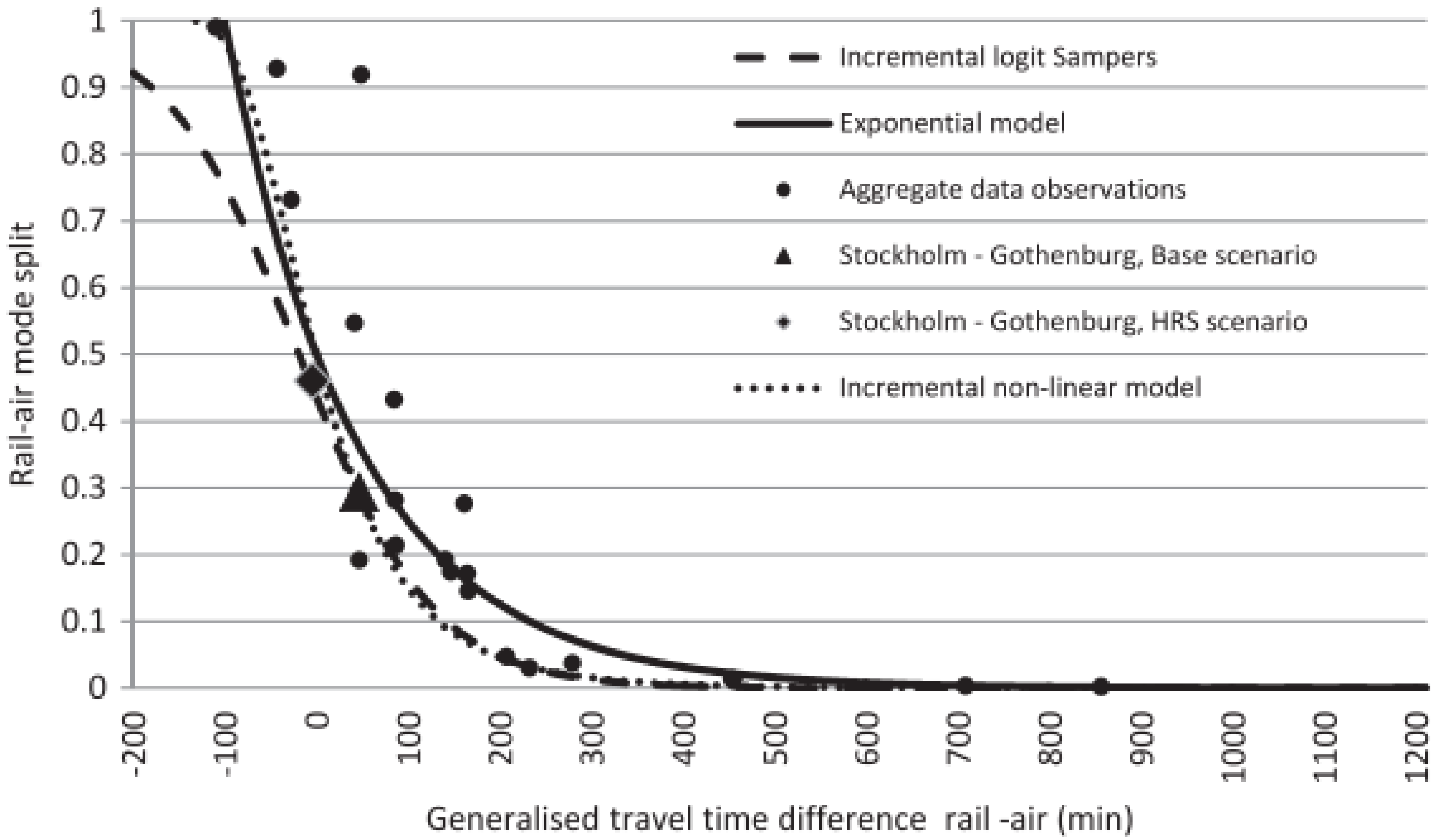
Fig. 2. The evaluated HSR rail track in the Stockholm–Gothenburg corridor.

Estimation: Total traffic and market shares

Base line and forecast scenario 2020.

	Rail			Air			Car			Coach		
	Priv	Bsn	Tot	Priv	Bsn	Tot	Priv	Bsn	Tot	Priv	Bsn	Tot
Million trips per year												
Baseline scenario	1.13	0.47	1.60	0.33	0.52	0.85	1.30	0.21	1.52	0.10	0.00	0.10
HSR	1.45	0.78	2.23	0.31	0.44	0.75	1.27	0.19	1.46	0.19	0.00	0.19
% change	29	67	40	−4	−16	−12	−3	−10	−4	−3	−11	−3
Market shares												
Baseline scenario	0.40	0.39	0.39	0.11	0.43	0.21	0.45	0.18	0.37	0.03	0.00	0.02
HSR scenario	0.46	0.55	0.49	0.10	0.40	0.17	0.40	0.18	0.32	0.03	0.00	0.02

Share for rail travel, as function of generalized travel time difference between air and rail, business trips



Conclusions

- In general, the **elasticities** of long-distance models estimated on cross-sectional data in the literature tend to be **lower** (in absolute terms) than the elasticities observed when new HSR lines has been opened, such as those in Madrid–Barcelona, Madrid–Seville and the first phase of the Paris–Lyon HSR line.
- The high observed elasticities, however, are likely a result of very **long initial rail travel times**, in particular in the Spanish corridors.
- The **own elasticity** of in-vehicle **travel time** on travel demand in response to a proposed HSR line in the Stockholm–Gothenburg corridor is **- 1.0 to - 1.15** in the non-linear model, which is similar to the second phase of the opening of the Paris–Lyon HSR line