4. TRANSPORT COSTS

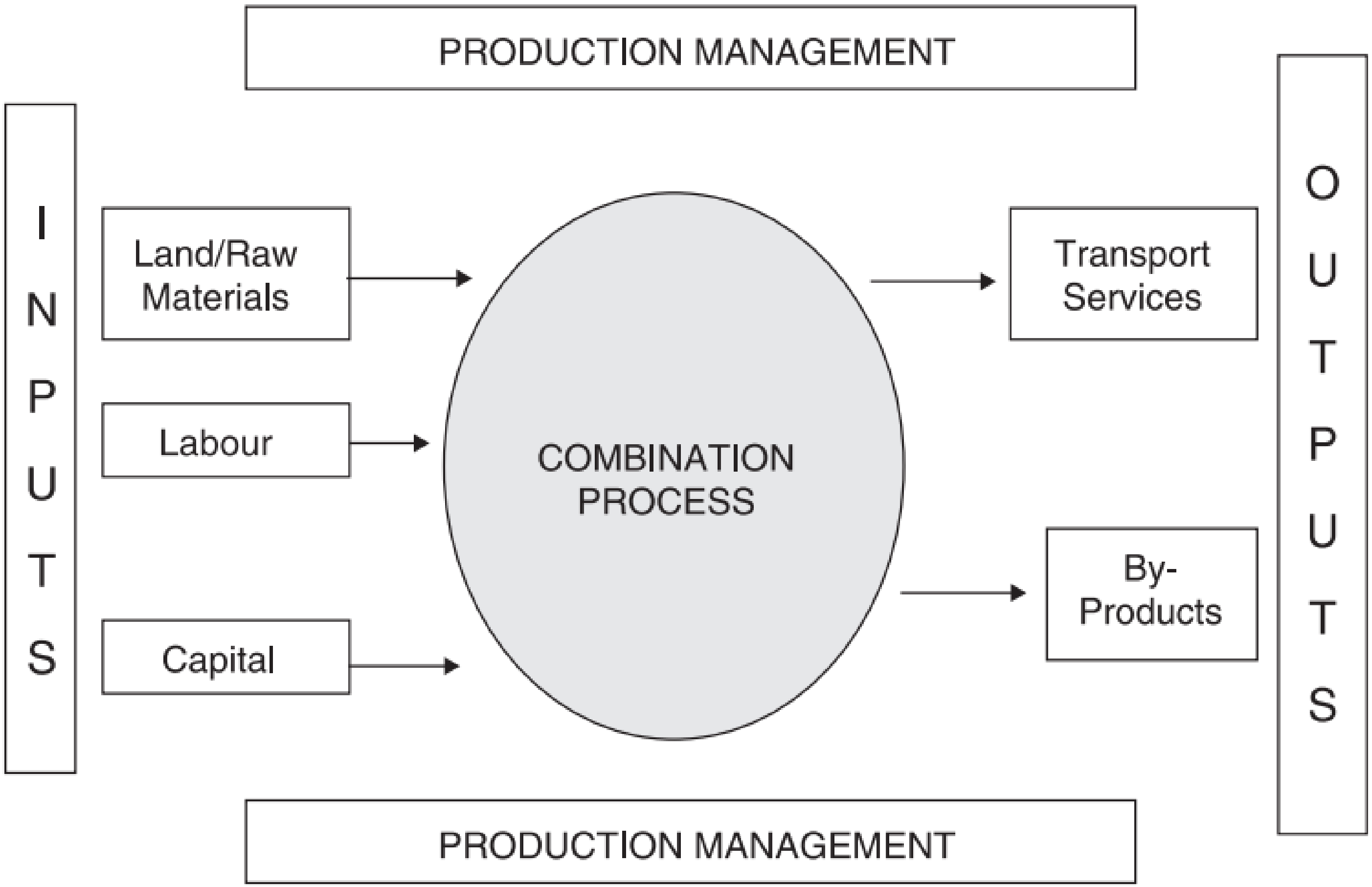
Introduction

- **Elasticity** of demand → major factor on the demand side
- **Cost** of production → major factor on the supply side
- **Generalized** cost (monetary + time costs) + External costs = Total costs

Public transport costs

- **Public transport** services are vital for modern societies and economies; however, they usually need to be subsidized (because of low revenues)
- However, it is crucial to keep **downward pressure** on the cost in order to provide more services or keep subsidies low; but this is difficult
- How are **costs incurred** in public transport? → usually large fixed costs and small marginal costs (when operating under less than full capacity)

Production process



Efficiency

- The **inputs/outputs ratio** is the main base for assessing whether a given operation can be described as efficient or not.
- **Measurement of efficiency** is very helpful in the assessment of the performance of (subsidized) public transport operators (whether they provide good service for taxpayer's money)
- It can be also utilized for **benchmarking**

Technical, cost and allocative efficiency

Technical efficiency = minimum level of inputs to produce maximum level of outputs

Cost efficiency = most cost efficient input minimization

Allocative efficiency = cost efficiency + right quantities

CASE STUDY IN RAIL EFFICIENCY

- This paper empirically explores the relationship between **competition design and efficiency** in the railway industry.
- It uses Data Envelopment Analysis (DEA) to construct **efficiency scores**, and explain these scores, using variables reflecting institutional factors and competition design.

Driessen, G., Lijesen, M., & Mulder, M. (2006). *The impact of competition on productive efficiency in European railways* (No. 71). CPB Netherlands Bureau for Economic Policy Analysis.

Outputs and inputs

Variable	Symbol	Unit of measurement	Mean
Outputs			
Passengers kilometres	Pkm	Billions of passenger kilometres	19.5
Freight kilometres	Fkm	Billions of gross-hauled tonne-kilometres	13.6
Inputs			
Input of labour	L	Annual average number of staff (x1000)	70.4
Tracks	T	Track length at the end of the year (km x 1000)	11.2
Input of capital	C	Annual average number of rolling stock (x 1000)	55.1

Efficiency scores

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Austria	0.80	0.80	0.77	0.76	0.80	0.83	0.83	0.87	0.90	0.91	1.00	1.00
Belgium	1.00	1.00	0.99	0.96	1.00	0.96	0.95	0.96	0.96	0.95	0.97	0.94
Denmark	0.87	0.87	0.89	0.89	0.87	0.87	0.87	0.92	0.91	1.00	1.00	.
Finland	0.77	0.74	0.76	0.84	0.90	0.91	0.89	0.96	0.97	0.97	1.00	1.00
France	0.77	0.74	0.70	0.72	0.75	0.72	0.80	0.84	0.89	0.93	0.98	1.00
Germany	0.80	0.82	0.75	0.72	0.77	0.76	0.76	0.88	0.92	0.93	1.00	1.00
Italy	0.93	0.94	0.93	0.89	0.93	0.97	0.97	0.97	0.93	0.94	1.00	1.00
Netherlands	0.89	0.96	0.97	0.97	0.95	1.00	0.97	0.96	0.99	0.98	1.00	1.00
Norway	0.76	0.81	0.80	0.81	0.81	0.83	0.89	0.87	0.94	1.00	0.95	1.00
Portugal	0.67	0.68	0.68	0.84	0.88	0.90	0.89	0.89	0.88	0.74	0.91	0.95
Spain	0.51	0.50	0.52	0.59	0.59	0.64	0.68	0.75	0.82	0.88	0.93	1.00
Sweden	0.86	0.85	0.96	0.96	1.00	1.00	1.00	0.92	0.98	1.00	.	.
Switzerland	0.59	0.61	0.58	0.58	0.63	0.65	0.64	0.71	0.74	0.81	0.87	0.93

Source: Driessen et al. (2006)

Efficiency determinants - data

Variable	Symbol	Description
Dummy variables		
Institutional (or full) separation	VERT1	If variable is 1, then infrastructure and services are institutionally separated; 0 if this is not the case.
Accounting (or partial) separation	VERT2	If variable is 1, then infrastructure and services are separated on an accounting basis; 0 if this is not the case
Free entry	ENTRY	If variable is 1, then legislation is transposed that allows free entry to competitors (either freight or passenger) and competition has evolved to a significant extent; 0 if this is not the case.[a]
Competitive tendering	TEND	If variable is 1, then competitive tendering is used to procure regional railway franchises; 0 if this is not the case.
Managerial independence from the government	INDP	If variable is 1, then legislation is transposed that assures independent management from the government of railway companies; 0, if this is not the case.[b]
Japan dummy	DUMJAP	If variable is 1, then country is Japan; 0, if this is not the case
Control variables		
Total area	AREA	Measured in 1000 square miles
Gross Domestic Product per capita	GDP	Measured in constant prices (2000) 1000 US dollars PPPs
Population density	POPDEN	Measured in population per square mile
Traffic structure	TSTRUC	measured by passenger kilometres / total traffic in kilometres
Traffic density	TDEN	Total traffic in kilometres (in millions) / total length of lines in kilometres

2006)

Efficiency determinants – results

Table 6.2 Tobit regression results

Model	(1) Europe			
Dependent variable				
DEA efficiency indices				
Independent variables	Coefficient estimate	(Standard error)		Marginal effect
CONSTANT	0.5827	(0.0493)	***	0.4643
VERT1	0.0447	(0.0231)	*	0.0356
VERT2	0.0225	(0.0213)		0.0179
ENTRY	− 0.0812	(0.0311)	***	− 0.0647
TEND	0.0826	(0.0346)	**	0.0658
INDP	− 0.0691	(0.0181)	***	− 0.0551
TIME	0.0211	(0.0033)	***	0.0168
AREA	0.0002	(0.0001)		0.0002
POPDEN	-7.75×10^{-5}	(5.45×10^{-5})		-6.18×10^{-5}
GDP	0.0016	(0.0014)		0.0013
TDEN	0.0776	(0.0118)	***	0.0618
TSTRUC	− 0.1331	(0.0481)	***	− 0.1061
DUMJAP				

Source: Driessen et al. (2006)

Conclusions

- The results suggest that competitive **tendering improves** productive efficiency, which is in line with economic intuition as well as with expectations.
- They also found that **free entry lowers** productive efficiency. A possible explanation is that free entry may disable railway operators to reap economies of density.
- The final result is that **more autonomy** of management **lowers** productive efficiency. Most of the incumbent railway companies are state owned and do not face any competitive pressure. As a consequence, increased independence without sufficient competition and adequate regulation may deteriorate incentives for productive efficiency.

COSTS IN THE SHORT RUN

Short run – level of capital fixed

- In the short run at least **one factor** of production is **fixed** (we assume capital)
- In the short run, a discussion of **returns to scale is not relevant**, since all inputs cannot change in the same proportion.
- Adding more workers to a fixed amount of capital reduces MP_L = **law of diminishing returns.**

Passenger x Freight

- **Production**: Inputs (vehicles, drivers, power); Output (vehicle-km)
- **Passenger x freight** → passengers load and unload by themselves!

 - Are passenger services more **efficient**?

- Are there any **complementarities** in producing together passenger and freight? (air, rail)
- Freight rail need **1.45** higher labour component in comparison with passenger rail (Nash, 1985)

Case: Mode cost comparison

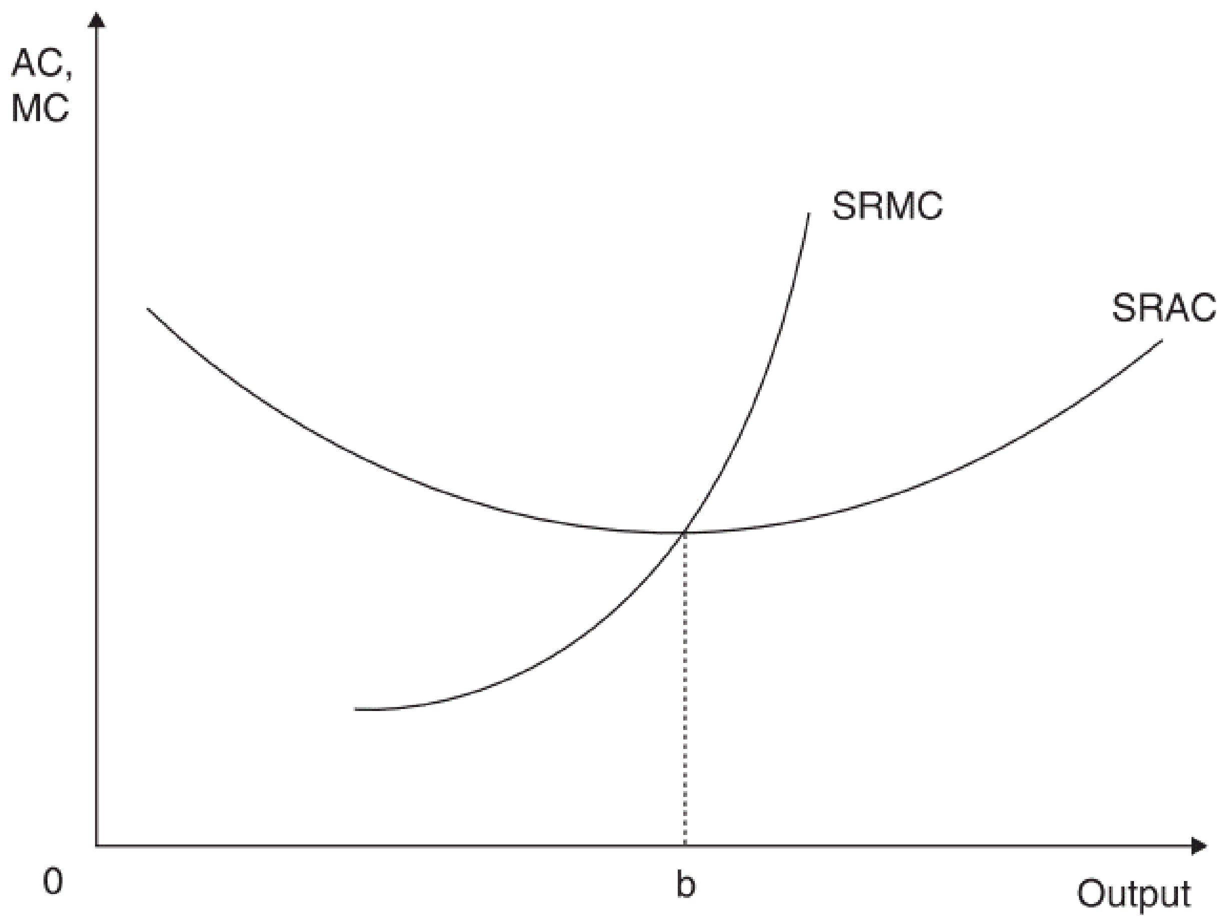
Modal comparisons

- **Labour intensive** industries: parcel and bus operations;
- **Capital intensive** industries: railways, ferries and airlines
- **High fuel** costs: bus, airline
- **High fixed** costs: railways;
- **Low fixed** costs: parcels, bus

Market structure

- The division between **fixed and variable** costs has major implications on the structure of the market
- High level of FC together with capital intensive production would suggest **large firms**, which would act against market entry and competition in the market
- On the other hand, on more labour intensive industries such as bus and parcel operations, **competition** in the market should be both achievable and sustainable

Short run average and marginal costs



Case: The importance of AC in the business model of low cost airlines

- The importance of AC is highlighted in this case study that looks at the **operational characteristics** of low cost airlines
- Their business model is based on achieving low AC; not only by cutting costs but also **by other measures**
- **Before** deregulation of US (1978) and EU (1990) of air markets, there was **restricted capacity** on routes and **regulated price** and market was dominated by national operators
- After deregulation, many low cost operators entered the market (Ryanair and many others…) – it is important to achieve **low AC, not just low cost**

Low average cost model

- Low **staff** costs
- Low aircraft **turnaround** times
- Route networks based on **secondary** airports
- **On-line** ticket sales
- Cabin crew perform **other** duties
- **Point** to point operations (no hub and spoke)
- All **extras** for a charge
- No **spare** aircraft capacity in reserve
- Fleet based on a **single** aircraft type

Operational costs

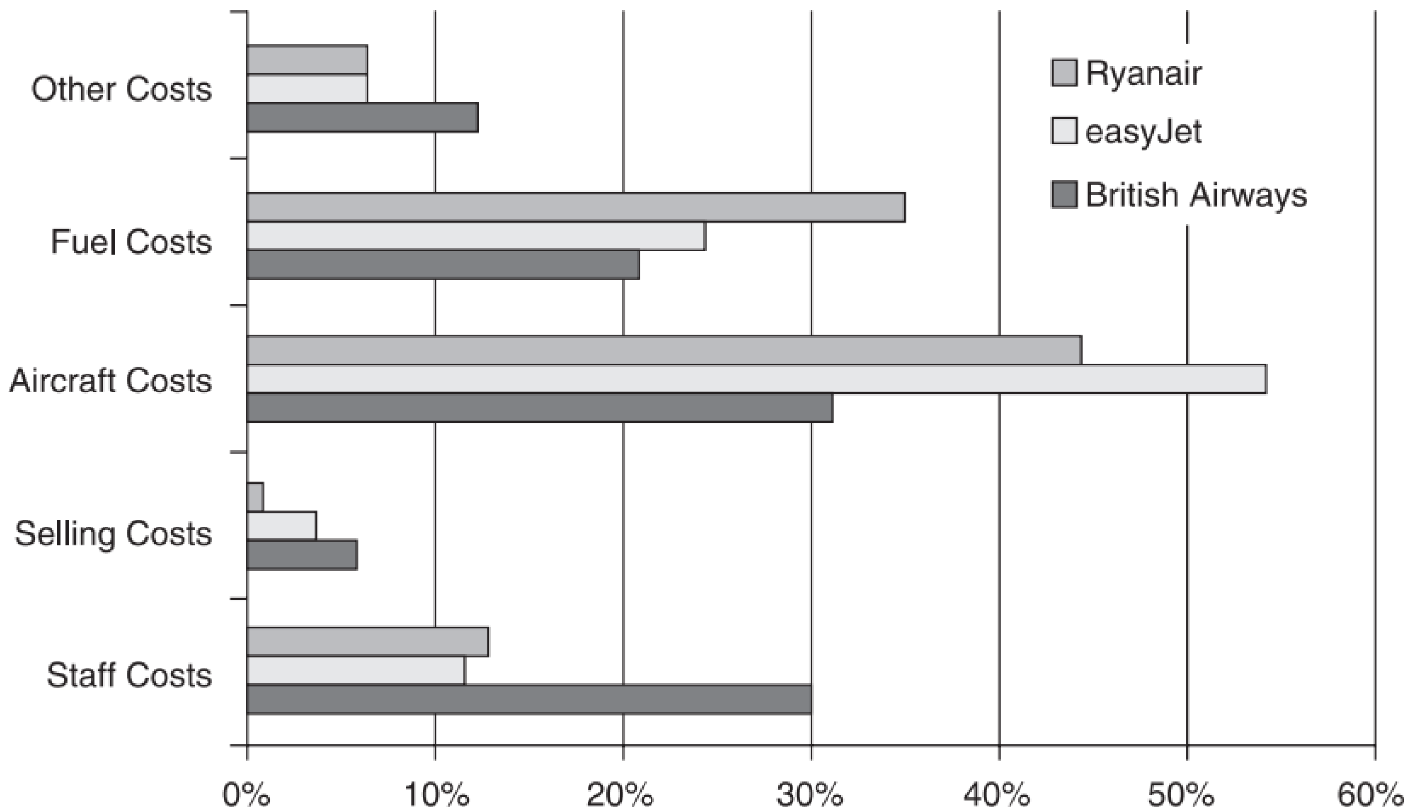


Figure 5.5 *Percentage breakdown, operating costs, British Airways, easyJet and Ryanair, 2006*

National x low cost operators

- **National** operators have higher share of labour and selling costs.
- When **labour is salaried**, then in the SR it is more FC than VC. The share of VC is around 50% for BA but about 70% for LCA
- Variable cost vary with output, however fixed costs do not. The key to success is **high utilization of fixed assets** (costs) – aircraft, crew

Conclusion – LCA business model

- The key is to achieve **high utilization** of pilots, crew and aircrafts – to achieve low AC
- LCA changed the **economics** of airline operations. Traditional thinking used to be that it is an industry with a high proportion of capital costs and a relatively low level of variable costs
- Under regulation, operators limited supply as this increased profits. In the LCA model, profits are maximized through **low profit margins** and **high passenger volumes**

COSTS IN THE LONG RUN

Economies of scale

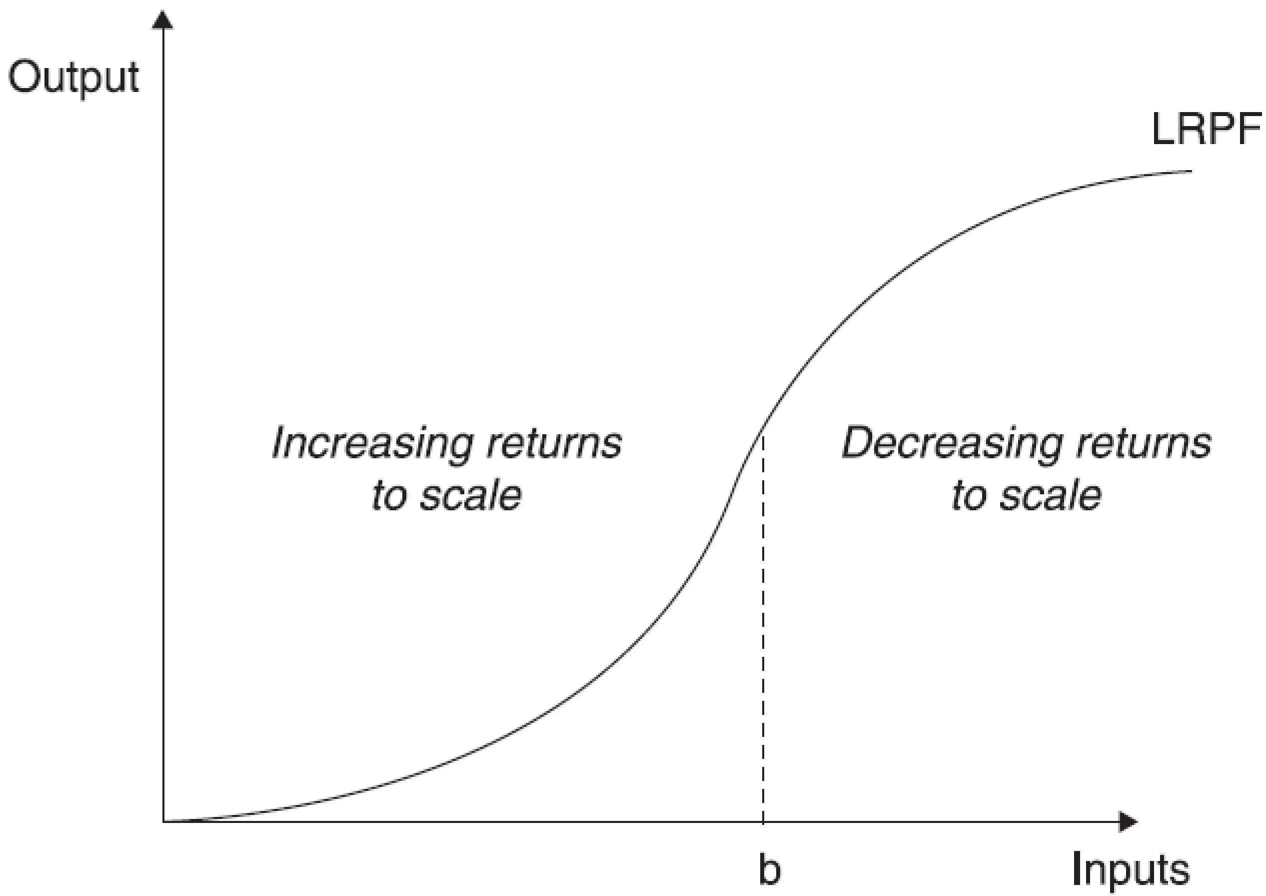


Figure 5.6 *The long run production function*

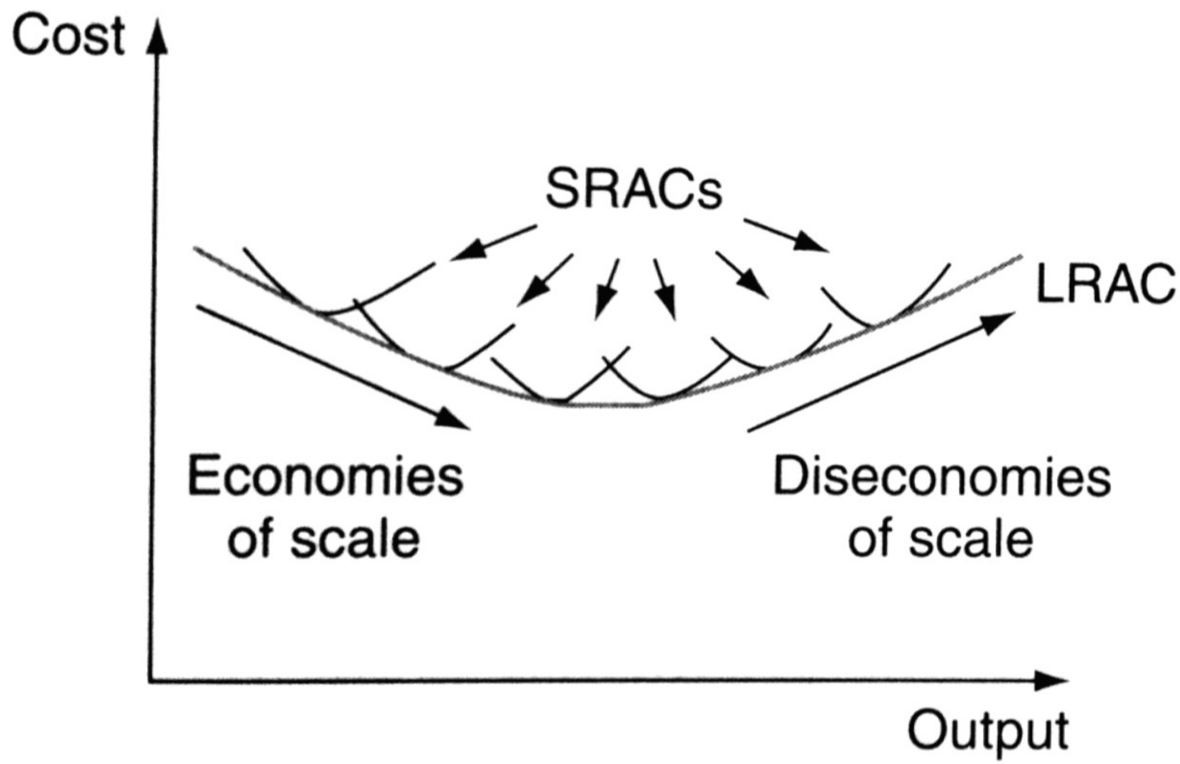
Sources of increasing returns to scale

- **Specialization of labour** → larger firm allow more specialization of the workforce
- **Scheduling** of inputs → larger firms have greater flexibility in the combination of inputs
- **Capital** input → expensive capital purchases, specialization
- **Indivisibilities** → investment needs come when the operation is close to capacity

Sources of decreasing returns to scale

- **Loss of control** → as firm size increases, there is a loss of control over the whole organization; the emergence of X-inefficiency
- **Geographical location** → when firm moves out of optimal location, the costs will increase
- **Administration** procedures → large firms need middle and upper management; the emergence of bureaucracy; the longer time for decision-making

SR and LR average cost curves



Minimum efficiency size

- The average costs fall firstly with firm size, then they reach minimum at the optimal level of production, known as **minimum efficiency size (MES)**
- The firm has higher production **flexibility** in SR than in LR
- The optimalization in transport is **complicated** by the demand peaks and natural monopoly elements

Case: Economies of scale and reform in railway operations

- The general view of economies of scale within the rail industry **used to be** that, due to a high capital requirements, **economies of scale are significant** and hence company size needs to be large in order to capture them
- In the past this was one of the main reasons which led to **nationalization** of railway industries across Europe (CH: 1901 – UK: 1948)

Vertical separation

- However, in the last 30 years **a new approach** has emerged. It argues that economies of scale are associated with the **infrastructure only** and not with services
- Therefore the solution is to **separate infrastructure from services**, to keep a monopolistic provider of infrastructure and to allow competition in the provision of rail services
- **Vertical separation** (SE, UK, CZ) x **Holding structure** (DE, FR, AT)

Empirical evidence

- **Preston** (1994, 1999) in a study of 15 (integrated) Western railways found diseconomies of scale for larger rail systems (W. Germany and UK) and increasing returns for smaller systems (Ireland, Switzerland). **Optimal size**: Danish or Belgian rail network
- **Implication**: Germany and UK should divide their systems into three or four smaller integrated networks
- **Swiss** private rail network would benefit from mergers

Does vertical separation work?

- The impact of vertical **separation** on the **efficiency** of rail operations is not clear from empirical studies (competition entry x loss of coordination)
- Are there really **no economies** of scale in the provision of rail services?
- Even if they are, the **dynamic entry** of low cost rail operators (RegioJet, Quigo) may overrun scale considerations

Economies of scale, density and scope

- If an equal proportionate increase in all outputs and route kilometers leads to the same proportionate increase in costs → **constant returns to scale**
- If an equal proportionate increase in all outputs holding route kilometers constant leads to the same proportionate increase in costs → **constant returns to density**
- If splitting the production of passenger and freight outputs and of infrastructure leads to increased costs → the railway is said to experience **economies of scope**

Nash, C. (2011). Competition and regulation in rail transport. *Handbook of Transport Economics.*

Empirical update

Current empirical studies state that:

- **Competition entries** increase efficiency
- **Economies of scale** in operation are small to negligible
- **Economies of scope** were (vertical integration) not identified
- **Economies of density** are strong

Exercises (1)

1. Identify reasons why airlines would want to take over other airlines.
2. Critically evaluate the following statement: “All constraints on behaviour are costly, which explains why the short-run total cost curve lies above the long-run total cost curve.”

Exercise (2)

1. Fuel costs are important inputs to any transportation activity. Suppose that real energy prices rise. Graphically depict the impact that this would have upon a firm’s total short-run and long-run cost structure.
2. Would you expect a firm’s long-run response to a fall in energy to be greater, less, or equal to its short-run response to a fall in energy prices?
3. What does this suggest about the firm’s short-run input price elasticity of fuel relative to its long-run input price elasticity of fuel?

Exercise (3)

The July 7, 1993 *Wall Street Journal* provides the following information: “Northwest Airlines averted – at least for now – a threatened federal bankruptcy-law filling after its pilots’ union agreed to a last-minute pact to save the carrier 365 USD million over three years.” Using Northwest’s short-run cost curves, depict where Northwest was operating before and after the agreement with the pilots’ union.

Exercise (4)

Suppose that you are given the following information on All Around Airlines:

- The average variable cost of producing airline trips varies between 11.5 cents a mile when 50,000 trips per year are produced and 16.7 cents per mile when 500,000 trips per year are produced. Its lowest value is 11.5 cents a mile when 250,000 trips are produced.
- The average total cost of producing trips varies between 15.3 cents per mile when 250,000 trips are produced and 17.3 cents per mile when 500,000 trips are produced. The minimum short-run average total cost is 13.0 cents when 300,000 trips are produced.

Questions:

- – Approximately, how many trips will be produced in the short run if the fare is 15.4 cents per mile?
- – Will any trips be produced if the fare is 12.1 cents per mile? If so, why; and if not, why not?
- – Will any trips be produced if the fare is 10 cents per mile? If so, why; and if not, why not?

Exercise (5)

Exercise 5.1 Technical, cost and allocative efficiency in bus operations

The following table gives some basic information relating to two small-scale bus operators:

	Company A	*Company B*
Number of buses:	3	5
Number of employees:	13	21
Average wage:	19000	16000
Vehicle kilometres run:	210000	300000
Bus cost per kilometre (including fuel costs):	0.36	0.30
Annual number of passengers carried:	370000	460000

a) Consider the following questions:

- i Which of the two companies is more technically efficient in the production of bus services (note: you will need to separately calculate labour productivity and bus productivity and compare the two figures)?
- ii Which of the two companies is more cost efficient in the production of bus services?
- iii Which of the two companies is more allocatively efficient?

Exercise (6)

Economies of scale in railway operations

- List what you believe to be the main sources of economies of scale in the rail industry. Once you have produced this list, indicate which arise as a result of returns to scale and which are cost savings.
- What on the other hand do you believe are the main sources of diseconomies of scale in larger integrated railways?
- If you were a rail industry regulator in Britain today, what other factors apart from economies of scale would you take into account when deciding on the number of operators to have in the market?

Exercise (7)

In 1968, Keeler (1971) identified the per seat-mile costs (shown in table 5.14) associated with four major intercity modes of travel: rail, air, automobile, and intercity bus.

Table 5.14 Intercity modal costs, 1968

Mode	Cost Per Seat-Mile (cents)
Intercity Bus (200-mile trip)	1.44
Air (Lockheed 1,011, 256-seat configuration, 250-mile trip)	3.00
Automobile (two occupants)	4.5
Rail (three-car train seating 240 passengers)	1.5

Source: Reprinted from Keeler (1971), table 7, p. 160,

What does this table tell us about the cost competitiveness of rail in comparison with the other three intercity modes?

Exercise (8)

Consider the following sets of statistics for 1990:

Intercity modal costs

Mode	Per-Mile Cost	Average Length of Trip
Certificated Air Carrier	13.02	803
Rail	12.85	274
Intercity Bus	11.55	141
Automobile	13.33*	115*

* Per mile costs of operating vehicle occupant: assumes 1.62 occupants per vehicle in 1990. Average Length of Trip for automobile is based upon intercity vacation trips.

Based upon this information, can you conclude that rail trips are competitive with air trips? How about intercity bus and automobile trips? Use the concept of economies of distance to argue that rail trips *will be more competitive* with shorter-haul air trips, but *will be less competitive* with longer-haul intercity bus and auto trips.