

Economies of Scale, Scope, and Density

EE382

Economies of scale

- Represents the behavior of costs with a change in output when all factors are allowed to vary
- If cost increases less than proportionately with output, the cost function is said to exhibit economies of scale,
- If costs and output increase in the same proportion, there are said to be constant returns to scale
- If costs increases more than proportionately with output, there are diseconomies of scale

Economies of scale

- Declining long run average cost as output increases

- $LRMC < LRAC$ Increasing Economies of scale
- $LRMC = LRAC$ Constant Economies of Scale
- $LRMC > LRAC$ Decreasing Economies of scale

Economies of scope

- Declining average cost as network size increases
- Exists where there are cost economies from multi-product production
- As a producer organizes its services over a greater number of routes and centers, it is likely to see, ceteris paribus, its long run average cost fall. This is because it is more able to engage in transshipment (also known as consignment consolidation), where by it divides the journeys it makes into segments, merging as many of those segments as it can

For example

- Let us assume that a freight company is offering three transport services terminating in city A, but originating in cities B, C, and D (the origin cities)
 - Option 1: Three completely separate vehicles to make three completely separate journeys
 - Option 2: Three completely separate journeys from the origin cities to a fourth city (E) lying between the origin cities and city A. Once all three delivers are made to city E, the cargo can be loaded onto a separate (larger) vehicle, which then makes a single journey to city A

- The provider has to purchase a fourth (larger) vehicle to implement this strategy, thereby facing greater fixed costs
- However, over time this investment will be more than recouped through lower variable costs generated by greater load-factors on its vehicles
- The greater the proportion of the total distance travelled accounted for by the amalgamated service, the greater the variable cost savings

Economies of scope are assessed when:

$$S = \{[C(Q^1) + C(Q^2) - C(Q^1 + Q^2)] / \{C(Q^1 + Q^2)\}$$

where:

$C(Q^1)$ is the cost producing Q^1 units of output one alone;

$C(Q^2)$ is the cost producing Q^2 units of output two alone; and

$C(Q^1 + Q^2)$ is the cost producing Q^1 plus Q^2 units of together

Economies of scope exist if $S > 0$

There are economies of scale if $\frac{C}{Q}$ falls as Q expands

- Benefits of economies of scope are likely to diminish as the degree of transshipment increases
 - Greater transshipment necessarily requires more frequent loading and unloading of vehicles, increasingly offsetting the reductions in long run average cost
 - Greater transshipment entails the use of increasingly circuitous routes, offsetting the reductions in long run average cost
 - Greater transshipment increases the time costs that consumers have to bear - less frequent services as the products or passengers are increasingly required to remain at operation centers until the full load for the next stage of the journey has arrived and is loaded onto the vehicle

- External limits to the degree of transshipment that is possible
 - Legal- legislation stipulating the maximum loads allowed in vehicles, potentially constraining the degree of transshipment possible
 - Physical - limits to the size of vehicles imposed by the available infrastructure: the width of roads, the height of bridges and the length of runways

Economies of density

- Larger markets enable higher load factors to be enjoyed and hence lower unit cost per passenger
- Average cost are reduced as existing capital is used more intensively

Example - Aviation

- There are cost economies from serving larger markets
- Effectively allows the more intensive use of capital

Economies of density

- Density economies are said to exist when a one percent increase in all outputs, **holding network size, production technology, and input prices constant**, increase the firm's cost by less than one percent
- In contrast, scale economies exist when a one percent increase in output and size of network increases the cost by less than one percent, **with production technology and input prices held constant**

- The presence of density economies can affect the introduction of efficient pricing in the **short term**, but generally **not over the long term** since at some point density economies will be exhausted
- In the air market, for example, deregulation has allowed carriers to respond to market forces and obtain the available density economies to varying degrees.

- Returns to Density (RTD) similar to returns to a capacity utilization when **capacity is fixed in the short run**.
- Since the plant size (network size for the case of transportation firms) is largely fixed in the short run, RTD measures the behavior of cost when increasing traffic level (output) given the plant size (network size)

- $SRMC < SRAC$ Increasing EOD
- $SRMC = SRAC$ Constant EOD
- $SRMC > SRAC$ Decreasing EOD

Because of the presence of high fixed costs and cost of operating terminals (airport, station, depots), most transportation firms have increasing RTD

- The coming together of economies of scope and density has been characterized by the adoption of 'hub-and-spoke' operations

Hub-and-spoke operations

US domestic aviation

- All main airlines basing their services on radial flights from a limited number of hubs

Shipping

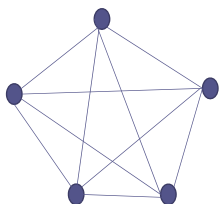
- Traffic into Europe coming by large ships to a small number of large ports to be distributed to other ports by small vessels

Bus

- Victoria Coach Station in London as the hub for long distance intercity bus services in the United Kingdom

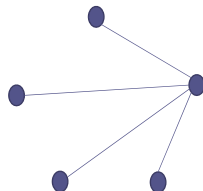
Point-to-point versus hub-and-spoke networks

Point-to-point network



10 different routes

hub-and-spoke network



4 different routes

Cost advantages of hub-and-spoke operations

- With direct services between each city pair there would need to be 10 services provided, and many of these may be relatively thin with limited traffic
- Hub-and-Spoke
 - Traffic is hubbed through one of the cities with passengers being consolidated at this hub to go on to their final destinations, then only four services are required
- This allows larger aircraft to be used, and potentially higher load factors enjoyed, thus reducing costs and fares

The 'dog-bone' pattern of international hub-and-spoke operations



Network competition in the air cargo sector



Reference

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- Button, K. (2010). Transport Economics. 3rd ed. Edward Elgar Publishing Ltd.