Transportation system & organizations

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Example 2.1
Selecting a Transportation Mode

An individual is planning to take a trip between the downtown area of two cities, A and B, which are 650 km apart. There are three options available:

Travel by air. This trip will involve driving to the airport near city A, parking, waiting at the terminal, flying to airport B, walking to a taxi stand, and taking a taxi to the final destination.

Travel by auto. This trip will involve driving 650 km through several congested areas, parking in the downtown area, and walking to the final destination.

Travel by rail. This trip will involve taking a cab to the railroad station in city A, a direct rail connection to the downtown area in city B, and a short walk to the final destination.

Since this is a business trip, the person making the trip is willing to pay up to $25 for each hour of travel time reduced by a competing mode. (For example, if one mode is two hours faster than another, the traveler is willing to pay $50 more to use the faster mode.) After examining all direct costs involved in making the trip by air, auto, or rail (including parking, fuel, fares, tips, and taxi charges) the traveler concludes that the trip by air will cost $250 with a total travel time of five hours, the trip by auto will cost $200 with a total travel time of eight hours and the trip by rail will cost $150 with a total travel time of 12 hours. Which mode is selected based on travel time and cost factors alone? What other factors might be considered by the traveler in making a final selection?

Air : 250 + 25(5) = 375 $

Auto : 200 + 25(8) = 400 $

Rail : 150 + 25(12) = 450 $

Select Mode by Air

Solution:

Safety. While each of these modes is safe, the traveler may feel "safer" in one mode than another. For example, rail may be preferred because of concerns regarding air safety issues.

Reliability. If it is very important to attend the meeting, mode selection based on highest probability of an on-time arrival.

If the drive involves travel through work zones and heavily congested areas, rail or air would be preferred.

Convenience. The number of departures and arrivals provided by each mode could be a factor. For example, if the railroad provides only two trains/day and the airline has six flights/day, the traveler may prefer to go by air.

Interaction of Supply and Demand

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Transportation system is the product of two factors that act on each other:

- State of economy (produces demand)
- Extent and quality of the current system (constitutes the supply)

Example: High unemployment and/or rising fuel costs lead to decrease in transportation

New mode with low cost attracts more demand

Interaction of Supply and Demand

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- Figure 2.1 shows how demand in terms of traffic volume could vary with cost:

if the transportation cost per km, C, decreases, then, since more people will use it at a lower cost

Demand

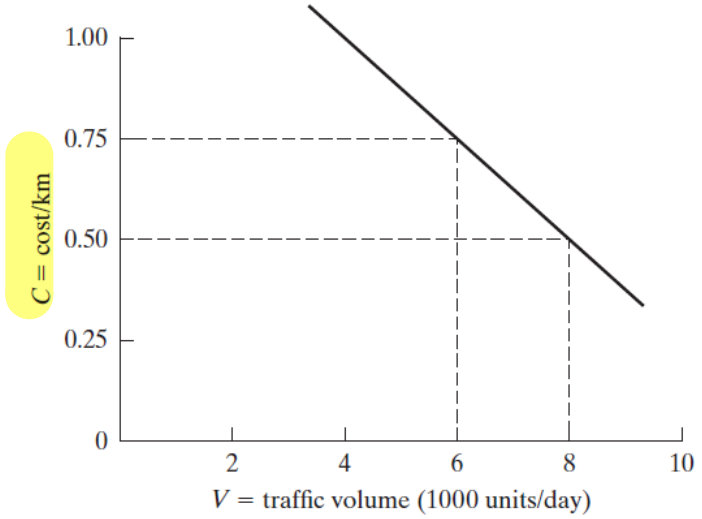

Figure 2.1 Relationship between Transportation Demand and Cost

Interaction of Supply and Demand

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- The Figure 2.3 shows how the total cost of transportation system could increase as the traffic volume increases:

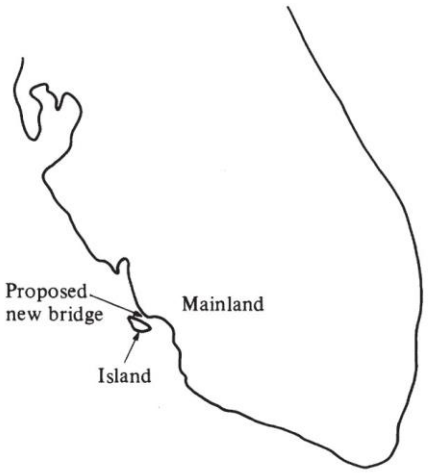

Figure 2.2 Location of a New Bridge between the Mainland and an Island

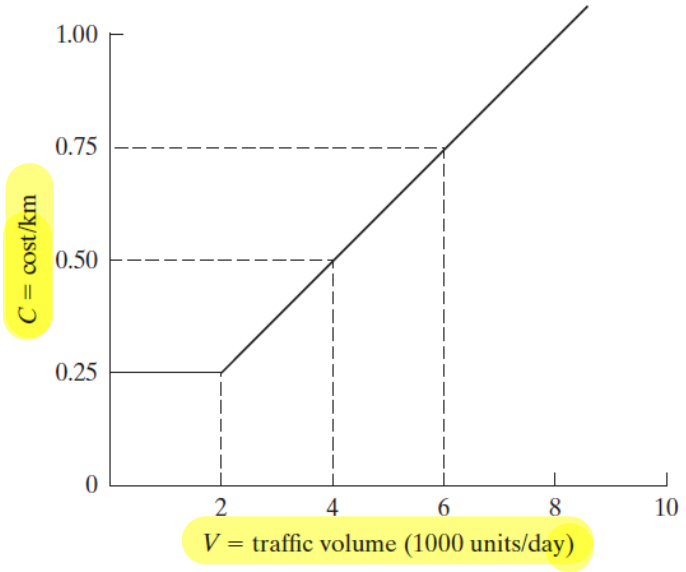

Figure 2.3 Relationship between Transportation Supply and Cost

Interaction of Supply and Demand

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- The two curves (2.1 and 2.3) determine what volume (V) can be expected for a transportation system
- The figure below shows the equilibrium point V. Going beyond this point would make the cost go up and the demand drop
- Likewise, if V dropped below equilibrium, the cost goes down and demand increases

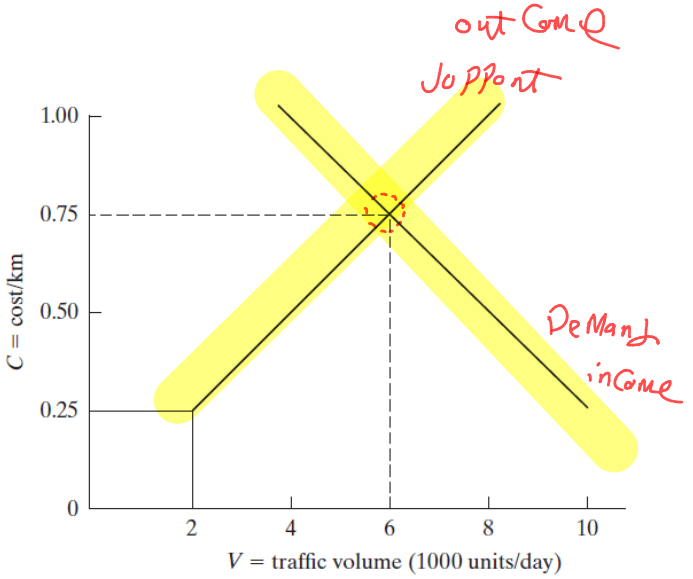

Figure 2.4 Equilibrium Volume for Traffic Crossing a Bridge

Interaction of Supply and Demand

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Supply vs cost curve: as volume increases total cost per km will increase. Total cost includes cost for waiting time and toll

Point of intersection of both lines- equilibrium point

Demand vs cost curve: as cost per km will decrease, volume will increases

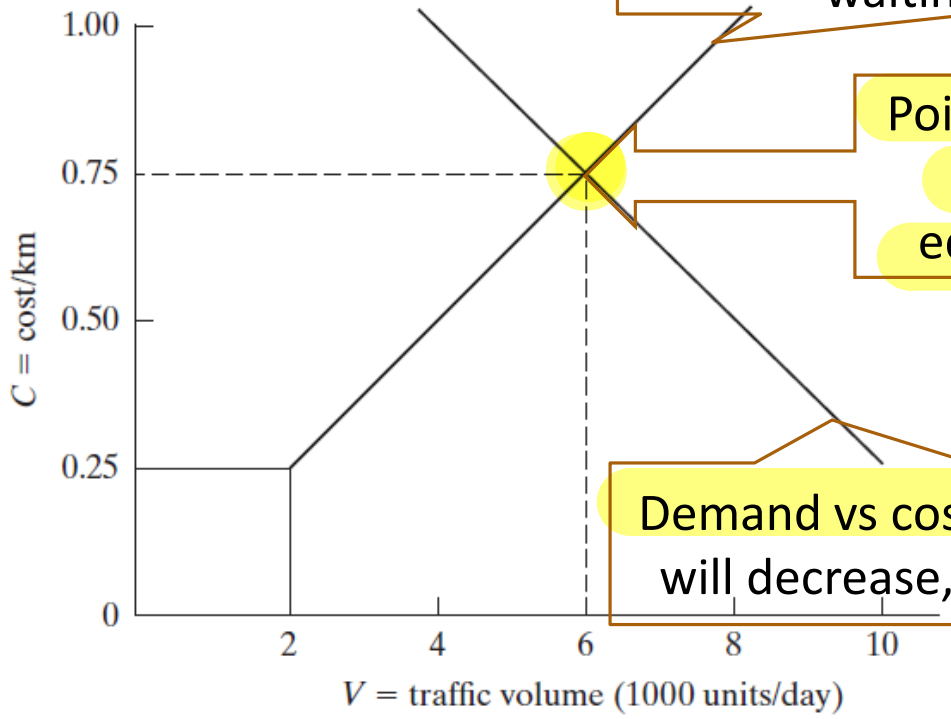

Figure 2.4 Equilibrium Volume for Traffic Crossing a Bridge

Example: Demand vs supply curve

You can also see these curves in case you start a new bus service in campus,

1. when demand is low, cost of running this system is high. As more students use, cost per student will reduce.

2. on supply side, for low demand, you will provide less buses so cost will be low. As number of students will increase cost required to run the system will also increase

In transport, we balance demand and supply and get point of intersection so at this point both sides will be satisfied.

Forces That Change the Transportation System

The equilibrium explained above is the result of:

- ✓ Market forces (state of economy, competition, costs, prices of service)
- ✓ Government actions (regulation, subsidy, promotion)
- ✓ Transportation technology (speed, capacity, range, reliability)

Transportation system changes as these forces shift over time

Example 2.2 Using a Supply-Demand Curve to Compute the Bridge Cost/Vehicle (Toll) That Will Maximize Total Revenue

A toll bridge carries 5000 veh/day. The current cost (toll) is 150 cents. When the cost (toll) is increased by 25 cents, traffic volume decreases by 500 veh/day. Determine the cost/veh (new toll) that should be charged such that revenue is maximized. How much additional revenue will be received?

5000 veh/day — 150 cents — $x = 0$

4500 veh/day — 175 cents — $x = 25$

V — x

$V = ax + b$

slope — y-intercept

$$\text{Slope } (a) = \frac{\Delta V}{\Delta x} = \frac{4500 - 5000}{25 - 0} = \frac{-500}{25}$$

$$= -20$$

$V = -20x + b$

$4500 = -20(25) + b$ $\Rightarrow b = 5000$

$V = -20x + 5000$

new Cost/vehicle $= T = 150 + x$

$R = V T$

$= (-20x + 5000)(150 + x)$

$R = -3000x - 20x^2 + 750000 + 5000x$

$R = 750000 + 2000x - 20x^2$

$\frac{dR}{dx} = 2000 - 40x = 0$

$x = \frac{2000}{40} = 50$ cents

New toll $= T_{Max} = 150 + 50 = 200$

$V_{Max} = -20(50) + 5000 = 4000$

$AR = V_{Max} T_{Max} - V_{Current} T_{Current}$

$= 4000 * 200/100 - 5000 * 150/100$

$= 500\ \$$

2-6

A large manufacturer uses two factors to decide whether to use truck or rail for movement of its products to market: cost and total travel time. The manufacturer uses a utility formula that rates each mode. The formula is $U = 6C + 14T$, where C is cost ($/tonne) and T is time (hrs). For a given shipment of goods, a trucking firm can deliver in 12 hrs and charges $30/tonne, whereas a railroad charges $22/tonne and can deliver in 16 hrs.

(a) Which mode should the shipper select?

(b) What other factors should the shipper take into account in making a decision? (Discuss at least two.)

(a)

$U_{truck} = 6(30) + 14(12)$

$= 348$

$U_{Rail} = 6(22) + 14(16)$

$= 356$

The shipper should ship his goods by truck

$U_{truck} < U_{rail}$

(b)

1. *Reliability:* Does the mode consistently operate on schedule?
2. *Convenience:* Which mode can deliver the freight to a serviceable location?
3. *Security:* Which mode reduces the risk of pilfering.
4. *Rideability:* Which mode provides the best ride for the product? In other words, which mode is less likely to cause damage to the product while in transit?

$U = 6C + 14T$

Truck

$h = 12$ hrs

$C = 30$ $/tonne

rail

$h = 16$ hrs

$C = 22$ $/tone