CE 430
Transportation Systems

Tutorial #1

(Ch.5: Transportation modes)

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The cost function of a large railroad corporation is $Y = 10^7 + 0.5T$, where Y is the total cost of shipping in US dollars and T is the tons shipped. Last year the company charged on average 88₡ for each ton of freight. Their annual shipments total 48 million tons. This year they are considering geographical expansion through the purchase of a smaller railroad corporation that last year shipped total of 21 million tons. Economists estimated that the total cost of function (for the merged corporation) will be $Y = 10.5^7 + 03.T$, while 10% more freight should be expected due to the better geographic coverage, at a price discounted by 8₡.

Show that the large and the merged railroad realize substantial economies of scale (EOS). Which railroad realizes greater EOS? Use a numerical example or a graphic for proof. Show numerically that the large railroad should merge with the smaller one.

	Large railroad corp.	Merged corp.
Cost function (Y)	**$Y=10^7+0.5\ T$**	**$Y=10.5^7+0.3\ T$**
Unit revenue	**88 ₡/ton**	**= 88 - 8 = 80 ₡/ton**
Total Shipment (T)	**$48x10^6$ ton**	**$1.1x10^6(48+21)$ $=75.9x10^6$ ton**
Total cost	**$Y=10^7+(0.5)(48x10^6)$ = $ $34x10^6$**	**$Y=10.5^7+0.03(75.9x10.5^6)$ = $36.841x10^6$**
Unit cost (u)	**u= $34x10^6/48x10^6$ = 71 ₡/ton**	**u = $36.841x10^6/75.9x10$ 49 ₡/ton**

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Unit revenue	88 ¢ /ton	80 ¢ /ton
Total Shipment (T)	$48x10^6$ ton	$75.9x10^6$ ton
Total cost	$\$\ 34x10^6$	$\$\ 36.841x10^6$
Unit cost (u)	71 ¢/ton	49 ¢/ton

	Large railroad corp.	Merged corp.
Unit cost for $20x10^6$ tons shipped (U_{20}) $U_{20} = Y_{20}/T_{20}$	$= \frac{10^7+(0.5)(20x10^6)}{20x10^6}$ = \$ 1/ton	$= \frac{10.5^7+(0.3)(20x10^6)}{20x10^6}$ =\$ 1.003 /ton
Unit cost for $10x10^6$ tons shipped (U_{10}) $U_{10} = Y_{10}/T_{10}$	$= \frac{10^7+(0.5)(10x10^6)}{10x10^6}$ = \$ 1.5 /ton	$= \frac{10.5^7+(0.3)(10x10^6)}{10x10^6}$ =\$ 1.707 /ton
% of cost reduction $\frac{U_{10}-U_{20}}{U_{10}}$	$\frac{1.5-1}{1.5}$ = 33.3%	$\frac{1.707-1.003}{1.707}$ = 41.2%
EOS?	Yes	Yes

Thus, both corporations have EOS and it is greater in the merged corporation

Ex.9/page 260

A businessman residing in Chicago considers his options for a trip to Detroit. His options are private car, rental car, bus, or airplane. Given the following data, suggest the best mode for his travel.
Distance between cities (one way) = 425 km.
Estimated access travel at origin and destination = 38 km at each city; the access distance and access trips are the same for all modes.

Costs:

1/ private auto: 20¢/km (all costs combined); no access mode required;
2/ rental car (2 days): $50/day plus $12/day for insurance and tax; 11 *l*/100 km fuel efficiency and gas price is 40¢/*l*; no access mode required;
3/ bus: round-trip fare $55; access mode required;
4/ air: round-trip fare $100; access mode required.

Access modes and costs:

In Chicago taxies charge $2 plus 20¢/km, buses charge $1 per ride (assume two rides);
In Detroit taxies charge $2.40 plus 15¢/km, buses charge $1.5 per ride (assume two rides).
The door-to-door travel times by mode are as follows:

	Private auto	Rental car	Bus	Air
Best	4.5	5.0	6.0	1.5
Worst	6.0[a]	6.5[a]	8.0[b]	3.0[b]

a Accounts for potentially congested conditions.
b Use of bus for access.

In order to make his selection, the businessman assumed a disutility function (a measure of discomfort due to the cost and travel time encountered):
Disutility = (total trip cost)/5 + 8 (one-way travel time)

Which mode did the businessman select? (Round out all the cost estimates to the nearest integer)

	Privet car	Rental car	Air plan (Taxi access mode)	Air plan (Bus access mode)
One-way Distance	**=38+425+38 = 501 km** (access+ intercity distance+ access)	**501 km**	**501 km**	**501 km**
Total distance	**=(2)(501) = 1002 km**	**1002 km**	**1002 km**	**1002 km**
Cost	**= (0.2)(1002) = $ 200.4**	**=2(50+12)+0.4 $(11*\frac{1002}{100})$ = $ 168.1**	**=100+2(2+0.2*38) +2(2.4+0.15*38) =$ 135.4**	**=100+2(1*2)+2(1.5*2) = $ 110**
One-way time	**4.5 hr**	**5 hr**	**1.5 hr**	**3 hr**
Disutility	**$=(\frac{200.4}{5})+(8)(4.5)$ = 76.08**	**$=(\frac{168.1}{5})+(8)(5)$ = 73.62**	**$=(\frac{135.4}{5})+(8)(1.5)$ = 39.08**	**$=(\frac{110}{5})+(8)(3)$ =46**

Among these modes, businessman selected to travel by air plan using taxi access mode