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Preliminary Economic Analysis

Case Study

PRELIMINARY ECONOMIC ANALYSIS OF MOVING A BULK COMMODITY BY BARGE

Harry Benford

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Statement of Problem

The Bulk Transport Co. (BTC) has been asked by an industrial corporation to submit a bid for moving a bulk commodity from Port U to five other ports along the coast (Ports V, W, X, Y & Z). The annual transport needs and distances involved are summarized in Table 1.

TABLE 1

TRADE ROUTE SUMMARY

Port U to:	Nautical Miles one way	Long Tons per year
Port V	804	197,200
Port W	957	166,300
Port X	1254	121,300
Port Y	1364	136,500
Port Z	1459	91,000

BTC operates barges and tugs, and proposes to provide such equipment specifically for the needs outlined above. The return trips would presumably be in ballast. In an effort to find the most suitable and at the same time most economical combination of barge and tug, BTC wants to consider tugs of three different horsepowers and barges of four different capacities. This makes a total possible combination of twelve sets of tugs and barges. (Coastwise conditions are assumed to dictate a pulling operation with a single barge, rather than a pushing operation with, possibly, multiple barges.)

Loading and discharge times are estimated to take ~~20~~ 40 hours per round trip regardless of barge size.

A preliminary check of harbor depths indicates that draft restrictions will not be a critical factor within the range of barge sizes considered.

The first object of the study is to estimate, for each tug and barge combination, the freight rate required to move the commodity to each of the five receiving ports. The freight rate is to be high enough to make the operation reasonably profitable to BTC. The second object is to find which combinations of tug and barge come closest (whether singly or in fleets) to matching the specified transport needs.

Barges

Four hypothetical barges are considered. Barge A would be a converted Liberty ship with hand- or radio-controlled rudder. The others would be newly built vessels with conventional coastwise barge characteristics: shipshape bow and scow stern with fixed anti-yaw skegs. All barges would have three-man crews. Table 2 summarizes information on the barges.

TABLE 2

BARGE CHARACTERISTICS

Designation	DWT L.T.	Displ. L.T.S.W.	Yaw Control	Estimated Cost	Notes
A	10,800	14,257	rudder	$ 650,000	Converted Liberty
B	12,000	14,100	skegs	$1,360,000	
C	16,200	19,000	skegs	$1,700,000	
D	20,000	23,400	skegs	$2,000,000	

Tugs

Three hypothetical tugs are considered. Table 3 lists their characteristics. All are assumed to have Kort nozzles, diesel engines, and a specific fuel consumption of 0.37 pounds per BHP-hr. A crew of ten would be carried.

TABLE 3

TUG CHARACTERISTICS

Designation	BHP (max. cont.)	Screws	Approx. free route speed	Approx. bollard pull, lbs.	Estimated Cost
I	2,150	1	13 k	69,000	$ 600,000
II	3,000	1	14 k	96,000	$ 750,000
III	4,400	2	14.5k	132,000	$1,000,000

Note: Estimated costs of barges and tugs include design agent's fees, owner's expenses, and interest charges on payments prior to delivery.

Barge and Tug Combinations

The four barges and three tugs could be paired in twelve possible combinations. Table 4 shows the principal characteristics of each pair.

TABLE 4

PAIRED BARGE AND TUG CHARACTERISTICS

Barge	Tug	Speed in Knots V_1 loaded trial condition	V_2 loaded sea speed	V_3 ballast sea speed	Estimated Cost
A	I	9.75	8.30	9.75	$1,250,000
	II	10.70	9.10	10.70	1,400,000
	III	11.95	10.15	11.95	1,650,000
B	I	8.35	7.10	8.35	1,960,000
	II	9.25	7.85	9.25	2,110,000
	III	10.55	8.95	10.55	2,360,000
C	I	7.80	6.65	7.80	2,300,000
	II	8.70	7.40	8.70	2,450,000
	III	10.05	8.54	10.05	2,700,000
D	I	7.40	6.30	7.40	2,600,000
	II	8.35	7.10	8.35	2,750,000
	III	9.65	8.20	9.65	3,000,000

Notes:

1. Loaded sea speed is assumed equal to 0.85 times trial speed.
2. Ballast sea speed is assumed equal to loaded trial speed.

Operating Costs

Diesel oil is estimated on a basis of 10.5 cents per gallon, with the annual quantity calculated separately for each barge-tug combination and port of call. Lubricating oil costs are purposely omitted, the assumed fuel ~~ratio~~ rate being high enough to cover. Port fees and extra tug charges are also specifically omitted. The other operating costs remain the same regardless of trade route. Their estimated values are summarized in Table 5.

TABLE 5

FIXED ANNUAL OPERATING COSTS IN THOUSANDS OF DOLLARS

	Barges				Tugs		
	A	B	C	D	I	II	III
Wages and Subsist.	29	29	29	29	150	150	150
Payroll Tax	1	1	1	1	4	4	4
Maint. and Repair	25	28	31	34	26	28	30
H & M Insurance)	26	55	68	80	23	29	38
P & I Insurance)					3	3	3
Stores and Misc.	4	4	4	4	7	7	7
Overhead	20	20	20	20	35	35	35
Total	105	137	153	168	248	256	267

Financial Arrangement and Taxes

The total cost of the investment is assumed to be raised through a bank loan, which is to be repaid in uniform annual amounts over a ten-year period at an interest rate of 5.5 percent. The economic life is assumed to be 18 years, which figure is used for calculating a straight-line depreciation allocation, with 48 percent profits tax and zero disposal value. These factors apply to tugs as well as barges.

Economic Analysis

The primary aim of the analysis is to estimate, for each barge-tug combination, the Required Freight Rate (RFR) for each of the five ports of call. The RFR is the revenue per ton of cargo that BTC must collect if the operation is to generate a given level of overall, after-tax profitability. Two arbitrary levels of profitability are considered in this analysis, as discussed in the following section.

RFR is found for each barge-tug combination in each trade route just as though the pair was engaged full time in that particular service. In no case does this turn out to be true -- the annual transport capacity invariably being in excess of the need of any one port. The results are valid, nevertheless, because the stipulated level of profitability would be maintained as long as the appropriate RFR's were applied to any combination of alternating trade routes.

Levels of Profitability

Profit Plan "A" earns after-tax returns just sufficient to repay the bank loan in ten years at 5.5 percent interest. BTC retains nothing during that period, but keeps all after-tax returns during the final eight years. This level could be considered a reasonable minimum for the reasons listed below:

a. The bank might hesitate to lend the full value of the investment at any lower level of expected return.
b. The overall, after-tax level of profitability is equivalent to an 11 percent interest rate of return, shared by bank and BTC.

Other pertinent facts are as follows:

a. The annual after-tax return to BTC, after the 10th year, would be 11.7 percent of the investment.
b. The present worth of BTC's after-tax returns would be 43.4 percent of the investment at an interest rate of 5.5 percent, or 21.2 percent of the investment at an interest rate of 11 percent.
c. The before-tax capital recovery factor would have to be 17.4 percent.

Profit Plan "B" uses a before-tax capital recovery factor arbitrarily set 25 percent higher than that required in Profit Plan "A." This provides some margin against errors in estimates without seeming unduly avaricious. The following points support this:

a. Without some cushion, errors in our estimates would probably put BTC in the red during the first ten years.
b. The overall, after-tax level of profitability is moderately high, being equivalent to an interest rate of 14 percent, divided between bank and BTC.

Other pertinent facts are as follows:

a. The after-tax return to BTC would be 2.7 percent of the investment during the first ten years, 14 percent thereafter.
b. The present worth of BTC's after-tax returns would be 72.3 percent of the investment at an interest rate of 5.5 percent, or 41.2 percent of the investment at 11 percent.
c. The before-tax capital recovery factor would have to be 21.75 percent.
d. The bank could be repaid in a little over 8 years if all after-tax returns were so used during that period.

Scheduling

An assumed 340 operating days per year is used allowing 15 days for repair time, and 10 days for weather delays.

Conclusions re Economics

Table 6 shows the Required Freight Rates, calculated on the foregoing assumptions and estimates, for Port V. Similar tables for the other ports are omitted here for the sake of brevity. They all show exactly the same relative economics. Table 8 shows the detailed RFR calculations for Port V.

TABLE 6

REQUIRED FREIGHT RATES TO PORT V

Barge	Tug	Required Freight Rates, $/LT Profit Plan "A"	Profit Plan "B"
A	I	1.61	1.75
	II	1.64	1.78
	III	1.71	1.86
B	I	2.05	2.26
	II	2.03	2.25
	III	2.04	2.26
C	I	1.76	1.96
	II	1.72	1.92
	III	1.69	1.88
D	I	1.61	1.80
	II	1.55	1.73
	III	1.51	1.69

Conclusions re Scheduling

Table 7 summarizes the ratios of transport demand (for each port) to the transport capability (of each barge-tug combination). The ratio is equivalent to the number of barges that would be required to service each port. The last column, giving the total number for each barge-tug pair, exceeds one in each case. This means that more than one barge would be needed if all five ports are to be serviced. If BTC wants a fleet tailored to the demand, it must either go to a larger (or faster) barge than any contemplated here, or use two barges. If two barges are desired, they need not be identical as to size or tug. Buying identical vessels would probably be advisable, however, because of duplicate cost savings. The following combinations appear to the most practical:

Two A-II combinations (annual capacity = 0.95 x demand)
Two A-III combinations (annual capacity = 1.03 x demand)

Two B-II combinations (annual capacity = 0.93 x demand)
Two B-III combinations (annual capacity = 1.03 x demand)

There may, of course, be opportunities to sell excess transport capacity to other oil companies. If so, the foregoing efforts to tailor the barge to the needs will be unnecessary, and the more economical (but mis-fitted) barges should not be disregarded.

The necessary lack of accuracy in estimated sea times for this analysis should be kept in mind when evaluating scheduling aspects.

TABLE 7

RATIOS OF TRANSPORT DEMAND TO TRANSPORT CAPACITY
(Number of Barges Needed to Meet Port Requirements)

				Port			
Barge	Tug	V	W	X	Y	Z	Total
A	I	.491	.478	.430	.523	.367	2.29
	II	.454	.441	.399	.481	.338	2.11
	III	.416	.404	.363	.439	.308	1.93
B	I	.502	.492	.448	.537	.379	2.36
	II	.461	.451	.407	.493	.346	2.16
	III	.415	.405	.364	.440	.312	1.94
C	I	.394	.386	.350	.423	.298	1.85
	II	.359	.351	.318	.385	.271	1.68
	III	.319	.311	.281	.339	.239	1.49
D	I	.335	.327	.297	.358	.253	1.57
	II	.301	.295	.268	.323	.228	1.41
	III	.267	.261	.236	.284	.201	1.25

Recommendations

This preliminary study has been made in order to give BTC a rough indication of the probable economic potential of the proposed operation. If BTC wants to continue the project it should arrange for further, more carefully estimated analyses. The following areas, in particular, deserve further study.

a. The speed and power relationships should be carefully developed. This will require blocking out hull forms for barges and tugs. It will involve considerations of yaw control, propeller design, and influence of weather and deadweight on sea speed.

b. More accurate estimates of building costs would be desired. This would require some preliminary plans and specifications for alternative vessels for the benefit of cooperating shipyards.

c. Variations in tug dimensions might be worth a separate study. The greater invested cost of a longer hull should be balanced against the increased annual income resulting from a faster return trip. (The return trip speed is strongly influenced by the tug's free route speed, which varies with tug length.)

d. Variations in barge proportions and fullness of form should be considered. Blocky forms are cheap to build but expensive to move. There is some ideal form.

e. Since the barges are to be manned, BTC should consider rudders rather than skegs for yaw control in all cases. This would markedly increase the transport capacity of Barges B, C, and D with corresponding reductions in RFR.

f. None of the barge-tug combinations is large enough to handle the entire demand of all five ports. Combinations D-III comes closest. BTC might think about a barge 25 percent larger than Barge D, with perhaps a 5,000 BHP tug. Such a combination could meet the entire demand by itself and at a RFR 10 to 15 cents per ton cheaper than D-III.

g. The largest barges seem to be most economic, yet do not fit the demand pattern. BTC should consider the possibility of building two of the largest barges and finding another customer for the excess capacity.

h. If proposals f and g above are both felt to be out of the question, the best solution would seem to be Barge I: the converted Liberty ship (or rather two of them). This being the case, the barge design studies discussed in the preceding paragraphs would be unnecessary. This decision should not be reached, however, without first considering proposal e above.

DATE DUE

~~Nov. 12 1980~~			