A NOTE OF RESIDENTIAL HEATING OIL INVENTORY POLICIES

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Abstract

The question whether present inventory policies of residential heating oil consumers are stable or likely to change as a result of higher oil prices or a shortage situation is investigated on the basis of a model which explains heating energy cost as a function of a consumer's tank capacity, the size of oil deliveries, his choice of a safety level of oil in his tank, and on the basis of data for Massachusetts. For the most common situation of a consumer who owns a 270 gallon tank and consumes 1000 to 2000 gallons per heating season, the result is:

Unless the consumer expect substantial fluctuations in the price of oil to occur during each year throughout the depreciation period of the tank, there is little incentive to change the present inventory policy: One 270 gallon tank and the avoidance of policies which reduce the delivery size through partial fills or a large safety level, are stable policies.

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A NOTE ON RESIDENTIAL HEATING OIL INVENTORY POLICIES

1. Introduction

The question whether present inventory policies of residential heating oil consumers are stable or likely to change as a result of higher oil prices or a shortage situation is of importance to:

(1) The policy maker, since additional demand to build up inventories will worsen an already tight supply situation.

(2) The consumer who would like to keep the cost of home heating low.

(3) The oil distributor who faces changes in distribution costs as a result of changes in inventory policies.

This paper models heating energy costs as a function of consumer decisions on:

(1) The tank capacity.

(2) The delivery size (the amount of oil put into the tank whenever the delivery truck comes around).

(3) The safety level (the minimum amount of oil the consumer wishes to keep in his tank for safety reasons).

The cost items considered are:

(1) Oil delivery costs from the oil supplier's bulk storage facility to the consumer. These costs depend on the size of the delivery to each consumer.

(2) Cost of investment in the tank and the average amount of oil kept in the tank. These costs depend on all three variables: tank capacity, delivery size and safety level).

(3) Cost of oil. These costs depend on the tank capacity in case the oil price changes during the year.

If the decision criterion is the sum of these costs, the main result of our study is: Unless a consumer, who owns the usual 270 gallon tank, expects substantial fluctuations in the price of oil to occur during each year throughout the depreciation period of the tank, there is little incentive to change the present inventory policy. One 270 gallon tank, and the avoidance of policies which reduce the delivery size through partial fills or a large safety level, are stable policies.

Data for this study was provided by a large heating oil distributor who serves Eastern Massachusetts and the Better Home Heating Council, Boston.

Section 2 investigates the dependency of oil distribution cost on the size of deliveries to consumers. Section 3 deals with the cost of storing oil in a home. Section 4 describes a way to consider oil price fluctuations during the year. Section 5 presents results for various inventory situations.

2. Oil Distribution Cost

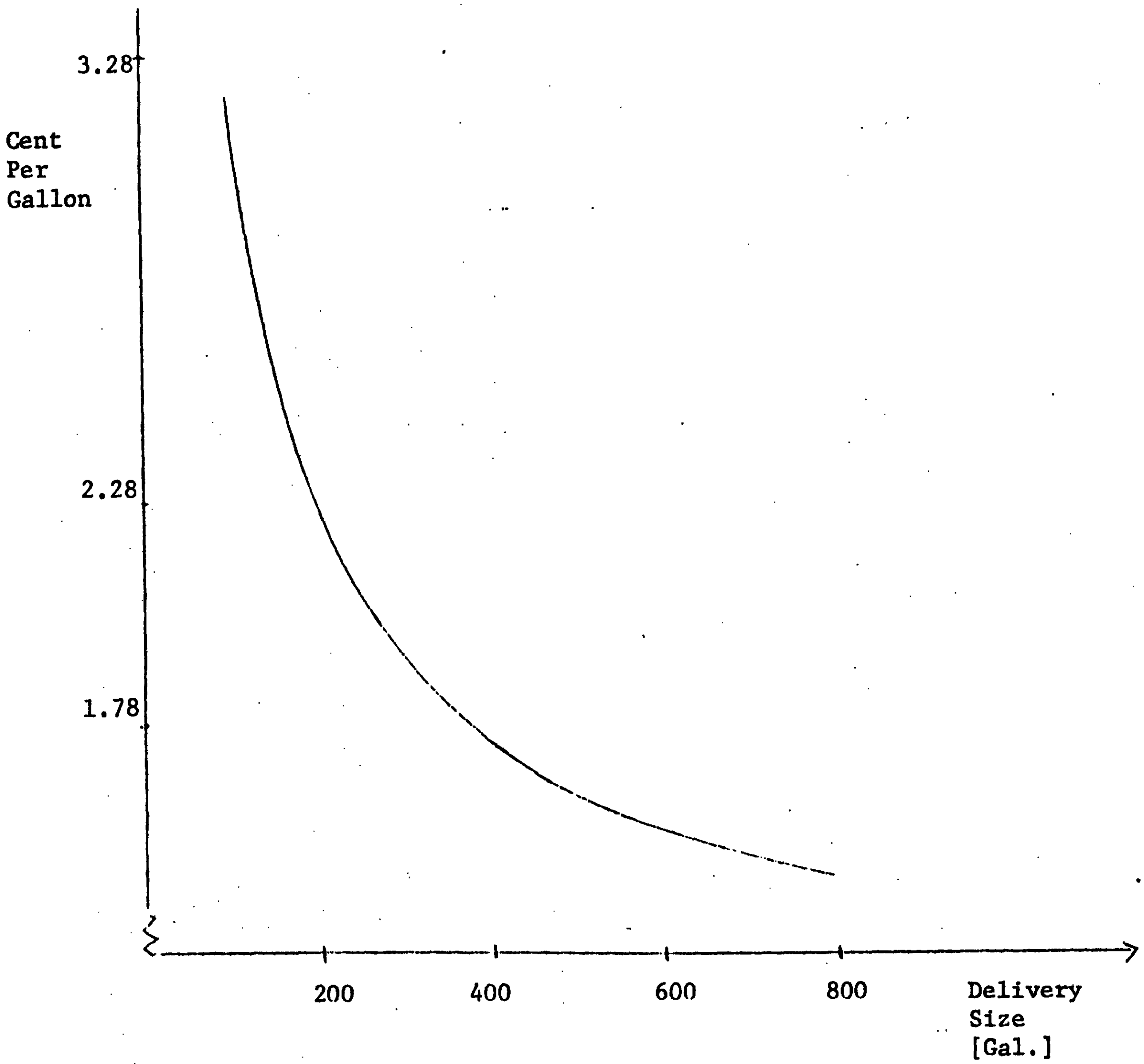
In this section we model oil distribution cost as a function of the size of oil deliveries to the residential consumer. Figure 1 is the result of this effort. It shows that this cost is sensitive to changes in delivery size. For example: an increase from 200 to 400 gallons per delivery reduces the delivery cost per gallon by .5 cent or 20%. A decrease of the delivery size from 200 to 100 gallons means a delivery cost increase of 1 cent per gallon or 40%.

From Figure 1 alone an important conclusion follows for the evaluation of residential inventory situations: At present the most common tank size is the 270 gallon tank and a delivery size of around 200 gallons. The oil distributor has reason to strongly resist a reduction of this delivery size either through partial fills of a tank or the increase of safety levels.

Figure 1 was derived as follows:

Oil distribution cost are mainly the cost to operate the delivery trucks. The bulk of truck cost is time proportional in the sense that if distribution times can be reduced by 20% and the oil distributor operates 5 trucks. one truck can be saved. A smaller part of the truck cost is proportional to the mileage driven. Both distribution time and mileage driven to serve a given number of customers with given consumptions per year depend on the delivery size to the individual customer.

Figure 1: Oil Distribution Cost (in Cent per Gallon)



We use data on:

DIS = Quantity of oil distributed (in gallons per truck per year).

DR = Delivery size average (in gallons per consumer per delivery)

Cost associated with the operation of one truck (in $ per truck per year). These costs are divided into two segments:

TC = Costs that are time proportional in the sense defined above (wages and related cost, 50% of truck repairs, depreciation, insurance, registration).

MC = Truck cost that are proportional to the mileage driven (50% of truck repairs, tires, gas and oil).

The time- and mileage proportional distribution cost per gallon associated with the delivery size DR are:

$$\frac{TC + MC}{DIS} \qquad (2.1)$$

In order to write (2.1) as a function of the delivery size we introduce the notation:

D = Variable delivery size (in gallons per customer and delivery).

T(D) = Time spent to deliver one truckload of deliveries of size D (in minutes per truckload).

M(D) = Mileage driven to deliver one truckload of deliveries of size D (in miles per truckload).

The time- and mileage proportional distribution cost per gallon as a function of a variable delivery size D is:

$$(2.2) \qquad \frac{TC \dfrac{T(D)}{T(DR)} + MC \dfrac{M(D)}{M(DR)}}{DIS}$$

The remaining task is to formulate the functions T(D) and M(D), which describe the dependence of the time spent and the mileage driven to distribute one truckload of oil on the delivery size.

Only part of the time of a truck tour is dependent on delivery sizes. Times which are independent of the delivery size are:

(a) Pumping times at the oil supplier.
(b) Transportation times from the supply-point to the distribution area.
(c) Pumping times at customer locations.

Times which do depend on the delivery size are:

(a) Set-up times at customer locations.

The set-up time per customer is the time between getting the truck off and back onto the road minus the actual pumping time. The set-up time per customer is independent of the delivery size. The total set-up time per truck tour depends on the number of stops per tour and, therefore, on the delivery size. The set-up time per truck tour is computed from.

$$\text{(2.3)} \quad \text{Set-up time per consumer} \cdot \frac{\text{Truck Capacity}}{\text{Delivery Size}}$$

(b) Driving times (and distances) between customer locations.

The consumption of each consumer does not change as a result of a change in delivery size, nor does the number of truck tours necessary to serve a given clientele. We can think of a geographical area which is served through one truck tour. The size of this area depends on the consumption per customer and time unit, on how close the consumers live together and on the dealer's policy insofar as he decides how exactly the day of reaching the safety level should coincide with the delivery date. The size of the area does not depend on the delivery size.

The quantity which changes with the delivery size is the number of stops per truck tour, which is roughly:

$$\text{(2.4)} \quad \text{Number of Stops} = \frac{\text{Truck Capacity}}{\text{Delivery Size}}$$

In order to express the distance travelled per truck tour as a function of the number of customers visited, a simple model of the distribution area is constructed: A large number of residential customers is assumed to be evenly distributed within a square area similar to the one of Figure 2. We select random samples of 5, 10, 20 customer locations within the area and compute an efficient round-trip for each sample on the assumption that the truck enters and leaves the area at a specific location.

Figure 3 gives the average distance travelled per truck tour as a function of the number of stops. The distance unit is the side length of the square shaped distribution area of figure 2.

The curve of Figure 3 can be approximated by:

$$\text{(2.5)} \quad a = 1{,}0236 \cdot b^{.4755} \approx \sqrt{b}$$

where 'a' denotes the number of distance units travelled and 'b' denotes the number of stops per tour.

Figure 2: Round Trip Computed for a Simplified Delivery Area

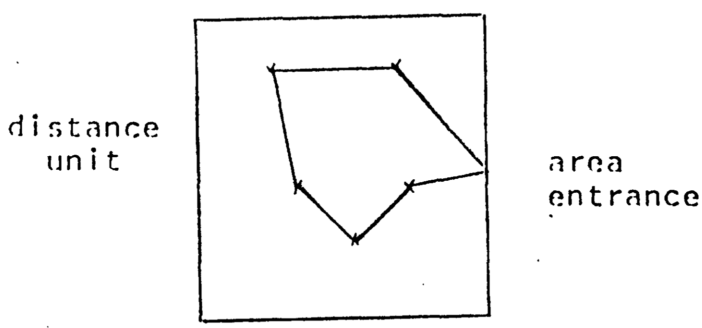
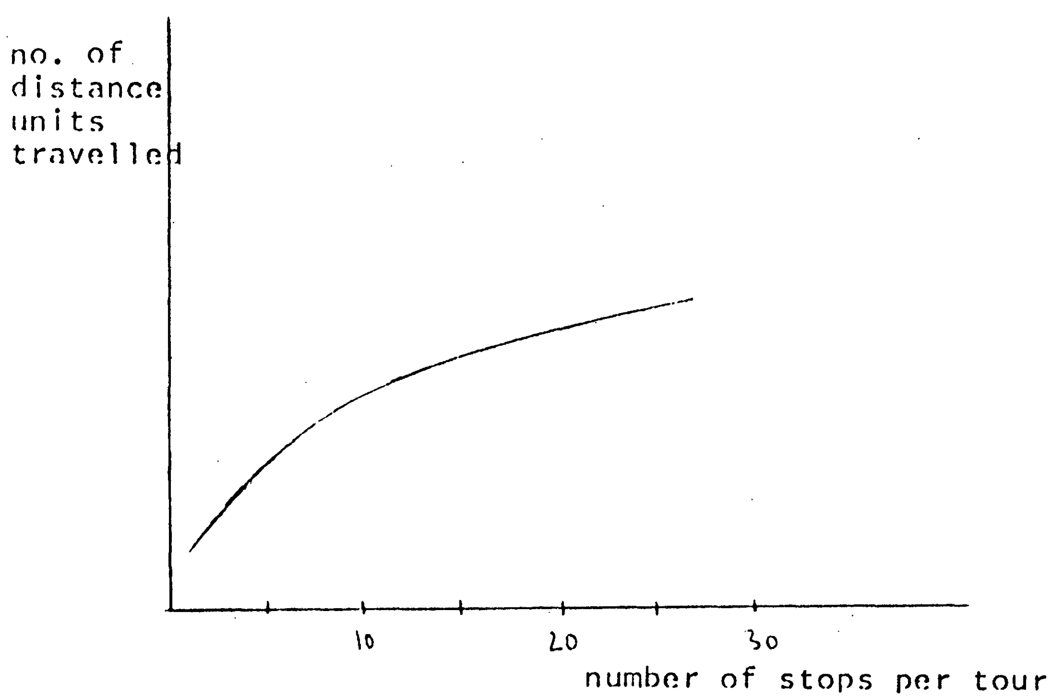


Figure 3: Number of Distance units travelled per Truck Tour



How will this function be used? Our distributor averages 15 customer stops per tour and a 2 mile distance between stops. We estimate that by an increase of the number of stops from 15 to 25 the distance travelled per delivery trip would increase from 2 x 15 = 30 miles per tour to:

$$30 \sqrt{\frac{25}{15}} \approx 30 \cdot \frac{4.8}{3.8} \approx 38 \text{ (miles per tour)}$$

and the average distance between two customers would decrease to:

$$\frac{38}{25} \approx 1.5 \quad \text{(miles)}$$

Some additional notation is used to write expressions for the time spent and the mileage driven to distribute one truck load of oil as a fuction of the delivery size:

FT = Time per tour which is invariant of the number of stops (time to drive from the supply point to the delivery area plus pumping times).

FM = Mileage per tour which is invariant of the number of stops (distance from the supply point to the edge of the distribution area).

PTR = Set-up time at each stop.

MSR = Miles between two stops for the fixed delivery size DR (in miles per stop).

SR = Driving speed between stops (in miles per minute).

CAP = Truck capacity (in gallons per truck).

Since

$$\frac{CAP}{D}$$

is the number of stops per truck tour, the mileage driven within the distribution area would be (using equation 2.5):

$$(2.6) \qquad MSR \cdot \frac{CAP}{DR} \cdot \sqrt{\frac{\frac{CAP}{D}}{\frac{CAP}{DR}}} = MSR \cdot \frac{CAP}{DR} \cdot \sqrt{\frac{DR}{D}}$$

The time total for the whole truck tour is equal to fixed times and variable times (set-up time and travel time within the distribution area):

$$(2.7) \qquad T(D) = FT + PTR \frac{CAP}{D} + MSR \frac{CAP}{DR} \sqrt{\frac{DR}{D}} \; \frac{1}{SR}$$

The mileage total within the area is equal to:

$$(2.8) \qquad M(D) = FM + MSR \frac{CAP}{D} \sqrt{\frac{DR}{DR}}$$

The expressions 2.7 and 2.8 are used in equation 2.2.

3. Cost of Investment in Tank and Oil

The costs of the investment in tank and oil are:

a. Depreciation of the tank.

b. Interest on the money tied in the tank investment.

c. Interest on the money tied in the average amount of oil stored in the tank.

The depreciation of the tank is calculated from:

$$\text{(3.1)} \quad \frac{\text{Tank Price}}{\text{Depreciation Period}}$$

The interest on the money tied in the tank investment is calculated from:

$$\text{(3.2)} \quad \frac{1}{2} \quad \times \quad \text{Price of Tank} \quad \times \quad \text{Interest Rate}$$

Based on a constant consumption rate the interest on the money tied in the stored oil is:

$$\text{(3.3)} \quad \text{Interest rate} \times \text{Price of Oil} \times \left[\text{Safety Level} + \frac{\text{Delivery Size}}{2}\right]$$

The costs (3.1, 3.2 and 3.3) - in $ per heating season - depend on all three decision variables: tank capacity, delivery size and safety level. In addition a given tank capacity can consist of combinations of different tank sizes (with different cost implications). Figure 4 gives a few cost examples.

Figure 4:

Cost of Investment Into Tank Capacity
(in $ per season)

Tank size (in gallons)	Interest rate (in % per season) 0	3	7.5	15
270	12.2	15.1	19.2	26.2
1000	23.3	28.6	36.5	49.6

Cost of Investment into Oil (in $ per Heating Season)

Delivery Size	Interest rate (in % per season) 0	3	7.5	15
100	0	1.0	2.4	4.8
200	0	1.9	4.8	9.6
400	0	3.8	9.6	19.2
600	0	5.8	14.4	28.8
800	0	9.6	19.2	38.4

<u>where:</u>

Price of tank (270 gallons)	$ 185
" " " (1000 gallons)	$ 350
Depreciation period	15 years
Oil price	$ .4

The safety level is kept at 30% of the delivery size.

4. The Cost of Oil

If the oil price changes during a year, the cost of oil (in \$ per heating season) depends on the quantities of oil that are stored at different prices. The larger the available tank capacity, the larger is the fraction of the consumption per season that can be bought at a lower price. This aspect is considered by assuming that:

(a) The oil price does not include the portion of oil distribution cost which depends on the delivery size.

(b) It is the first delivery of the heating season which can be bought at a lower price. All following deliveries have to be purchased at a higher price.

Table 5 gives a few cost examples.

Figure 5: Cost of Oil (In Dollars per Heating Season)

Price of oil at first delivery (in $/gallon)	Delivery size at first delivery (in gallons)		
	200	400	800
.4	400	400	400
.38	396	392	384
.36	392	384	368

where:

consumption 1000 gallons per heating season

price of oil for subsequent deliveries $ .4

5. Results

This section reports on costs (in $ per heating season) that are variable for various inventory situations. According to the assumed situation 4 cost criteria are distinguished:

1. A large tank size is already available. The price of oil is stable. The cost criterion is the sum of oil distribution cost and the cost of investment into stored oil.

2. The tank capacity must still be bought. The price of oil is stable. The cost criterion is the sum of oil distribution cost and the cost of investment into oil and into tank capacity.

3. A large tank size is already available. The price of oil for the first delivery during the heating season is lower than for later deliveries. The cost criterion is the sum of oil distribution cost, the cost of investment into oil and the cost of oil.

4. The tank capacity must still be bought. The price of oil for the first delivery during the heating season is lower than for later deliveries. The cost criterion is the sum of oil distribution cost, the cost of investment into oil and into tank capacity, and the cost of oil.

Tables 1 and 2 assume a consumption of 1000 gallons per heating season.

In Table 1 an existing, large tank capacity is assumed. At a low interest rate the savings in distribution costs call for a large delivery size. At higher interest rates the cost of investment into the stored oil has more weight and leads to a reduction of the profitable delivery size.

In Table 2 it is assumed that the tank capacity does not exist, but has to be purchased in form of one or more 270 gallon tanks. The cost of tank capacity becomes the prominent cost item. Only 1 tank should be bought.

Tables 3 and 4 assume a consumption of 2000 gallons per heating season and in all other respects the situation of Tables 1 and 2. The larger consumption causes no major change of results.

Tables 5 and 6 consider the effect of inflation. It is assumed that 270 gallon tanks can be bought at the price assumed so far, but that the cost of oil distribution and the price of oil have increased by 50% in later years. There is no major change of the results.

Tables 7 to 9 assume a consumption of 1000 gallons per season.

Table 7 assumes that the first oil delivery of the heating season can be bought at a price which is 2 cent below the price per gallon

1) *CRITERIUM* 1:
CONSUMPTION ON 1000 *GALLONS PER SEASON*

DELIVERY SIZE	*INTEREST RATE* 0.0	3.0	7.5	15.0
100	31.90	32.86	34.30	36.70
150	26.00	27.44	29.60	33.20
200	22.80	24.72	27.60	X32.40
300	19.40	22.28	X26.60	33.80
400	17.50	21.34	27.10	36.70
500	16.30	X 21.10	28.30	40.30
600	15.40	21.16	29.80	44.20
800	14.30	21.98	33.50	52.70
1000	/13.60	23.20	37.60	61.60

2) *CRITERIUM* 2:
CONSUMPTION ON 1000 *GALLONS PER SEASON*

TANKS NO	*SIZE*	*DELIVERY SIZE*	*INTEREST RATE* 0.0	3.0	7.5	15.0
1	270	100	44.23	47.97	53.57	62.91
1	270	150	38.33	42.55	48.87	59.41
1	270	200	X35.13	/39.83	X 46.87	X 58.61
2	270	300	44.07	52.50	65.14	86.22
2	270	400	42.17	51.56	65.64	89.12
3	270	500	53.30	66.42	86.11	118.92
3	270	600	52.40	66.48	87.61	122.82
4	270	800	63.63	82.41	110.58	157.53
5	270	1000	75.27	98.74	133.95	192.64

3) *CRITERIUM* 1
CONSUMPTION ON 2000 *GALLONS PER SEASON*

TANKS NO	*SIZE*	*DELIVERY SIZE*	*INTEREST RATE* 0.0	3.0	7.5	15.0
		100	63.80	64.76	66.20	68.60
		150	52.00	53.44	55.60	59.20
		200	45.60	47.52	50.40	55.20
		300	38.80	41.68	46.00	X53.20
		400	35.00	38.84	44.60	54.20
		500	32.60	37.40	X44.60	56.60
		600	30.80	36.56	45.20	59.60
		800	28.60	X 36.28	47.80	67.00
		1000	/27.20	36.80	51.20	75.20

4) *CRITERIUM 2:*
CONSUMPTION ON 2000 *GALLONS PER SEASON*

TANKS		*DELIVERY*	*INTEREST RATE*			
NO	*SIZE*	*SIZE*	0.0	3.0	7.5	15.0
1	270	100	76.13	79.87	85.47	94.81
1	270	150	64.33	68.55	74.87	85.41
1	270	200	× 57.93	× 62.63	× 69.67	× 81.41
2	270	300	63.47	71.90	84.54	105.62
2	270	400	59.67	69.06	83.14	106.62
3	270	500	69.60	82.72	102.41	135.22
3	270	600	67.80	81.88	103.01	138.22
4	270	800	77.93	96.71	124.88	171.83
5	270	1000	88.87	112.34	147.55	206.24

5) *CRITERIUM 2:*
CONSUMPTION 1000 *GALLONS PER SEASON*
50 *PER CENT INCREASE IN TRUCK COST AND OIL PRICE*

		0.0	3.0	7.5	15.0
	100	60.18	64.40	70.72	81.26
	150	51.33	56.27	63.67	76.01
	200	46.53	52.19	60.67	74.81
AS	300	53.77	63.64	78.44	103.12
ABOVE	400	50.92	62.23	79.19	107.47
	500	61.45	76.98	100.26	139.07
	600	60.10	77.06	102.51	144.92
	800	70.78	93.40	127.33	183.88
	1000	82.07	110.34	152.75	223.44

6) *CRITERIUM 2:*
CONSUMPTION 2000 *GALLONS PER SEASON*
50 *PER CENT INCREASE IN TRUCK COST OIL PRICE*

		0.0	3.0	7.5	15.0
	100	108.03	112.25	118.57	129.11
	150	90.33	95.27	102.67	115.01
AS	200	80.73	86.39	94.87	109.01
ABOVE	300	82.87	92.74	107.54	132.22
	400	77.17	88.48	105.44	133.72
	500	85.90	101.43	124.71	163.52
	600	83.20	100.16	125.61	168.02
	800	92.23	114.85	148.78	205.33
	1000	102.47	130.74	173.15	243.84

charged for the remaining deliveries and that a large tank capacity is already available. The table suggests that the whole consumption of the heating season should be stored at the lower price unless the assumed interest rate is high. At an interest rate of 15% the first delivery should be 400 gallons and subsequent deliveries should be 200 gallons (see Table 1).

Tables 8 and 9 cover the case where the tank capacity must still be bought in form of 270 gallon tanks. A 2 cent (Table 8) and even a 4 cent (Table 9) price decrease for the first delivery are insufficant incentives to invest into more than 1 270 gallon tank.

Tables 10 to 12 show results equivalent to Table 7 to 9 for a consumption of 2000 gallon per heating season. There is no major change from the results reported for the 1000 gallon user.

Tables 13 and 14 assume a constant oil price and compare the investment into 1 1000 gallon tank (row 1 to 3 of the table) with the investment into 1 270 gallon tank (row 4). For both the 1000 gallon and the 2000 gallon user the investment into the 270 gallon tank is advantegeous.

Tables 15 and 16 compare the investment into both tank sizes for the case that the oil price of the first delivery is reduced by 4 cent per gallon. Only for the 2000 gallon user the large tank becomes profitable.

7) *CRITERIUM* 3:
CONSUMPTION 1000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .38 *DOLLARS PER GALLON*

DELIVERY SIZE	*INTEREST RATE* 0.0	3.0	7.5	15.0
100	429.90	430.86	432.29	434.68
150	423.00	424.43	426.57	430.15
200	418.80	420.70	423.55	428.30
300	413.40	416.24	420.49	426.60
400	409.50	413.26	418.61	X425.74
500	406.30	410.98	417.15	425.75
600	403.40	408.96	416.09	426.62
800	398.30	405.50	X415.35	431.10
1000	X393.60	X402.72	416.40	439.20

8) *CRITERIUM* 4:
CONSUMPTION 1000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .38 *DOLLARS PER GALLON*

TANK NO	*SIZE*	*DELIVERY SIZE*	*INTEREST RATE* 0.0	3.0	7.5	15.0
1	270	100	442.23	445.96	451.56	460.88
1	270	150	435.33	439.54	445.84	456.35
1	270	200	X431.13	X435.81	X442.82	X454.51
2	270	300	438.07	446.45	459.03	479.02
2	270	400	434.17	443.48	457.15	478.15
3	270	500	443.30	456.30	474.96	504.37
3	270	600	440.40	454.29	473.90	505.24
4	270	800	447.63	465.93	492.44	535.94
5	270	1000	455.27	478.26	512.75	570.24

9) *CRITERIUM* 4:
CONSUMPTION 1000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .36 *DOLLARS PER GALLON*

		0.0	3.0	7.5	15.0
	100	440.23	443.96	449.55	458.86
	150	432.33	436.53	442.82	453.30
	200	427.13	X431.79	X438.77	X450.42
AS	300	432.07	440.41	452.93	472.80
ABOVE	400	X426.17	435.40	448.96	469.77
	500	433.30	446.18	464.66	493.77
	600	428.40	442.12	461.47	492.38
	800	431.63	449.62	475.67	518.40
	1000	435.27	457.78	491.55	547.84

10) *CRITERIUM 3:*
CONSUMPTION 2000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .38 *DOLLARS PER GALLON*

DELIVERY	*INTEREST RATE*			
SIZE	0.0	3.0	7.5	15.0
100	861.80	862.76	864.19	866.59
150	849.00	850.43	852.59	856.17
200	841.60	843.51	846.38	851.15
300	832.80	835.66	839.95	847.09
400	827.00	830.80	836.50	845.21
500	822.60	827.34	834.45	843.75
600	818.80	824.47	832.56	842.69
800	812.60	820.13	829.50	X 841.95
1000	X807.20	X816.30	X827.30	843.00

11) *CRITERIUM 4:*
CONSUMPTION 2000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .38 *DOLLARS PER GALLON*

TANK NO	*SIZE*	*DELIVERY SIZE*	*INTEREST RATE* 0.0	3.0	7.5	15.0
1	270	100	874.13	877.87	883.46	892.80
1	270	150	861.33	865.54	871.86	882.38
1	270	200	853.93	X 858.62	X 865.65	X 877.36
2	270	300	857.47	865.88	878.49	899.51
2	270	400	X 851.67	861.02	875.05	897.62
3	270	500	859.60	872.66	892.26	922.37
3	270	600	855.80	869.80	890.38	921.31
4	270	800	861.93	880.56	906.58	946.79
5	270	1000	868.87	891.84	923.65	974.04

12) *CRITERIUM 4:*
CONSUMPTION 2000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .36 *DOLLARS PER GALLON*

		0.0	3.0	7.5	15.0
	100	872.13	875.86	881.46	890.78
	150	858.33	862.54	868.84	879.35
	200	849.93	854.61	X 861.62	X 873.31
AS	300	851.47	859.85	872.43	893.40
ABOVE	400	X 843.67	X 852.98	866.95	889.43
	500	849.60	862.60	882.11	912.07
	600	843.80	857.71	878.16	908.88
	800	845.93	864.41	890.20	930.02
	1000	848.87	871.60	903.05	952.84

13) *CRITERIUM 2:*
CONSUMPTION 1000 *GALLONS PER SEASON*

TANK NO	TANK SIZE	DELIVERY SIZE	INTEREST RATE 0.0	3.0	7.5	15.0
1	1000	300	42.73	50.86	63.06	83.38
1	1000	500	39.63	49.68	64.76	89.88
1	1000	800	37.63	50.56	69.96	102.28
1	270	200	35.13	39.83	46.87	58.61

14) *CRITERIUM 2:*
CONSUMPTION 2000 *GALLONS PER SEASON*

		0.0	3.0	7.5	15.0
AS	300	62.13	70.26	82.46	102.78
ABOVE	500	55.93	65.98	81.06	106.18
	800	51.93	64.86	84.26	116.58

15) *CRITERIUM 4:*
CONSUMPTION 1000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .36 *DOLLARS PER GALLON*

		0.0	3.0	7.5	15.0
AS	300	430.73	438.78	450.84	469.97
ABOVE	500	419.63	429.44	443.31	464.73
	800	405.63	417.77	435.04	463.15

16) *CRITERIUM 4:*
CONSUMPTION 2000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .36 *DOLLARS PER GALLON*

AS		0.0	3.0	7.5	15.0
ABOVE	300	850.13	858.22	870.35	892.27
	500	835.93	845.86	861.81	884.53
	800	819.93	833.23	850.41	875.97

17) *CRITERIUM 4:*
CONSUMPTION 1000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .36 *DOLLARS PER GALLON*

TANKS	*DELIV.*	0.0	3.0	7.5	15.0
1/270+	300	443.07	453.89	470.11	496.18
1/1000	500	431.97	444.55	462.58	490.94
	1000	409.27	425.93	450.93	492.59
1/270	200	431.13	435.81	442.82	454.51

18) *CRITERIUM 4:*
CONSUMPTION 2000 *GALLONS PER SEASON*
OIL PRICE AT FIRST DELIVERY .36 *DOLLARS PER GALLON*

TANKS	*DELIV.*	0.0	3.0	7.5	15.0
1/270+	300	862.47	873.33	889.62	918.48
1/1000	500	848.27	860.97	881.08	910.74
	1000	822.87	840.31	863.13	898.59
1/270	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 17 and 18 assume a consumer who already owns 1 270 gallon tank and compares the investment alternatives of an additional 270 gallon or 1000 gallon tank. Only for the 2000 gallon user the investment into a 1000 gallon tank is profitable.

6. Conclusion

Although the cost reductions which could result from larger delivery sizes are substantial for the oil distributor, even the complete transfer of the reductions to the consumer does not provide a sufficient incentive for the purchase of additional tank capacity. For example:

An increase in the delivery size from 200 to 400 gallons reduces delivery cost by .5 cent per gallon or by $ 5 if 1000 gallons are consumed per season (compare Figure 1). In order to realize this increased delivery size the consumer has to invest into an additional tank and a larger oil inventory at a cost of $ 17 per season (compare Tables 1 and 2).

Of the variables that could increase the attractiveness of a larger tank capacity (such as a low interest rate, a large annual consumption) only the realization of oil price differences can be a sufficiently strong incentive to buy tank capacity in addition to one 270 gallon tank. For example:

A consumer of 1000 gallons per season who owns a 270 gallon tank needs a price reduction of 10% (from 40 to 36 cent for the first delivery throughout the depreciation period for the tank) to profit from additional tank capacity.

A future consumer who does not own tank capacity has a better chance to save money from the purchase of a tank size larger than 270 gallons. A 5% cost reduction for the first delivery is sufficient to warrant a 1000 gallon tank for a consumer with a consumption of 2000 gallons per season.

Appendix: Data Used to Compute Figure 1

Time variable truck cost TC = 18400 $ per year and truck.

Mileage variable truck cost MC = 2800 $ per year and truck.

Average mileage per tour, which is invariant of the number of stops FM = 20 miles per tour.

Average time per tour which is invariant of the number of stops FT = 98 minutes per tour.

Set-up time at each stop PTR = 5 minutes per stop.

Average number of miles between two stops MSR = 1.5 miles per stop.

Driving speed between stops SR = 15 miles per hour.

Truck capacity CAP = 3200 gallons per truck.

Average delivery size DR = 200 gal per delivery and customer.

Number of gallons distributed per truck and year DIS = 930000 gallons per year.