SESSION V
Paper (a)

LIMITED SCALE LOGGING - RELEVANCE OF HARPCE MODEL AND COST OF SHIFTS

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Limited Scale Logging (L.S.L.) generally implies that production, for one reason or another, is restricted and that manpower and machinery cannot be used to optimum efficiency. More often than not the term "Limited Scale" is associated with woodlot and shelterbelt logging and the proverbial "scrubby gully down the back end of the farm".

The topic has received little attention from FRI harvesting researchers as compared with other areas it is not considered a high research priority.

This paper comments on two aspects of FRI work that need to be better understood by those involved in L.S.L. Part one comments on the harvesting computer program called HARPCE. Part two discusses additional logging costs incurred as a result of the high number of "shifts" associated with this type of operation. Note that "shifts" is used here to mean moving equipment and men to a new logging site and not just moving to a new setting.

PART ONE : HARPCE

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HARPCE (1), or the "Harvesting Production and Cost Estimator" is a computer program incorporated into the Silvicultural Stand Model (SILMOD). This program deals with logging procedures, and the transport of timber from the logging site to the sawmill. Given a predicted tree size at the time of clearfelling, it provides an estimate of logging and cartage costs using information supplied by the user.

Because the program can be run independently of other programs, it has been assumed by some that HARPCE can be used to predict precise logging costs and production levels for small forest woodlots and shelterbelts. This is not so, and HARPCE, in its current format, is not suitable for examining L.S.L. It is important that those involved in L.S.L. are fully aware of HARPCE's limitations. These are outlined below.

LIMITATIONS

(i) Because of the data base used to develop the model, HARPCE is truly applicable only to clearfelling operations in stands of *Pinus radiata*.

(ii) All of the logging conditions and time study data used to develop the program are based on logging operations within commercial forests. None of these could be regarded as Limited Scale.

(iii) HARPCE limits the choice of logging systems to four, and further restricts the use of these systems to particular topography classes, as shown below.

Topography Class	Slope (deg.)	Preferred System	Alternative System
1	0 - 10	Skidder	Tractor, Hauler
2	10 - 20	Tractor	Hauler
3	20 - 35	Hauler (210 kW)	None
4	35+	Hauler (335 kW)	None

Each of the systems is a "Hot Deck" (2) system.

(iv) The program contains formulae for calculating production for each logging system and these cannot be adjusted by the user. The only way the user can modify production estimates is by adjustment of the recoverable tree size.

(v) The average hauling distance for each system is also set in the program. For the ground based systems of skidder and tractor it is 140 metres and for the two hauler systems 170 metres.

(vi) Because HARPCE is based on production forest logging conditions it has a lower stocking limit of 200 stems per hectare.

(vii) All of the costs contained in the program and the subsequent estimates of logging costs are based on the FRI costing approach (3) and assume new equipment prices.

(viii) Logging transport within HARPCE is restricted to trucking, using a 175 kW, 6 axled truck and trailer. Payloads are 25 tonne for on-highway and 30 tonne for off-highway.

(ix) All public roads are assumed to be Ministry of Works Class I standard (4). The distance logs are to be carted is an input item with truck production calculated by formulae contained in the program.

HARPCE should be seen as part of a tool (the SILMOD model) for investigating the effects of various silvicultural treatments on the productivity and profitability of a stand. It is not designed for investigating the results of manipulating the logging operation itself.

L.S.L. presents a different situation with different operational requirements and costs to a commercial forest, e.g. more edge trees, more equipment shifts, restricted access, generally older equipment, and lower production levels. Therefore HARPCE is not suited to estimating costs of L.S.L.

To extend or modify HARPCE to apply to L.S.L. requires a good data base, but to date there is little documentation on L.S.L. sites and systems. To collect and analyse the required data and modify HARPCE would require many months of research. This seminar may indicate whether this is warranted.

REFERENCES

1. Blundell, W.; Evison, D; Reutebuch, S. 1985. "Harvesting and Production and Cost Estimator". Forest Research Institute (in press).

2. "Loggers language. A New Zealand terminology". 1985. N.Z. Logging Industry Research Assoc.

3. "The Principles and practices of costing as applied to log harvesting systems management". N.Z. Forest Research Institute, Economics of Silviculture, Report No. 87 (unpubl.).

4. "Heavy Motor Vehicle Regulations 1974". Ministry of Works and Development.

PART TWO : THE COST OF SHIFTING

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The number of small, privately owned woodlots, shelterbelts and agroforestry areas due for logging will increase in the near future as a result of plantings during the 1960s and subsequent years (Liley 1985).

In logging these widely scattered, smaller sites, many "economies of scale" that reduce costs for large commercial operations do not apply. An increased logging cost resulting from frequent, lengthy equipment shifts is one example.

The costs of shifting for four logging systems (specified in Table 1) are compared in Table 2, using data from logging standards (1), Heavy Haulage Association (6), Road Transport Association (4), and the Ministry of Works.

TABLE 1 : SYSTEMS COMPARED FOR SHIFTING COST

SKIDDER	TRACTOR	HAULER	HAULER
137 kW 5 crew 3 saws	90 kW 5 crew 3 saws	164 kW 9 crew 6 saws	375 kW 9 crew 6 saws
LOADER, GANGBUS, CARAVAN, COMMON TO ALL SYSTEMS			

These systems - skidder, tractor and two sizes of hauler - are commonly used in New Zealand production forests, and often their use is extended to Limited Scale Logging. However, they are not necessarily the most suitable systems for logging small areas.

For each system, values were assigned for fixed and variable daily costs and daily production. Shifting times were estimated for shifts of 25, 75 and 150 km, and finally shifting costs were calculated. Included in shifting time were such items as rig/unrig time, transporter travel time, etc., and in shifting cost, cost of transporters, piloting cost, special permit fee and loss of production during the shift.

Trailer-mounted Skagit spar being manoeuvred into position on a new landing by a transporting truck.

(LIRA Photo L188/18)

TABLE 2 : SHIFTING COSTS ($) AND SHIFTING TIMES (DAYS)

SYSTEM		SHIFT DISTANCE (KMS)			DAILY PROD. (m3)
		25	75	150	
Skidder	Cost	512	910	1378	300
	Days	0.50	0.75	1.00	
Tractor	Cost	512	910	1378	250
	Days	0.50	0.75	1.00	
Hauler 164	Cost	677	1274	2183	200
	Days	1.50	1.75	2.00	
Hauler 375 S.P	Cost	307	622	1167	250
	Days	0.75	1.00	1.38	
Hauler 375 D.M.	Cost	1227	1950	3109	250
	Days	2.75	3.10	3.25	

Hauler D.M. = Dismantled for transporter
Hauler S.P. = Self propelled
Days = Productive days required to perform shift

For the large hauler, two shifting methods were examined. The first was to completely dismantle the tower and cab (D.M.) so that the machine was in three separate components, as is sometimes required for compliance with height and weight roading limitations. The second method (S.P.) was to lower the tower into its holder on the cab and drive off - as is done for "in forest" shifts.

These figures were used to calculate logging costs ($\$/m^3$) for the different systems, with a varying number of annual shifts within each of the kilometre classes (Appendix 1). The relationship between overall cost and number of shifts is illustrated, for each system, in Fig. 1. (As the trend for tractors was the same as for skidders it is not shown).

For both tractors and skidders, there is a gradual increase in logging cost as the number of shifts increases, with a 60% increase at 50 shifts of 150 kilometres.

For haulers, the logging cost is more sensitive to number of shifts, but the increase depends on the system used. It is greatest for the dismantled large hauler, reaching 500% for 50 long (150 km) shifts.

These figures provide a guide to overall annual logging cost, for a particular system, shift distance and number of shifts. For this analysis, production, shift times and direct costs of shifting have been assigned representative values based on data from production forests. In practice these parameters can vary between different logging operations and so influence final cost. To examine the importance of this variation, logging costs for the 75 km shift class were recalculated, adjusting the parameter values in Table 2 up and down by an arbitrary 25%. Results are given in Appendix 2 and graphed in Fig. 2. (As these calculations were intended only as broad guidelines, results for the self-propelled hauler are not included.)

Adjusting the direct shifting COST by 25% has little effect on overall logging cost.

Adjusting the shifting TIME by 25% has little effect for skidders, however, for haulers the logging cost could increase by 100% where dismantling of the system for a lot of shifts occurs.

Adjusting the daily production VOLUME by 25% results in a consistent 25-33% shift in logging cost.

The preceding analysis of shifting costs in a production forest situation provides a basis for examining the effect of equipment shifts on the logging cost for L.S.L.

A small-scale survey of farm woodlots indicated that these sites are typically 4-5 hectares in size, contain about 1800 m^3, and are situated approximately 70-80 kilometres apart. Given these characteristics and the levels of production and shift time in Table 2 the number of shifts per year for each logging system is :

Skidder	32 shifts
Hauler 164	21 shifts
Hauler D.M.	21 shifts

Based on these shift numbers, the increase in logging cost over the cost of the same system operating without shifts is approximately 22% for a skidder, 31% for a hauler 164, and 59% for a hauler D.M. These increases, however, are calculated on the assumption that the logging systems operating in small woodlots can maintain a level of production comparable to that of a full time logging contractor operating in a production forest. Realistically a lower daily production level will be most likely, for the reasons outlined in the HARPCE paper and by other speakers.

To better represent a woodlot logger the calculations were repeated, reducing the values of daily production in Table 2 by a conservative 25%, but applying the same number of shifts as above.

Table 3 compares logging costs for a production forest contractor, working full time without shifts, and those of a woodlot logger, on 25% less production and making 32 or 21 shifts.

TABLE 3 : LOGGING COSTS : FOREST VERSUS WOODLOT

	FOREST ($\$/m^3$)	NO. SHIFTS	WOODLOT ($\$/m^3$)	NO. SHIFTS	COST INCREASE
Skidder	5 - 16	0	8 - 41	32	+ 63%
Hauler 164	11 - 72	0	20 - 50	21	+ 75%
Hauler D.M.	11 - 03	0	23 - 42	21	+112%

It is acknowledged that other options do exist for logging limited scale areas. These include cutting to length in the bush for a smaller hauler, contour tracking to utilise skidders/ tractors, use of helicopters, and clearfelling stands early to eliminate the need for large haulers. What this analysis demonstrates, however, is the importance of planning. As indicated in Table 3, costs rapidly escalate when there are frequent shifts of equipment and production is not maintained.

CONCLUSIONS

In order to maximise profits from L.S.L., the operation must be well planned and efficient.

Important points are :

(i) The sequence of areas to be logged must be decided in advance to avoid unnecessary equipment shifts.

(ii) An appropriate logging system needs to be employed which will keep production at as high a level as possible.

(iii) Logging should be carried out by experienced personnel who have both the practical knowhow and the planning skills required for this type of operation.

To achieve all this, a high level of co-operation is required between the buyer, the grower and the logger.

REFERENCES

1. Blundell, W.M.; Evison, D.C.; Reutebuch, S.E. 1984. "Harvesting production and cost estimator - program HARPCE". New Zealand Forest Service, FRI Bulletin (in prep.).

2. Liley, W.B. 1985. "The Small Scale Forest Resource".

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3. McGonagill, K. 1975. "Willamette Skyline Appraisal Guide". Book Four 3rd Rev. Willamette National Forest.

4. NZ Contractors Federation 1984. "Guide to NZ Plant Hire Rates".

5. Simpson, J.W. 1983. "Rigging Procedure for Spars". NZ Logging Industry Research Assn. Inc.

6. NZ Heavy Haulage Association (Inc.). Minimum Rates Schedule (March 1984).

FIGURE 1 - ANNUAL LOGGING COST WITH VARYING NUMBERS OF SHIFTS AND SHIFT DISTANCES

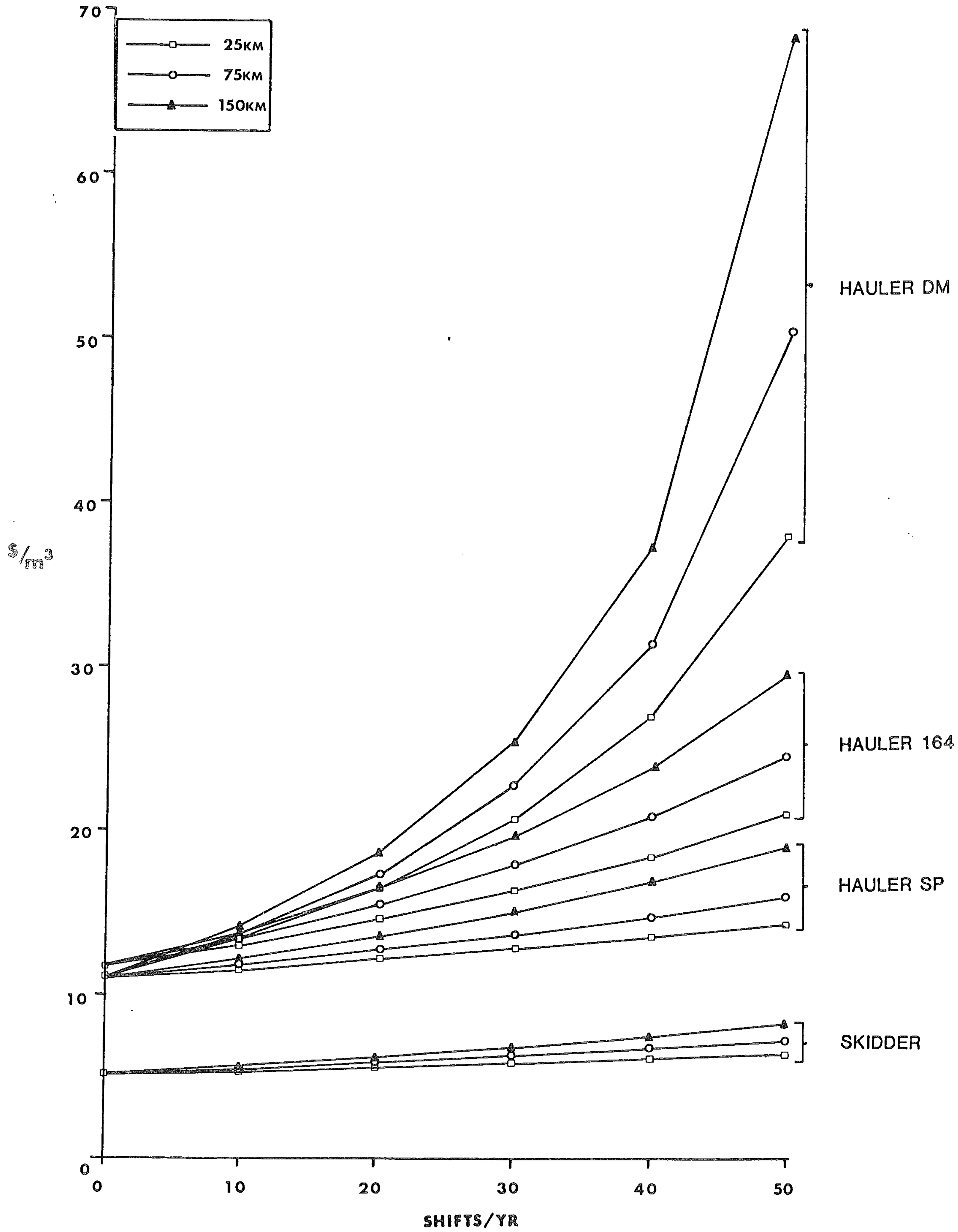


FIGURE 2 (A) - LOGGING COST WITH ADJUSTED VARIABLES : SKIDDER

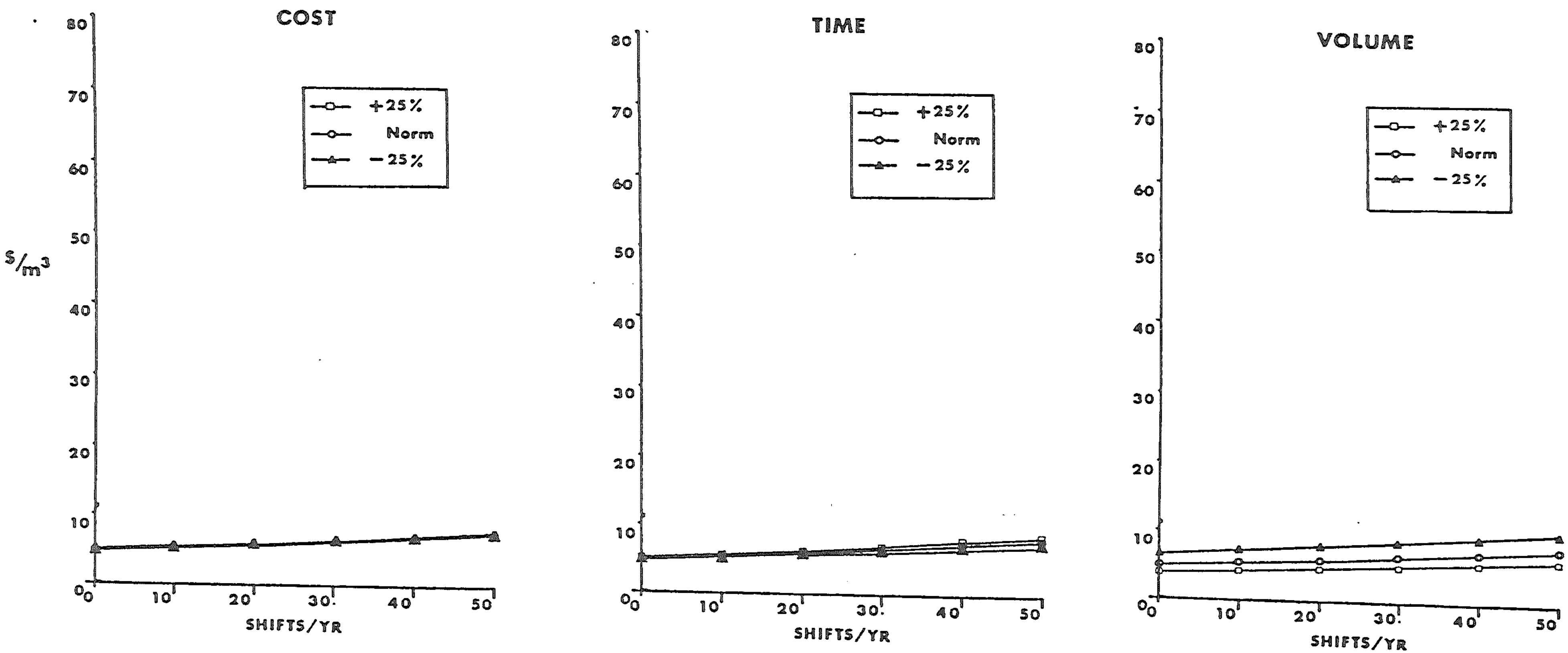


FIGURE 2 (B) - LOGGING COST WITH ADJUSTED VARIABLES : HAULER 164

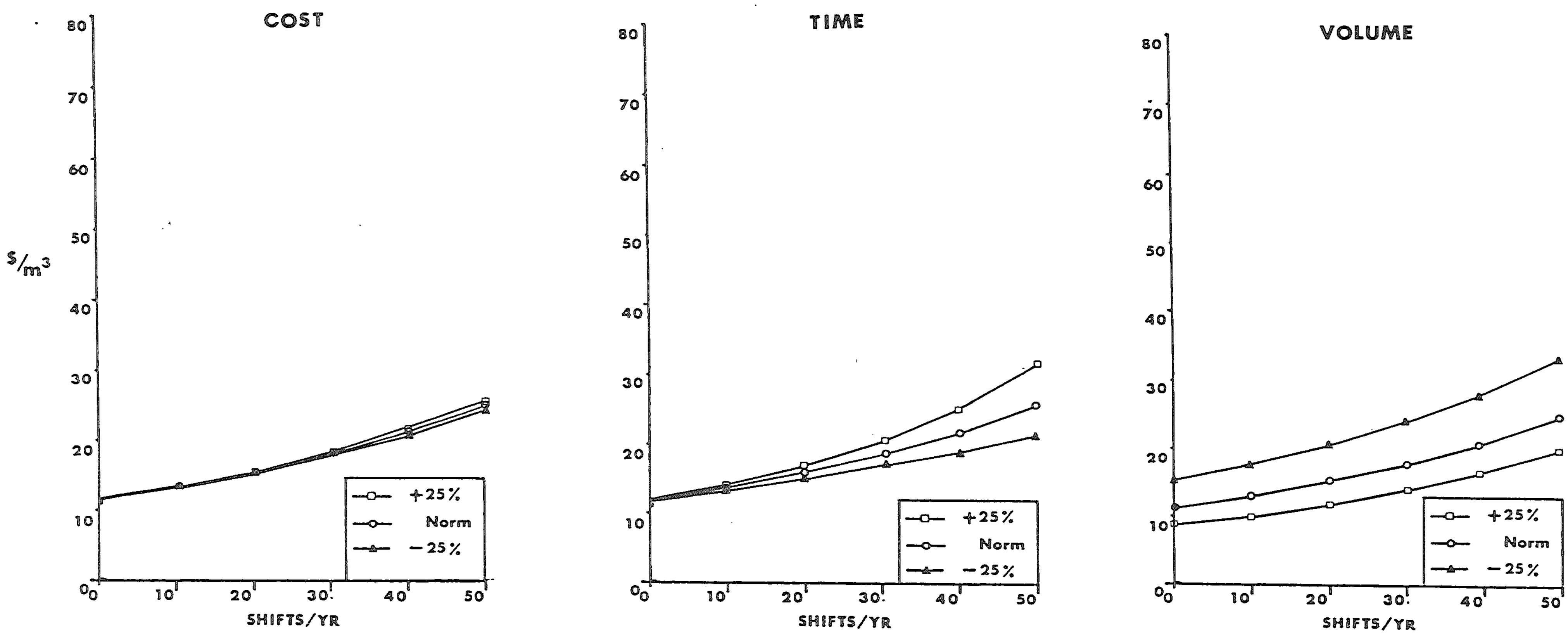
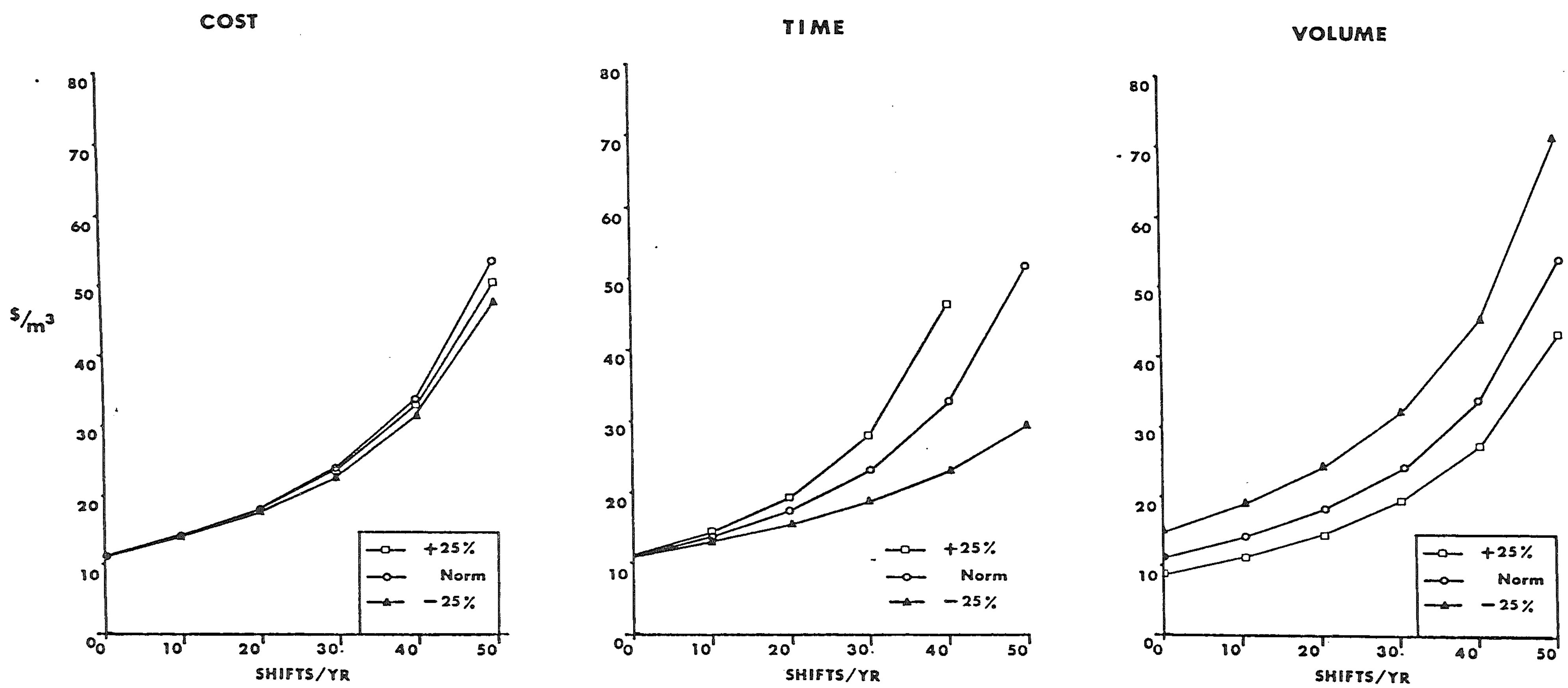


FIGURE 2(C) : LOGGING COST WITH ADJUSTED VARIABLES : HAULER DM



APPENDIX 1

LOGGING COST ($\$/m^3$) : INCREASE WITH SHIFTS

NO. SHIFTS	DISTANCE PER SHIFT		
	25 km	75 km	150 km
Skidder			
0	5.16	5.16	5.16
10	5.38	5.52	5.67
20	5.61	5.90	6.22
30	5.85	6.27	6.84
40	6.13	6.75	7.53
50	6.37	7.23	8.29
Hauler S.P.			
0	11.03	11.03	11.03
10	11.58	11.82	12.19
20	12.18	12.68	13.53
30	12.82	13.65	15.07
40	13.51	14.71	16.87
50	14.26	15.91	19.01
Hauler D.M.			
0	11.03	11.03	11.03
10	13.29	13.66	14.16
20	16.33	17.30	18.58
30	20.60	22.67	25.43
40	27.07	31.34	37.40
50	38.02	50.29	68.10
Hauler 164			
0	11.72	11.72	11.72
10	13.03	13.39	13.83
20	14.54	15.38	16.43
30	16.33	17.79	19.69
40	18.45	20.78	23.90
50	21.03	24.58	29.55

APPENDIX 2

LOGGING COST ($\$/m^3$) WITH ADJUSTED VARIABLES

	NO. SHIFTS	+ 25%	NORM	- 25%
Shifting Time				
Hauler D.M.	0	11.03	11.03	11.03
	10	14.35	13.75	13.03
	20	19.43	17.56	15.55
	30	28.15	23.28	18.83
	40	46.63	32.81	23.28
	50	112.09	51.88	29.64
Hauler 164	0	11.72	11.72	11.72
	10	13.77	13.39	13.02
	20	16.35	15.38	14.50
	30	19.67	17.79	18.17
	40	24.11	20.78	18.17
	50	30.37	24.58	20.48
Skidder	0	5.16	5.16	5.16
	10	5.57	5.52	5.43
	20	6.02	5.90	5.72
	30	6.52	6.27	6.02
	40	7.07	6.75	6.34
	50	7.68	7.23	6.68
Production Volume				
Hauler D.M.	0	8.82	11.03	14.70
	10	11.00	13.75	18.34
	20	14.05	17.56	23.42
	30	18.63	23.28	31.04
	40	26.25	32.81	43.75
	50	41.50	51.88	69.17
Hauler 164	0	9.37	11.72	15.62
	10	10.71	13.39	17.85
	20	12.30	15.38	20.50
	30	14.23	17.79	23.72
	40	16.63	20.78	27.71
	50	19.67	24.58	32.78
Skidder	0	4.13	5.16	6.88
	10	4.41	5.52	7.36
	20	4.72	5.90	7.87
	30	5.05	6.27	8.41
	40	5.40	6.75	9.00
	50	5.79	7.23	9.65

APPENDIX 2 (Cont.)

LOGGING COST ($\$/m^3$) WITH ADJUSTED VARIABLES

	NO. SHIFTS	+ 25%	NORM	- 25%
Shifting Cost				
Hauler D.M.	0	11.03	11.03	11.03
	10	13.77	13.66	13.56
	20	17.55	17.30	17.06
	30	23.13	22.67	22.21
	40	32.15	31.34	30.54
	50	49.25	47.79	46.34
Hauler 164	0	11.72	11.72	11.72
	10	13.47	13.39	13.31
	20	15.55	15.38	15.20
	30	18.08	17.79	17.50
	40	21.22	20.78	20.35
	50	25.20	24.58	23.97
Skidder	0	5.16	5.16	5.16
	10	5.55	5.52	5.48
	20	5.97	5.90	5.82
	30	6.43	6.27	6.19
	40	6.91	6.75	6.59
	50	7.44	7.23	7.02