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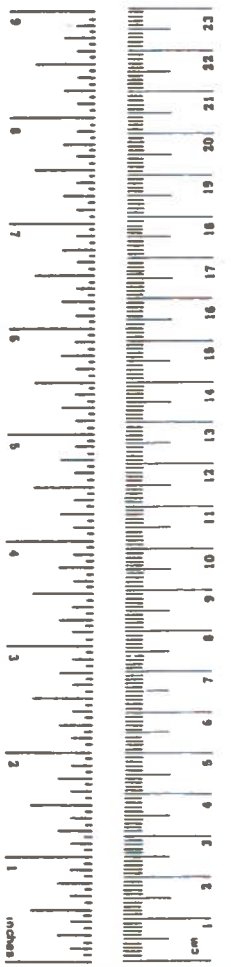
METRIC CONVERSION FACTORS

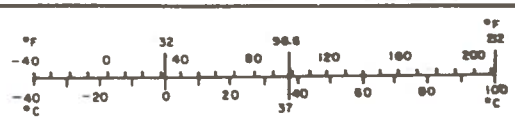
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°f	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°c



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°c	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°f



EXECUTIVE SUMMARY

This study of the cargo loss and damage statistics collected by the Interstate Commerce Commission (ICC) has been conducted to further define the total extent of intercity motor carrier cargo loss, both in terms of the absolute dollar loss, and of the loss as a ratio to the operating revenue, in the absence of complete data.

To accomplish this required two tasks:

1) The development of a method such that the national cargo loss for the motor carrier industry could be estimated with maximum precision, and

2) The assessment of the data on which the method is based, including the verification of the representativeness of the regulated motor carriers for the entire industry in their cargo loss experience.

In task 1, the method of ratio estimation is introduced and its feasibility statistically justified. Based on a random sample of 134 regulated motor carriers, the method gives rise to a standard error of a little more than 5 percent, resulting in a 95 percent probability that the intercity theft-related cargo loss value lies somewhere in the interval ($265 Millions, $330 Millions).

Task 2, however, presents some complications, as the assumption of representativeness is tested on two grounds: one, that cargo loss is randomly distributed throughout all regions and all commodities; and two, that the statistical distribution of the auxiliary variable used in task 1, operating revenue, is similar among the nonregulated and regulated motor carriers. The results of task 2 are summarized as follows.

Although no significant differences in the risk of cargo transportation, which is measured in terms of expected loss per operating revenue, are found across the nine ICC regions, theft-related loss is found to be commodity specific. Based on the reports from the General Freight Carriers, bulk commodities or commodities which are often shipped in truckloads, such as food, metal products, machinery, chemical products, etc., encounter much less risk than manufactured consumer items such as watches, cameras, clothing, TV and radios, toys and games. The former group carries a loss ratio from .001 to .0026, whereas the latter has a ratio from 0.75 to .45. Since the private carriers ship only one-third as much general freight as the motor carriers, very little of which are high risk items, and the exempt carriers transport only unprocessed agricultural products, the average theft-related loss ratio is lower for the nonregulated carriers of special commodities.

With respect to the distribution of the size of operation, as indicated by the total annual operating revenue or the total fleet size of a carrier, significant difference exists between those regulated carriers represented by the ICC data base and those excluded from it. An estimated 8 percent upward bias in the national estimate is apparent because the sample taken from the regulated segment represents only the upper spectrum of the motor carrier industry (i.e. carriers with annual operating revenue averaging $1,000,000 or more and having a fleet size of 60 to 100 truck/tractors). The missing elements, the smaller carriers, comprise 40 percent of the nonregulated and 12 percent of the regulated revenue, and are believed to have lower, but less stable, cargo loss ratios.

Hence, the results of task 2 indicate the possibility that of the interval estimate, ($265M, $330M), derived in task 1 is only an upper bound for the industry wide intercity theft-related loss.

The problem of hijacking was also considered, and was found to be most acute on the east coast, particularly in New England and the Mid-Atlantic Region. Although hijacking constitutes only 2 to 3 percent of the total theft and shortage loss, it hits most commodities, and the average loss per claim ranges from $600 to $2000, as opposed to the $60 to $250 for other theft and pilferage loss.

The details of the method and analyses summarized in this section are documented in the following report.

1. INTRODUCTION AND BACKGROUND ON THE COLLECTION AND DISSEMINATION OF CARGO SECURITY INFORMATION

This study represents an element of a continuing program to define the losses incurred during the transportation of products. Improvement in the definition of the national problem would greatly facilitate the development of remedial action with respect to federal policy and program planning. As early as 1969, the Senate small business committee, headed by Senator Alan Bible, began investigatory hearings into the general problem of cargo theft in the entire freight industry. The investigation revealed the appalling fact that the trucking industry, which hauls more cargo than any other mode, also sustains the greatest cargo loss. A generalized estimate made for 1970 showed that truck thefts and hijacking alone probably cost the industry $900 million a year. The total loss to the four transportation modes-trucks, rail, maritime, and air-was estimated at $1.5 billion. In the same year, the Trucking Industry Committe on Theft and Hijacking (TITCOTH) began analyses on the theft and loss data supplied to the National Freight Claim Council voluntarily and sporadically by some 70 to 80 regulated motor carriers of general freight, which led to the projection of $2.6 million in losses for all "for hire" carriers in 1970. Such data was reviewed by the Department of Transportation and found to be "only indicative of the larger motor carriers experience and measure the 'general' level of their general freight total loss and damage per dollar of operating revenue. The data did not provide and adequate statistical basis for valid judgement as they are not representative of the industry wide experience." As a follow-up on Bible's study on cargo theft, a four day cargo crime conference in Washington was organized by the Secretary of

Transportation, John A. Volpe, in 1971, marking the first attempt by a federal agency and the industry to delineate the extent of the problem. Simultaneously, the Interstate Commerce Commission issued an order requiring all Class I (over $1,000,000 annual gross operating revenue) motor carriers of property to file quarterly reports of freight loss and damage claims. Although these data are by far the most extensive and detailed cargo loss data base ever developed, there is still expressed concern about the projection of a national loss estimate to represent the entire motor carrier industry. The task in our study is to assess the adequacy of our present cargo security data and the validity of such a national projection.

2. DESCRIPTION OF CARGO LOSS DATA BASE

2.1 STRUCTURE OF THE MOTOR CARRIER INDUSTRY

All constructions of national estimates of cargo loss in the trucking industry depend, of course, on the details and quality of the source data and on a knowledge of the structure of the trucking industry. The intercity motor industry is divided into three major components: the regulated motor carriers, private motor carriers, and exempt motor carriers. The relationship between these and the further subdivisions is shown in Figure 2-1.

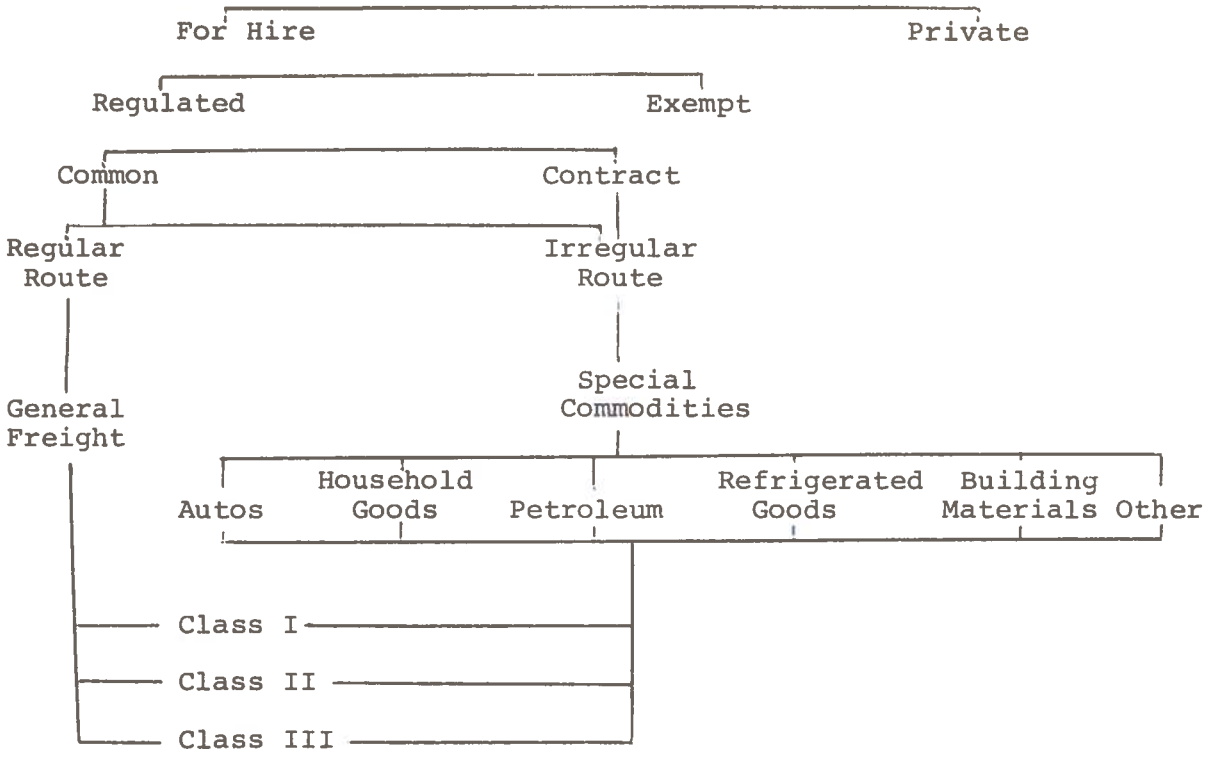


FIGURE 2-1. STRUCTURE OF THE MOTOR CARRIER INDUSTRY

Terms used in Figure 2-1 defined below.

Private Carrier - A company that maintains its own trucks to transport its own freight as an adjunct to its primary business. A small percent of private carriers also carry exempt commodities for other shippers as well as their own goods.

Common Carrier - A transportation business that offers service to the general public. Interstate common carriers must hold a franchise issued by the ICC that limits service to a specific geographical area. .

Contract Carrier - A trnasportation business that offers service to a designated (small) group of customers. Interstate contract carriers must hold a franchise issued by the ICC.

Class I Motor Carriers - Common or contract carriers of property that have average annual gross operating revenues from motor carrier operations of $1 million or more prior to 1974, or $3 million or more after 1974.

Class II Motor Carriers - Common or contract motor carriers of property that have average annual gross operating revenues from motor carrier operations of between $500,000 and $3 million after 1974, or between $500,000 and $1,000,000 prior to 1974.

Class III Motor Carriers - Common or contract motor carriers of property that have average annual gross operating revenues of less than $500,000 from motor carrier operations.

Exempt Carriers - Intercity for hire carriers which engage in the movement of certain specialized commodities, the carriage of which is exempt from the regulations. Most of these carriers carry unprocessed agricultural and horticultural products and livestock. It should be noted here that the owner-operators, those people who own and operate their own trucks without possessing Interstate Commerce Commission operating authority, can also be found in every sector of the

motor trucking industry simply by leasing themselves to the regulated and private sectors. They are however of greatest relative importance in the exempt sector, where they dominate all other operations.

2.2 COVERAGE OF THE CURRENT CARGO LOSS DATA BASE

The Interstate Commerce Commission, effective the fourth quarter of 1971, required common and contract motor carriers of property with average annual gross operating revenues of $1 million or more to file quarterly reports of freight loss and damage claims (Form QL&D). The QL&D forms provide the basis for the ICC cargo security statistics. The details of the reporting form are shown in Appendix A. It should be noted that only motor carriers of general freight are required to file Schedule A of the ICC form QL&D. Although there was no statistical proof, it was asserted that theft and loss problems do not exist for contract and specialized common carriers to the degree that they do for common carriers of general commodities. Schedule B, filed by common and contract carriers, does not contain losses due to shortage (failure to deliver all or part of shipment to consignee for unknown reasons). Since over 80 percent of shortage is considered due to theft, the shortage amount is included in the "theft-related" loss figure.[1]

Since detailed cargo loss data is available only for Class I and some Class II carriers of general freight, the relative size of this portion of the industry is of fundamental importance. The contribution of this sector is represented in Figure 2-2 in terms of operating revenue, number of trucks

[1] The question of whether to generalize shortage as theft related remains doubtful to many truckers and transportation planners alike. For purpose of consistency, the conventional definition is used.

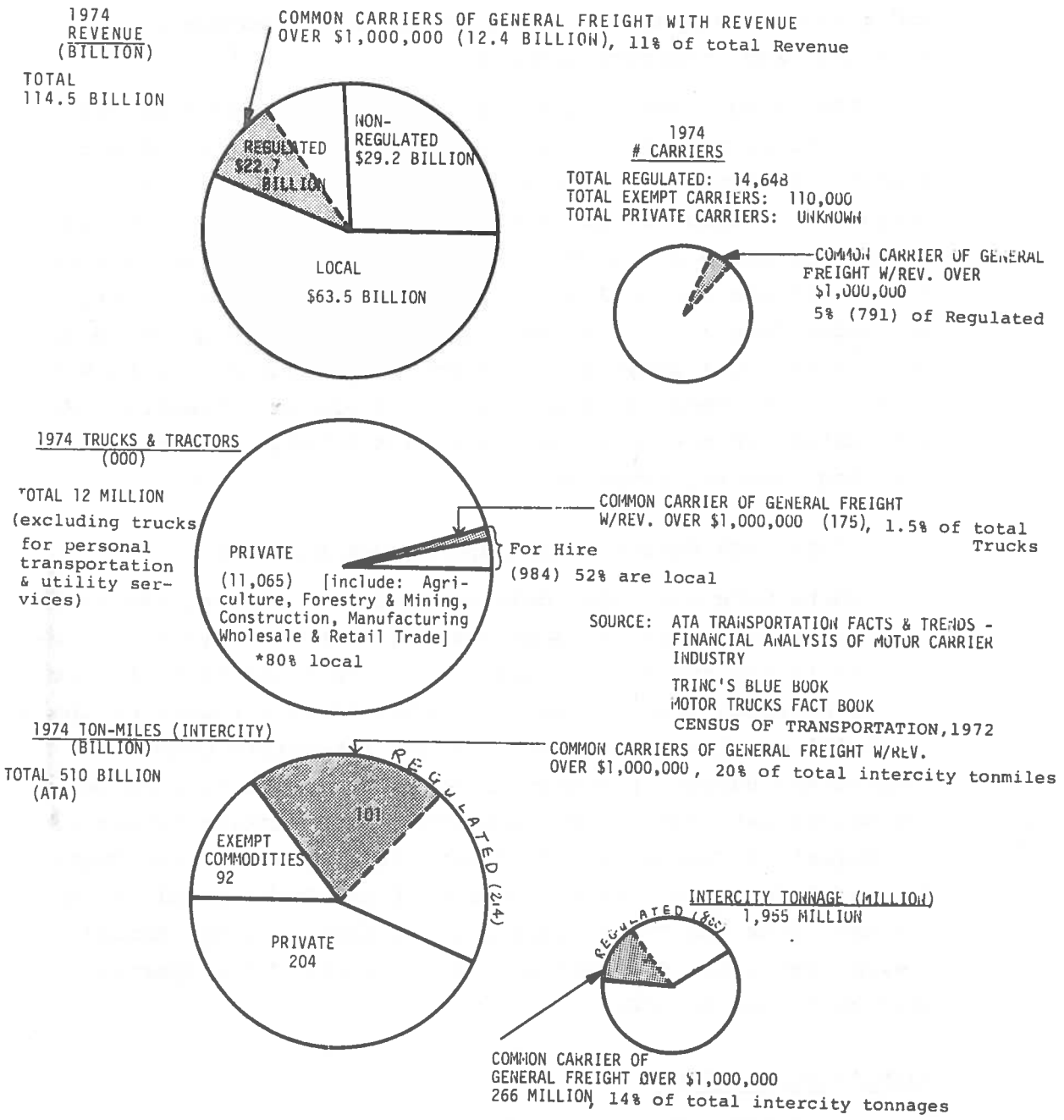


FIGURE 2-2. CARGO LOSS DATA COVERAGE, 1974

and tractors, number of intercity ton miles, number of carriers, and intercity tonnage.

The Class I and II carriers, for which cargo loss data is available, constitute only 1.5 percent of the total population in terms of number of trucks, 11 percent in terms of operating revenue, 20 percent in terms of ton miles, and 14 percent in terms of intercity tonnage. Also, for those carriers that are not engaged in inter-state commerce and thus not under federal regulation, loss and damage to goods being transported goes unreported, except for incident filings with local police, security agencies, or insurance companies. No information on the local carriers is available except the trucking industry revenues.

2.3 OTHER DATA SOURCES PERTINENT TO OUR ANALYSES

There were six other data sources available at the time of this writing that had some bearing on the analysis of cargo loss in the trucking industry: the F&OS Quarterly Report of the American Trucking Associations, Inc.; a report on the Class III carriers of property by the Interstate Commerce Commissison Bureau of Account; the TRINC Master File of Dun and Bradstreet, Inc.; the Commodity Transportation Census of the Bureau of Census; a 1974 Financial Analysis of the Motor Carrier Industry by Peter D. Gorne of the Continental Illinois National Bank and Trust Company of Chicago; and the Annual Freight Commodity Statistics - Motor Carrier of Property, also published by ICC.

TRINC's MASTER FILE

The TRINC master tape, while not fully comprehensive, presents the largest single data source of operating statistics for the industry covering 174,433 private (non-regulated) fleets and 11,552 ICC-regulated fleets. The TRINC tapes thus cover 185,985 fleets or 2.5 million trucks and tractors out

of an industry total of 12 million trucks and tractors (during the year 1974). The difference, of course, can be explained partially by the definition of "fleet". There are simply thousands of private owners having fewer than five trucks. These are not accounted for on the TRINC tape, nor indeed in any data base.

The TRINC tape is limited, however, because:

1) The coverage of 2.5 million trucks and tractors out of 12 million private trucks only provides us with a 20 percent sample.

2) The quantities measured do not fit well with the ICC data; performance characteristics such as average length of haul, average load, etc., which further describe the non-regulated sector, were not reported.

3) The most important measure for predictive purposes, operating revenue, was only sparsely reported with many missing values.

TABLE 2-1. COVERAGE OF TRINC's TAPE

	Number of Carriers	% of Coverage	Number of Tractors & Trucks	% of Coverage
Non-regulated	157,087	N/A	2,322,116	18%
Non-regulated whose primary business is trucking (owner-operater)	16,247	16%	152,532	N/A
Regulated - Class I and Class II	1,759	75%	94,926	54%

Note: A carrier may have more than 1 fleet in different locations of the country.

3. ESTIMATION OF NATIONAL MOTOR CARRIER CARGO LOSS

It is true that, in terms of cargo theft, risk increases with the amount of exposure on the road, in warehouses, and in distribution terminals. Our objective in this paper, however, is not to suggest ways and means to fight cargo related crimes, nor to recommend policies to regulate the flow of motor carrier traffic. Rather, in this section we will outline the method of accurately quantifying the magnitude of the theft problem to include the non-regulated world of intercity motor carrier industry.

Computing estimates from a sample restricted to the regulated sector and extending the inferences to the non-regulated sector can present problems. Since no element of random selection is involved, we are in no position to calculate the frequency distribution of the estimates without permitting bias if they are to be applied to the entire population. Even if such a procedure appears to do well when the results are compared to "guess-estimates" of experts in the field, this does not guarantee that it will do well again under different circumstances. On the other hand, till the implentation of this study, there is no indication that the cargo loss experience of the non-regulated carriers is any different from the regulated ones, except for a general supposition that the private carriers could have a lower theft ratio because of tight traffic and inventory control. Hence, if the regulated carriers can be regarded as "typical" with respect to their theft and other cargo loss problems, useful estimates can be derived to represent the entire industry.

3.1 THE GENERAL PROCEDURE AND FEASIBILITY OF THE RATIO ESTIMATION

A common, consistent, and unbiased method of estimating an aggregate total from a sample is, of course, the straight-

forward sample average multiplied by the total number of units, N, in the population. That is, our national estimate of total theft-related dollars-loss can be taken as the average dollars loss per carrier multiplied by the total number of carriers, private or regulated, in the country. Under certain conditions, however, a superior method of ratio estimation is available, by which the total dollars loss can be obtained through the use of a covariate x. The reduction in variance depends on the validity of the inequality:

$$\rho > 1/2 \times \frac{\text{coefficient variation of } x}{\text{coefficient variation of } y} = 1/2 \left(\frac{S_x}{\bar{x}} / \frac{S_y}{\bar{y}}\right)$$

where ρ is the correlation coefficient between x and y.

A general theory in regression indicates that, for a large population, the ratio estimate is the best (minimum variance) linear unbiased estimate if: 1) the regression of y on x is linear through the origin, and 2) the variance of y about the regression line is proportional to x. If the above conditions are satisfied, the estimate for the total theft-related loss, Y, is :

$$\hat{Y} = \frac{\Sigma Y_i}{\Sigma x_i} X , \qquad (1)$$

and, for a large sample of size n, the approximate variance of the estimate is

$$\text{Var}(\hat{Y}) = \frac{N^2 (1-f)}{n(n-1)} \Sigma (Y_i - \hat{R}x_i)^2 ; \; \hat{R} = \frac{\Sigma Y_i}{\Sigma x_i} \qquad (2)$$

or, alternatively, since $N = Y/\bar{Y} \simeq \hat{Y}/\bar{Y}$, it can be shown that,

$$\text{Var}(\hat{Y}) = (1-f) \frac{\hat{Y}^2}{n} (S_y^2/\bar{y}^2 - 2 S_{xy}^2/\bar{y}\bar{x} + S_x^2/\bar{x}^2) \qquad (3)$$

It was contended earlier that a possible covariate could be the operating revenue, since the amount of loss correlates with the amount of cargo put on the road. A random sample of 134 common carriers of general freight with average gross earnings of $1,000,000 or more a year was selected from Transportation System Center current Cargo Security Data Base. Simple regressions were done as a first step to explore the feasibility of using the ratio estimate. Results of the regressions follow in Table 3-1.

Both regressions are highly significant as indicated by the high F values. Compared to the theoretical 95th percentile of the F(1, 132) distribution, the regression of the revenue on claim dollars paid and theft-related dollars loss prove to be highly linear with a squared multiple correlation coefficient of .89 and .83 respectively. That is, the relationship with revenue alone explains about 89 percent of the variation in the claims paid among the carriers in the sample, and 83 percent of the variation in total theft-related dollars loss. In both cases the regression lines can be taken as through the origin since the intercepts (coefficients C1 and A) are not significantly different from zero, as indicated by the very low T-statistics. The absolute values of the estimates of these intercepts are deceiving because of the high standard errors (ST ER) associated with them. Thus, condition 1 is hereby satisfied. Further, detailed plots of the residuals can be very informative about the goodness of fit of the regression lines. Each regression model calls for the basic assumptions that these residuals are uncorrelated and have mean zero and a fixed but unknown variance. In Figures 3-3 and 3-4, the residuals are shown randomly clustered around zero, but instead of having a fixed variance, their deviation from zero is proportional to the values of the x's. If an accurate least square estimation of the coefficients is important, a

TABLE 3-1. A N O V A S

1: CLAIM = C1+C2*REVENUE

NOB = 134 NOVAR = 2
RANGE = 1 TO 134
RSQ = 0.88644 CRSQ = 0.88558 F(1/132) = 1030.380
SER = 1.29E+05 SSR = 2.196E+12 DW(0) = 2.08

COEF	VALUE	ST ER	T-STAT
C1	-14771.90000	13340.50000	-1.10729
C2	0.01407	4.3840E-04	32.09950

1: DTHEFT = A+B*REVENUE

NOB = 134 NOVAR = 2
RANGE = 1 TO 134
RSQ = 0.82934 CRSQ = 0.82805 F(1/1321 = 641.484
SER = 6.49E+04 SSR = 5.564E+11 DW(0) = 1.80

COEF	VALUE	ST ER	T-STAT
A	2498.67000	6715.55000	0.37207
B	0.00559	2,20690E-04	25.32750

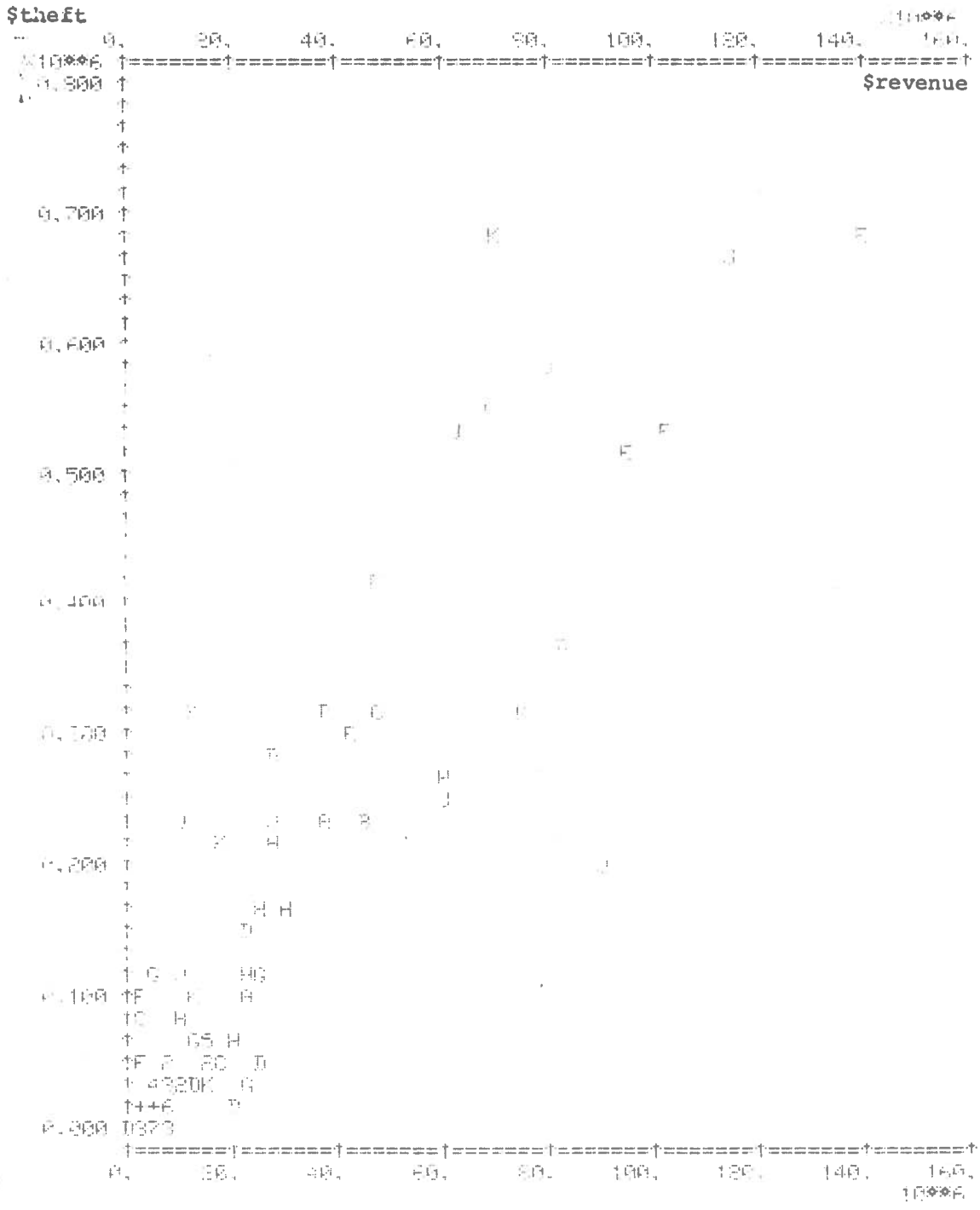


FIGURE 3-1. THEFT-RELATED DOLLARS LOSS VS. REVENUE DOLLARS

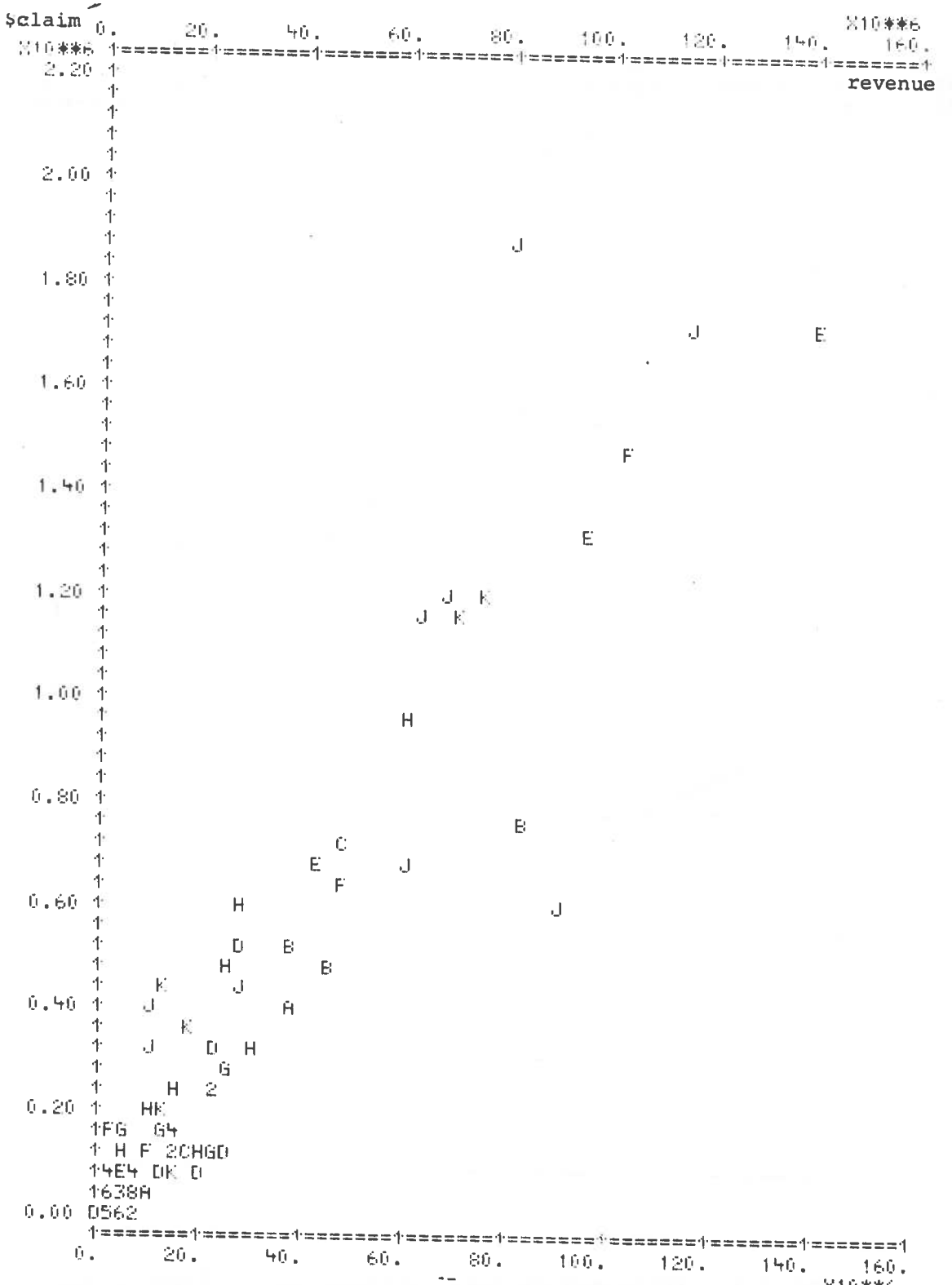


FIGURE 3-2. CLAIM DOLLARS PAID VS. REVENUE DOLLARS

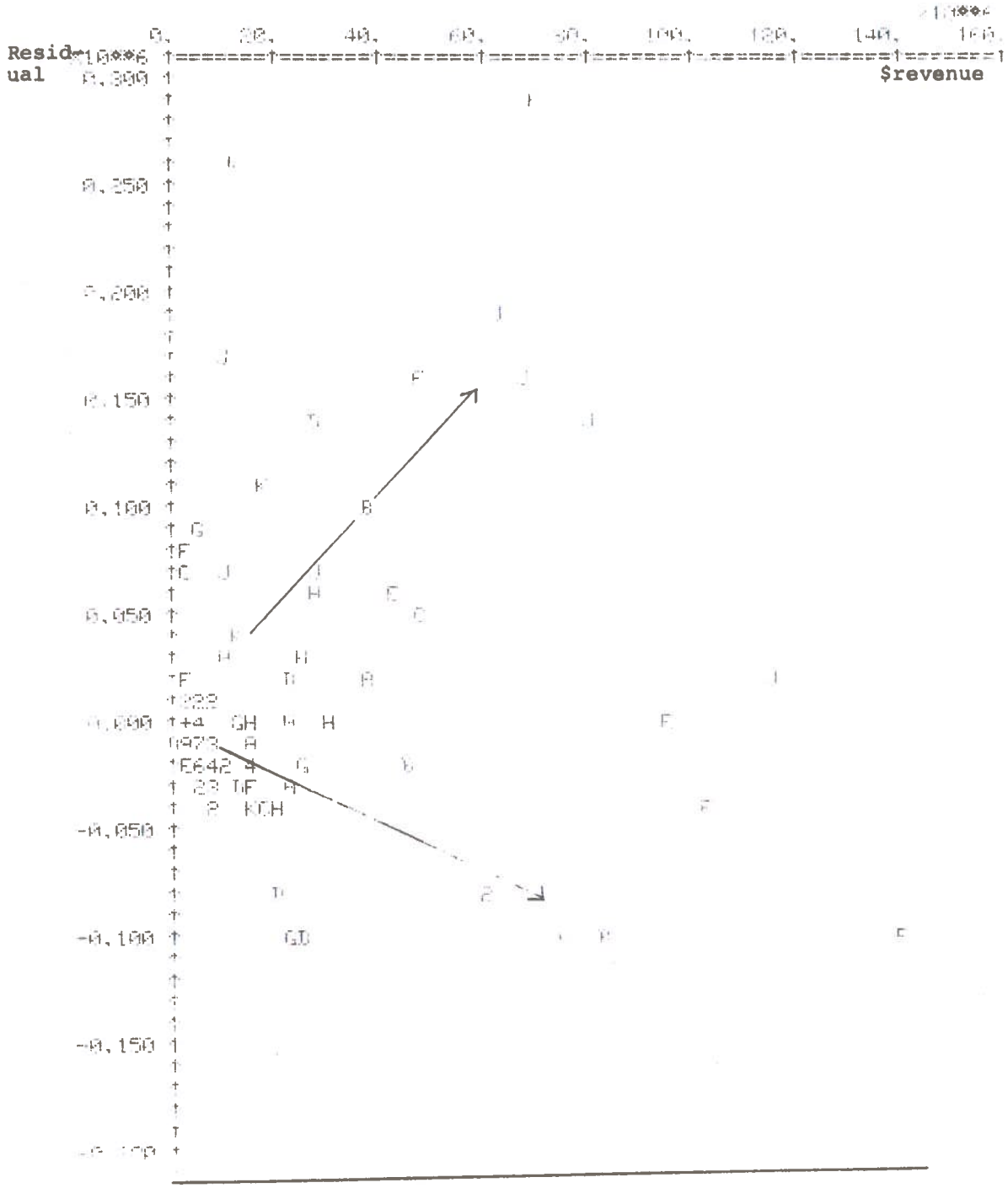


FIGURE 3-3. RESIDUALS OF THEFT DOLLARS VS. REVENUE DOLLARS

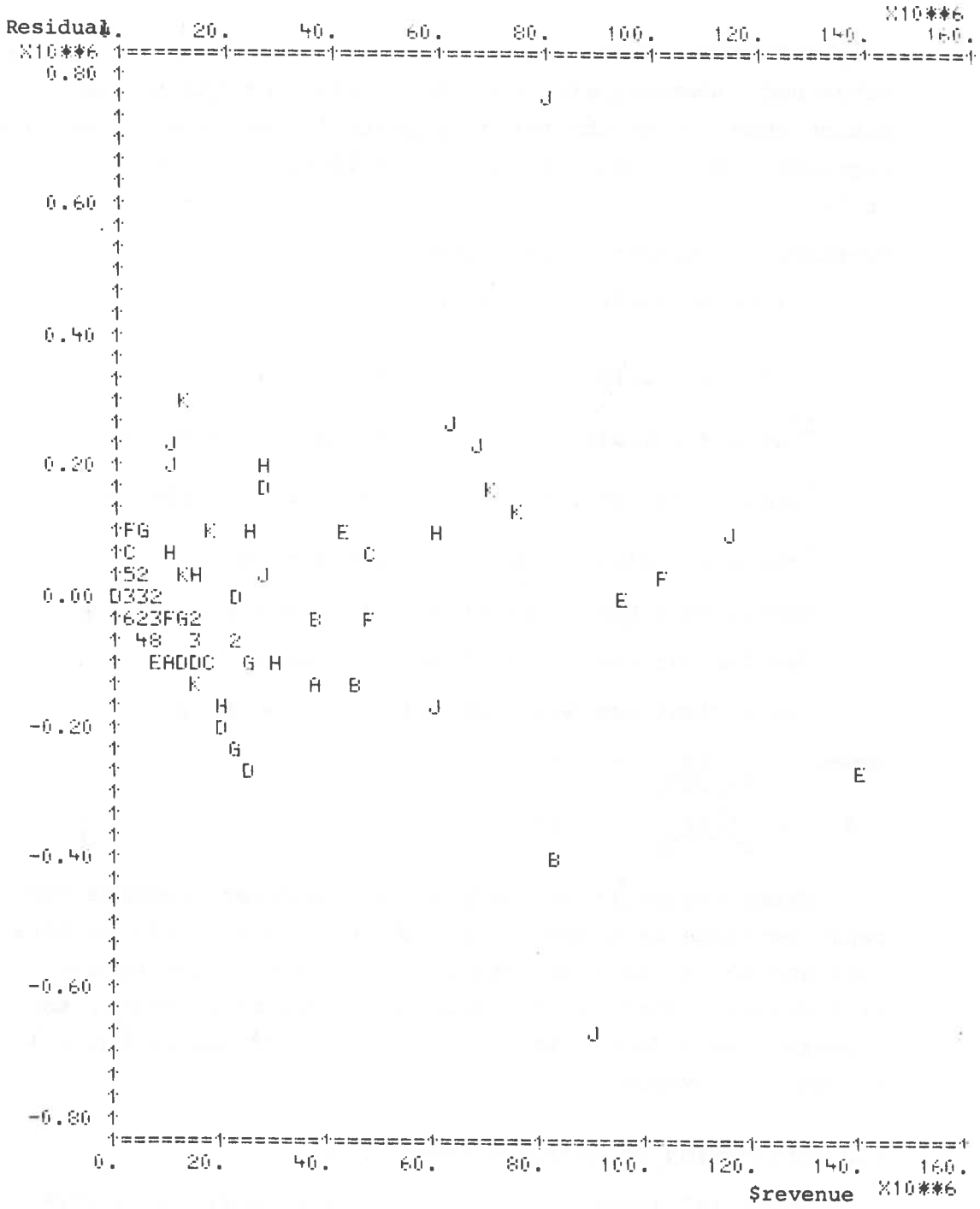


FIGURE 3-4. RESIDUALS OF CLAIM DOLLARS PAID VS. REVENUE DOLLARS

weighted least square will be more appropriate here. We are concerned, however, with the verification of the second condition under which the ratio estimate is justified. Both the regression ANOVA results and the residual plots show that it is.

Further, the sample results show:

ρ (dollar theft, dollar revenue) = .91

ρ (dollar claim, dollar revenue) = .94

$\hat{S}_{theft}$ = 156,572 sample mean = 96,042

$\hat{S}_{claim}$ = 381,289 sample mean = 220,740

$\hat{S}_{revenue}$ = 25,509,730 sample mean = 16,735,530

Coefficient variation of dollar $_{theft}$ = 1.63

Coefficient variation of dollar $_{revenue}$ = 1.52

Coefficient variation of dollar $_{claims}$ = 1.72

hence $\frac{1.52}{2(1.63)} = .47 < .91$

and $\frac{1.52}{2(1.73)} = .44 < .94$

These inequalities, as put forth earlier, endorse the ratio estimate as a better estimator of total theft dollars loss and total claim dollars paid than the simple expansion of averages. That is, E(dollar theft | dollar revenue), the expected theft dollar loss given a fixed dollar revenue, is $\hat{R}$ x dollar revenue.

3.2 ESTIMATION OF NATIONAL CARGO LOSS

The total intercity revenue for all carriers in 1974 is estimated to be \$51.9 billion [ref.16] (\$22.7 B regulated + \$29.2 B nonregulated). Hence the national theft-related cargo loss (intercity) is, according to equation (1),

$$\hat{Y} = \frac{\bar{Y}}{\bar{x}} X = \frac{\text{mean (\$theft)}}{\text{mean (\$revenue)}} \times \text{Total Revenue}$$

$$= .005739 \times \$51.9B$$

$$= \$297.8M$$

with an estimated standard error,

$$S(\hat{Y}) = \sqrt{\text{Var}(\hat{Y})} = 17.37 \times 10^6$$

17 million

% of standard error = 17.32/297.8 = 5.8%.

For the total intercity cargo loss not excluding theft-related loss, the corresponding estimate from the sample is:

$$\hat{L} = \frac{\text{mean (\$claim)}}{\text{mean (\$revenue)}} \times \text{Total Revenue}$$

$$= .0132 \times \$5.19B$$

$$= \$684.5M$$

with $S(\hat{L}) = 3.84 \times 10^7$ or \$38.4 million

% of standard error = 38.4/684.5 = 5.6%.

Further, the average theft ratio, .0057, has a variance,

$$V(\hat{R}) = \frac{\hat{R}}{n} (S_Y^2/\bar{Y}^2 + S_x^2/\bar{x}^2 - 2S_{yx}/\bar{y}\bar{x})$$

$$= 1.143 \times 10^{-7}$$

and $S(\hat{R}) = .338 \times 10^{-3} \simeq .0034$

Similarly, the "all claim" ratio, .0132, has a standard error of .0069. The 95 percent confidence intervals thus derived for these two ratios are, respectively, (.51%, .64%) and (1.18%, 1.45%).

4. PITFALLS AND VALIDITY OF ESTIMATES

In Section 3, we derived a theft-related loss ratio and a total loss ratio, which, when multiplied by the revenue amount, is the "best linear unbiased (in large sample) estimator" of total theft-related loss and total claims paid in the motor carrier industry. An approximation of the degree of random error attached to the estimates is also made. How relevant is the application of these ratios to the non-regulated carriers? The question is raised because variables such as revenue, ton-miles, etc. are only covariates; they cannot be taken as endogenous factors which affect to a large extent the loss occurred during freight transportation.

The extension of the estimates to the non-regulated carrier depends on two assumptions: 1) that the loss of cargo are completely random with respect to type of carriers, locations, and commodities carried; 2) that the distribution of the covariate is not significantly different in the two types of carriers.

4.1 ASSUMPTION ONE: RANDOM OCCURRENCE OF THEFTS ON FREIGHT CARGO

It is understandable that thefts hit carriers regardless of their classifications. The accessiblilty of cargo does depend, however, on the indivudual carriers' internal operational control, a plus for some private, and some regulated, carriers. The 1974 theft-related (robbery, burglary, larceny, theft) crime rates as reported by the U.S. Federal Bureau of Investigation are found to be quite uniform across all TRINC's regions in which the ICC-regulated carriers operate, except near the Pacific coast.

Whether different parts of the country encounter different cargo loss problems remains to be proven. Figure 4-1

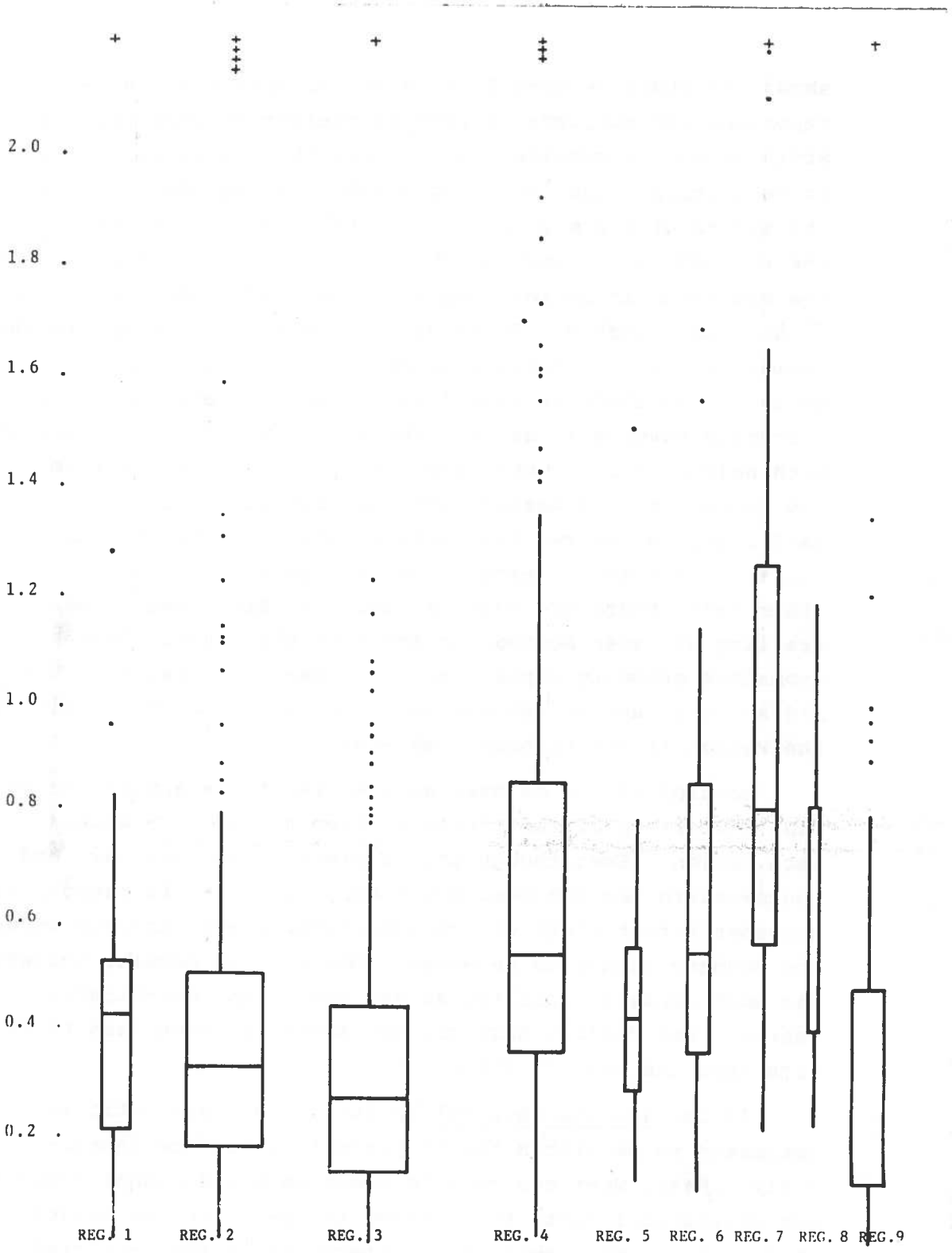


FIGURE 4-1. DISTRIBUTION OF THEFT RATIOS IN THE ICC REGIONS

shows the theft-related loss ratios of some six hundred reporting ICC carriers of general freight by regions. The width of each schematic box measures the number of carriers in each group. Each box also marks: the median theft ratio; the spread of the middle half of the data; the length of the two end tails; and the outlying stragglers. For example, the Mid-Atlantic Region (Region 2) has 138 reporting carriers within its boundary. It is one of the largest groups in the nation, and also, contrary to previous reports, one which exhibits low theft-related loss relative to the volume of operating revenue it earns. The median ratio is .34 percent, with half of the 138 carriers having ratios ranging from .19 percent to .53 percent and the majority of the other half lying on the two tail ends of the distribution stretching to as low as .0 percent and as high as .8 percent. On the other hand, there are quite a number of high loss companies trailing off even beyond the scope of the graph. These anomalies probably explain the high mean loss ratio of the Mid-Atlantic Region and earlier conclusions which classified the Region as the highest risk area.

Looking at the country as a whole, there appears to be wide dispersion of theft-related loss ratios even within each region. Even though the carriers in the Southern and Southwestern Regions bear noticeably higher theft ratios, the hypothesis that theft occurs sporadically and randomly across the country cannot be rejected. Contrary to popular belief, the most densely populated areas, namely the Mid-Atlantic, Central, and Pacific Regions, are shown to have less theft risk than the rest of the country.

If the average national theft-related loss ratio is estimated to be within the 95 percent confidence interval (.51%, .64%), what can be said about each individual region? Can statistical tests be employed to reinforce our belief that there is no significant differences in theft-related

ratios across the nine ICC regions? Again, the estimation method described in Section 3 is used for each region in which a sample of 18 carriers is randomly chosen from our 1974 Cargo Loss Data Base. Such a small sample may result in some bias in the estimation of variaces and consequently affect the statistical testing there-after. Bearing the biases in mind, the lower bounds of which are also estimated, we can still proceed to derive the 95 percent probability interval for the theft-related loss ratios in each region. Teh results are set forth in Table 4-1; and the intervals are plotted together for comparison in Figure 4-2. The overlapping of all the intervals, together with the distribution of individual theft ratios within each group as shown in Figure 4-1, convinces us of the similarity in the theft-related risks across the country.

The commodity factor, explored in more detail later, remains the key issue which separates the non-regulated and regulated carriers. It was estimated that in 1972 regulated carriers carried 41 percent of the total intercity freight tonnages, 35 percent of which was general freight; the rest was composed of special commodities such as household goods, petroleum products, agricultural products, building materials, motor vehicles, refrigerated products, etc. The Census of Transportation, 1972, reveals that Private Carriers carried only one quarter to one third as much general freight as their regulated counter-parts. Exempt carriers, by definition, transport exempt commodities which are mostly agricultural and horticultural products. If crimes on cargo are commodity specific, our estimates of theft-related loss for the entire motor industry may be under or over stated.

TABLE 4-1. ESTIMATED THEFT RATIOS BY ICC REGIONS

	Mean $theft related loss $\bar{y}$	Mean $operating revenue $\bar{x}$	Theft ratio $\hat{R} = \frac{\bar{y}}{\bar{x}}$	Standard Error of theft ratio $S(\hat{R})$	95% prob. interval of the theft ratio $\hat{R} \pm t_{(95\%)} S(\hat{R})$	Relative Error $\frac{E(\hat{R} - R)}{R}$
Region 1	$53,338	$9,646,600	.553%	.104%	(.356%, .756%)	1.9%
Region 2	46,542	10,409,256	.447	.06	(.325%, .569%)	.8
Region 3	156,836	32,315,066	.485	.03	(.422%, .548%)	0
Region 4	205,001	36,860,414	.556	.056	(.446%, .667%)	1.4
Region 5	86,637	18,721,942	.463	.078	(.310%, .616%)	2.2
Region 6	65,529	10,102,624	.649	.083	(.486%, .812%)	.3
Region 7	132,593	22,931,392	.578	.103	(.377%, .780%)	2.3
Region 8	160,887	25,949,839	.620	.075	(.478%, .762%)	.6
Region 9	341,367	45,731,947	.746	.130	(.499%, .993%)	.9

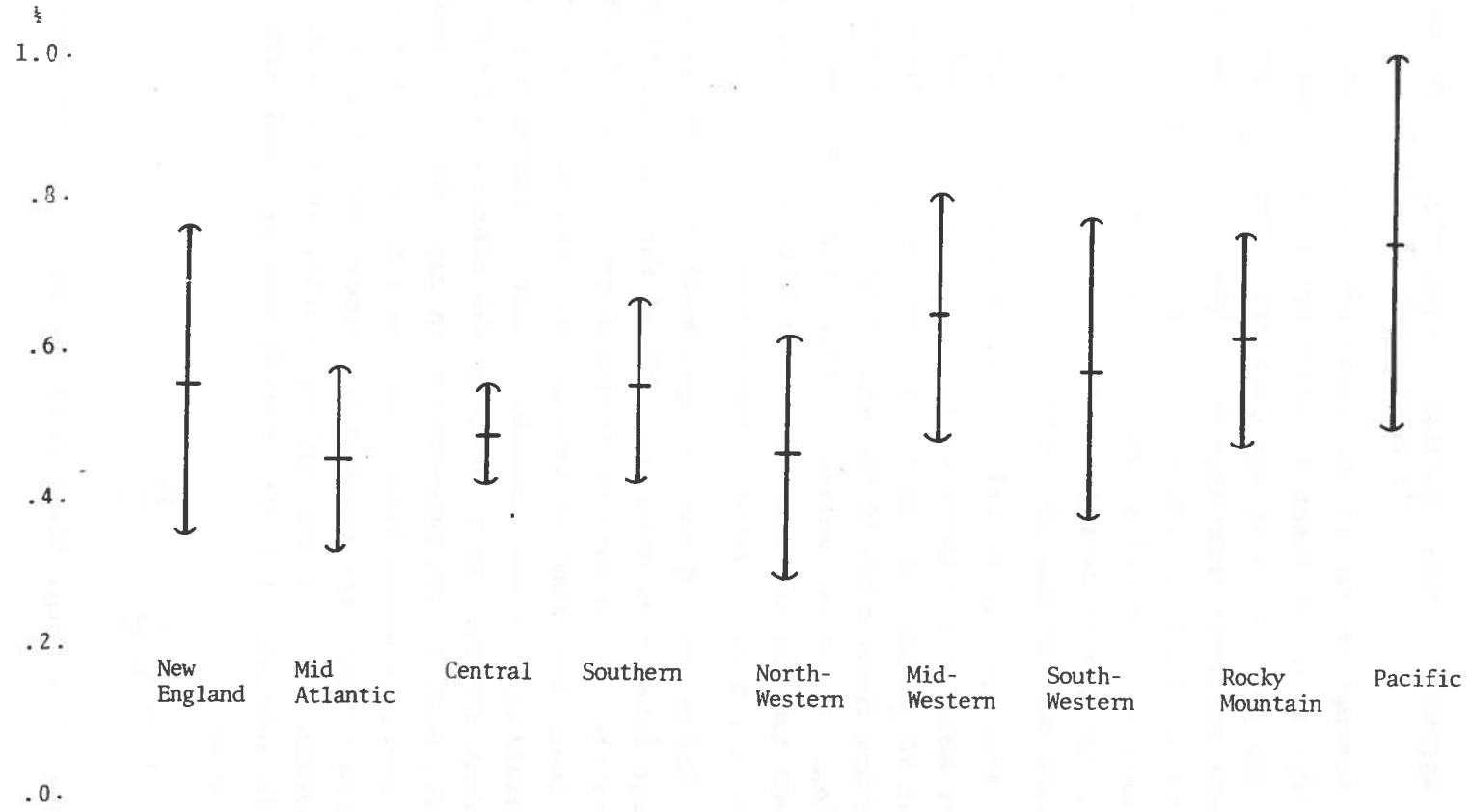


FIGURE 4-2. NINETY-FIVE-PERCENT CONFIDENCE INTERVALS AROUND ESTIMATES OF THEFT-RELATED LOSS RATIOS FOR THE NINE ICC REGIONS

4.2 ASSUMPTION TWO: SIMILAR DISTRIBUTION OF THE COVARIATE IN BOTH TYPES OF CARRIERS

Assumption Two is necessary because our sample of carriers is by no means a random probability sample selected from the population of all carriers. The accuracy of the present estimate then depends on how "typical" or "representative" these selected ones are in terms of the auxiliary variable and operating revenue. Using the fleet size as a proxy for annual revenue, a histogram (Fig 4-3) of frequencies is obtained for our ICC sample.

From the little information obtained from the TRINC tapes about the private carriers, it is estimated that about 90 percent of these carriers have 20 or fewer trucks-tractors comprising 40 percent of the private trucking population. The distribution of fleet size, therefore, is highly skewed towards the low values but with a long tail stretching even to a fleet size as large as over 10,000.

Since the ICC sample represents only the upper spectrum, (large fleet size more than 20) of the motor carrier industry using the sample data to estimate another subpopulation (i.e. the lower spectrum) is inadequate. Estimation for the entire population, however, depends on our willingness to accept the current average theft ratio as the average ratio of the universe, even though representation may fail for those individual carriers whose fleet size are outside the range of the sample. There are reasons to support this belief. For if information about the smaller carrier were available, our ratio estimate of theft related loss or total cargo loss would be:

$$Y = X_L \frac{y_l}{x_l} + X_S \frac{y_s}{x_s}$$

where: Y = Total theft-related loss, or total cargo loss.

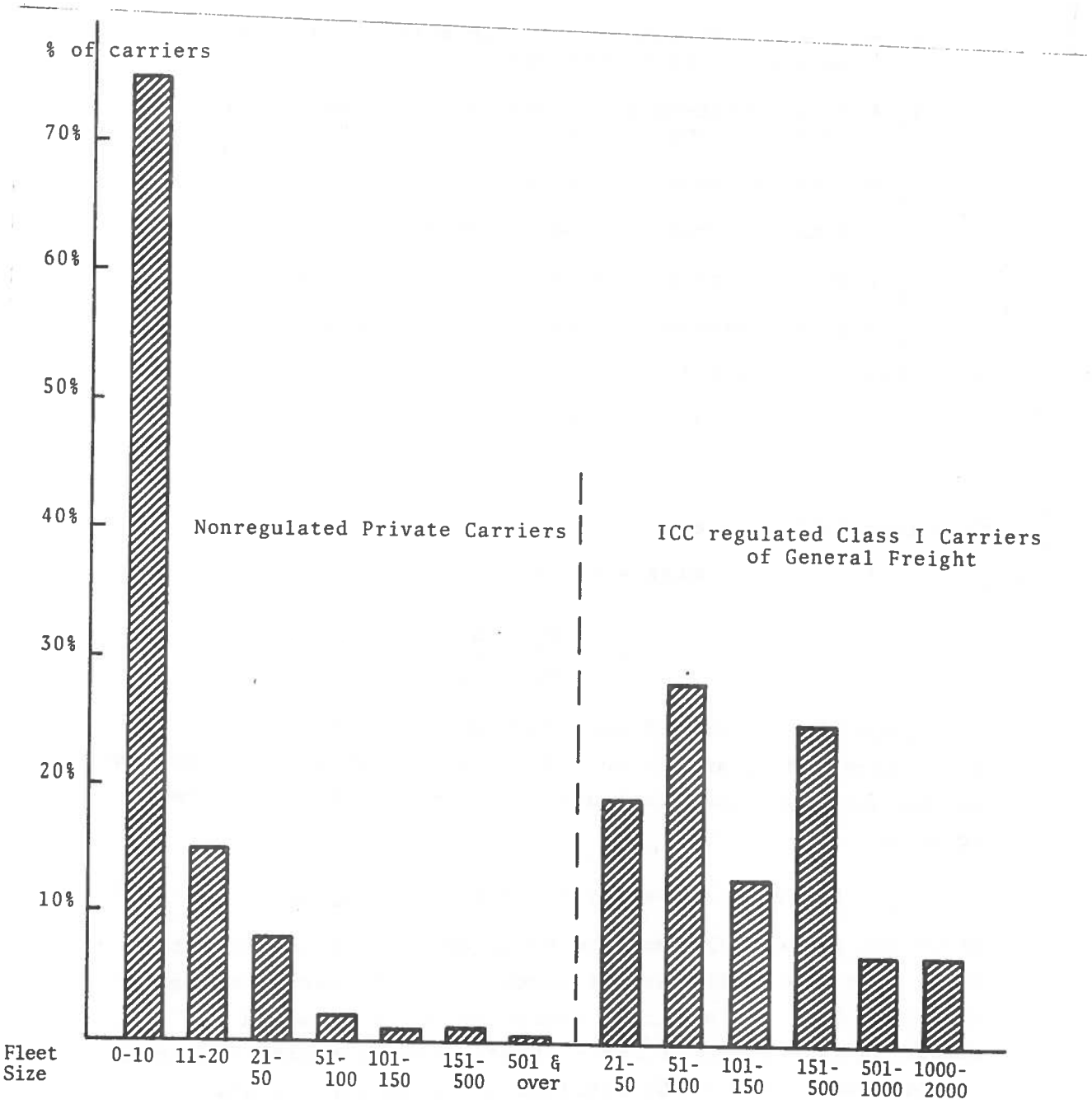


FIGURE 4-3. DISTRIBUTION OF FLEET SIZE OF MOTOR CARRIERS

y_l = Total theft-related loss or total cargo loss in sample of large carriers.

y_s = Total theft-related loss or total cargo loss in sample of small carriers.

X_L = Total revenue for large carriers.

X_S = Total revenue for small carriers.

X_l = Total revenue in sample of large carriers.

X_s = Total revenue in sample of small carriers.

Our current estimate is:

$$Y_c = (X_L + X_S) \frac{y_l}{x_l}$$

This results in a bias:

$$\text{Bias} = Y - Y_c$$

$$= X_s \left(\frac{y_s}{x_s} - \frac{y_l}{x_l}\right).$$

Such bias is significant only when both the ratio difference and X_S are large. Since X_S accounts for 40 percent of the non-regulated fleet and 12 percent of the regulated revenue:

$$X_S \simeq \$29.2b \times 40\% + \$22.7 \times 12\% \simeq \$14 \text{ billion}$$

Since the ratio difference in total cargo loss between the small carriers (averaging 54 trucks) and the large carriers (op. rev. over $10 million, averaging 600 trucks) in our sample is .4 percent (1.38% - .96%*), the approximate bias is $14 billion x .004 = $56 million, which amounts to only 8 percent of our $684 million cargo loss estimate.

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*Note that even the small carriers in our sample of regulated carriers are much larger than most non-regulated carriers.

5. DAMAGE AND LOSS ANALYSES BY COMMODITY CLASSES

Due to the wealth of cargo loss data in the regulated area, analyses of it by commodity classes are possible. Of the many shipments put on the road which involve higher risks in terms of damages and wreckages, etc.? Which encounter relatively more theft-related incidents and therefore result in more revenue loss for the motor carriers? How important are these high loss/high risk shipments to the freight industry? Must special attention be given them? These are some questions we address in this section. The analyses will be restricted to general freight because of the accessibility of relevant data such as tonnages, tonmiles, revenues, and cargo loss.

It was mentioned earlier that each of the three components of intercity freight traffic, namely, the ICC-regulated common and contract carriers, exempt commodities carriers, and private carriers, deals with different areas of freight transport. Although the private sector has ton times as many truck-tractors as the "for hire" sector, and engages in industries ranging from argriculture, forestry, mining, and construction, to manufacturing, wholesale, and retail trade, its functions are not limited to the shipment of freight from shippers to customers. Many of these trucks also take the place of the conveyor belts by moving raw material, supplies, and half finished products between plants for storage or further processing. In addition, most industrial companies require small "straight trucks" in the routine operations of their plants for various errands such as hauling coal or raw material from stock piles or separate warehouse buildings, hauling junks to dump, delivering express to railway stations, picking up mail from post offices, etc. Regarding freight shipments, private carriers only account for two thirds as many tonmiles as the "for hire" carriers.

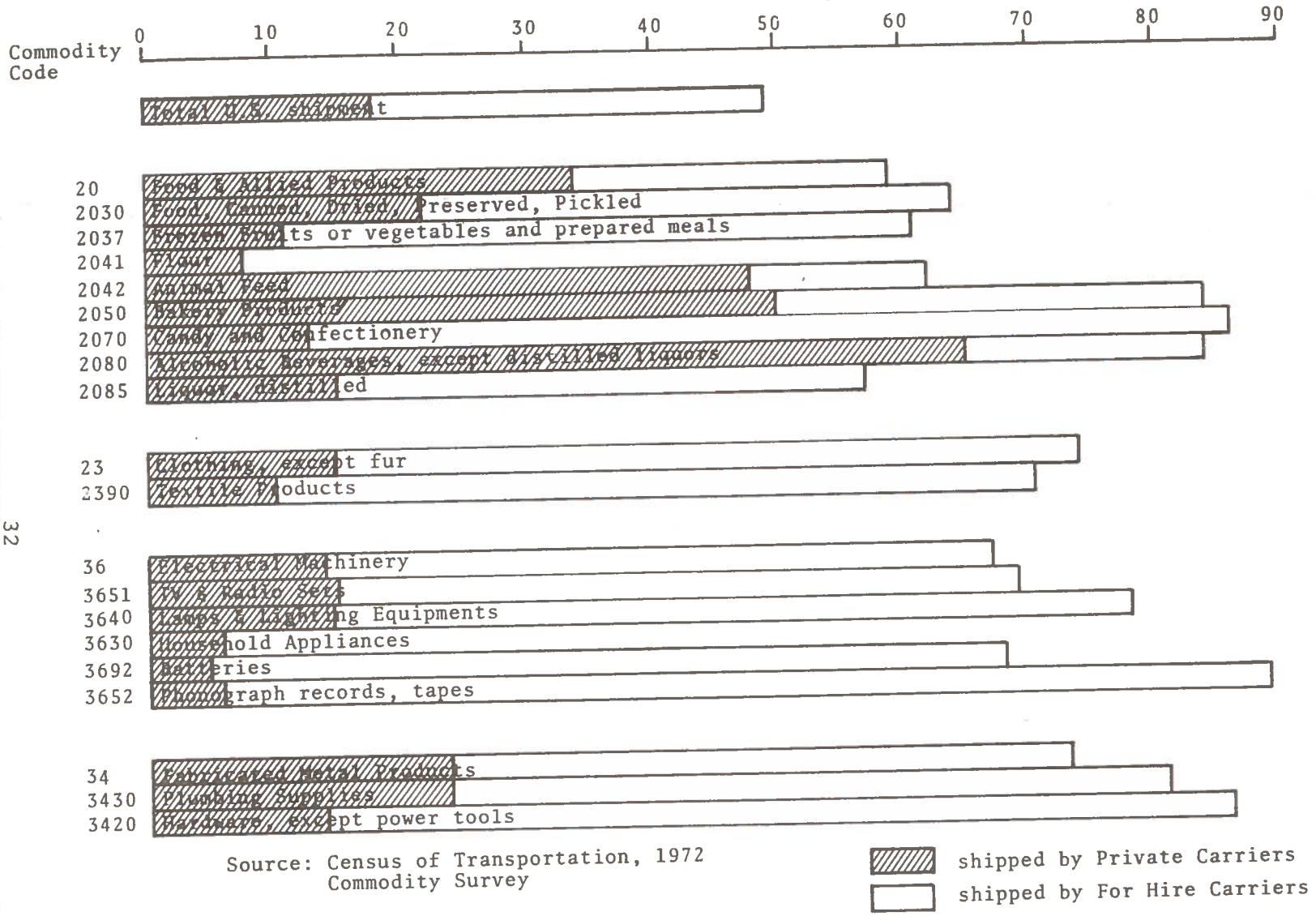


FIGURE 5-1. PERCENTAGE OF SHIPMENT TONNAGE BORNE BY FOR-HIRE AND PRIVATE CARRIERS

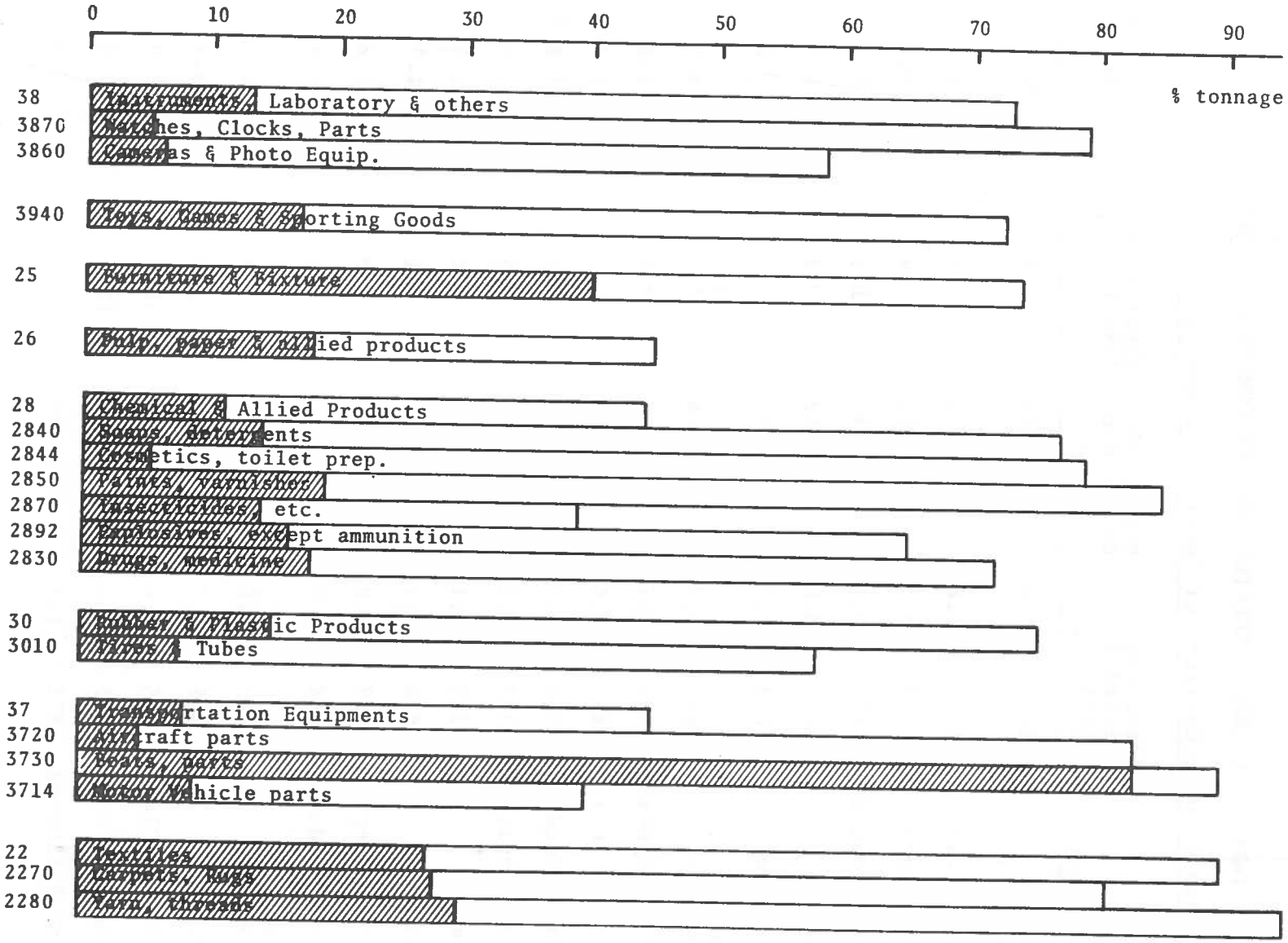


FIGURE 5-1. (Cont.)

TABLE 5-1. THEFT-RELATED LOSS BY COMMODITY CLASSES

Class I Motor Carriers of General Freight, 1972

Commodity	total theft related loss (000)	%	est. gross op. revenue ($000)	theft related loss ratios %	total claim paid ratios %
Clothing (no fur)	$11030	17.9	$ 48,349	22.8	26.0
TV & Radio	3573	5.8	25,381	14.1	19.0
Auto Parts	2299	3.7	162,623	1.4	3.0
Metal Products	1887	3.1	178,796	1.0	3.0
Textile	1839	3.0	190,652	.9	2.0
Hardware	1679	2.7	32,436	5.2	9.0
Electrical Products	1691	2.7	57,476	2.9	8.0
Toys & Games	1659	2.7	22,058	7.5	11.0
Tires, tubes	1629	2.6	95,875	1.7	2.0
Canned Food	1349	2.2	196,440	.7	1.8
House Appliance	1347	2.2	37,272	3.6	12.0
Plastic	1283	2.1	132,430	1.0	2.5
Shoes	1646	2.7	153,420	1.1	1.3
Toilet Prep.	1212	2.0	152,445	.8	1.2
Paper Products	1242	2.0	264,610	.5	1.3
Textile Products	1142	1.8	23,925	4.8	6.7
Drugs	1029	1.7	46,081	2.2	5.3
Watches, Clocks	1005	1.6	2,198	45.0	52.0
Cameras & Equip	953	1.5	7,281	13.1	17.0
Food & Kindred	875	1.4	544,657	.2	.5

TABLE 5-1. THEFT-RELATED LOSS BY COMMODITY CLASSES (CONTINUED)

Class I Motor Carriers of General Freight, 1972 (Continued)

Commodity	total theft related loss (000)	%	est. gross op. revenue ($000)	theft related loss ratios %	total claim paid ratios %
Machinery	$ 894	1.4	$ 336,930	.26	1.2
Soaps,Detergent	874	1.4	38,247	2.28	5.3
Candy	799	1.3	60,778	1.31	2.7
Furniture	723	1.2	62,182	1.20	7.0
Chemical Prod	740	1.2	524,742	.14	.5
Lamps, shades	742	1.2	27,168	2.73	10.4
Carpets, rugs	525	1.0	35,176	1.50	4.6
Plumbing Supplies	563	1.0	278,960	.20	.9
Metal Sheets	640	1.0	529,432	.12	.5
Varnish, paints	609	1.0	50,029	1.20	4.2
Power tools	475	1.0	10,298	4.61	6.5
Office machines	453	1.0	10,324	4.38	7.6
All Others	13568		4,338,672	.25	

NOTE:

The data sources employed are "Freight Commodity Statistics of Class I Motor Carriers of Property" and the "Quarterly Freight Loss and Damage Claims reported by Common and Contract Motor Carriers of Property". Both are published by ICC on a regular basis. The former classifies statistics (such as gross revenues, total freight traffic, etc.) by commodities only for truckload shipments. Shipments weighing less than 10,000 lbs. are aggregated into one classification code: 47 - small packaged freight shipments. The Census of Transportation Commodity Survey, 1972, however, provides information for each commodity, on the percentages of TL(truckoad) and LTL(less than truckload) freight, so that adjustments can be made to estimate the total freight revenue generated by each commodity. For example, the 1972 "Freight Commodity Statistics" shows a $13,296K freight revenue generated by truckload shipments of apparel & related products; while the CTS indicates that TL shipments only comprises 44.3% of all apparel tonnages. Hence, the estimated total freight revenue generated by this particular commodity in 1972 is $13,296K/.443 = $48,349K.

The majority of these shipments, however, are not in the general freight category. The distribution of general freight between private and "for hire" (regulated common carriers) carriers is shown on Figure 5-1.

Our attention is focused on the Regulated Motor Carriers of General Freight with annual gross revenues of $1,000,000 or more. The total gross revenue generated by this group was almost $9.883 billion in 1972, $10.7 billion in 1973, and $12.4 billion in 1974. The 1972 data (see Table 5-1) indicates that, in absolute dollars, clothing (17.9% of total theft-related loss), tv and radio sets (5.8%), motor vehicle parts (3.7%), metal products (3.1%), and textiles (3.0%) ranked among the highest in theft-related loss. In terms of loss relative to the freight revenue, however, only clothing, and TV and radios retained their places as high risk items. Watches and clocks took the lead with a theft ratio of 45 percent and total loss ratio of 52 percent. That is, of every dollar earned by a motor carrier through transporting this commodity, 45 cents was lost through theft, pilferage, shortage, or hijacking; another 7 cents was lost because of visible damages, etc. Reranking the commodities identifies Watches and Clocks, Apparel, TV and Radios, Cameras and Related Equipment, Toys, Games and Sporting Goods as the five highest risk commodities. They are fragile, and above all else, popular consumer luxury items. The situation is not peculiar to 1972. An analysis of the 1973 loss data reveals that the theft-related loss ratios for all commodities are almost constant. Food and Kindred Products, Chemical and Allied Products, Machinery (except electrical), Plumbing Supplies, and Primary Metal Products remain the low risk commodities with theft ratios ranging only from .12 percent of the carriers' total income. One can surmise, therefore, that the Special Commodity Carriers (carrying Petroleum Products, Refrigerated

Products, Agricultural Products, Building Materials) and those exemp carriers probably have a low theft loss simply because of the products they carry.

A theft-related loss ratio as high as 45 percent or even 22 percent is disturbing. Nevertheless, just how disturbing it should be to the Motor Carrier industry requires closer examination. The shares of the total industry-wide operating revenue of each high risk commodity are listed in Table 5-2.

TABLE 5-2. SHIPMENTS OF HIGH-RISK COMMODITIES

	Total shipment in U.S. (in 000 tons)	% by M.C.	% by P.C.	Estimated operating ($000)	Class I rev. %*
Watches & Clocks	90	73.9	5.4	2,198	.02
Apparel	5500	68.5	15.2	48,349	.49
TV & Radio	600	54.7	14.7	25,381	.26
Cameras & Equip.	600	52.4	6.2	7,281	.07
Toys, Games, etc.	1700	55.8	16.8	22,058	.22
Hardware	1500	74.8	12.9	32,345	.33

* % is derived by dividing the gross revenue by the total Class I general freight operating revenue: $9.884 billion.

The statistics above show that from the carriers' standpoint, these high risk commodities only account for 1.4 percent of their total income and therefore do not give any cause for dismay. Since the bulk of the the general freight shipments are borne by the regulated carriers (see Fig. 5.1), the private carrier industry's concern is also minimal.

Hijacking, though it is usually highly publicized by the popular media, only constitutes 2 to 3 percent of the theft-related loss. Almost all of the hijacking occurs

in the east, with the Mid-Atlantic Region suffering over 50 percent of the hijacking loss. Except for Clothing, Cigarettes, and TV and Radios, no one commodity has consistently proved to be particularly vulnerable to hijacking over the years.

TABLE 5-3. DISTRIBUTION OF LOSS DUE TO HIJACKING

Region	% share of national hijacking loss			% share of operating revenue		
	'72	'73	'74	'72	'73	'74
New England	8	18	19	4	3	3
Mid Atlantic	59	55	45	18	18	18
Central	18	10	12	31	32	31
Southern	2	13	18	17	16	16
Northwestern	0	1	0	4	4	5
Midwestern	7	2	4	4	4	4
Southwestern	1	0	0	8	8	8
Rocky Mountain	0	0	0	4	4	4
Pacific	4	0	0	11	11	11

6. RECOMMENDATIONS

The importance of accurate and up to date statistical information on cargo claims paid, both by cause and by commodity, has been emphasized by the ICC since its initiation of the QL&D reporting requirements. The following inadequacies, however, are inherent in the Cargo security Data Base,

1) Since only Class I and some Class II carriers of General Freight with gross revenue over $1,000,000 or more annually are required to file Schedule A, which contains detailed theft-related loss information, smaller carriers are omitted.

2) Non-regulated carriers are not required to file the QL&D reports, and surveys on this sector have proved futile.

The problem of noncoverage can be a serious one if the elements included in the data base are quite different from those excluded, and statistical inference about the entire population is to be drawn based on information about the former. Our analyses on the cargo loss data reveal a significant loss ratio difference between the smaller carriers (lower loss ratios, but more variable), and the larger ones (higher loss ratios, more stable)(See Appendix B), and very probably between the regulated carriers (carrying more high risk commodities) and the nonregulated ones (carrying more low risk commodities). Projection of the national estimate based on the larger,regulated carriers results in an upward bias.

Since a major portion of the nonregulated carriers have, fleet size and volume of operation comparable to the Class III regulated carriers, detailed cargo loss information solicited from the latter will be most valuable in providing accurate estimates for the former. On the other hand, a good upperbound is not meaningless for policy planning purposes, noting that

such a conservative estimate as $684 million total cargo loss (excluding the local carriers) is not inconsistent with the earlier estimate of $900 million trucking theft and loss derived from the opinions of experts in the industry in 1971.

For those carriers that are not engaged in interstate commerce and, thus, not under federal regulation, loss and damage to goods being transported goes unreported, except for incident filings with local police, security agencies, or insurance companies. This results from the fact that no Federal agency has established a clear requirement for a reporting system that corresponds to the ones currently implemented by the regulatory agencies. If data on intrastate cargo movements could be added to those of interstate movements, and coupled with other data from public and private sectors, a more insightful analysis could be made of the entire loss and damage picture.

The study also pinpoints several high risk commodities, not in terms of the total revenue lost, but rather, in terms of the average dollar lost relative to the operating revenue gaines. Estimation of such measures explains the possibility that some motor carriers may not be aware of these high risk commodities because they amount to only 1.4 percent of their total income. Such a small fraction hardly warrants attention. These products, which rank high in their loss ratios, also rank high in their marketability and monetary value. A clearer awareness of the economic impact of such losses on the consumers, who naturally are the ultimate victims of the crime on freight, is necessary. It remains for the motor carrier industry and the government to continually cooperate to promote cargo security on motor freight transit.

APPENDIX A. A SAMPLE OF THE QL CD REPORT FILED BY MOTOR CARRIERS

SCHEDULE A, LOSS AND DAMAGE CLAIMS PAID
COMMON CARRIERS OF GENERAL FREIGHT

FORM QL&D

QUARTER
19

[ ] 1ST [ ] 3RD

[ ] 2ND [ ] 4TH

THIS SCHEDULE TO BE FILED ONLY BY COMMON CARRIERS OF GENERAL FREIGHT, SERVICE CLASSIFICATION SYMBOLS A01A, A01B, A01C, A02, A03 AND A04.

Line No.	ITEMS		A	B	C	D	E	F	G	H
	No.									
1	3720	Aircraft or Missile Engines, Parts								
2	2080	Beverages, Malt, Extracts, Except Distilled Liquor								
3	1960	Ammunition for Small Arms, 30MM & Under								
4	2042	Animal Feed								
5	3714	Auto, Bus, Truck Parts, Accessories								
6	2050	Bakery Products								
7	3692	Batteries, Wet or Dry Cell								
8	3790	[illegible], Parts, Accessories								
9	3860	Cameras, Photo Equipment, Supplies								
10	2070	Candy & Confectionery								
11	2270	Carpets & Rugs								
12	2840	Chemicals or Allied Products, N.O.								

Line No.	Code No.	Commodity Description	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
53	2390	Textile Products, Misc. Fabricated.......								
54	2200	Textiles, Woven, Knit, Misc. Mill Products, N.O.I.								
55	2230	Textile Yarn, Thread....................								
56	3010	Tires & Tubes...........................								
57	2100	Tobacco Products, Except Cigarettes......								
58	2844	Toilet Preparations, Cosmetics..........								
59	3540	Tools, Power & Machine..................								
60	3940	Toys, Games & Sporting Goods............								
61	3651	TV & Radio Sets, Recorders, Amplifiers, Parts....................................								
62	3870	Watches, Clocks, Parts..................								
63	4600	Miscellaneous Freight Shipments, N.O.I...								
64	--	GRAND TOTALS								

1. Schedule A should be completed by *Common Carriers of General Freight*. Other carriers should consult Schedule A as required for the preparation of Schedule B, but should not file Schedule A.

2. All freight loss and damage claims paid by common carriers of general freight during the three month period covered by the report should be recorded in Schedule A. Show the number of claims paid and the dollar amounts paid by commodity, broken down among the various reasons which resulted in the [illegible] by one carrier to another should be included as a claim paid and the dollar amount reported. [illegible] reported for claims paid to the claimant (whether shipper, consignee or connecting carrier) should be the amount of reporting carrier's portion of its liability for the loss. Example: Carrier A pays directly to a shipper $300 in full settlement of a claim which is to be equally shared by connecting carriers B and C. Each of the carriers, A, B and C will report $100 on their respective Schedule A during the quarter in which settlement is made. Likewise, if a claim is paid directly by an insurance company to a claimant, the amount that is paid should be reported by the reporting carrier in the same manner as though payment was made directly by the carrier.

3. The commodity code numbers and descriptions are based on those prescribed for the reporting of freight commodity statistics, 49 CFR 1248, at the 2-digit level with exceptions. [illegible] adding zeros at the end. Commodities should be reported at the highest code level shown in Schedule A [illegible] NOI be duplicated. *For the purposes of report Form QCD* [illegible] *the sub-codes listed*. All codes shown are derived from and compatible with the *Standard Transportation Commodity Code*. However, Code 4600, Miscellaneous Freight Shipments, NOI [illegible] covering all claims not elsewhere classifiable. The NOI means "not otherwise indexed [illegible]". Conversion table of National Motor Freight Classification item numbers are available from the National Motor Freight Traffic Association.

4. [illegible] should be used for classifying claims according to [illegible]

[illegible] force or threat of force.

[illegible] Physical damage to freight discovered after delivery of shipment to consignee in apparent good order with no evidence of irregularity.

[illegible] Delivery of shipment reflecting damage observable by consignee at time of delivery.

[illegible] Shipment damage resulting from wreck, or other [illegible] fire, etc.

[illegible] Shipment damage due to failure of equipment [illegible]

[illegible] should be reported under the caption [illegible] excluded from the caption Wreck and Catastrophe.

[illegible] column H, Schedule A must agree with line 4, Schedule C. Any differences should be explained.

☆ U.S. GOVERNMENT PRINTING OFFICE : 1974 O - 527-112

SERVICE CLASSIFICATION SYMBOL			INTERSTATE COMMERCE COMMISSION	APPROVED
TYPE	COMMODITY NO.	SERVICE	QUARTERLY REPORT OF FREIGHT LOSS AND DAMAGE CLAIMS	OFFICE OF MANAGEMENT AND BUDGET NO. 60-R0002
			SCHEDULE B, ANALYSIS OF THEFT - ALL CARRIERS	NO NUMBER — FORM QL&D

FULL NAME AND ADDRESS OF REPORTING CARRIER

THIS SCHEDULE TO BE FILED ONLY BY CARRIERS REPORTING CLAIM PAYMENTS OF $100, OR MORE, DUE TO KNOWN THEFT AND PILFERAGE, OR HIJACKING.

QUARTER 19

[ ] 1ST [ ] 3RD

[ ] 2ND [ ] 4TH

LINE NO.	A COMMODITY		B	C	D LOCATION CODE	
	CODE NO.	DESCRIPTION (See Freight Claim Code)	THEFT AND PILFERAGE (Dollars-cents omitted)	HIJACKING (Dollars-cents omitted)	NAME	NO.
1						
2						
3						
4						
5						
6						
7						
8						

NAME	POSTAL ABBREVIATION	CODE	NAME	POSTAL ABBREVIATION	CODE
ALABAMA	AL	01	[illegible]	MT	30
ALASKA	AK	02	[illegible]	NE	31
ARIZONA	AZ	04	[illegible]	NV	32
ARKANSAS	AR	05	[illegible]	NH	33
CALIFORNIA	CA	06	[illegible] (Except code 62)	NJ	34
COLORADO	CO	08	NEW MEXICO	NM	35
CONNECTICUT	CT	09	NEW YORK COMMERCIAL ZONE	NZ	62
DELAWARE	DE	10	NEW [illegible] (Except code 62)	NY	36
DISTRICT OF COLUMBIA	DC	11	[illegible] CAROLINA	NC	37
FLORIDA	FL	12	[illegible] DAKOTA	ND	38
GEORGIA	GA	13	[illegible]	OH	39
HAWAII	HI	15	OKLAHOMA	OK	40
IDAHO	ID	16	OREGON	OR	41
CHICAGO COMMERCIAL ZONE	CZ	61	PENNSYLVANIA	PA	42
ILLINOIS (Except code 61)	IL	17	RHODE ISLAND	RI	44
INDIANA (Except code 61)	IN	18	[illegible] CAROLINA	SC	45
IOWA	IA	19	[illegible] DAKOTA	SD	46
KANSAS	KS	20	TENNESSEE	TN	47
KENTUCKY	KY	21	TEXAS	TX	48
LOUISIANA	LA	22	UTAH	UT	49
MAINE	ME	23	VERMONT	VT	50
MARYLAND	MD	24	VIRGINIA	VA	51
MASSACHUSETTS	MA	25	WASHINGTON	WA	53
MICHIGAN	MI	26	WEST VIRGINIA	WV	54
MINNESOTA	MN	27	[illegible]	WI	55
[illegible]	[illegible]	28	[illegible]	WY	56
MISSOURI	MO	29	UNKNOWN	XX	00

INSTRUCTIONS FOR SCHEDULE B

1. The payment of claims due to theft (stealing), and consequently the reporting of such claims paid, is the responsibility of the carrier on whose line the theft occurred. Respondent should list individually by commodity each claim paid during the quarter in the amount of $100, or more, known to be the result of theft and pilferage, or hijacking. (See instruction 4, Schedule A, for definitions.) Show the appropriate code number as used in Schedule A. The commodity description should be that shown on the freight bill. Report the dollar amount of each claim paid in Column B or C, as appropriate. Indicate the location where each theft occurred to the best of your belief by showing the name of the state or commercial zone, and the state or zone code number using standard codes shown in Table 1. The Chicago or New York commercial zones should be shown whenever the theft occurred within the commercial zone as defined by the Commission, 49 CFR 1048, otherwise show the state code. If necessary, attach extra pages following format of Schedule. Number pages consecutively, and record grand totals of dollars on last page only.
2. If after completion of investigation of facts relative to claim, the carrier has no information as to where the theft occurred, the location code may be shown as XX under Name, and 00 under Number, and an explanation of the circumstances of the claim which preclude the carrier having any knowledge of the location should be made under "Remarks".
3. When no claims reportable in Schedule B were paid during the quarter that fact should be indicated by checking the "No" box, item 20, Schedule C; Schedule B need not be filed.

REMARKS N/A

INTERSTATE COMMERCE COMMISSION

QUARTERLY REPORT OF FREIGHT LOSS AND DAMAGE CLAIMS

APPROVED
BUDGET BUREAU NO. 60-R0092

SCHEDULE C. ANALYSIS OF CLAIMS PROCESSED - ALL CARRIERS

I.C.C. NUMBER

FORM QL&D

CARRIER NAME AND ADDRESS, TO WHICH DATA CLAIMS

QUARTER (X)

[ ] 1ST [ ] 3RD

[ ] 2ND [ ] 4TH

LINE NO.	ITEMS	A NUMBER	B AMOUNT (Dollars-omit cents)
1	Claims on hand at beginning of quarter		$
2	Claims received or reopened during quarter		
3	Total (Line 1 + 2)		
	Claims disposed of during quarter:		
4	Total paid		
	Total denied or closed:		
5	Clear delivery receipt		
6	Not timely filed		
7	*/ Other		
8	Denied in part		
9	Total (Lines 4 through 8)		
10	Claims on hand at end of quarter (Line 3 less Line 9)		

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 95 cents
Stock Number 2600-00945

OMB 60-R0362

No.		A NUMBER	B AMOUNT (Dollars-omit cents)
11	Number of claims closed (paid or denied) within 30 days.....		
12	Number of claims closed (paid or denied) 30 to 120 days.....		
13	Number of claims unsettled more than 120 days on hand at close of quarter.....		
	Amounts recovered during quarter:		
14	Salvage.....		$
15	Insurance.....		
16	Total (Line 14 + 15).....		
17	Net claims paid during quarter (Line 4, Col. B, less line 16).....		
18	Total operating revenues for quarter (Account 3000).....		
19	Ratio net claims paid to revenues, percent (Line 17 ÷ line 18, two decimal places)		%
20	Cost of cargo insurance paid to outside insurance companies for quarter.....		$
21	Did respondent pay any claim of $100 or more for known theft and pilferage, or hijacking during quarter? If yes, complete and file Schedule B.		(Check one) [ ] YES [ ] NO

CERTIFICATION

I, the undersigned _____ of _____ certify that this report
(Print or type name and title of officer making the certification) (Exact name of reporting company)
was prepared by me or under my supervision; that I have carefully examined it; and, on the basis of my knowledge, belief, and verification (where necessary) I declare it to be a full, true and correct statement of the freight loss and damage statistics named, and that the various items here reported were determined in accordance with effective rules promulgated by the Interstate Commerce Commission.

Signature _____ Telephone No. (Include Area Code) _____ Date _____ 19 ___

INSTRUCTIONS

1. Schedule C and the Certification should be completed by all carriers filing Form QL&D.
2. On lines 1 and 2, report the number of claims on hand at the beginning of the quarter and the number received or reopened during the quarter in Column A; report the total dollar amount of the claims in Column B. The total number of claims on hand at the beginning of the quarter, line 1, should agree with the total number of claims on hand at the close of the quarter, line 10, of the report for the prior quarter.
3. Report the total number and dollar amount of all claims paid during the quarter on line 4. Dollar amounts reported for claims paid to claimants (whether shipper, consignee, or connecting shipper) should be the amount of reporting carrier's portion of its liability for the loss, including amounts paid by insurance companies. Report the number and dollar value of all claims handled on a "total loss" basis which are settled in full during the quarter on lines 5, 6, or 7, distributed according to the reasons specified. Dollar portions of paid claims for which interline carriers are liable, or excess dollar amounts of claims paid in part, should be shown on line 8, Column B, without reporting a number.
4. Retrospective premium refunds should be offset to amounts reported on line 20, in the quarter in which received.
5. Where the word NONE truly and completely states the fact, it should be given as the answer to any particular inquiry. Cancellations, arbitrary check marks, and the like, must not be used as answers to inquiries unless specifically authorized in writing by the Commission.

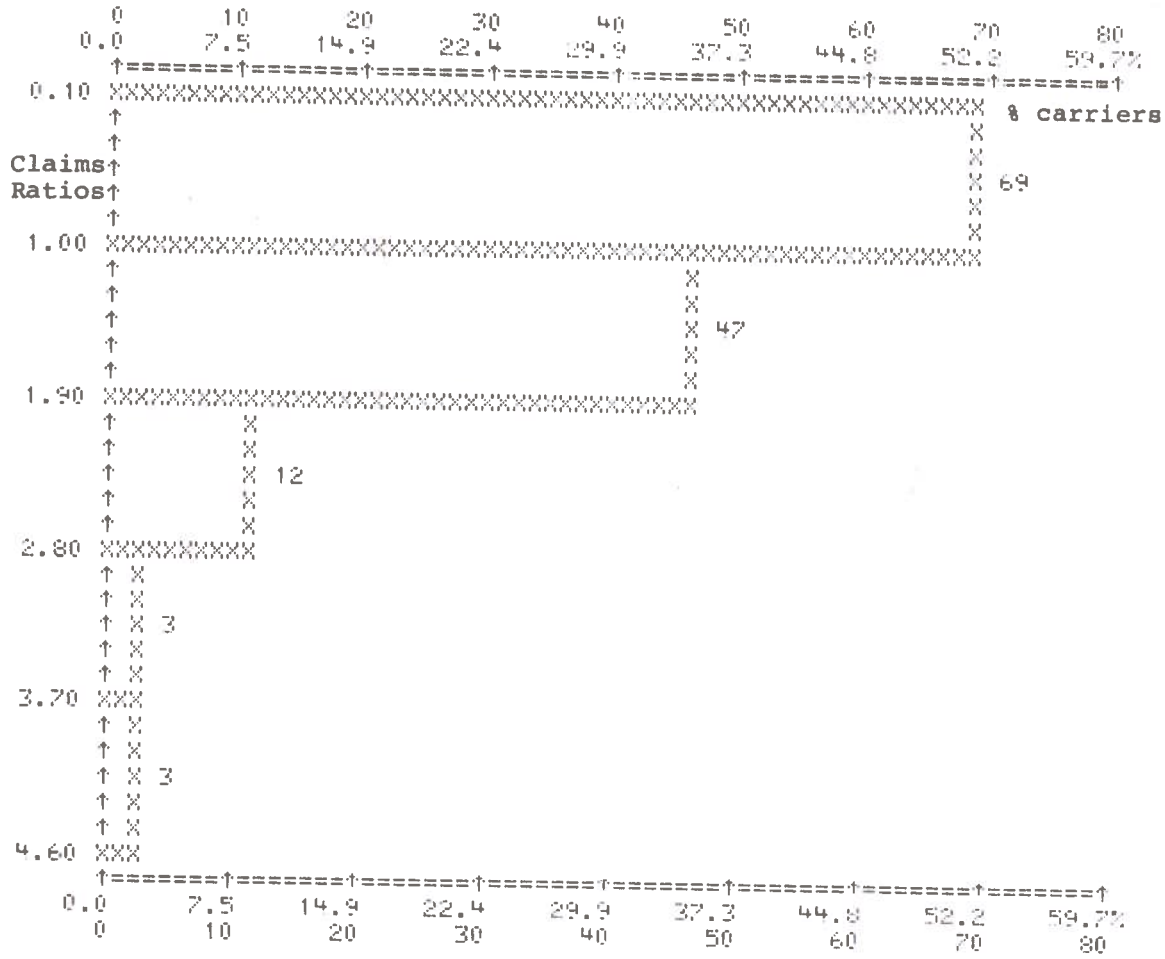
APPENDIX B. DIFFERENTIAL CHARACTERISTICS OF HI-LOSS AND LO-LOSS CARRIERS

Our initial hypothesis is that there are differences in the operational proctices between the hi-loss carriers and the low-loss ones. The object is to identify these differences. A hi-loss carrier is not one with high claim dollars paid, but rather one with high claim dollars paid per dollars operating revenue. In our random sample of 134 regulated carriers, the median loss ratio is .98 percent. That is, there are as many carriers in the sample with loss ratios greater than .98 percent as there are with ratios lower than that. Hence the 1 percent cutoff point is chosen for convenience, so that the two groups of carriers can be compared with respect to their operational characteristics, such as the average length of haul, freight revenue per ton-mile. The number of trucks and tractors owned, the payroll dollars to revenues dollars ratio, the percentage of vehicle miles driven by rented drivers (the independent truckers), and the annual gross revenues. Fig. B1. shows the frequency distribution of the total claims paid ratios. The following section explains the use of the Wilcoxon rank test in determining whether one group of carriers is significantly different from the other.

For each aforementioned attribute, the model is as follows:

$$z_i = e_i \qquad i = 1,2,3,\ldots,69$$

$$w_j = e_j + \Delta \qquad j = 1,2,3,\ldots,65$$



**********LEGEND**********

TIME BOUNDS: 1 TO 134

HISTOGRAM INCLUDES 134 OBSERVATIONS
VARIABLES IN POOL:
ALCLAIM

****

FIGURE B-1. DISTRIBUTION OF THE "TOTAL CLAIMS PAID" RATIOS AMONG CLASS I MOTOR CARRIERS OF GENERAL FREIGHT

where the z_i's are the attribute values of the lo-loss (less than 1%) carriers and w_j's are those of the hi-loss (more than 1%) carriers and the e's are independent random variables assumed to be from the same continuous population. The Δ is the location difference. Hence, the null hypothesis is H_o: $\Delta = 0$, against the alternative H_1: $\Delta \neq 0$. The test statistic employed is:

$$W = \sum_{j}^{65} R_j$$

where the R_j's are the ranks of w_j's when all the z_i's and w_j's are ranked jointly.

For a large sample approximation, under the null hypothesis, H_o, the test statistic

$$W^* = \frac{W - E_0(W)}{\sqrt{Var_0(W)}}$$

$$\simeq \frac{W - (65\ (65+69+1)/2)}{\sqrt{\ 69x65(65+69+1)/12}}$$

has an asymptotic standard normal, N (0,1), distribution. The null hypothesis is rejected if W* is more than 1.96 or less than -1.96, the 95th percentile of the N(0,1) distribution; the test results are set forth in Table B-1.

TABLE B-1. WILCOXEN RANK TEST RESULTS

Attributes	W	W*	
$revenues	5254	3.86	reject H_o; $\Delta > o$
average length of haul	5184	3.55	reject H_o; $\Delta > o$
vehicle miles	5252	3.85	reject H_o; $\Delta > o$
$payroll/$revenue	3963	-1.89	accept H_o; $\Delta = o$
trucks & tractors owned	5206	3.64	reject H_o; $\Delta > o$
freight revenue per ton-mile	3958	-1.91	accept H_o; $\Delta = o$

Based on the sample of 134 regulated carriers, the high loss carriers are found to be earning high annual operating income, traveling more miles annually and also more miles per trip, to have a larger fleet, but to charge their customers just as much revenue per ton-mile and to pay their employees just as much per revenue dollar as their low loss counterparts. Another interesting finding revealed by the scatter plot of revenue dollars and the claim ratios of these 134 carriers is a high degree of instability among the "smaller" carriers having annual operating income of $10 million or less. The business is therefore even riskier for owner-operators running five trucks or less.

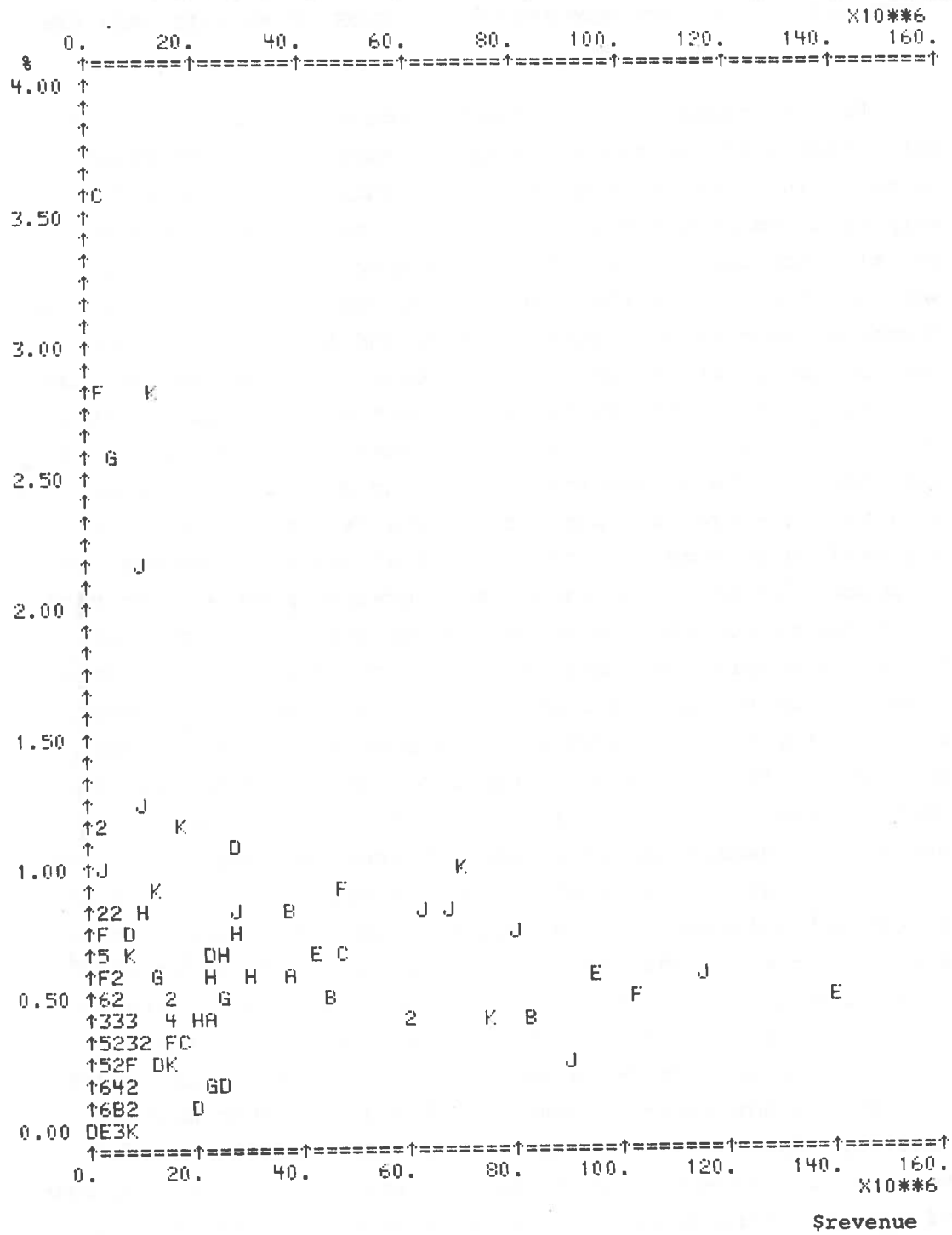


FIGURE B-2. THEFT RATIOS VS. REVENUE DOLLARS

APPENDIX C. PROJECT MEMORANDUM: A NOTE ON PRIVATE CARRIERS

Private trucks, as opposed to 'for-hire' carriers, are by definition motor carriages owned and employed by the shipper to meet his transportation service requirements, whether to ship finished products to customers or to transprot raw materials from suppliers. Their existence is contingent upon and only incident to the company's primary business operations. Companies such as Burlington, Sears, and Safeway, are among the country's largest private truckers. It is estimated that private carriers account for 40 percent of the total intercity truck ton miles.[1] Based on figures estimated from Transportation Association of America (TAA) using equivalent revenue data for non-regulated and local carriers, private carriers are said to produce 30 percent of total trucking revenue, or 90 percent of total non-regulated trucking revenue.[2] Private truck fleets comprise 36-40 percent of the total number of trucks (tractors and trailers) in the country.[3] Such a sizeable portion has made private trucking an important element in the motor carrier industry. Since private carriers are not subject to ICC economic regulatory or reporting requirements, necessary quantitative information, not to mention their cargo damage and loss data, to describe their scope and nature of operation is scant. Any attempt by the government to extract information from them will be viewed as an intrusion into their rights as free enterprises. It is reported[4] that, upon an operational study by the Department of Transportation on private carriers, the Private Carrier Conference (PCC) of American Trucking Association (ATA) made the remark, "....PCC is not going to come to DOT and tell them matters about our operations that have to do with competitive trade secrets, ... except in broad general ways. Any study you make of private carriage will get lousy answers, because you can't ask the right questions. It is so complex that it must be broad brush, and you must come up with generalities."

Despite this, we would probe this gray area of trucking in the

hope of gaining some insights into the operations of private carrier industry. Particular attention is paid to references about their cargo damage and loss experience.

In 1967, with the collaboration of PCC, Handling and Shipping magazine surveyed[5] the 9950 PCC members, who are alleged to be 56 per cent of all shippers using their own private carriages. From this we can estimate that the total number of private carriers in the country today should be more than 17,800, compared to 3,500 Class I and Class II (common and contract) carriers, 12,000 Class III carriers and about 100,000 independent truckers on the road. The survey response rate is 950 out of 9950, just about 10 percent. Even though 10 percent is a low response rate, nevetheless 950 is a large number of companies and any information therefrom should not be slighted.

Among other managerial characteristics findings, the survey indicates that, on the average, private carriers ship 62 percent of their freight using their own fleets; the rest is shipped by 'for-hire' common carriers. As to the type and range of their operations, 26 percent of the respondents handle local distribution, 57 percent have both local and on-the-road operation, while 70 percent carry interstate cargo. More than 53 percent pick up or deliver at locations other than those belonging to their parent companies. 60 percent of the respondents run over 300 miles, of which 21 percent even run over 1000 miles, and only 2.5 percent have local operations of less than 25 miles. Thus, if it is valid to extrapolate the survey that 70 percent of the private carriers are interstate, 60 percent are operating at distance requiring out point control, and 53 percent conduct other than inter-plant operations.

Respondents cited better service, transportation cost improvement, loss and damage reduction, and a need for specialized transportation equipment as the primary reasons for runing their own transportation service. Such reasons are expaned upon by William L. Fayle, in his paper[6], presented in the

Transportation Research Forum, eighth annual meeting, 1967, which describes some differences between common carriers and private carriers. Some major points that might explain the cargo-theft problem of private carriers are:

1) The most important element in private trucking seems to be the shipper's capability to control traffic movements between plants, from vendors, and to customers, etc. Company trucks are continuously under the control of the central department, so that tracing and expediting shipments are much more efficient. This is vital if the company is to control its inventories and meet production scheduling requirements. Also, it is precisely such tight control over movement and inventory which provides a safeguard against pilferage, loss, or damage of goods on the move or in storage in warehouses.
2) An advantage of private carriers over common carriers in curbing theft and damage problems is the reduction in transit and delivery time. Generally, less than truckload (LTL) shipment may involve several lines of common carriers. Services on such movements are usually poor because of the physical transfer of freight from carrier to carrier, resulting in increased exposure to loss and damage. Private truck can go directly to the points of destination without going through transfer points such as distribution terminals where most of the thefts occur.
3) Shippers having their own fleet can avail themselves of the latest improvements. This can mean better and safer containers and specialized equipment for fragile commodities that reduce damages.
4) On the other hand, common carriers have certain packaging requirements which are waived by some private carriers, in which goods are handled in open racks, unwrapped, or in bulk. Such practices often attract potential thieves at loading or delivery docks.

In spite of the stability, reliability, and flexibility which shippers strive to achieve through the use of private carriages, reports on crime occurring in this area have not been at all encouraging. From an article published by Commercial Car Journal in July 1970[7], the following is extracted:

> "To the thief a truck is just a truck regardless of make, model, or size. If its's worth shipping, it's worth stealing, no matter who carries the freight. Private carriers today are losing as much cargo to hijackers as their colleagues in common carriage.... CCI has found that the same factors that permit large-scale freight thefts from common carriers are more often than not even more prevalent in private carrier... Private carriers don't seem worried about the problem, they don't have an 'operating ratio to defend...' "Many private fleets are operated simply as an element or 'product overhead' with no idea of cost and no idea of loss, theft and pilferage is never traced. Theft isn't considered theft, it's 'inventory shrinkage,' just another cost of doing business.
>
> "For even the most conscientious and security minded carrier, the loss from theft runs at the same rate as it does for the common carrier: an estimate third of 1 percent of trucking revenue. For a great many, however, it's more than twice that ... The loss of goods in transit, cargo theft and hijacking is bleeding off more than $1.5 billion a year, although no one has accurate figures and no one was sure it isn't twice that amount."

Conclusion

While the article is inconclusive about the exact nature and quantity of loss and damage on cargo carried by private carriers, it does point out the seriousness and also the vagueness of the problem. The statistics on private carriers are only aggregates, pulled together from different sources, and can only give us a general overall picture of their operations. To what degree do these operational practices relate to the rate of crimes and thefts? Apparently, many shippers have switched to private carrier services to reduce cargo loss because they feel former experiences with common carriers were unsatisfactory in this respect. Is the rate of cargo loss actually lower in private carriers than in common carriers? The Commercial Car Journal after talking to top private carriers such as Burlington in 1970 has reported the contrary. Our next step in the study is to identify factors that may encourage cargo theft and loss, and those distinctive features, if any, of the high loss carriers, whether common or private; features such as the economy of scale, employees' compensation rate, regional difference, etc. The research reported by this memorandum will serve as a general background in such study.

Footnotes:

1. DOT TSC, "Owner-Operated Leased to Regulated Carriers' Industry Overview; Compensation Systems; Operating Cost," 1975. Unpublished Material On File at the Transportation Information Division, Cambridge MA.
2. "Trends & Statistics," Commercial Car Journal, April, 1970.
3. "Truck Inventory and Use," Census of Transportation, 1972.
4. "Traffic World, June 12, 1972.
5. "Private Carriers - All We Want Are Facts," Handling & Shipping, October, 1967.
6. William F. Fayle, "Some Reasons Why Industrial Firms Employ Private Motor Carriage," Transportation Research Forum, 8th annual meeting , 1967.
7. Neil R. Regeimbal, "Crime Put a Bite On Private Carrier, Commercial Car Journal," July, 1970.

APPENDIX D. PROJECT MEMORANDUM: A REVIEW AND SUMMARY OF THE BDM MOTOR CARRIER CARGO CLAIM AND LOSS SURVEY AND ANALYSIS

A review of the economic analysis of national cargo loss and theft costs for calendar year 1971, submitted by the Braddock, Dunn and McDonald, Corp. (BDM) for the Department of Transportation, was made to determine if the scope of their study is comparable to our intended efforts in data collection and analysis of the same problem. In particular, the cargo loss estimates for the motor carrier industry developed by BDM is closely examined for their validity and coverage. This review is based on the Final Report (1975) and "An Economic Model of Cargo Loss: A Method for Evaluating Cargo Loss Reduction Programs" (1972) published by BDM.

Data Source

The basic input to the economic model for deriving overall estimates of cargo theft and loss was the result of a direct survey of carriers and shippers, although interviews with trade associations and various government agencies have provided valuable background information which help verify and strengthen the survey statistics. A stratified random survey was developed for carriers in the four modes of transportation, namely, air, maritime, rail, and truck. Only the data collection method used in the trucking industry is summarized and critiqued here.

"Population Sampling

For the survey of ICC-regulated motor carriers, approximately 450 Class I and II, general and specialized freight carriers were selected from Trinc's Blue Book of the Trucking Industry (1972 edition). A sampling of approximately 300 Class III motor carriers was obtained from an Interstate Commerce Commission listing of regional carriers.

"The non-regulated trucking industry was also surveyed with particular emphasis on private carriers. In cooperation with the Private Carrier Conference of the American Trucking Association, a survey of 270 private carriers was conducted. In addition, the Private Truck Council of America was briefed on the objectives of the DOT survey. The Council expressed interest in the program and described the study objectives in a newsletter distributed to its membership. A further sampling of 310 non-regulated local and intrastate motor carriers was randomly selected from across the continental United States. The total of trucking companies surveyed, both regulated and non-regulated, was approximately, 1,400. This figure represents slightly less than 1 percent of the nation's total regulated and non-regulated motor carrier population.

"...The trucking industry posed a difficult problem for survey because of the several differing modes of operation within the industry. Private carriage in particular required a somewhat different survey format. For example, a sizeable portion of private carriers are simply a division of a large corporation or manufacturing company which transports the goods of that company. Such classifications (in the questionnaire) as 'revenue,' shipments,' and 'interline' operations are, for the most part, not applicable. Five variations of a basic truck questionnaire were employed in the study and much new and useful information was gained about the nature of private trucking."

The Survey Response and Survey Statistics

The survey response was dismally low. Consequently, the sampling variances of the estimates derived from the survey increase considerably. Further, failure to obtain data from some designated survey elements may cause bias in the survey statistics.

TABLE D-1. SURVEY RESPONSE

MODE	DATE MAILED	# OF SURVEYS MAILED	# OF USABLE SURVEYS RECEIVED	@%
TRUCK				
CLASS I&II	MAY 15, 1973	450	147	33%
CLASS III	MAY 30, 1973	300	29	9%
PRIVATE	JUNE 26, 1973	315	23	
LOCAL & INTRASTATE	JUNE 27, 1973	310	10	5%
		625	33	

The cause for these nonresponses, as explained in the BMD Final Report, is mainly the nonexistence of "appropriate financial and operational data for the non-regulated trucking industry." Most private companies simply do not maintain detailed records, or any formal records at all, on their freight claim experience.

Table D-2 shows the ICC regulated trucking industry stratifications and survey data. The danger of extrapolating industry-wide estimates from these data is the possible bias that can arise. Suppose $\bar{C}_N$, the average carrier net claims paid, is estimated by $\bar{c}_N$, the sample average, and

$$\bar{c}_n = \frac{c_n}{n} = \frac{c_1 + c_2}{n} = \frac{n_1}{n} \times \frac{c_1}{n_1} + \frac{n_2}{n} \times \frac{c_2}{n_2}$$

$$= w_1 \times \bar{c}_1 + w_2 \times \bar{c}_2$$

$$= \bar{c}_1 - w_2(\bar{c}_1 - \bar{c}_2$$

where w_1 and w_2 denote the proportions of response and nonresponse, $(w_1 + w_2 = 1)$, and c_1 and c_2, $\bar{c}_1$ and $\bar{c}_2$, the totals and averages in the two groups. Using only $\bar{c}_1$ to estimate $\bar{C}_N$ results in a bias the magnitude of which depends on the difference between $\bar{c}_1$ and $\bar{c}_2$, and the nonresponse rate, w_2. For the bias to be important,

however, a large nonresponse rate must coincide with a huge difference between the two groups. Hence with a response rate of only 14 percent from the nonregulated carriers, the validity of the survey estimates will have to depend on the homogeneity among various carriers in the trucking industry in their damage and loss experience.

With this precaution in mind, BDM has calculated the total trucking industry loss by yet another way. The "loss per ton-mile," L_R (= $\frac{\text{total loss}}{\text{total ton-miles}}$), logged by the ICC-regulated carriers is used as the loss experience factor for those nonregulated carriers. Hence,

Nonregulated intercity carrier loss = L_R x total nonregulated intercity ton-miles;

and

Nonregulated local carrier, loss = L_R x total nonregulated local ton-miles.

Such derivation of cargo loss implies that cargo loss is only a function of ton-miles, an implication which has ignored all other unique characteristics of private or local carriers. Total loss for the entire industry is the sum of total loss incurred by the regulated and nonregulated carriers. Using the data from Table D-2, the total net claims paid for ICC-regulated Class I (i.e., over $1 million operating revenue) carriers is estimated as:

$$C_{\text{class I}} = \sum_{h=3}^{7} N_h \bar{C}_h$$

$$= \$103,560,000.$$

Compared to the 1972 ICC published data for Class I Motor Carriers of General Freight, which shows a "claims paid all causes" of $126 million for 1972, the above figure seems to be a reasonable estimate for 1971. Nevertheless, survey estimates for different classifications by volume of operating revenue

TABLE D-2. ICC-REGULATED TRUCKING INDUSTRY STRATIFICATION AND SURVEY DATA

STRATUM	STRATUM TOTAL POPULATION	STRATUM SAMPLE POPULATION	AVERAGE CARRIER NET CLAIMS PAID	AVERAGE CARRIER INDIRECT COSTS
1 $0-$0.3M	N_1=11,108	n_1=21	C_{N1}=$154 σ=$462	C_{I1}=$2,003 σ=$4,034
2 $0.3M-$1M	N_2=2,159	n_2=16	C_{N2}=$768 σ=$1,028	C_{I2}=$3,951 σ=$2,693
3 $1M-$5M	N_3=1,286	n_3=16	C_{N3}=$7,446 σ=$4,840	C_{I3}=$32,622 σ=$19,723
4 $5M-$10M	N_4=222	n_4=9	C_{N4}=$42,962 σ=$18,842	C_{I4}=$60,817 σ=$40,416
5 $10M-$30M	N_5=174	n_5=16	C_{N5}=$186,546 σ=$101,718	C_{I5}=$187,893 σ=$168,881
6 $30M-$60M	N_6=42	n_6=12	C_{N6}=$649,094 σ=$343,157	C_{I6}=$313,732 σ=$151,407
7 $60M+	N_7=33	n_7=4	C_{N7}=$[illegible]9,423 σ=$443,434	C_{I7}=$324,203 σ=$ 59,665
TOTAL POPULATION	N=15,024	N/A	$\bar{C}_N$=$7,117 σ=$590	$\bar{C}_I$=$9,504 σ=$938

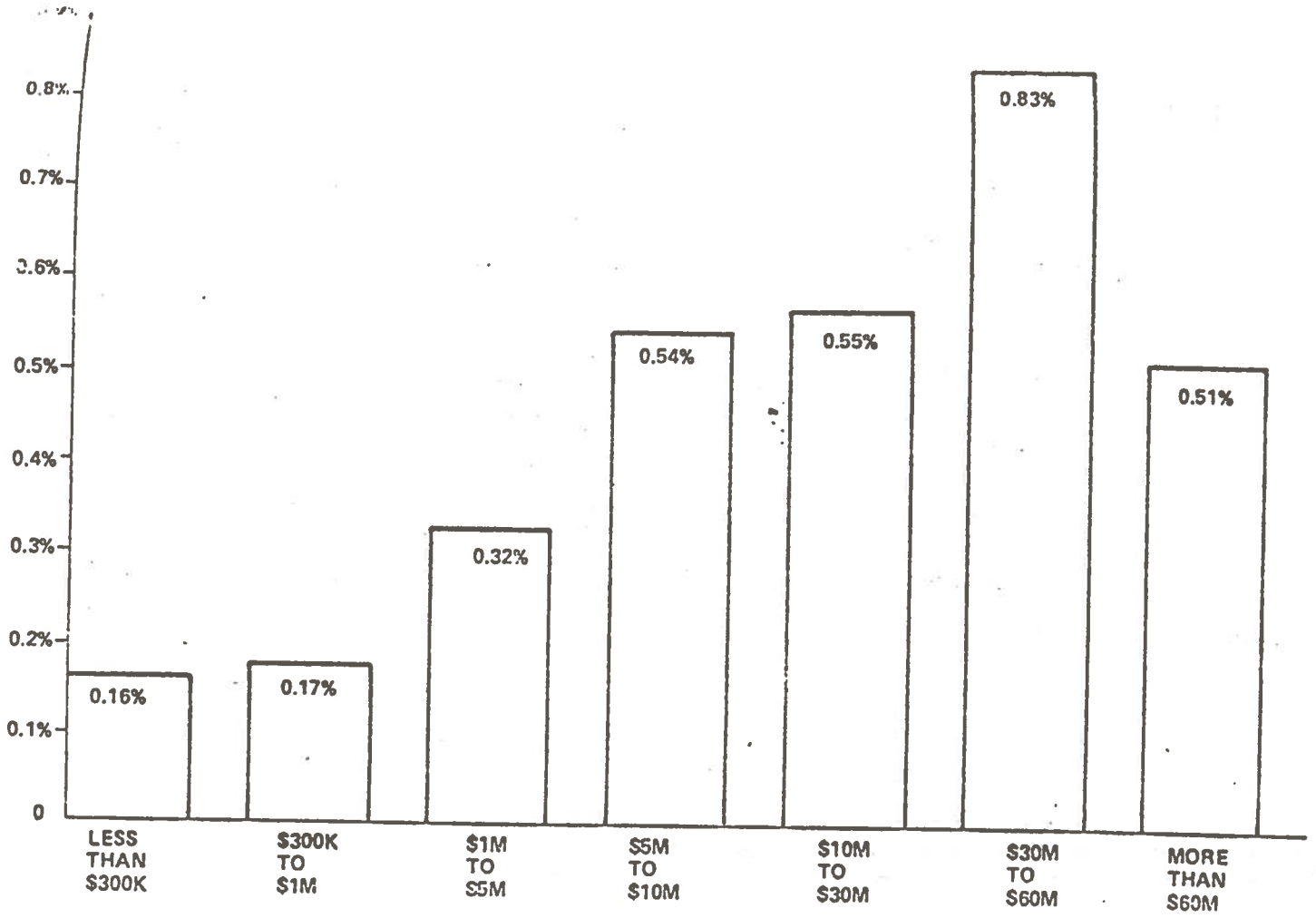


FIGURE D-1. REGULATED MOTOR CARRIER: THEFT-RELATED DIRECT COSTS AS A PERCENTAGE OF REVENUE

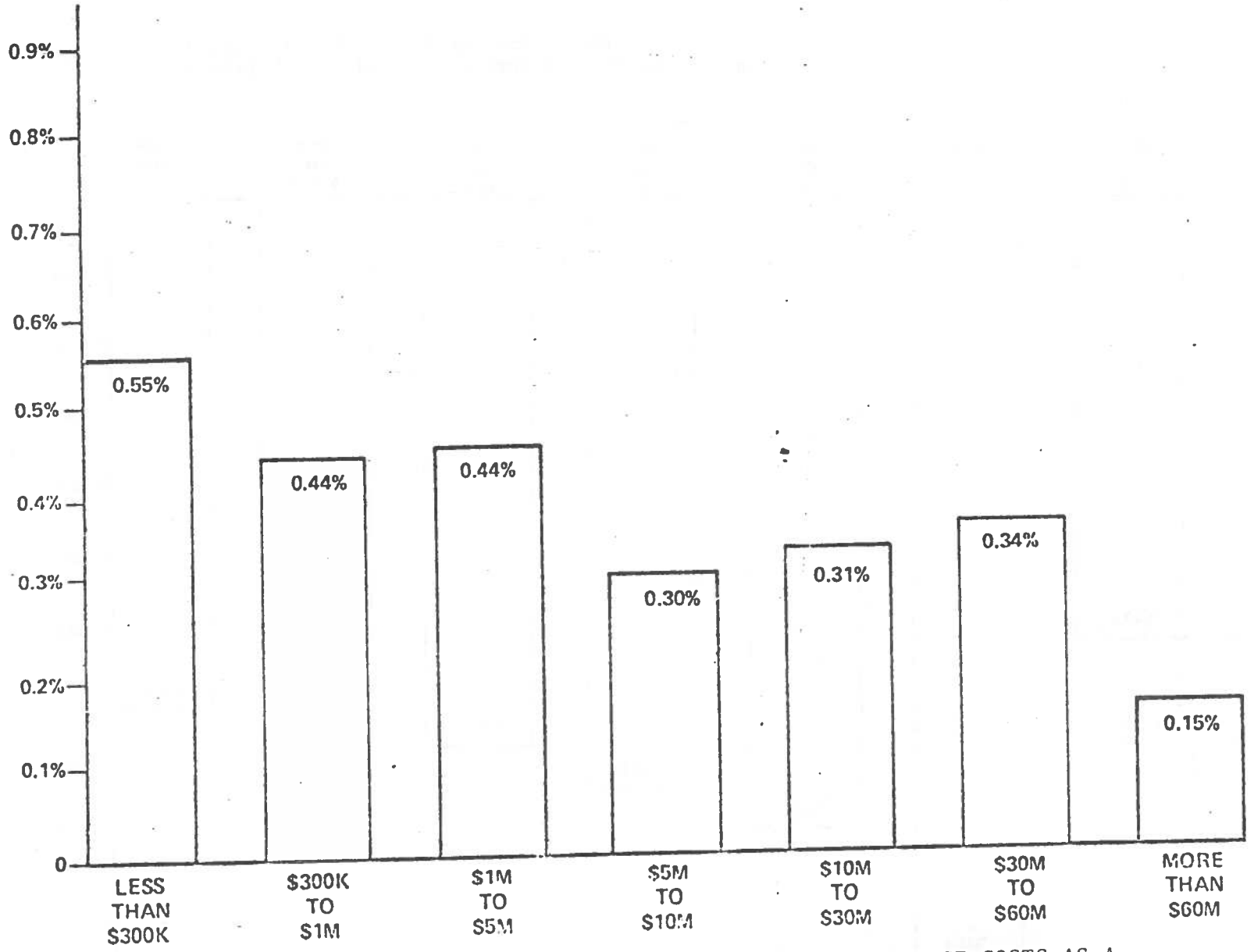


FIGURE D-2. REGULATED MOTOR CARRIER: THEFT-RELATED INDIRECT COSTS AS A PERCENTAGE OF REVENUE

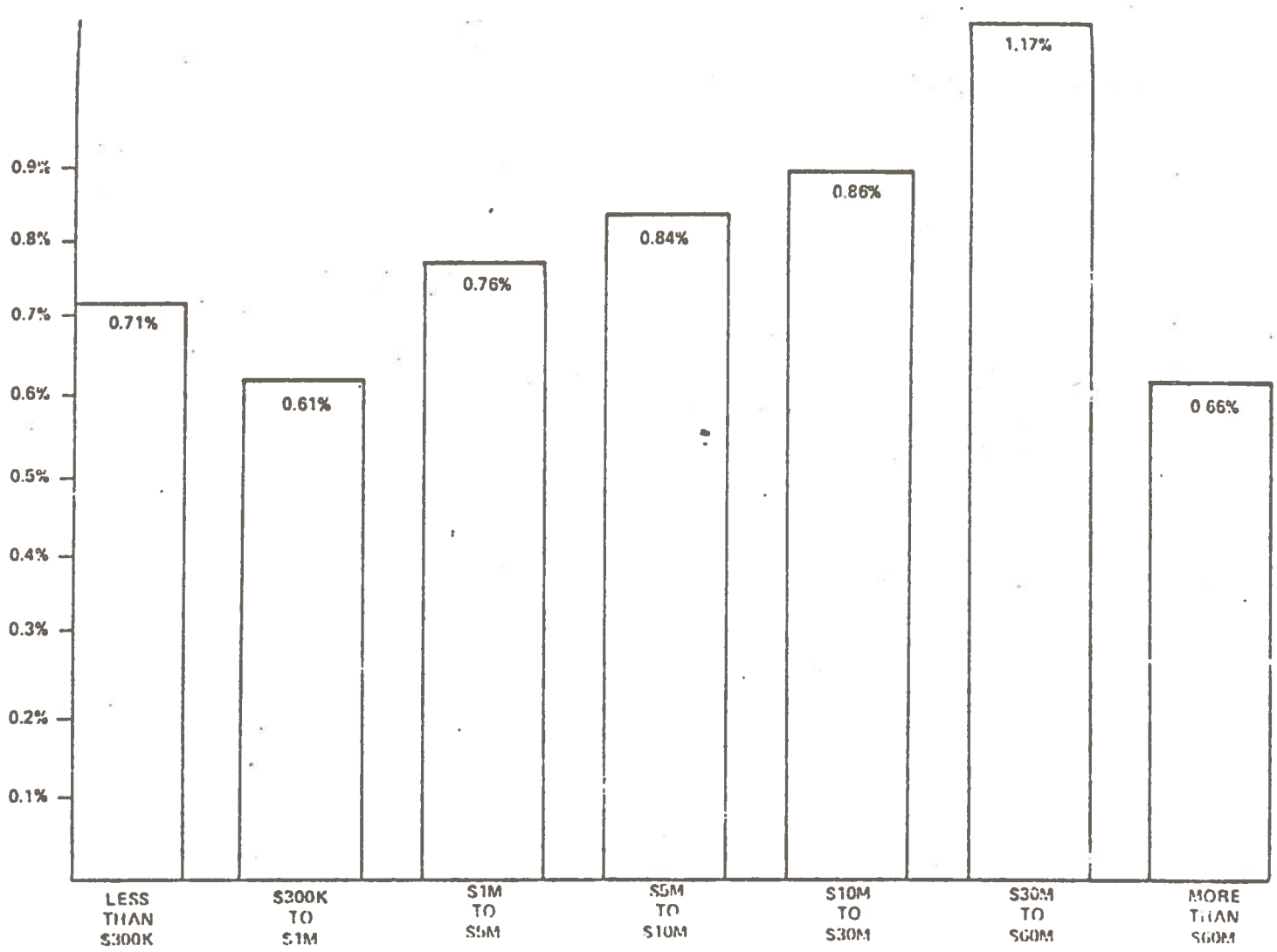


FIGURE D-3. REGULATED MOTOR CARRIER: DIRECT AND INDIRECT THEFT LOSS AS A PERCENTAGE OF REVENUE

as listed in Table D-2 should not be taken seriously since they are subjected to tremendous variations. Figures D-1 to D-3 show the theft-related indirect and direct cost ratios by these classifications in an attempt to portray the distribution of loss in the trucking industry. Again any trend or pattern revealed should be accepted with caution for the same reason.

The Model

The economic model developed by BDM describes and estimates the total magnitude and impact of the cargo theft and loss. Rather than explaining the functional relationship between the trends in various existing economic factors and the trend in cargo freight claims, and the circumstances under which the latter is minimized or maximized, the model delineates four cost components: namely, the shipper/consignee cost, the carriers' cost, the retailers' cost, and the cost ultimately incurred upon the consumers. BDM further explained,

> "Losses suffered by two of the four segments of the economy, namely the Retailer or Users and by the public, could not be estimated in this study nor, perhaps, in any study. Due to their inherent intangible characteristics, these costs such as loss of sales, loss of seasonal business, and loss of customer goodwill, which occur as a result of loss or delay in shipments, cannot be accurately quantified in monetary terms. These costs undoubtedly raise the absolute measure of the cost of cargo loss; however, excluding these factors from the model will not affect its utility for identifying problems and evaluating cargo theft and loss trends."

The model is summarized in Table D-3. These equations are self explanatory except perhaps for the first one, the shipper's direct cost. This is the immediate loss suffered by the shipper/consigner after a shipment is lost. If he files a claim, he would bear the cost of replacing the value of

TABLE D-3. CARGO LOSS COST MODEL

SHIPPER DIRECT COSTS = $S/C_D = V \cdot \frac{t}{12} \cdot i + [V - (C + I_{S/C})][1 + P_I] + S/C_u$

CARRIER DIRECT COSTS = $C_D = [C - S - I_C][1 + P_C]$

$C_D = C_N[1 + P_C]$

SHIPPER INDIRECT COSTS = $S/C_I = CP_s + CL_s + CI_s + SE_s$

CARRIER INDIRECT COSTS = $C_I = CP_c + CL_c + CI_c + SE_c$

TOTAL LOSS = $L = S/C_D + C_D + S/C_I + C_I$

NATIONAL LOSS = $\sum_{\text{MODES}} L$

V = VALUE OF GOODS LOST OR DAMAGED
t = AVERAGE TIME TO SETTLE CLAIMS (MONTHS)
i = AVERAGE ANNUAL INTEREST RATE FOR INDUSTRY
C = GROSS CLAIMS PAID BY CARRIER
$C_N = C - S - I_C$ = NET CLAIMS PAID BY CARRIER
$I_{S/C}$ = INSURANCE PAYMENTS TO SHIPPER
P_I = NATIONAL AVERAGE INDUSTRIAL PROFIT RATE
S = SALVAGE RECEIVED BY CARRIER
I_C = INSURANCE PAYMENTS RECEIVED BY CARRIER
P_C = AVERAGE ANNUAL PROFIT RATE FOR CARRIERS
C_P = COST OF PROCESSING CLAIMS
C_L = COST OF CLAIM LITIGATION
C_I = INSURANCE PREMIUM COST
SE = COST OF SECURITY PERSONNEL AND FACILITIES
S/C_u = unreported S/C losses

good at least for the period during which the claim is processed, which is $V \cdot \frac{t}{12} \cdot i$, assuming the replacement is from a loan with interest rate i. Also he would lose whatever is not claimable from the carrier and insurance company, plus the profit he may make on the lost capital had he been fully compensated, which is $(V - C + I_{s/c})(1 + P_I)$.

The model has in effect distributed and expanded the loss to different sectors of the economy, and described in monetary terms the effect of a claim, both direct and indirect, on the trucking and shipping industry. While it is comprehensive and deterministic in nature, its utility in forcasting cargo loss and damage is minimal. Also, the data input into the model requires detailed records maintained by the carrier of shipper, which unfortunately are very often unavailable. For example, for the shipper/consignee indirect cost data, BDM interviewed various government agencies such as the General Service Administration and Government Accounting Office, etc., but the data obtained were not sufficient enough to establish any statistics. Therefore, throughout their study, BDM has assumed the shipper/consignee indirect cost to be equal to that of the carriers.

Conclusion

The BDM study has shed much light on future survey activities in the collecting of various operating data from the trucking companies. It has uncovered pitfalls and problems (e.g. the nonexistence of financial records of the private companies), and attempted methods to get around those difficulties. Assuming that companies of different sizes and freight volumes have different ways of operation, BDM broke down the regulated carriers into categories, so that the survey sample was designed to be comprehensive enough to represent the whole spectrum of carriers, including private, local, and regulated carriers as well . Unfortunately the data

elicited were so sparse and inaccessible that any statistics thus derived could afford only limited credibility. The study does reflect the infeasibility of a survey in matters concerning the estimation of cargo damage and loss data from non-regulated motor carriers.

As for the model itself, it has accomplished the objective of evaluating and spreading the impact and distribution of theft-related loss. Its impracticality however lies in its almost total dependence on survey data for the estimation of its parameters, since none of the data required are in published form.

GLOSSARY

The nine ICC Regions:

New England Region	Middle Atlantic Region	Central Region
Connecticut	Delaware	Illinois
Maine	District of Columbia	Indiana
Massachusetts	Maryland	Michigan (Lower Peninsula)
New Hampshire	New Jersey	Ohio
Rhode Island	New York	
Vermont	Pennsylvania	
	West Virginia	

Southern Region	Northwestern Region	Mid-Western Region
Alabama	Michigan (Upper Peninsula)	Iowa
Florida	Minnesota	Kansas
Georgia	North Dakota	Missouri
Kentucky	South Dakota	Nebraska
Mississippi	Wisconsin	
North Carolina		
South Carolina		
Tennessee		
Virginia		

Southwestern Region	Rocky Mountain Region	Pacific Region
Arkansas	Colorado	Arizona
Louisiana	Idaho	California
Oklahoma	Montana	Nevada
Texas	New Mexico	Oregon
	Utah	Washington
	Wyoming	

TRUCK: The term "truck", according to the Census of Transportation, 1977, Truck Inventory and Use Survey, refers to a property-carrying motor vehicle used on public highways and streets. In a technical sense, a truck may be a "single-unit truck" or it may be a "combination". The latter consists of a power unit (a "truck-tractor") and one or two trailing units (most commonly a "semi-trailer").

TRUCKLOAD: A "truckload" consists of a shipment of not less than 10,000 pounds of any one commodity transported in intercity service which moves on a single bill of lading. If a single shipment requires more than one truck, each truck used is reported as a truckload. If more than one shipment is moved in the same truck, each shipment of 10,000 pounds or more is reported separately as a truckload shipment. In a mixed truckload shipment, the shipment is assigned to the code of commodity which forms the major portion of the shipment in weight; shipments weighing less than 10,000 pounds are included in codes 47 and 471 "Small Packaged Freight Shipments".

TRUCK FLEET SIZE: Truck Fleet Size is based on the total number of trucks owned and operated by a truck owner regardless of the base of operation.

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U. S. DEPARTMENT OF TRANSPORTATION
TRANSPORTATION SYSTEMS CENTER
KENDALL SQUARE, CAMBRIDGE, MA. 02142