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Motor Carrier Cost Analysis

*by Russell S. Elliott**

ABSTRACT

Motor carrier rates historically have been compared on a per hundred weight (cwt) basis which does not accurately reflect distances as a factor in the cost. A Defense Logistics Agency (DLA) Defense Depot with shorter average less-than-truckload (LTL) distances for example, could have a low cwt cost when compared to other depots. However, when distances are considered, the same defense depot could be spending more on a cost per mile basis than other defense depots. The purpose of this study was to provide insight into motor carrier costs on a per cwt per mile (cwt/mile) basis and to compare these costs across defense depots. One year of historical data were used to develop the mean cwt/mile rates for each defense depot. These cwt/mile rates were subdivided into weight bracket and mileage groups. Graphic representation by weight bracket and mileage groups was used to compare the defense depots and to observe any obvious trends. An analysis of variance (ANOVA) tests which blocked weight brackets and mileage brackets along with multiple classification analysis (MCA) was used to determine differences in mean cwt/mile across the defense depots.

I. INTRODUCTION

A requirement existed to examine motor carrier cost trends on a cost per mile basis from Defense Logistics Agency (DLA) Defense Depots (hereinafter referred to as 'depot(s)'). A cost per mile study will enhance the interpretation of depot cost trends because the traditional cost per hundred pound (cwt) charges do not accurately reflect distance as a factor in the cost. A depot with shorter average less-than-truckload (LTL) distances for example, could have a low cwt cost when compared to other depots. However, when distances are considered, the same depot could be spending more on a per mile basis than other depots.

The primary study objective was to determine the motor carrier costs on a per mile basis for each DLA depot and to compare those costs across the depots. The study was limited to interstate motor carrier shipments with DLA depots as origins and all continental United States (CONUS) points as destinations. Dedicated truck service was excluded from the analysis due to the special nature of this service. The time period of the data was fiscal year 1985 (FY85).

II. METHODOLOGY

A. Input Data

The input data consisted of records from the Freight Information System (FINS) file for the fiscal year 1985. For a record to be selected for the analysis, the transportation mode field had to indicate motor carrier shipments. The data used from each record selected consisted of the origin depot Standard Point Location Code (SPLC); the origin depot Government Bill of Lading Location Code (GBLOC); the total weight; the billed weight; the total charges; the destination state; the destination city; and the SPLC assigned to the destination activity. The mileages used for the study were generated by an algorithm which approximated mileages based on the longitude and latitude of the origin and destination SPLCs.

B. Data Preparation

A computer program was written and run to select the appropriate records from the FINS file. A second program was run which used an algorithm to approximate mileages and appended these mileages to the selected records from the FINS file. Finally, a third program was run for each depot to select the data and make computations as follows: eliminate dedicated truck service; eliminate obviously erroneous data; convert weights to the billed weight; select records that were interstate shipments only; aggregate the transportation charges according to weight bracket and mileage group; and compute the average transportation charge per cwt per mile for each weight bracket and mileage group. Table 1 shows the weight brackets used and Table 2 shows the mileage groups used for this analysis.

TABLE 1

WEIGHT BRACKETS

0- 499 lbs	15000-19999 lbs
500- 999 lbs	20000-24999 lbs
1000- 1999 lbs	25000-29999 lbs
2000- 4999 lbs	30000-34999 lbs
5000- 9999 lbs	35000-39999 lbs
10000-14999 lbs	40000 lbs and over

TABLE 2

MILEAGE GROUPS

1– 50-100 miles	10–1000-1200 miles
2–100-150 miles	11–1200-1400 miles
3–150-200 miles	12–1400-1600 miles
4–200-300 miles	13–1600-1800 miles
5–300-400 miles	14–1800-2200 miles
6–400-550 miles	15–2200-2600 miles
7–550-700 miles	16–2600-3000 miles
8–700-850 miles	17–3000 miles and over
9–850-1000 miles	

III. ANALYSIS

A. Data Trends

The data tend to behave as expected on an individual depot basis. The motor carrier rates per cwt per mile tend to decrease with respect to increases in distance and/or increases in weight. Carrier costs follow the tapering principle such that as distance and/or weight increases, total cost increases at a slower rate. Thus, on a per unit basis, the average rate per cwt per mile decreases.

B. Cost Comparisons Across Defense Depots

There tends to be a greater disparity in rates per cwt per mile between the shorter distances (550 miles or less), particularly for the 50-100 mile group. Above the 550-700 mile group, the rates tend to converge along a narrow band for LTL shipments under 10,000 pounds. Figure 1 shows a typical rate comparison for LTL shipments.

There are two major occurrences at the 10,000 pound break point. First, shipments greater than 10,000 pounds are normally considered as volume or truckload (TL) shipments. Each depot defines its own LTL and TL weight break point. Three depots define TL as 10,000 pounds, one depot defines TL as 15,000 pounds, one depot defines TL as 20,000 pounds and one depot defines TL as 25,000 pounds. The significance of this is that TL rates tend to be lower than LTL rates.

Second, the DLA Guaranteed Traffic Program (GTP) generally starts at 10,000 pounds for TL shipments. The purpose of the TL GTP is to reduce the cost and transit time of TL shipments. Figure 2 shows a typical rate comparison for TL shipments.

The behavior of the curves in the figures were expected. LTL rates were expected to be higher than TL rates because LTL rates contain terminal and line haul costs whereas TL rates contain mainly line haul costs. TL rates tend to be more linear than LTL rates. The low mileage groups have an effect upon both TL and LTL rates. This effect can be caused by the minimum charges assessed by motor carriers.

C. Statistical Analysis of Data

The GTP has been implemented for all TL shipments throughout DLA. DLA depots have also implemented GTP for LTL shipments with the exception of DDF. Since one of the primary purposes of the GTP is to reduce rates, a reasonable expectation is that DDF rates for LTL traffic will be higher than those of the other defense depots. Another expectation is that a geographical difference in rates should be shown. The general nature of motor carrier rates published by rate bureaus tend to reflect the different general operational characteristics of the geographical areas of CONUS. For example, the

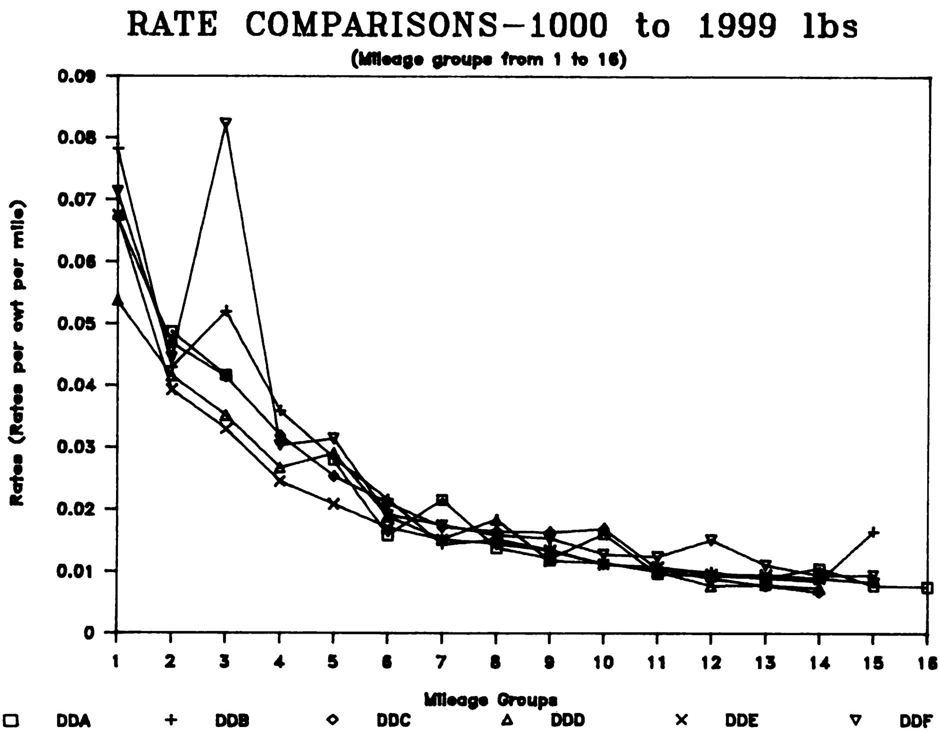

Figure 1

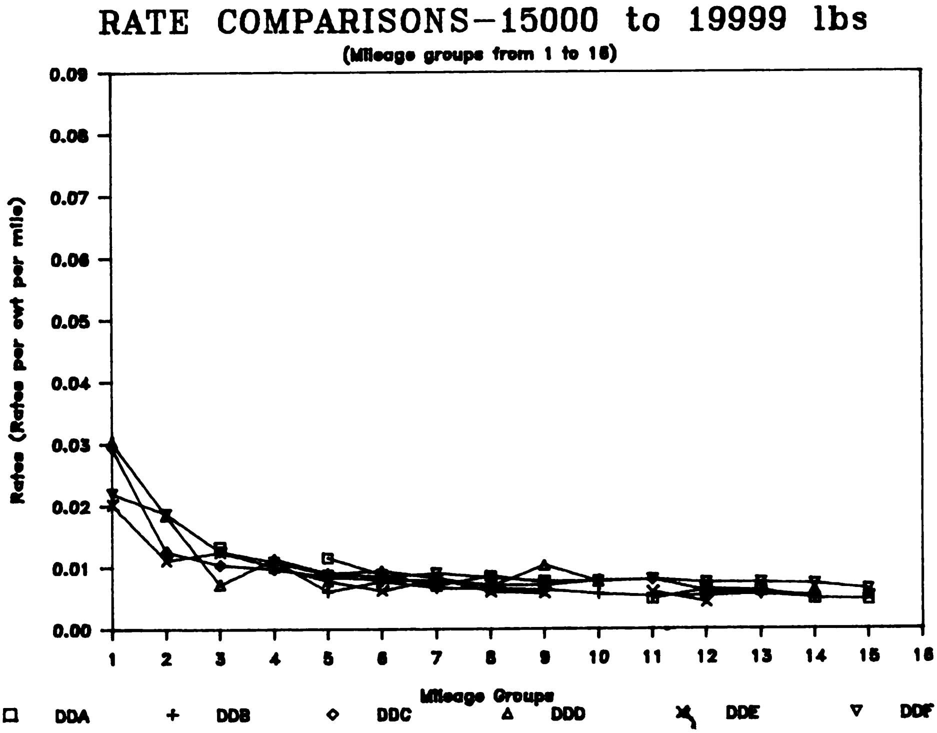

Figure 2

labor costs in the Eastern part of the US tend to increase rates in that area, whereas the labor costs in the Southern portion of the US tend to decrease rates in that area. Statistical analyses of the data were performed to determine if differences exist in the average rate per cwt per mile and to determine where these differences occur. Analysis of variance (ANOVA) tests which blocked, or factored, for mileage groups and weight brackets were conducted for the following areas:

1. LTL shipments as defined by the depots;
2. TL shipments as defined by the depots;
3. weight break point area for LTL and TL shipments (10000 pounds to 25000 pounds);
4. all shipment weights for the depots;
5. shipments under 10000 pounds; and
6. shipments over 10000 pounds.

The purpose of an ANOVA is to statistically test the null hypothesis that all means of the rate per cwt per mile are equivalent or that there is no significant difference between the means for all depots. If the null hypothesis is rejected, then we can conclude that the alternative hypothesis (the mean rates per cwt per mile are different) is true. The results of each ANOVA test for the above areas significantly rejected the null hypothesis. Therefore, the alternative hypothesis should be accepted. This indicates that the mean rates per cwt per mile are not equivalent for all depots.

A Multiple Classification Analysis (MCA) was conducted to determine where differences between the mean rate per cwt per mile occurred for each of the above areas. The MCAs show the grand mean, the number of observations for each depot, an unadjusted mean deviation from the grand mean for each depot, and an adjusted mean deviation from the grand mean for each depot. The unadjusted mean deviation shows the deviation from the grand mean based on all observations of each depot. The adjusted mean deviation shows the deviation of the mean from the grand mean based on mileage groups and weight brackets. Table 3 shows the results of the MCAs.

Table 3 shows the depots ranked in descending order based on the adjusted mean deviation. The deviations are shown in positive and negative numbers which indicate the direction of the deviation from the grand mean. When the mean is greater than the grand mean the deviation is positive and when the mean is less than the grand mean the deviation is negative.

The interpretation of Table 3 should be based on the adjusted mean deviation which considers the mean rate per cwt per mile adjusted for both mileage groups and weight brackets. If the interpretation is based on the unadjusted deviation the results would be misleading. For example, the results of the MCA for TL shipments, as defined by the depots show that

Table 3
Multiple Classification Analysis Results

LTL Shipments as defined by the depots
GRAND MEAN = 0.1275

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDB	39633	0.0097	0.0560
DDE	75976	0.0558	-0.0007
DDA	29276	-0.0694	-0.0077
DDF	36893	0.0012	-0.0087
DDC	88855	-0.0240	-0.0120
DDD	26201	-0.0194	-0.0212

TL Shipments as defined by the depots
GRAND MEAN = 0.0075

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDF	4041	0.0009	0.0007
DDA	772	-0.0031	0.0007
DDD	494	-0.0016	0.0005
DDC	5546	-0.0019	-0.0001
DDE	2737	0.0051	-0.0004
DDB	2427	-0.0016	-0.0009

Weight break point area for LTL and TL shipments (10000 pounds to 25000 pounds)
GRAND MEAN = 0.0099

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDD	869	0.0001	0.0013
DDF	2008	0.0006	0.0006
DDC	3318	-0.0013	0.0000
DDA	676	-0.0025	-0.0004
DDB	1412	-0.0024	-0.0006
DDE	1783	0.0045	-0.0008

All shipments
GRAND MEAN = 0.1228

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDB	42060	0.0082	0.0536
DDE	78713	0.0560	-0.0014
DDA	30048	-0.0646	-0.0068
DDF	40934	-0.0046	-0.0097
DDC	94401	-0.0236	-0.0107
DDD	26695	-0.0151	-0.0198

Shipments under 10,000 pounds
GRAND MEAN = 0.1301

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDB	39633	0.0086	0.0561
DDE	75976	0.0547	-0.0010
DDA	28600	-0.0693	-0.0080
DDF	36896	0.0001	-0.0089
DDC	87471	-0.0236	-0.0120
DDD	25524	-0.0179	-0.0212

Shipments over 10,000 pounds
GRAND MEAN = 0.0079

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDD	1171	0.0009	0.0090
DDF	4041	0.0005	0.0070
DDA	1448	-0.0020	-0.0000
DDC	6930	-0.0013	-0.0002
DDE	2737	0.0048	-0.0005
DDB	2427	-0.0020	-0.0007

DDE has the largest positive unadjusted deviation of 0.0051. DDE's adjusted deviation is -0.0004, which is one of the lowest adjusted deviations. The majority of DDE shipments are in the lower mileage groups with the highest rates per cwt per mile. When the deviation is adjusted for weight brackets and mileage groups, the adjusted deviation drops to -0.0004 for DDE. Therefore, the results will be explained in terms of the adjusted deviations.

DDF tends to have a high rate for depot defined TL shipments and shipments over 10000 pounds and lower than average for shipments under 10000 pounds and depot defined LTL shipments. This indicates that there is an inconsistent relationship between TL and LTL rates for all depots. It would be expected that if TL rates were high, then LTL rates would be high for the same depot which is not always the case.

DDD also tends to have a high rate for depot defined TL and shipments over 10000 pounds. This result was unexpected because it indicates that the geographical differences in motor carrier rate bureaus do not exist for TL GTP traffic. If there was a geographical difference in TL GTP rates, then it would be expected that DDE would have higher rates than DDD.

DDA was expected to have higher mean rates than the results show. One explanation is that the analysis did not include intrastate shipments. The elimination of intrastate rates can decrease the number of low mileage shipments, which in turn, tends to produce lower rates on a per mile basis. DDA's lower mean rate may be explained by the fact that the rates from DDA may reflect backhaul rates from the west coast area to the east cost are. Backhaul rates are normally lower than regular rates because most carriers will charge a lower rate to cover the cost of returning his equipment to his base territory (i.e., fuel costs and driver costs only).

The results indicate that DDE tends to have the highest rates for depot defined LTL shipments, shipments under 10000 pounds and all shipments. This result was expected due to the geographical location of DDB. DDB has the lowest rates for depot defined TL and shipments over 10000 pounds. This was initially unexpected. The reason for the low rates may be explained by backhaul rates.

DDE tends to have a high mean rate per cwt per mile for depot defined LTL, all shipments, and shipments under 10,000 pounds. The majority of DDE shipments tend to be in the lower weight brackets and the lower mileage groups, which will cause a higher mean rate. DDE also tends to ship in the motor rate bureau areas, which tend to have the highest rates of the rate bureaus.

DDC tends to have a low mean rate per cwt per mile (lower than the mean rate). This may indicate that the GTP, for both TL and LTL traffic, is meeting its objective to decrease motor carrier transportation rates.

DDD mean rates tend to vary between LTL and TL traffic. DDD tends to have the lowest mean rate for LTL traffic, one of the highest mean rates for TL traffic, and the lowest mean rate for all shipments. The reason for this is the low number of TL shipments (26201 LTL shipments vs. 494 TL shipments).

General observations of the results indicate that a majority of motor carrier shipments from the depots are LTL. The weight brackets of 0 to 499 pounds tend to contain the majority of the LTL traffic. The LTL shipments have a great impact on the mean rate per cwt per mile for all depot shipments. The grand mean for all shipments is 0.1228, 0.1301 for LTL (shipments under 10000 lbs), and 0.0079 for TL (shipments over 10000 lbs). This indicates that the LTL rate per cwt per mile strongly influences the overall rate per cwt per mile for all the depots. This is expected because the overwhelming majority of the shipments are LTL for each depot. The differences in the mean rate per cwt per mile for each depot are relatively small (i.e., from under six cents to under one cent), yet these differences are statistically significant. The results did not show strong geographical rate differences. The reason is that all of the defense depots have interregional shipments which would tend to decrease the impact of the differences in the general operational characteristics of the geographical areas.

D. LTL GTP versus LTL NON-GTP

The purpose of GTP for LTL traffic is to reduce transit times, transportation costs, and administrative handling on an individual depot basis. Several studies analyzing GTP indicate that GTP does reduce the transit times and transportation rate on a per depot basis. When a rate is reduced, then the rate per cwt per mile is also reduced. DDF has not implemented the LTL GTP, thus it was expected that DDF's LTL mean rates per cwt per mile would be higher than the other depots. The first analysis does not support this assumption because all shipments were analyzed.

The first analysis showed that the majority of the shipments are LTL and under 500 pounds therefore a second analysis was conducted to compare LTL GTP versus LTL non-GTP mean rates per cwt per mile. Shipments under 200 pounds were excluded from the additional analyses. The weight of 200 pounds was selected because the GTP agreements establish a minimum charge based on a minimum shipment weight of 200 pounds.

The additional analyses were conducted in the following categories: depot defined LTL shipments; LTL shipments under 10000 pounds; and all shipments. The ANOVA test results rejected the null hypothesis (the mean rates per cwt per mile are equivalent for each depot) for each category; therefore, the alternative hypothesis was accepted (the mean rates per cwt per mile for each depot are statistically different). The test statistic, which indicates whether to accept or reject the null hypothesis, was reduced for each ANOVA test category. This indicates that by eliminating shipments under 200 pounds some variability in the mean rates per cwt per mile was eliminated.

The MCA results are shown in Table 4. These results are interesting for three reasons. First, the ranking of the depots are the same in each of the categories. Second, DDB and DDF are the two depots with the highest mean rates per cwt per mile. The differences between DDB and DDF adjusted deviations of mean rates per cwt per mile are at least twice the mean rate per cwt per mile of the third ranked depot. Third, the grand means decrease by at least .0991.

The results show that DDB mean rates per cwt per mile are the highest. This is expected due to the

Table 4
MCA Results for LTL Shipments Over 200 Pounds

LTL Shipments as defined by the depots
GRAND MEAN = 0.0254

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDB	19850	-0.0053	0.0023
DDF	23574	0.0055	0.0020
DDC	44602	-0.0018	0.0007
DDD	13890	-0.0002	0.0005
DDA	17918	-0.0094	0.0004
DDE	36776	0.0060	-0.0038

LTL Shipments under 10000 pounds
GRAND MEAN = 0.0257

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDB	19850	-0.0056	0.0024
DDF	23574	0.0052	0.0020
DDC	43218	-0.0016	0.0008
DDD	13213	0.0060	0.0005
DDA	17242	-0.0093	0.0004
DDE	36776	0.0058	-0.0038

All shipments
GRAND MEAN = 0.0237

DEPOT	OBSERVATIONS	UNADJUSTED DEVIATION	ADJUSTED DEVIATION
DDB	22277	-0.0052	0.0022
DDF	27615	0.0038	0.0016
DDC	50148	-0.0021	0.0008
DDD	14384	0.0011	0.0007
DDA	18690	-0.0082	0.0004
DDE	39513	0.0064	-0.0038

geographical location of DDB. DDB and DDF adjusted mean rates per cwt per mile are out of line when compared with the other depots. The LTL GTP for DDC, DDD, DDA and DDE appears to be working properly. DDE has an extremely low mean rate per cwt per mile which indicates that their LTL GTP is excellent. DDF mean rates are the second highest for each of the above categories. This was expected since DDF has not implemented GTP for LTL traffic.

IV. CONCLUSION

The results of this analysis show that the mean rates per cwt per mile for all the depots are not equivalent. The ANOVA test used for each of the nine areas under consideration resulted in significant rejection of the null hypothesis. The largest absolute deviations from the grand means occurred for LTL traffic. This indicates that greater savings can probably be achieved with GTP for LTL traffic. Since the largest percentage of shipments are LTL, more cost savings attention to LTL traffic should be given.

The minimum charges that are established by the LTL GTP agreements are based on the minimum weight of 200 pounds. The effect of the minimum charges become apparent when shipments under 200 pounds are eliminated from the analyses. The ranking of the defense depots changes and the grand mean is reduced. DDF had a below average mean rate per cwt per mile when all shipments were analyzed. However, when shipments over 200 pounds were analyzed, DDF's mean rates per cwt per mile jumped to the second highest. This shows that the minimum charge for LTL GTP can have an adverse effect on mean rates per cwt per mile.

The results also show that closer attention should be paid to the minimum charges during the negotiation of GTPs. High minimum charges affect the low mileage group rates and this effect is shown in the figures for all weight brackets. Lower minimum charges would reduce the rate per cwt per mile for the lower mileage groups, which in turn would reduce the mean rate per cwt per mile for LTL shipments. This could result in a more cost effective GTP. The results also show that each depot is unique in its shipment patterns. DDA and DDB mean rates appear to be influenced by backhaul rates, DDE mean rates appear to be influenced by its short distance shipments and rate bureau territory. Each depot's mean rate is influenced by the type of commodity shipped. This uniqueness of each depot increases the difficulty of comparing the mean rate per cwt per mile across the depots.

ENDNOTE

*Defense Logistics Agency, Operations Research and Economic Analysis Management Support Office