MILK ASSEMBLY COSTS AND SAMPLE HAULING RATES FOR THE GREATER OHIO AREA

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May 1990

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The research reported herein is based on Gallagher’s master’s thesis research which was completed in the Department of Agricultural Economics and Rural Sociology at The Ohio State University. Funding was provided in part by the late Thomas A. Wilson, former Market Administrator, New York-New Jersey Milk Marketing Area, and in part by the Ohio Agricultural Research and Development Center.

The authors are indebted to Milk Marketing, Inc. Their initial impetus in requesting such a study resulted in its undertaking. Additionally, their assistance was utilized in data collection and technical consultation.

The contents of this report are the sole responsibility of the authors and should not be interpreted as reflecting the views or opinions of the Office of the Market Administrator, New York-New Jersey Milk Marketing Area or Milk Marketing, Inc.
MILK ASSEMBLY COSTS AND SAMPLE HAULING RATES FOR THE GREATER OHIO AREA

Executive Summary

This study examines hauling costs in the greater Ohio area using cost data from 40 milk hauling firms. Presented data represent costs for 1988. The principal objective of this study is to examine how hauling costs vary with differences in region, miles driven, and the amount of milk hauled. A secondary objective is to examine the reasonableness of hauling rate structures. Results are summarized as follows:

* Significant cost differences exists across regions. Regions having low dairy farm concentrations and hilly terrain face higher hauling costs than regions with high dairy farm concentration and relatively flat terrain. Hauling rates should reflect these differences.

* On average, revenue milk haulers receive from dairy farmers do not cover average cost of hauling a load of milk. However, larger loads tend to have an average cost below average revenue, indicating that larger loads are profitable.

* In general, milk haulers who haul larger loads of milk are more cost efficient than haulers with smaller loads of milk. This places a premium on having a load near its capacity. It also suggests that milk haulers should move to the largest vehicles that are technically feasible, given that they can fill the truck to near capacity.

* Costs of picking up milk from a dairy farm does not vary greatly with the size of the milk pick-up. Overall efficiency can be increased if milk haulers service dairy farmers every other day.

* Hauling schedules with higher stop charges or sliding volume charges have the potential to be more equitable than currently used hauling schedules.
Transporting milk from farms to milk processing plants is an integral part of a complex milk marketing system. In the greater Ohio area, a large number of privately owned companies haul milk from farms to plants. For the most part, these companies procure accounts with the dairy farmers they service. Negotiations between farmers, milk haulers, and milk marketers determine procurement practices and hauling charges. Reasonableness of negotiated charges, or hauling rates, concerns dairy farmers, milk haulers, milk marketers, and dairy processors. Whether negotiated rates are reasonable depends on how well the rates reflect costs of hauling milk.

This report presents results from a study which analyzed milk assembly costs in the greater Ohio area. Calculated costs are used to assess the equitability and fairness of various hauling rate structures. Methods used in determining costs are reported in the following section. The second section illustrates cost variations due to differences in region, miles driven to collect and deliver milk, and weights of milk hauled. Cost variations may provide milk haulers with information useful in structuring their businesses. Hauling rate structures are examined in the third section.

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METHODS USED TO STUDY MILK HAULING COSTS

The principle objectives of this study are to determine the costs of hauling milk for differing regions, miles driven, and weights of milk hauled. Cost data from a sample of milk hauling firms are used to accomplish these objectives.

The Survey Area

Milk hauling companies in the greater Ohio area (Figure 1) were surveyed in regard to their cost of hauling milk. Differences in terrain and dairy farm density may affect milk hauling costs. To study this possibility, the area is divided into four regions:

1. Central Ohio -- Eastern Indiana (C.Oh.-E.In.),
2. Southern Ohio -- Northern Kentucky (S.Oh.-N.Ky.),
3. Southwestern Pennsylvania -- Northern West Virginia (S.Pa.-N.WV.), and

The C.Oh.-E.In. region is relatively flat allowing for use of larger trucks. This region has relatively large dairy farms scattered over a wide area. The S.Oh.-N.Ky. region is characterized by rolling terrain and contains relatively few dairy farms. Dairy farms also tend to be smaller in this region than in the C.Oh.-E.In. region. The S.Pa.-N.WV. region is comparatively hilly and contains relatively small dairy farms spread over a large area. Milk hauling costs in this region are expected to be high. The N.Oh.-N.Pa. region is rolling. This region has the highest concentration of dairy farms of all regions.
Figure 1. Regions for Determining Milk Hauling Costs

- Northeastern Ohio/Northwestern Pennsylvania
- Central Ohio/Eastern Indiana
- Southern Ohio/Northern Kentucky
- Southwestern Pennsylvania/Northern West Virginia
Data Collection

Data have been collected from 40 firms between December 1988 and March 1989. Sampled hauling companies assemble milk for Milk Marketing, Incorporated (MMI). Data collection has been accomplished using a survey designed by Gallagher and administered by MMI fieldmen. (The survey instrument is shown in Gallagher, E. W.)

Costs Included in the Study

Data deal with costs for all loads of milk assembled by each surveyed company. A load is defined as the itinerary a milk hauler follows to collect a tank or trailer of milk, deliver the milk to a processing plant, and return to the point of origin or the first farm on the next load. On average, sampled milk hauling companies operate one or two vehicles and collect two or three loads over a two day period.

All costs relative to milk hauling are included. Costs associated with hauling other products such as water are not considered. Milk hauling costs include cash costs, overhead costs, and opportunity costs. An example of an opportunity cost is a charge for owner labor. While not a cash cost, owner labor is a real cost to the company because the owner can find employment elsewhere. Examples of overhead costs include vehicle insurance and office costs.

Costs associated with capital invested in the milk hauling company are determined and treated as opportunity costs. Capital costs are calculated by first placing market values on hauling vehicles and the load's itinerary. Opportunity costs are determined
with an asset replacement model using a 10 percent interest rate. This procedure incorporates an allowance for debt interest charges and accounting depreciation.

Costs are stated on a per load basis. Total load costs are accounted for in three categories (see the Appendix for a more detailed explanation):

1. **Labor cost.** This cost includes the labor associated with operating the milk truck.

2. **Fuel cost.** This cost is exclusively the cost of the fuel used to assemble a load of milk, deliver the milk to the processing plant, and return to the hauler's garage or the first farm on the next load.

3. **Vehicle costs.** Vehicle costs are overhead and opportunity costs. They include preventive and repair maintenance, tire, insurance, highway taxes, tolls, licence and registration, truck and route ownership, spare vehicle, non-truck operator labor, and other overhead costs.

**Determining Factors Affecting Costs**

Production and duality theories are used to analyze the effects that various factors have on costs of hauling a load. These theories allow the effects of various factors to be examined assuming that a milk hauler completes the load's itinerary at the lowest possible cost (i.e. minimize costs for a given level of output). Six factors are examined:

1. **Labor cost per hour.** Labor cost per hour equals labor cost (defined above) divided by hours to collect and deliver a load of milk and return to the hauler's garage or first stop on the next load.
2. Fuel cost per gallon. Fuel cost per gallon equals fuel cost (defined above) divided by gallons of fuel used.

3. Vehicle costs per mile. Vehicle costs per mile equal vehicle cost (defined above) divided by the load's mile.

4. Assembly miles. Assembly miles consist of the miles from the load's origin, typically the milk hauler's garage, to the last farm serviced on a load.

5. Transport miles. Transport miles consist of the miles from the last farm serviced to the delivery plant plus the miles from the plant to the load's origin or the first stop on the next load.

6. Hundredweights (cwts) of milk hauled. This amount equals the cwts of milk delivered to the plant.

A set of mathematical equations are developed that incorporate the above factors. These equations give statistical estimates of the costs of hauling milk from farms to processing plants. Based on these equations, average load costs are calculated given values for each of the six factors. Costs reported in the following section are based on these estimates and thus represent averages for given values of the six factors (i.e., average hauling costs for a region). An individual milk hauler can incur load cost that are different from those reported below.

Our methods allow cost comparisons for changes in one or more of the above factors. For example, costs are calculated for differing assembly and transport miles. Additionally, no restrictions are placed on the manner in which costs change for differing cwts hauled. Percentage increases in costs can be higher, lower, or the same as
percentage increases in cwt hauled. Our methods differ from previous studies. Most previous studies do not allow comparisons for differing miles driven. In addition, most previous studies assume that costs increase at a constant rate as cwts hauled increase.

COSTS OF HAULING MILK

On average, collecting a load of milk in the greater Ohio area requires driving 75 assembly miles and 98 transport miles, resulting in a total of 173 miles (Table 1). The highest total miles occurs in the S.Pa.-N.WV. region where farms and processing plants are scattered. Average load miles are lowest in the N.Oh.-N.Pa. region due to a concentration of dairy farms and dairy processing plants.

An average of 348 cwts are collected on a load in the greater Ohio area (Table 1). Load sizes are larger in the C.Oh.-E.In. and N.Oh.-N.Pa. regions: C.Oh.-E.In. and N.Oh.-N.Pa. average 392 and 390 cwts, respectively, as compared to 321 cwts in the S.Oh.-N.Ky. and 300 cwts in the S.Pa.-N.WV. regions. Factors influencing load size are terrain, farm density, and average dairy farm size. Both the S.Oh.-N.Ky. and S.Pa.-N.WV. regions have relatively hilly terrain, requiring larger engines to carry similar sized loads. Moreover, farms are scattered and tend to be of smaller size.

Hauling Costs by Regions

Labor costs vary across the regions (Table 1). The N.Oh.-N.Pa. region has the highest labor cost per hour, averaging $8.91. Following this region is the C.Oh.-E.In. region which has an average labor cost per hour of $8.11. Both the N.Oh.-N.Pa. and
Table 1. Miles Driven, Cwts. Hauled, and Costs of a Milk Load, Greater Ohio Area, 1988.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly Miles</td>
<td>75</td>
<td>68</td>
<td>81</td>
<td>89</td>
<td>59</td>
</tr>
<tr>
<td>Transport Miles</td>
<td>98</td>
<td>86</td>
<td>108</td>
<td>145</td>
<td>56</td>
</tr>
<tr>
<td>Total Miles</td>
<td>173</td>
<td>154</td>
<td>189</td>
<td>234</td>
<td>115</td>
</tr>
<tr>
<td>Cwts Hauled</td>
<td>348</td>
<td>392</td>
<td>321</td>
<td>300</td>
<td>390</td>
</tr>
<tr>
<td>Input Prices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor ($/hr.)</td>
<td>$8.13</td>
<td>$8.11</td>
<td>$7.96</td>
<td>$7.92</td>
<td>$8.91</td>
</tr>
<tr>
<td>Fuel ($/gal.)</td>
<td>.94</td>
<td>.95</td>
<td>.95</td>
<td>.98</td>
<td>.86</td>
</tr>
<tr>
<td>Vehicle ($/mile)</td>
<td>.65</td>
<td>.69</td>
<td>.65</td>
<td>.54</td>
<td>.81</td>
</tr>
<tr>
<td>Total Cost Per Load</td>
<td>$223</td>
<td>$208</td>
<td>$234</td>
<td>$271</td>
<td>NA</td>
</tr>
<tr>
<td>Percent Share of Total Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>35 %</td>
<td>35 %</td>
<td>34 %</td>
<td>36 %</td>
<td>NA</td>
</tr>
<tr>
<td>Fuel</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>16</td>
<td>NA</td>
</tr>
<tr>
<td>Vehicle</td>
<td>51</td>
<td>51</td>
<td>52</td>
<td>48</td>
<td>NA</td>
</tr>
</tbody>
</table>


1 See the text for region definitions.

2 Assembly miles equal the miles from the load’s origin to the last farm stop.

3 Transport miles equal the miles from the last farm stop to the delivery point plus the miles to the load’s origin or the first stop on the next load.

4 Insufficient data exists in this region to calculate costs.
C.Oh.-E.In. regions have more industry and other job opportunities than do the S.Oh.-N.Ky. and S.Pa.-N.WV. regions. This factor likely increases labor cost.

Total cost per load averages $223 (Table 1). Of the regions where sufficient data exists, the S.Pa.-N.WV. region has the highest cost. Total hauling cost is higher because more total miles must be driven in this region (i.e., 234 miles). The C.Oh.-E.In. region has the fewest average miles driven (154 miles) and also the lowest cost ($208).

Revenue and cost are stated on a cwt basis in Table 2. Revenue per cwt only includes compensation received from farmers. Occasionally, milk marketers divert a load from its primary plant to a more distant, non-primary plant. For this service, the hauler receives a compensatory payment. These payments for delivery to non-primary plants are not included. Thus, the average revenue figures may understate actual revenue. However, the additional cost of moving a load from the primary to the non-primary plant is not included in the estimation of total cost.

On average, revenue received from farmers does not cover the average cost of hauling a load. However, larger loads tend to have an average cost below average revenue, indicating that larger loads are profitable.

Hauling Costs for Differing Assembly Miles and Cwts Hauled

Figure 2 shows hauling costs on a per cwt basis. These numbers are calculated by finding total cost of hauling a load of milk and then dividing by the cwts of milk hauled. Per cwt hauling costs are given for differing assembly miles, as indicated along the
Table 2. Average Revenue and Average Costs Per Cwt. of Milk Hauled, Greater Ohio Area, 1988.

<table>
<thead>
<tr>
<th>Item</th>
<th>Study Crop Average</th>
<th>Region[^1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue per cwt. ^2</td>
<td>$ .55</td>
<td>$.52</td>
</tr>
<tr>
<td>Cost per cwt.</td>
<td>.64</td>
<td>.53</td>
</tr>
<tr>
<td>All loads</td>
<td>.53</td>
<td>.50</td>
</tr>
<tr>
<td>5500 Gallon Tank at 90% Capacity</td>
<td>.45</td>
<td>.44</td>
</tr>
</tbody>
</table>


[^1]: See the text for region definitions
[^2]: Only includes revenue received from farmers.
[^3]: Insufficient data exists in this region to calculate costs.

What do you do with other assumptions? Farms ⇒ Loads. You must be using the load system.
Figure 2. Per Cwt. Hauling Costs for Differing Assembly Miles and Load Sizes *

* Based on a cost function described in Gallagher, Edward W. Assumes 98 transport miles, $8.13 per hour labor cost, $.94 per gallon fuel cost and $.65 per mile vehicle costs.
bottom axis. In addition, the three lines give costs for differing cwts hauled. Lines show costs for:

1. 346 cwts (i.e., 34,600 pounds) -- corresponds to a 4,500 gallon tank filled to 90 percent of its capacity,

2. 423 cwts (i.e., 42,300 pounds) -- corresponds to a truck having a 5,500 gallon tank filled to 90 percent of its capacity, and

3. 500 cwts (i.e., 50,000 pounds) -- corresponds to a truck having a 6,500 gallon tank filled to 90 percent of its capacity.

All other variables are held constant at their mean values: 98 transport miles, $8.13 per hour labor cost, $.94 per gallon fuel price, and $.65 per mile vehicle cost.

Hauling costs per cwt increase between $.01 and $.04 for each 10 mile increase in assembly miles. For example, hauling costs per cwt equal $.60 when 60 assembly miles are driven and 346 cwts are hauled. At 70 assembly miles, hauling costs per cwt equal $.63. In this case, a $.03 increase results from increasing assembly miles from 60 to 70 miles. This per cwt increase yields a $10.38 increase in costs on a load basis. Smaller cost increases are associated with higher initial assembly miles. For example, moving from 150 assembly miles to 160 assembly miles while hauling 346 cwts of milk yields a $.02 increase in per cwt hauling costs. This increase compares with the previously mentioned $.03 increase when moving from 60 to 70 assembly miles.
Figure 3. Per Cwt. Hauling Costs for Differing Cwts. Hauled *

$ per cwt.

* Based on a cost function described in Gallagher, Edward W. Assumes 100 assembly miles, 98 transport miles, $8.13 per hour labor cost, $.94 per gallon fuel cost and $.65 per mile vehicle costs.
Hauling Costs for Differing Cwts Hauled

Figure 2 also illustrates that per cwt hauling cost decreases as load size increases. In all cases, per cwt hauling cost is less for larger load sizes. Figure 3 illustrates the rate at which per cwt cost decline, given that 100 assembly and 98 transport miles are driven. Overall, per cwt hauling cost declines over the entire range shown. However, the majority of the decline occurs between 200 and 360 cwts. Between 200 and 360 cwts, per cwt hauling cost decreases by $0.50. This compares to a $0.20 decrease between 360 and 500 cwts.

Because of cost advantages, milk hauling companies with larger load sizes tend to be more profitable than companies with smaller load sizes. As a result, the milk hauling industry will move towards larger load sizes in the future. Milk haulers with load sizes less than 360 cwts face a significant disadvantage because per cwt hauling costs can be decreased rapidly by moving to larger load sizes.

Relationships Between Per Cwt Hauling Costs, Assembly Miles, and Cwts Hauled

Additional assembly miles must be driven if a milk hauling company adds another dairy farm to its itinerary. Understanding the relationship between hauling cost and changes in cwts hauled and assembly miles is important when examining the decision to add another farm. Generally, a milk hauler can increase profitability if per cwt hauling costs remain the same or fall when an additional dairy farm is added.

As an example, suppose a milk hauler has a load that is under the tank’s capacity. Currently, the company hauls 320 cwts of milk; drives 70 assembly and 98 transport
miles; and has labor cost per hour, fuel cost per gallon, and vehicle costs per mile respectively equalling $8.13, $.94, and $.65. In this case, per cwt hauling costs equal $.68.

Suppose adding an additional farm will increase load size by 5,000 pounds. To have the same per cwt hauling costs, the milk hauling firm can drive an additional 35 assembly mile, assuming that transport miles stay the same.

In above example, per cwt hauling cost will not rise if assembly miles do not increase more than approximately seven miles for each 1,000 pound increase in load size. This is not an exact relationship. As a guide, 7 additional miles can be driven for a 1,000 pound farm pick-up and per cwt hauling cost will not increase, 14 miles can be driven for a 2,000 pound pick-up, and so on. In general, adding a larger farm pick-up is more profitable than adding a smaller farm pick-up if assembly miles are roughly the same.

Hauling Costs for Differing Transport Miles

Figure 4 shows hauling costs for differing transport miles. As expected, per cwt hauling cost increases as the number of transport miles rise. However, cost increases are not constant. For example, moving from 70 to 90 transport miles while hauling 346 cwts of milk results in a $.06 increase in per cwt hauling cost. Moving from 230 to 250 miles yields a $.04 increase. Generally, additional transport miles will increase cost less as the number of initial transport miles increase. Moreover, increases in costs are less for larger load sizes. When moving from 70 to 90 transport miles, per cwt hauling cost increase by $.06 for 346 cwts of milk hauled, $.05 for 423 cwts, and $.04 for 500 cwts.
Figure 4. Per Cwt. Hauling Costs for Differing Transport Miles and Load Sizes *

* Based on a cost function described in Gallagher, Edward W. Assumes 78 assembly miles, $8.13 per hour labor cost, $.94 per gallon fuel cost and $.65 per mile vehicle costs.
These relationships suggest that milk marketers should move larger loads of milk when milk has to be shipped to non-primary plants. This may be cost efficient even if a larger load has to be diverted more miles than a smaller load.

Implications of the Cost Relationships

Implications of the cost relationships can be summarized as follows:

1. Significant cost differences exist across regions. Regions with relatively flat terrain and a high concentration of dairy farms have lower milk hauling costs. Differences in inter-region costs should be considered when determining hauling rates.

2. Hauling larger loads of milk results in lower per cwt hauling costs. This suggests that, on average, milk haulers with larger loads are more cost efficient than those that operate relatively smaller loads. Thus, there is likely to be a continued move towards milk hauling vehicles with the largest capacity given road weight limitations.

3. Adding a dairy farm with a larger pick-up is more cost efficient than adding a farm with a smaller pick-up when additional assembly miles are the same for the two farms. In general, servicing a larger dairy farm pick-up costs less on a per cwt basis than servicing a smaller pick-up. This
general relationship holds unless excessively high miles must be driven to service the larger farm. Note that this relationship does not necessarily mean that smaller dairy farms are at a disadvantage. In some cases, a smaller dairy farm can increase its competitive position by increasing the size of its milk holding tank and moving to an every other day pick-up.

4. A larger load of milk can be transported more cost effectively than a smaller load of milk. In all but extreme circumstances, cost advantages may exist even if the larger load has to be diverted more miles. This suggests that milk marketers should route trucks with larger loads to more distant plants.

**HAULING RATE SCHEDULES**

A hauling rate schedule is used to determine the revenue a milk hauling company receives from each dairy farm on a load's itinerary. Schedules generally consist of a stop charge and a volume charge. A stop charge is a flat rate accrued each time milk is picked-up from a farm. A volume charge is assessed on the amount of milk hauled from each farm. A fairly typical hauling rate structure consists of a $5 stop charge and a $.40 per cwt. volume charge.

The reasonableness and fairness of alternative schedules is examined in this section. Two conditions must be met for a hauling rate schedule to be equitable to dairy farmers and milk haulers. First, the hauling rate schedule should generate revenues
which cover the cost of assembling and delivering a load of milk. The milk hauling company will generate a fair return if total revenue equals all cash, opportunity, and overhead costs accruing during the load. Second, the hauling rate schedule should charge each dairy farm its share of the costs of hauling milk. Schedules not meeting this condition may subsidize some dairy farms on a load's itinerary at the expense of other farmers.

Meeting the second equitability condition requires estimates of the servicing costs for each dairy farm on a load's itinerary. A means of allocating these costs is developed in the following sub-section. Differing hauling rate schedules are examined: Two have constant stop and volume charges and the third has a constant stop charge and an "incremental" volume charge. Note that stop and volume charges are not designed to cover a particular segment of a milk hauling firms costs. Rather, they are means of generating revenue that cover costs and result in equitable hauling charges.

Meeting the previously defined equitability conditions may vary between loads and milk hauling companies depending on the size of the load, region in which the load is assembled, and the number and size of producers on the load's itinerary. Thus, the results presented in this section should not be viewed as specific schedules resulting in equitable charges. Rather, they illustrate general principles which may lead to more equitable hauling rates.
Allocating Hauling Costs to Individual Dairy Farms

Allocating hauling costs to individual dairy farms requires consideration of: 1) cost savings generally resulting from larger loads and 2) costs of servicing each dairy farm. An extreme example will illustrate these considerations. Suppose that a load's itinerary consists of one farm and that total load cost equals $200. In this case, the allocated cost of servicing this farm equals $200. Suppose further that additional hauling capacity exists such that another pick-up can be added. Adding a second farm is not likely to double total load cost. Since the milk hauling firm already has incurred the cost of driving to the first farm and to the processing plant, adding the second farm only will increase cost related to more assembly miles and cwts hauled. Total costs will more likely equal $210. In this case, the cost of servicing the first farm declines because two farms now share the costs of driving to the first farm and to the processing plant. However, allocated cost to each dairy farm are not necessarily $105 -- half the total load cost. Costs of servicing each farm may vary due to differences in cwts picked-up and assembly miles driven to service and farm.

The following procedure is proposed to determine allocated costs. The costs of servicing each dairy farm is based on the reduction in load costs if the farm is not included on the load. However, this reduction is adjusted by the sum of every other farm's reduction to account for cost savings associated with larger load size. Operationally, the procedure is performed as follows:

1. The total cost of hauling a load is determined.
2. Reduction in total cost is calculated if a farm is not included on a load. This is done for each farm.

3. Reduction in costs for all farms (step 2) are summed.

4. For each dairy farm, the total cost of the load (step 1) is multiplied by its reduction in cost (step 2) and then divided by the sum of reductions (step 3). The result represents that dairy farm's portion of the load's cost.

This procedure is illustrated for an example load itinerary. On this load, 47,000 pounds of milk are hauled requiring 72 assembly and 98 transport miles. Labor cost equals $8.12 per hour, fuel cost equals $.94 per gallon, and vehicle costs equal $.65 per mile. Load costs are calculated using equations explained in "Determining Factors Affecting Cost" section. The cost of hauling this load is $222. The itinerary consists of 6 farms with the sizes of the pickups ranging from 1,000 to 17,000 pounds (see the second column of Table 3).

The cost of not including each farm (column 4 of Table 3) is calculated assuming the load is reduced by the size of the pick-up listed in the second column and assembly miles are reduced by 8 miles. Reductions in cost if the farm is not included are shown in column 4. Reductions sum to $85. Costs allocated to each farm are shown in column 5. Average cost per cwt is shown in column 6.

Allocated costs are relatively the same for each farm regardless of the size of the pick-up. This conforms with earlier results regarding the relationships between per cwt costs, assembly miles, and cwts hauled. A hauling rate schedule resulting in relatively
Table 3. An Example of Allocating Hauling Costs to Individual Dairy Farms.

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Size of Pickup</th>
<th>Costs of Load if the Farm is Not Included</th>
<th>Reduction in Cost</th>
<th>Allocated Cost</th>
<th>Allocated Cost per Cwt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000 lbs.</td>
<td>$209</td>
<td>$13</td>
<td>$33</td>
<td>$3.30</td>
</tr>
<tr>
<td>2</td>
<td>2,000</td>
<td>209</td>
<td>13</td>
<td>34</td>
<td>1.70</td>
</tr>
<tr>
<td>3</td>
<td>5,000</td>
<td>208</td>
<td>14</td>
<td>37</td>
<td>.73</td>
</tr>
<tr>
<td>4</td>
<td>9,000</td>
<td>208</td>
<td>14</td>
<td>37</td>
<td>.41</td>
</tr>
<tr>
<td>5</td>
<td>13,000</td>
<td>207</td>
<td>15</td>
<td>39</td>
<td>.30</td>
</tr>
<tr>
<td>6</td>
<td>17,000</td>
<td>206</td>
<td>16</td>
<td>42</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>Total 47,000 lbs.</td>
<td></td>
<td></td>
<td>85</td>
<td>$222</td>
</tr>
</tbody>
</table>

1. See the text for a more detailed explanation. Total cost for the load equal $222. Costs are calculated using a function giving total load cost for the greater Ohio area (Gallagher).

2. A function determining total load cost for the greater Ohio area is used to calculated costs if the farm is not included in the load.

3. Values equal $222 (costs of total load) minus the value in column 3.

4. Values equal $222 (costs of the load) times the value in column 4 divided by 85 (sum of marginal costs in column 4).
Allocating Hauling Costs to Individual Dairy Farms

Allocating hauling costs to individual dairy farms requires consideration of: 1) cost savings generally resulting from larger loads and 2) costs of servicing each dairy farm.

An extreme example will illustrate these considerations. Suppose that a load's itinerary consists of one farm and that total load cost equals $200. In this case, the allocated cost

<table>
<thead>
<tr>
<th>Farm No.</th>
<th>Farm Size of Pickup</th>
<th>Costs of Load if the Farm is Not Included</th>
<th>Reduction in Cost</th>
<th>Allocated Cost</th>
<th>Allocated Cost per Cwt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000 lbs.</td>
<td>$209</td>
<td>$13</td>
<td>$33</td>
<td>$3.30</td>
</tr>
<tr>
<td>2</td>
<td>2,000</td>
<td>$209</td>
<td>13</td>
<td>34</td>
<td>1.70</td>
</tr>
<tr>
<td>3</td>
<td>5,000</td>
<td>$208</td>
<td>14</td>
<td>37</td>
<td>.73</td>
</tr>
<tr>
<td>4</td>
<td>9,000</td>
<td>$208</td>
<td>14</td>
<td>37</td>
<td>.41</td>
</tr>
<tr>
<td>5</td>
<td>13,000</td>
<td>$207</td>
<td>15</td>
<td>39</td>
<td>.30</td>
</tr>
<tr>
<td>6</td>
<td>17,000</td>
<td>$206</td>
<td>16</td>
<td>42</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td>Total 47,000 lbs.</td>
<td></td>
<td></td>
<td>85</td>
<td>$222</td>
</tr>
</tbody>
</table>

Table 3. An Example of Allocating Hauling Costs to Individual Dairy Farms.

1 See the text for a more detailed explanation. Total cost for the load equal $222. Costs are calculated using a function giving total load cost for the greater Ohio area (Gallagher).

2 A function determining total load cost for the greater Ohio area is used to calculated costs if the farm is not included in the load.

3 Values equal $222 (costs of total load) minus the value in column 3.

4 Values equal $222 (costs of the load) times the value in column 4 divided by 85 (sum of marginal costs in column 4).
similar total charges for each of the farms on the sample itinerary will meet the second
equitability condition (i.e., each farm pays its share of milk hauling cost). For the
sample itinerary schedules having relatively high stop charges and low volume charges
will more likely meet the second equitability condition.

Hauling Charges with Constant Volume Charges

Hauling charges resulting from a $5 stop charge and $.40 per cwt volume charge
are shown in Table 4 for the sample itinerary. Total charge for each farm is shown in
the fifth column and the average charge per cwt is shown in column 6. Hauling charges
rapidly increase as pick-up size increases. For example, the hauling charge for the 1,000
pound pick-up is $9 while the charge equals $73 for the 17,000 pound pick-up. Allocated
costs range from $34 to $42. Pick-ups below 5,000 pounds have hauling charges less than
allocated costs while pick-ups of 13,000 pounds and above have hauling charges above
allocated cost (compare Table 3, column 5 to Table 4, column 5). This suggests that the
hauling rate schedule illustrated in Table 4 does not generate charges matching allocated
cost, thereby violating the second equitability condition.

The discrepancy between hauling charges and allocated costs is reduced by
increasing the stop charge and decreasing the volume charge. Table 5 shows hauling
charges using a $10 stop charge and a $.35 per cwt volume charge. The hauling charge
for the 1,000 pound pick-up is $13.50. This charge compares to $9 charge using the
hauling schedule illustrated in Table 4. Moreover, the total hauling charge for the
17,000 pound pick-up is reduced from $73 to $69.50 (compare Table 4 and 5, column 5).
Table 4. Hauling Charges for a Hauling Schedule with Constant Stop and Volume Charges.

<table>
<thead>
<tr>
<th>Farm Number</th>
<th>Size of Pickup</th>
<th>Stop</th>
<th>Hauling Charge</th>
<th>Volume</th>
<th>Total</th>
<th>Effective Charge Per Cwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1,000 lb.</td>
<td>$ 5</td>
<td>$ 4</td>
<td>$ 9</td>
<td>.90</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2,000</td>
<td>8</td>
<td>13</td>
<td>.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5,000</td>
<td>5</td>
<td>20</td>
<td>25</td>
<td>.50</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9,000</td>
<td>5</td>
<td>36</td>
<td>41</td>
<td>.46</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>13,000</td>
<td>5</td>
<td>52</td>
<td>57</td>
<td>.44</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>17,000</td>
<td>5</td>
<td>68</td>
<td>73</td>
<td>.43</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>47,000 lb.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hauling Charges are calculated with a $5 stop charge and a .40 per cwt volume charge.
Table 5. Hauling Charges for a Hauling Schedule with a Constant Stop and Volume Charges.

<table>
<thead>
<tr>
<th>Farm Number</th>
<th>Size of Pickup</th>
<th>Hauling Charge&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Volume</th>
<th>Total</th>
<th>Effective Charge per Cwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>1</td>
<td>1,000 lb.</td>
<td>$10</td>
<td>$3.50</td>
<td>$13.50</td>
<td>1.35</td>
</tr>
<tr>
<td>2</td>
<td>2,000</td>
<td>10</td>
<td>7.00</td>
<td>17.00</td>
<td>0.85</td>
</tr>
<tr>
<td>3</td>
<td>5,000</td>
<td>10</td>
<td>17.50</td>
<td>27.50</td>
<td>0.55</td>
</tr>
<tr>
<td>4</td>
<td>9,000</td>
<td>10</td>
<td>31.50</td>
<td>41.50</td>
<td>0.46</td>
</tr>
<tr>
<td>5</td>
<td>13,000</td>
<td>10</td>
<td>45.50</td>
<td>55.50</td>
<td>0.43</td>
</tr>
<tr>
<td>6</td>
<td>17,000</td>
<td>10</td>
<td>59.50</td>
<td>69.50</td>
<td>0.41</td>
</tr>
</tbody>
</table>

<sup>1</sup> Hauling charges are calculated with a $10 stop charge and a .35 per cwt. volume charge.
For both the 7,000 and 17,000 pound pick-ups, hauling charges more closely match allocated costs under the $10 stop and $.35 volume charge than under the $5 stop and $.40 volume charge schedule.

**Hauling Charges with Incremental Volume Charges**

Another alternative resulting in more equitable hauling charges is to have incremental, instead of constant, volume charges. Under an incremental volume charge structure, volume charges decrease as pounds per pick-up increase (i.e., larger production increments receive a discount). A properly structured incremental volume rate schedule should charge a farmer the appropriate rate for each increment of his/her farm’s production that falls into one of the discount volume rank. As an example, suppose that a $10 stop charge is used and that the volume charges are based on the following schedule:

<table>
<thead>
<tr>
<th>Minimum Pounds</th>
<th>Maximum Pounds</th>
<th>Volume Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4,000</td>
<td>$.40 per cwt.</td>
</tr>
<tr>
<td>4,001</td>
<td>8,000</td>
<td>$.35</td>
</tr>
<tr>
<td>8,001</td>
<td>12,000</td>
<td>$.30</td>
</tr>
<tr>
<td>12,001</td>
<td>16,000</td>
<td>$.24</td>
</tr>
<tr>
<td>16,001</td>
<td></td>
<td>$.17</td>
</tr>
</tbody>
</table>

For a 17,000 pound pick-up farm, the first 4,000 pounds are charged a rate of $.40 per cwt, the second 4,000 pounds are charged a rate of $.35 per cwt, and soon. Hauling charges resulting from this schedule are shown in Table 6. The magnitudes of differences between individual farm’s hauling charges and allocated costs are reduced as compared to the previous, constant stop charge.
examples. Thus, the sliding volume charge is more equitable according to the previously defined conditions.

The above stop and volume charges are not necessarily the best available. Choosing proper sliding volume charge which are fair to all farms may be difficult. However, fairness is more likely to occur using high stop charges and/or incremental volume charges. A properly formulated hauling schedule would be one that generates revenue to cover all economic costs of the load and that charges each farm their cost of hauling incurred upon the system.

**Implications and Limitations of the Above Hauling Rate Examination**

Implications from the above example include:

1. Costs allocated to each dairy farm appear to be relatively constant regardless of the amount of milk picked-up at each farm. This suggests that hauling rate schedules should have relatively high stop charges.

2. Designed properly, an incremental volume charge structure results in more equitable hauling charges.

Again, the above example is based on averages and a specific itinerary. Allocated costs may vary for differing itineraries and milk hauling companies.
Table 6. Hauling Charges and for a Hauling Schedule with a Constant Stop and Sliding Volume Charges.

<table>
<thead>
<tr>
<th>Farm Number</th>
<th>Size of Pickup</th>
<th>---</th>
<th>Hauling Charge$^1$</th>
<th>Volume</th>
<th>Total</th>
<th>Effective Charge per Cwt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000 lb.</td>
<td>$10</td>
<td>$4.00</td>
<td>$14.00</td>
<td>1.40</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2,000</td>
<td>10</td>
<td>8.00</td>
<td>18.00</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5,000</td>
<td>10</td>
<td>19.50</td>
<td>29.50</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9,000</td>
<td>10</td>
<td>33.00</td>
<td>43.00</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>13,000</td>
<td>10</td>
<td>44.40</td>
<td>54.40</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>17,000</td>
<td>10</td>
<td>53.50</td>
<td>63.50</td>
<td>0.37</td>
<td></td>
</tr>
</tbody>
</table>

$^1$ Hauling charges are calculated with a $10 stop charge and a sliding per cwt. volume charge. See the text for volume charge.
SUMMARY

In the greater Ohio area, there had been a lack of recent cost of milk assembly information. The information from this publication will aid dairy farmers, milk haulers, cooperative and plant personnel, and Federal marketing order administrators to make better decisions. Additionally, information that results in the proper alignment of cost and rates will help assure that the farm-to-plant milk hauling function will not be the cause of a disruption of the milk marketing system. Such a disruption could result in an inadequate supply of milk to meet the consumers' demands, or be the cause of an unnecessary high retail price.

The study area was divided into regions to allow for the perceived differences in the cost of assembling loads due to differing topography and other characteristics. Personal interview survey responses from 40 milk hauling companies resulted in the collection of information on 131 loads of milk. From this information, cost equations were estimated for the study area and three regions. Each equation used truck driver labor, fuel, and vehicle as the input costs, and hundredweights hauled, assembly miles, and transport miles as the outputs.

Average per unit costs fell as the output levels increased. Specifically, for cost per cwt, the larger the load the lower the average cost of assembly. If hauling rates are set to approximate the average cost of assembling a load, milk hauling companies operating relatively larger loads will be able to offer their customers lower hauling rates than companies that operate relatively smaller loads. Eventually, competitive pressure from
milk hauling companies and pricing pressure from dairy farmers will result in the utilization of larger capacity vehicles.

Finally, the average cost of servicing relatively larger production size farms is less than the cost of servicing the relatively smaller farms. Therefore, to charge farms the approximate cost of service, a system of high stop charges and sliding volume charges should be incorporated. The use of such a system would result in larger production size shippers paying a lower average cost but a higher total cost than relatively smaller shippers.
LABOR

The cost of labor for a load was inclusive of the cost incurred by the milk truck drivers. The explicit calculation of labor cost was the firm's average hired labor wage rate (allowances for employer social security contributions, workmen's compensation, hospitalization benefits, unemployment insurance, and bonuses were included in the wage rate) times the number of hours incurred on the load's itinerary. The labor hours included minor maintenance tasks such as prepping the vehicle in the morning and refueling at the end of the day. The wage rate allocated to each company's loads were the average wage rate paid to its hired drivers. The labor expense, for a firm owner that drove a milk truck, was calculated in the same manner as the employees and used the same wage rate paid to the employees. If a company reported no or infrequent use of hired drivers, the wage rate used in calculating the owner's labor cost was the average of wage rates paid by other companies to milk truck drivers within the particular region.\(^3\)

The labor expense of the owner and/or truck drivers, resulting from the incurred repair and other task labor hours (calculated using the respective company's milk driver wage rate), was allocated to vehicle cost.

\(^3\)The pool of drivers was restricted to the particular region due to the simplifying assumption that the transfer costs of drivers from one region to another would a) exceed the incremental increase in income for the driver, or b) result in the firm's average wage rate exceeding its reservation price for labor.
**FUEL**

Each load’s fuel cost was calculated by multiplying the reported fuel price per gallon by the reported gallons of fuel used on the load.

**VEHICLE**

The vehicle cost consisted of 3 components: vehicle annual equivalent cost, vehicle other expense, and the opportunity cost of route ownership.

**VEHICLE ANNUAL EQUIVALENT COST:** The vehicle annual equivalent cost is the amount of capital to recoup each year to allow for the purchase of a new vehicle at the end of its useful life. New vehicle purchase price, salvage value and years of useful life were included in the estimation. Separate calculations were made for chassis and tanks (or trailers). Information from chassis and tank (or trailer) retailers as well as information from the surveys was used to determine the new cost purchase price of four sizes of chassis, six tank capacities, and three trailer capacities. Spare rigs (non-primary vehicles) and rigs that were reported as having annual miles of approximately one-half of the respective company’s per vehicle average annual miles (excluding miles for spare rigs and low mileage rigs) were valued at their salvage value. All other rigs were valued at the new cost purchase price. Due to the study area’s relatively few vehicle sellers, and since the vehicle purchase prices represented such a large capital cost, and resulted in assumed relatively negligible purchase transfer costs between regions, the new cost purchase prices were the same for each region. The average useful lives of the chassis
and tanks or trailers were computed for each region based on the information from the surveys. This was done to simulate perceived inter-regional differences in the useful lives of the vehicles as a result of topographical and producer characteristic differences. Salvage value percentages were calculated for tractors, straight chassis, tanks, and trailers from survey data and for the entire study area based on information submitted from the surveys. The same salvage value percentages were used for all regions for the same reasons as described for the use of study area wide new cost purchase prices. An interest rate of 10 percent was used.

The annual equivalent cost for each of the primary milk hauling vehicles (i.e. the chassis and tanks or (trailers) used to haul milk from the farm to the plant during the survey period) was divided by the reported annual miles for each respective primary vehicle. If a company did not report annual miles for the primary vehicle, the regions average, for primary vehicles, was used. Again, this was done on a regional basis to simulate differences in vehicle use as a result of topographical and producer characteristic differences. The divisor included mileage not related to the farm-to-plant milk hauling function (if the firm operated multiple trucking enterprises (e.g. transporting cream or water)). The annual equivalent cost of a load was calculated by multiplying the reported load's total miles by the appropriate primary vehicle's annual equivalent cost per mile. Thus, the vehicle cost of a load of milk did not include the costs related to other trucking enterprises. The annual equivalent cost of non-primary vehicles was added to the total cost of vehicle other cost.
VEHICLE OTHER EXPENSE: Vehicle other cost included the annual costs of owner and/or milk truck driver repair and other labor, repair and preventive maintenance, tires, vehicle insurance, licenses and registration, tolls, miscellaneous vehicle expenses, firm overhead, and the annual equivalent cost of non-primary vehicles. Total vehicle other cost was allocated to each load in the same proportion as annual equivalent cost per load to annual equivalent cost.

OPPORTUNITY COST OF ROUTE OWNERSHIP: The opportunity cost of route ownership was calculated using route revenue information (the additional revenue generated from the movement of milk to non-primary plants was excluded). The revenue generated in a year on a route was used as the "rule-of-thumb" valuation of the route. Of the year's revenue, half was considered as the value of the route's assets (i.e. milk hauling vehicles) and the other half was considered the value of the route's customer list (farm stops). The author felt that the "rule-of-thumb" method would result in a relevant approximation of the route's value and was used in the analysis. The "rule-of-thumb" method should not be interpreted as a proven method in determining the value of a route.

The value associated with the vehicles has already been considered (in the annual equivalent cost), therefore, the opportunity cost of route ownership deals exclusively with the somewhat intangible asset nature of the route's customer list. For each route, one-half of a year's revenue was designated as the value of the customer list and the opportunity cost was calculated at ten percent of this value. The opportunity cost was
divided by the total (12-month) route hundredweights with the resulting quotient multiplied by the hundredweights reported for each load. Due to the apparent non-depreciable nature of the value of the customer list, the salvage value of the list is equal to the list's value.