

MAIL SURVEY TO COLLECT TRUCK-COMMODITY DATA

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This paper presents some results of a mail survey designed to test procedures for collecting truck commodity data from a sample of truck registrants. The results of an earlier test based on Kansas data were reported in another report (1). The first test showed that respondents to a mail questionnaire will yield data on commodity carried and on truck movement and that more than one mailing would be required to obtain a satisfactory response rate. The present study tested both questionnaire design and follow-up procedures.

SAMPLE DESIGN

Three states, Missouri, New York, and Wisconsin, participated in the study. A sample of 819 truck registrations was selected in each state. Two restraints were placed on the sample. The first was that one-third of the sample, or 273 trucks, should have licenses for more than 26,000 lb gross weight. The remaining two-thirds, or 546 trucks, should have licenses for no more than 26,000 lb gross weight. The second restraint was that the sample numbers should be distributed throughout the entire file of registrations.

Four questionnaires of increasing complexity, shown in Figures 1 and 2, were tested in each state. The differences in data obtained are as follows:

1. Form C-1, the simplest, yielded data on commodity type, commodity weight, and mileage;
2. Form C-2 yielded data on commodity type, origin and destination, and mileage;
3. Form C-3 yielded the same data as form C-2 plus data on commodity weight; and
4. Form C-4, the most complex questionnaire, yielded data on commodity type and weight, origin and destination, land use, and type of service performed.

Forms C-1, C-2, and C-3 asked identical questions concerning vehicle characteristics. Form C-4 requested more detailed data on vehicles than did the other 3 forms.

Each of the 4 forms were assigned to one-fourth of the samples in each state. Forms for the 819 samples in a state were mailed over a 13-week period, 63 per week. One-third of the 63 mailings were taken from the sample of trucks registered at more than 26,000 lb gross weight. Information was requested for travel performed during a specified 24-hour period of 3 to 4 days after the form was mailed. These periods were uniformly distributed over the 7 days of each week of the 13-week period.

After the selection of the sample, the telephone numbers of a predetermined one-third of the registrants were determined where possible. The numbers that were found were called, generally on the day following the assigned data period. Registrants were reminded to complete the questionnaire and return it. A reminder letter was mailed to another predetermined third of the sample, generally 2 days after the original mailing. The mailed reminder should have reached the registrant during the assigned travel day or during the following day. The remaining third of the samples was not reminded during the first week to respond to the questionnaire. A follow-up inquiry and questionnaire were mailed to each nonrespondent one week after the original mailing. One week

FORM C-1

WISCONSIN STATE DEPARTMENT OF TRANSPORTATION
In cooperation with
U. S. FEDERAL HIGHWAY ADMINISTRATION
Bureau of Public Roads

FORM APPROVED
BUDGET BUREAU NO. 01-549037

TRUCK USAGE STUDY

The license number at the right identifies a motor vehicle which you registered in
The following questions concern its use together with any trailer during a 24-hour period starting at: 2 A.M. on _____ (DATE)

License # _____
M _____
Y _____
W _____

1. What kind of vehicle is it? (CHECK ONE)

Truck only Truck & Trailer
 Tractor & Semitrailer Tractor, Semi, & Full Trailer
 Other: _____ (PLEASE DESCRIBE)

2. How many axles does it have? Axles (COUNT ALL AXLES OF VEHICLE OR VEHICLE COMBINATION-INCLUDE FRONT AXLES)

3. Was the vehicle driven at any time during the 24-hour period starting at 2 A.M. on the date specified above?
 Yes GO TO ITEM 4
 No PLEASE RETURN QUESTIONNAIRE

4. How many miles was the vehicle driven during the 24-hour period starting at 2 A.M. on the date specified above?
Miles _____

5. Did the vehicle make any stops to pick up or deliver items during the specified 24-hour period?
 Yes
 No

6. List the kinds of items—up to five—that took up the most space in your vehicle for all trips during the specified 24-hour period. Also list the weight—estimate if necessary—of each kind of item and the miles your vehicle carried them. If you cannot estimate the weight, list the number or quantity of items and the measure of the quantity. Examples: 500 gallons, 10 cubic yards.

IF YOU DELIVERED OR PICKED UP THE SAME KIND OF ITEM AT MORE THAN ONE POINT DURING THE 24-HOUR PERIOD, PLEASE ENTER YOUR ESTIMATE OF THE AVERAGE DISTANCE THE VEHICLE CARRIED THAT ITEM.)

Bulkiness of Commodity	Kind of Item (EXAMPLES: FURNITURE, CANNED GOODS, ETC.)	Weight in Pounds or the Quantity and Measure	Miles Carried
Item taking up the most space			
Second bulkiest item			
Third bulkiest item			
Fourth bulkiest item			
Fifth bulkiest item			
Remainder of loads	Remainder of loads		

THANK YOU. PLEASE RETURN QUESTIONNAIRE

C-1

6. On the first line below, list the location of the vehicle at 2 A.M. if the vehicle was parked then. But if the vehicle was on the road at 2 A.M., list the location of that trip's starting point. On the other lines, list the locations at which items were picked up or delivered during the 24-hour period starting at 2 A.M. on the date specified above.

In addition to location, list the principal commodity carried in the vehicle between each delivery-pickup point, and the distance between successive points.

Space is provided for five locations. If more than five stops were made to pickup or deliver, please note the information on a spare sheet of paper and return it with this form.

Location Sequence	Location Description: (ADDRESS, CITY OR COUNTY, STATE)	Principal Commodity Carried to that Location (EXAMPLES: SAND, CANNED GOODS, GASOLINE IN 55 GAL. DRUMS, EMPTY)	Distance from Previous Location
At Trip Start			XXXXXXX
1st Stop			
2nd Stop			
3rd Stop			
4th Stop			
5th Stop			

THANK YOU. PLEASE RETURN QUESTIONNAIRE

C-2

6. On the first line below, list the location of the vehicle at 2 A.M. if the vehicle was parked then. But if the vehicle was on the road at 2 A.M., list the location of that trip's starting point. On the other lines, list the locations at which items were picked up or delivered during the 24-hour period starting at 2 A.M. on the date specified above.

In addition to location, list the principal commodity carried in the vehicle between each delivery-pickup point, its weight, and the distance between successive points. If weight is unknown, list the number or quantity of items and the measure of the quantity. (Examples: 500 gallons, 10 cubic yards, 100 cases, etc.)

Space is provided for five locations. If more than five stops were made to pickup or deliver, please note the information on a spare sheet of paper and return it with this form.

Location Sequence	Location Description: (ADDRESS, CITY OR COUNTY, STATE)	Principal Commodity Carried to that Location (EXAMPLES: SAND, CANNED GOODS, EMPTY)	Weight in Pounds or the Quantity and Measure	Distance from Previous Location
At Trip Start				XXXXXXXX
1st Stop				
2nd Stop				
3rd Stop				
4th Stop				
5th Stop				

THANK YOU. PLEASE RETURN QUESTIONNAIRE

C-3

Figure 1. Survey forms C-1, C-2, and C-3.

FORM C-4 WISCONSIN STATE DEPARTMENT OF TRANSPORTATION
 In cooperation with U. S. FEDERAL HIGHWAY ADMINISTRATION
 Bureau of Public Roads TRUCK USAGE STUDY

FORM APPROVED BUREAU BUREAU NO. 04-58022

License # _____
 M _____
 T _____
 W _____

SECTION A - GENERAL INFORMATION

1. Which classification describes your vehicle?
 (CHECK ONE)

1) Single unit with 4 tires
 2) Single unit with 6 tires
 3) Single unit with 10 tires
 4) Combination, tractor-trailer
 5) Combination, truck-full trailer
 6) Combination, tractor-semi & full trailer
 7) Combination, truck-two trailers
 8) Other _____ (PLEASE SPECIFY)

2. How many axles on each unit?
 (CHECK THE APPROPRIATE COLUMN FOR EACH UNIT)

Vehicle Unit	Number of Axles			
	1	2	3	4
Truck alone or power vehicle				
Semi-trailer or first trailer, if any				
Second trailer, if any				

3. What is the body type of each unit?
 (CHECK THE APPROPRIATE COLUMN FOR EACH COMPONENT EXCEPT A TRACTOR)

Truck	Semi-trailer	Full trailer	Other, describe				
				Box	Flatbed	Van	Other

MOBILE CRANES AND UTILITY SERVICE TRUCKS ARE TWO EXAMPLES OF EQUIPMENT CARRIERS

4. What was the condition of your vehicle at 2 A.M. on the date specified above?
 (CHECK ONE)

In working condition and-
 In motion toward a destination (GO TO ITEM 5)
 Parked overnight en route to a destination (GO TO ITEM 5)
 Parked overnight out en route to a destination (GO TO ITEM 5)
 Not in working condition and-
 Repaired during the 24-hour period (GO TO ITEM 5)
 Not repaired during the 24-hour period (PLEASE RETURN QUESTIONNAIRE)

5. What was the starting point for this trip?
 (CITY, TOWN, OR COUNTY) _____ (STATE) _____

6. List the items that were in your vehicle at 2 A.M. on the specified date and their weights (or quantities). Check "vehicle empty", if appropriate.
 (If "mixed freight", list the 3 items taking up the most space, their weights, and the weights of the remainder of the load)

7. How many miles was the vehicle driven during the 24-hour period following 2 A.M. on the specified date?
 Miles _____ (GO TO ITEM 8)
 Not driven (PLEASE RETURN QUESTIONNAIRE)

8. During the 24-hour period, how many stops did the vehicle make to deliver or pick up items or people or other purposes?
 Stops _____ (ANY RETURN TO HOME BASE SHOULD ALSO BE COUNTED AS A STOP) (SEE INSTRUCTIONS IN ITEM 8a)

8a. If your answer to Item 8a shows 10 stops or fewer, answer the questions in Section B for each stop (identical). Do not answer Section C.
 If your answer to Item 8a shows 11 stops or more, answer the questions in Section C for the first five stops and for the last five stops. Do not answer Section B.

SECTION C - MULTISTOP TRIPS (FOR TRUCKS WITH 11 OR MORE STOPS)

FIRST DESTINATION IN MULTISTOP OPERATION

a) Where was the vehicle first driven after 2 A.M.? To: _____ (ADDRESS OR OTHER LOCATION) (STATE) _____
 ENTER THE NUMBER SHOWN BELOW FOR THAT PLACE)

b) What type of place is it?
 1) Deliver or pick up commodities - (GO TO ITEM 4)
 2) Transport driver or passengers - (GO TO NEXT BOX)
 3) Refuel, eat, or rest - (GO TO NEXT BOX)

c) How many miles is this place from where the vehicle was at 2 A.M.?
 Miles _____

d) What was the purpose for this stop?
 (CHECK ONE)
 1) Deliver or pick up commodities - (GO TO ITEM 4)
 2) Transport driver or passengers - (GO TO NEXT BOX)
 3) Refuel, eat, or rest - (GO TO NEXT BOX)

e) Please list the items delivered and their weights (or quantities).

f) Please list the items picked up and their weights (or quantities).

SECOND DESTINATION IN MULTISTOP OPERATION

a) Where was the vehicle driven next? To: _____ (ADDRESS OR OTHER LOCATION) (STATE) _____
 ENTER THE NUMBER SHOWN BELOW FOR THAT PLACE)

For Multistop, First 5 And Last 5 Stops

NEXT TO THE LAST STOP IN MULTISTOP OPERATION

a) Where was the vehicle driven next? To: _____ (ADDRESS OR OTHER LOCATION) (STATE) _____
 ENTER THE NUMBER SHOWN BELOW FOR THAT PLACE)

b) What type of place is it?
 1) Deliver or pick up commodities - (GO TO ITEM 4)
 2) Transport driver or passengers - (GO TO NEXT BOX)
 3) Refuel, eat, or rest - (GO TO NEXT BOX)

c) How many miles is this place from the previous place?
 Miles _____

d) What was the purpose for this stop?
 (CHECK ONE)
 1) Deliver or pick up commodities - (GO TO ITEM 4)
 2) Transport driver or passengers - (GO TO NEXT BOX)
 3) Refuel, eat, or rest - (GO TO NEXT BOX)

e) Please list the items delivered and their weights (or quantities).

f) Please list the items picked up and their weights (or quantities).

LAST STOP IN MULTISTOP OPERATION

a) Where was the vehicle driven next? To: _____ (ADDRESS OR OTHER LOCATION) (STATE) _____
 ENTER THE NUMBER SHOWN BELOW FOR THAT PLACE)

b) What type of place is it?
 1) Deliver or pick up commodities - (GO TO ITEM 4)
 2) Transport driver or passengers - (GO TO NEXT BOX)
 3) Refuel, eat, or rest - (GO TO NEXT BOX)

c) How many miles is this place from the previous place?
 Miles _____

d) What was the purpose for this stop?
 (CHECK ONE)
 1) Deliver or pick up commodities - (GO TO ITEM 4)
 2) Transport driver or passengers - (GO TO NEXT BOX)
 3) Refuel, eat, or rest - (GO TO NEXT BOX)

e) Please list the items delivered and their weights (or quantities).

f) Please list the items picked up and their weights (or quantities).

THANK YOU. PLEASE RETURN QUESTIONNAIRE

SECTION B - FOR TRUCKS WITH NO MORE THAN 10 STOPS

FIRST DESTINATION

a) Where was the vehicle first driven after 2 A.M.? To: _____ (CITY, TOWN, COUNTY) _____ (STATE) _____
 ENTER THE NUMBER SHOWN BELOW FOR THAT PLACE)

b) What type of place is it?
 Yes (GO TO ITEM 4)
 No (PLEASE RETURN QUESTIONNAIRE)

c) How many miles is this place from where the vehicle was at 2 A.M.?
 Miles _____

d) Did your vehicle get there within the 24-hour period after 2 A.M.?
 Yes (GO TO ITEM 4)
 No (PLEASE RETURN QUESTIONNAIRE)

e) What was the purpose for this stop?
 (CHECK ONE)
 1) Deliver or pick up commodities - (GO TO ITEM 4)
 2) Transport driver or passengers - (GO TO ITEM 4)
 3) Refuel, eat, or rest - (GO TO ITEM 4)

f) Please list the items delivered and their weights (or quantities).

g) Please list the items picked up and their weights (or quantities).

h) Was your vehicle driven elsewhere within the 24-hour period?
 Yes (GO TO NEXT BOX)
 No (PLEASE RETURN QUESTIONNAIRE)

SECOND DESTINATION

a) Where was the vehicle driven next? To: _____ (CITY, TOWN, COUNTY) _____ (STATE) _____
 ENTER THE NUMBER SHOWN BELOW FOR THAT PLACE)

b) What type of place is it?
 Yes (GO TO NEXT BOX)
 No (PLEASE RETURN QUESTIONNAIRE)

Same Data For Up To 10 Destinations

- | | | |
|--|-----------------------------|---|
| 1. Retail yard | 7. Factory, building | 13. Other non-residential structure |
| 2. Airport | 8. Office building | 14. Residential structure |
| 3. Boat dock or pier | 9. Store or office | 15. Construction site |
| 4. Show or market | 10. Animal pens | 16. Farm field or other field |
| 5. Truck terminal | 11. Garage, service station | 17. Quarry, gravel pit, stone crusher, etc. |
| 6. Warehouse other than a truck terminal | 12. Truck stop | 18. Farm |
| | | 19. Other type of place |

Figure 2. Survey form C-4.

1. LICENSE NUMBER		TRUCK USAGE PILOT STUDY CONTROL CARD - 2			2. IDENTIFICATION NUMBER				
					STATE	MONTH	DAY	WEIGHT	Seq.#
ACTIVITY CONTROL					3. DAY OF WEEK <i>Sunday</i>				
4. TYPE OF ACTIVITY		SCHEDULED		7. EXPLAIN IF ANY ACTIVITY WAS NOT COMPLETED AS SCHEDULED			10. OTHER REG. DATA		
		5. DAY	6. DATE				(A) YR. MODEL		
(A) MAIL		<i>Wed</i>					(B) MAKE		
(B) PHONE REMINDER		<i>Mon</i>					(C) BODY TYPE		
(C) MAIL FOLLOW UP - 1		<i>Wed</i>					11. NOTES:		
(D) MAIL FOLLOW UP - 2		<i>Wed</i>							
(E) SUBSTITUTE TRAVEL DAY		<i>Sun</i>							
(F) CUT-OFF DAY		<i>Wed</i>							
REG. NAME:									
REG. ADDRESS:									
TEL. No.		8. DATE RECEIVED:							
9. FINAL RESPONSE STATUS (CHECK ONE)	ANSWERED ALL OR IN PART	REFUSED	TRUCK SOLD OR WRECKED	UNDELIVERABLE	DATA NOT AVAILABLE	RECEIVED AFTER CUT-OFF	NOT RECEIVED		

Figure 3. Control card (control cards 1 and 3 were for mail reminder and no reminder).

later, if no response had been received, another questionnaire was mailed but a substitute travel day was assigned that was exactly 2 weeks later than the original one.

Any response received after the third week was classified as a nonresponse. However, had a respondent indicated that data were unavailable for a time because the vehicle was on the road, the response would have been accepted even though received after the cutoff date.

Each participating state was sent a set of sample control cards that indicated the type of questionnaire to mail, the type of reminder to use, and the 24-hour data period to be assigned. An example is shown in Figure 3. Detailed procedures, schedule of activities, progress report forms, and form letters sent to registrants are included in the Appendix.¹

In Missouri and Wisconsin, mailing started during the week of Monday, September 15, 1969. In New York mailing started during the week of Monday, May 4, 1970. Because the New York data have not been completely processed, this report presents an analysis based on the data from the other 2 states. A supplementary report based on New York's data will be issued as soon as possible. The entire analysis is based on the unweighted results of the sample. The data were obtained from forms mailed during a 13-week period from September to December 1969.

RESULTS

Comparison of Responses

Table 1 gives the distribution of acceptable responses. A response was classified as acceptable if it was received before the cutoff date and answered at least in part or indicated that the truck had been either sold or wrecked. The total number of responses

¹The appendix to the original paper is not reproduced here but is available in xerox form at cost of reproduction and handling from the Highway Research Board. When ordering, refer to XS-35, HRB Special Report 120.

for each form are approximately the same for each type of reminder. However, Figure 4 shows that mail and phone reminders yielded small gains at the end of the 3-week period over no reminder. Moreover, a comparison of the number of responses received within each week following the first mailing shows that mail and phone reminders induced quicker replies. Memory bias is thereby reduced. A mail or phone reminder should, therefore, be incorporated in any subsequent study.

The total acceptable returns show little difference in response for forms C-1, C-2, and C-3, which are the simplest to complete but do not yield as much information as form C-4. The average number of acceptable responses per form for the first 3 weeks was 173.5. The average number for form C-4 was 160.5, 92.5 percent of the first average. This loss must be balanced against the additional information obtained with

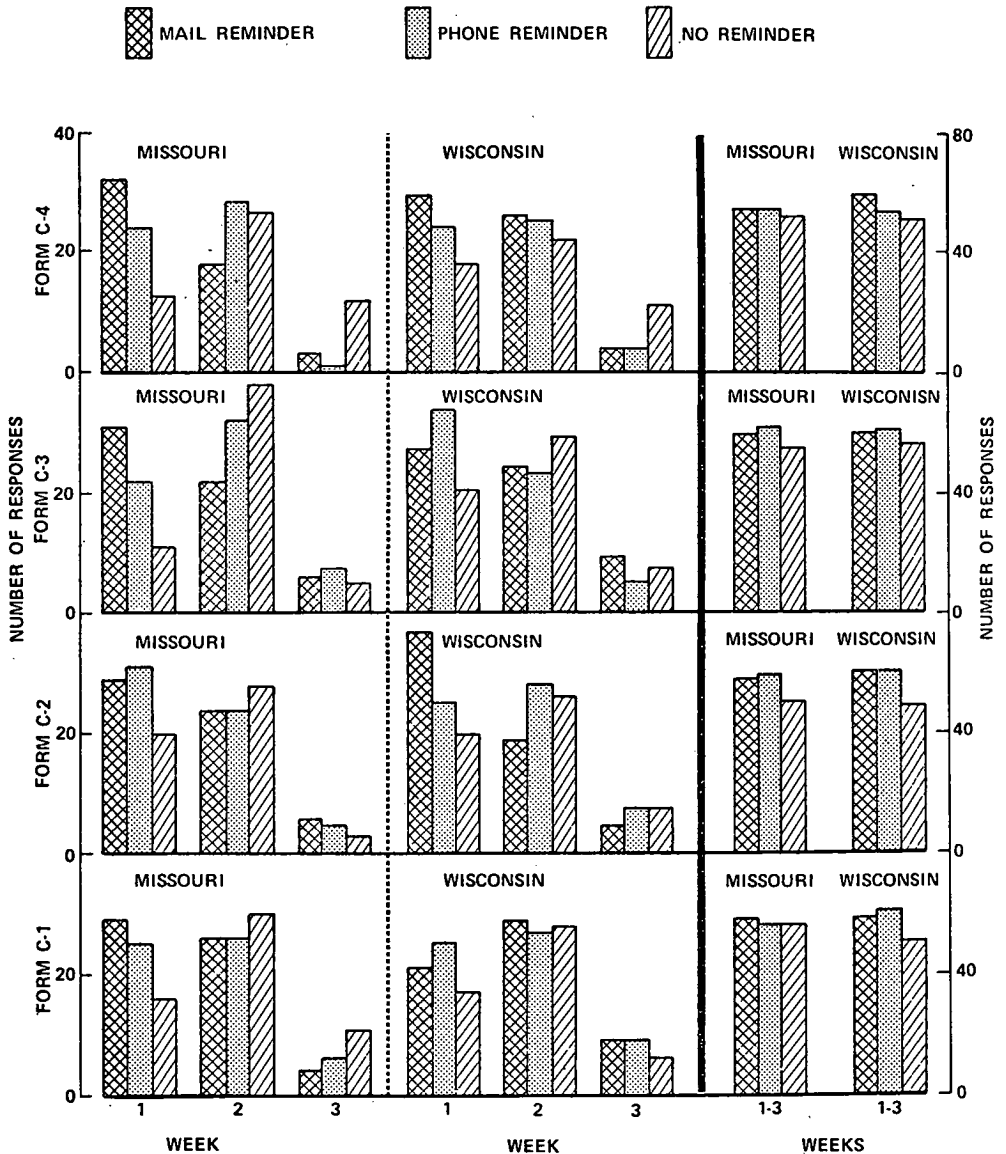


Figure 4. Acceptable responses by type of form and reminder.

TABLE 1
NUMBER OF ACCEPTABLE RESPONSES RECEIVED BEFORE CUTOFF DATE BY
FORM, PERIOD RECEIVED, REMINDER, AND STATE

Form and Week Received	Mail Reminder		Phone Reminder		No Reminder		All Responses	
	Missouri	Wisconsin	Missouri	Wisconsin	Missouri	Wisconsin	Missouri	Wisconsin
Form C-1								
1st week	29	21	25	25	16	17	70	63
2nd week	26	29	26	27	30	28	82	84
3rd week	4	9	6	9	11	6	21	24
Total	59	59	57	61	57	51	173	171
Form C-2								
1st week	29	37	31	25	20	20	80	82
2nd week	24	19	24	28	28	26	76	73
3rd week	6	5	5	8	3	8	14	21
Total	59	61	60	61	51	54	170	176
Form C-3								
1st week	31	27	22	33	11	20	64	80
2nd week	22	24	32	23	38	29	92	76
3rd week	6	9	7	5	5	7	18	21
Total	59	60	61	61	54	56	174	177
Form C-4								
1st week	32	29	24	24	13	18	69	71
2nd week	18	26	28	25	27	22	73	73
3rd week	3	4	1	4	12	11	16	19
Total	53	59	53	53	52	51	158	163
All forms								
1st week	121	114	102	107	60	75	283	296
2nd week	90	98	110	103	123	105	323	306
3rd week	19	27	19	26	31	32	69	85
Total	230	239	231	236	214	212	675	687

Note: Included are responses for trucks sold or wrecked as well as incomplete responses on truck's status on travel day.

TABLE 2
NUMBER OF NONRESPONSES BY FORM, REMINDER, PERIOD STATUS WAS DETERMINED, AND STATE

Form and Week Status Determined	Mail Reminder		Phone Reminder		No Reminder		All Responses	
	Missouri	Wisconsin	Missouri	Wisconsin	Missouri	Wisconsin	Missouri	Wisconsin
Form C-1								
1st week	2		2		3	2	7	2
2nd week	1		1		1		3	
3rd week								
After cutoff date	7	8	7	8	8	16	22	32
Total	10	8	10	8	12	18	32	34
Form C-2								
1st week	2		1		3	2	6	2
2nd week	1						1	
3rd week			1		1		2	
After cutoff date	7	7	7	7	12	12	26	26
Total	10	7	9	7	16	14	35	28
Form C-3								
1st week				1	1		1	1
2nd week	1		2			1	3	1
3rd week			1				1	
After cutoff date	7	9	5	5	14	12	26	26
Total	8	9	8	6	15	13	31	28
Form C-4								
1st week	1	1		1	1	1	2	3
2nd week	2		1	2	1		4	2
3rd week						1	1	1
After cutoff date	14	9	13	13	13	14	40	36
Total	17	10	14	16	15	16	46	42
All forms								
1st week	5	1	3	2	8	5	16	8
2nd week	5		4	2	2	1	11	3
3rd week			2		1	1	3	1
After cutoff date	35	33	32	33	47	54	114	120
Total	45	34	41	37	58	61	144	132

Note: Included are the following 5 categories: refused, undeliverable, data not available, never received, and received after cutoff date.

form C-4 and possibly better quality data as will be indicated later in this analysis. The overall response rate for acceptable returns was 82.4 percent for Missouri and 83.9 percent for Wisconsin.

Table 2 gives the distribution of nonresponses. This classification includes refusals, undeliverable addresses, data not available, questionnaire never returned, and questionnaire received after cutoff date. The status of most nonrespondents could not be determined until after the cutoff date. Extending the period for accepting responses will result in a better response rate. This must be balanced against the cost per additional response and possible loss in accuracy because of memory bias. The returns have not been analyzed to provide information on this point. However, it is believed that the period for acceptable responses of 3 weeks should not be extended.

In Missouri, the number of samples for each type of reminder varied slightly from the 273 established in the study design as follows: 275 samples, mail reminder; 273 samples, phone reminder; and 272 samples, no reminder. An error in the preparation of control cards in Washington caused this minor deviation from the study design. The slight imbalance does not affect the analysis.

Stops per Vehicle

Some trucks engaged in local pickup and delivery, generally in urban areas, make many stops during a 24-hour period. For this study, multistop vehicles of this type were defined as vehicles making more than 10 stops within a 24-hour period. Forms C-1 and C-4 were designed to reduce the response burden for the activities of multistop vehicles. However, form C-1 does not provide information on the total number of stops.

Data given in Tables 3 and 4 show that most responses yielded data for vehicles making fewer than 10 stops within a 24-hour period. The average number of stops for the combined data of both states is 4.02 for non-multistop vehicles and 19.32 for multistop vehicles. Of the 259 vehicles reported, 38 or about one-seventh made more than 10 stops within a 24-hour period. Any mail questionnaire on truck movements that provides space to enter data for 10 stops should be adequate for about six-sevenths of the cases. Special provision must be made for the remainder.

The data provide no clear indication of whether vehicles registered in the heaviest weight class average fewer stops per 24-hour period than lighter vehicles not engaged in multistop operation.

TABLE 3

NUMBER OF TRUCKS MAKING FEWER THAN 10 STOPS, NUMBER OF SUCH STOPS, AND NUMBER OF STOPS PER TRUCK BY STATE, REGISTERED GROSS WEIGHT, AND FORM

State and Registered Gross Weight (lb)	Form C-2			Form C-3			Form C-4			All Forms		
	Number of Stops	Number of Trucks	Stops per Truck	Number of Stops	Number of Trucks	Stops per Truck	Number of Stops	Number of Trucks	Stops per Truck	Number of Stops	Number of Trucks	Stops per Truck
Missouri												
6,000 or less	19	7	2.71	37	9	4.11	23	6	3.83	79	22	3.59
6,001 to 18,000	9	3	3.00	24	9	2.67	26	9	2.89	59	21	2.81
18,001 to 24,000	18	5	3.60	5	1	5.00	8	4	2.00	31	10	3.10
24,001 to 30,000	28	5	5.60	38	8	4.75	11	3	3.67	77	16	4.81
30,001 to 48,000	43	9	4.78	41	9	4.56	31	7	4.43	115	25	4.60
48,001 to 70,000	35	4	8.75	18	4	4.50	0	0	—	53	8	6.62
70,001 or more	6	1	6.00	24	5	4.80	4	2	2.00	34	8	4.25
Total	158	34	4.65	187	45	4.16	103	31	3.32	448	110	4.07
Wisconsin												
6,000 or less	29	7	4.14	0	0	—	11	4	2.75	40	11	3.64
6,001 to 18,000	59	13	4.54	24	8	3.00	39	11	3.55	122	32	3.81
18,001 to 26,000	43	10	4.30	30	5	6.00	38	6	6.33	111	21	5.29
26,001 to 30,000	12	2	6.00	11	3	3.67	14	5	2.80	37	10	3.70
30,001 to 48,000	1	1	1.00	19	6	3.17	14	4	3.50	34	11	3.09
48,001 to 70,000	17	4	4.25	32	6	5.33	28	5	5.60	77	15	5.13
70,001 or more	8	5	1.60	8	3	2.67	5	3	1.67	21	11	1.91
Total	169	42	4.02	124	31	4.00	149	38	3.92	442	111	3.98

TABLE 4

NUMBER OF TRUCKS MAKING MORE THAN 10 STOPS, NUMBER OF SUCH STOPS, AND NUMBER OF STOPS PER TRUCK BY STATE, REGISTERED GROSS WEIGHT, AND FORM

State and Registered Gross Weight (lb)	Form C-2			Form C-3			Form C-4			All Forms		
	Number of Stops	Number of Trucks	Stops per Truck	Number of Stops	Number of Trucks	Stops per Truck	Number of Stops	Number of Trucks	Stops per Truck	Number of Stops	Number of Trucks	Stops per Truck
Missouri												
6,000 or less	34	1	34.00	0	0	—	11	1	11.00	45	2	22.50
6,001 to 18,000	11	1	11.00	0	0	—	0	0	—	11	1	11.00
18,001 to 24,000	0	0	—	15	1	15.00	0	0	—	15	1	15.00
24,001 to 30,000	52	2	26.00	0	0	—	37	2	18.50	89	4	22.25
30,001 to 48,000	53	3	17.33	25	2	12.50	46	3	15.33	124	8	15.50
48,001 to 70,000	19	1	19.00	0	0	—	11	1	11.00	30	2	15.00
70,001 or more	0	0	—	0	0	—	0	0	—	0	0	0
Total	169	8	21.12	40	3	13.33	105	7	15.00	314	18	17.44
Wisconsin												
6,000 or less	0	0	—	0	0	—	0	0	—	0	0	—
6,001 to 18,000	25	1	25.00	43	1	43.00	11	1	11.00	79	3	26.33
18,001 to 26,000	0	0	—	42	2	21.00	0	0	—	42	2	21.00
26,001 to 30,000	0	0	—	40	2	20.00	14	1	14.00	54	3	18.00
30,001 to 48,000	69	3	23.00	74	3	24.67	28	1	28.00	171	7	24.43
48,001 to 70,000	24	2	12.00	26	1	26.00	24	2	12.00	62	5	12.40
70,001 or more	0	0	—	0	0	—	0	0	—	0	0	—
Total	118	6	19.67	225	9	25.00	77	5	15.40	420	20	21.00

Coding

The first pilot study in Kansas showed that respondents provided sufficient details on commodities carried to make possible assignment of 4- or 5-digit commodity codes. Respondents in Missouri and Wisconsin provided equally good detail (Table 5). Only non-multistop data are tabulated because it was assumed that any problem in coding would show up with data for those vehicles. Inclusion of multistop data might have obscured problem areas.

One of the major objectives of this study is to determine if origin-destination of truck commodity movements can be determined by mail questionnaire. Another objective is to measure the ton-miles of commodities moved on highways. The 2 basic questions are (a) Will the respondents report origin and destination data and weight data? and (b) Even if reported, will the weight data be sufficiently accurate for use in calculating ton-miles?

TABLE 5

COMMODITIES TRANSPORTED BY TRUCKS MAKING FEWER THAN 10 STOPS BY STATE, REGISTERED GROSS WEIGHT, AND CODE ASSIGNED

State and Registered Gross Weight (lb)	2-Digit Code	3-Digit Code	4-Digit Code	5-Digit Code	Commodity Given Code Not Assignable	Commodity Not Given	Noncommodity Transport ^a
Missouri							
6,000 or less			18	70	5	7	117
6,001 to 18,000			20	50	0	1	49
18,001 to 24,000			8	27	0	1	5
24,001 to 30,000			19	43	0	1	6
30,001 to 48,000			8	83	1	5	7
48,001 to 70,000			0	42	0	0	1
70,001 or more			1	23	0	0	2
Total	0	0	74	338	6	15	187
Wisconsin							
6,000 or less			2	38	0	3	105
6,001 to 18,000			25	111	1	2	27
18,001 to 26,000			13	125	0	0	0
26,001 to 30,000			8	33	0	0	4
30,001 to 48,000			1	27	0	1	3
48,001 to 70,000			1	67	0	0	0
70,001 or more			3	18	0	0	1
Total	0	0	53	419	1	6	140

^aUse of truck for personal transportation and for movement of tools and equipment to the job. Any future study will use separate codes to distinguish between the two uses.

Examination of the returns showed that origins and destinations can be accurately determined for large areas such as counties and cities. In many cases, although not all, respondents supplied street addresses. For this study, codes were assigned for county, city, and SMSA. No attempt was made to code to block or other small area. In any case, geographic coding proved very time consuming.

Carried-Load

Table 6 gives a comparison of average carried-load as indicated by data obtained in the summer of 1968 for the Annual Truck Characteristics Study and the data available on forms C-3 and C-4. Form C-1, if correctly filled out, provides the total weight for the bulkiest commodities carried during a 24-hour period rather than the weight carried between each stop. Form C-2 does not collect weight data. Form C-3 yields for each stop the weight of the principal commodity carried to that stop. However, many trucks carry only one commodity between stops. It was hypothesized for the analysis of average carried-load that weight of principal commodity carried to a stop could be equated, with acceptable error, to total weight carried to the stop. Form C-4 yields values of carried-load because the respondent supplied weight of commodity delivered and weight of commodity picked up at each stop. The values for each stop obtained from forms C-3 and C-4 were treated as independent observations for comparison with the truck weight data because a truck may be weighed anywhere along its route.

In some instances, respondents reported the number of items or quantity of a commodity and the weight had to be computed on the basis of density and size of load.

The values of average carried-load given in Table 6 for data from forms C-3 and C-4 seem reasonable. In many cases, the values are within the range of averages obtained on main rural roads and on urban roads. Much of the difference may be attributed to the small sample size for each vehicle type. Form C-3 yields few or no data on average carried-load for the lighter, single-unit vehicles. This provides one indication that form C-4, which is quite complex, elicits more accurate response than the less complex forms.

It was provisionally decided that respondents could report weights or data from which weights could be computed sufficiently accurately for acceptable estimates of ton-miles. However, this should be evaluated again with a larger sample of observations.

Ton-Miles

Tables 7 and 8 give data on ton-miles for broad categories of commodities and by origin and destination as reported on forms C-3 and C-4 in Missouri. Tables 9 and 10 give the same information as reported in Wisconsin.

TABLE 6
AVERAGE CARRIED-LOAD BY STATE, VEHICLE TYPE, AND DATA SOURCE

State and Truck Type	1968 Study, Table W-3			Pilot Study	
	All Main Rural Roads	Urban Roads	Main Rural and Urban Roads	Form C-4	Form C-3
	Missouri				
Panel and pickup	1,039	1,225	1,089	1,080	1,480
Other 2-axle, 4-tire	996	2,460	1,512	900	
2-axle, 6-tire	6,175	3,851	5,713	7,180	
3-axle, single unit	17,057	17,362	17,111	18,250	18,520
2S1	9,377	10,603	9,549	6,410	2,435
2S2	16,930	16,618	16,893	25,330	20,550
3S2	28,932	28,830	28,921		33,040
Wisconsin					
Panel and pickup	802	514	719	483	
Other 2-axle, 4-tire	844	697	811	1,150	
2-axle, 6-tire	5,109	3,495	4,795	6,097	
3-axle, single unit	12,079	17,763	13,285	15,019	25,380
2S1	8,005	3,575	7,663	18,000	12,700
2S2	17,278	13,423	17,071	12,564	36,820
3S2	30,738	32,561	30,802	31,350	38,330
2-2	5,026	5,800			4,500

TABLE 7

TON-MILES OF COMMODITY MOVEMENTS REPORTED ON FORM C-3 IN MISSOURI
BY COMMODITY TYPE AND ORIGIN AND DESTINATION

2-Digit Code	Commodity Category	Intrastate Movement			Interstate Movement			Total	
		In One City	City to City	City to County	County to County	City to City	City to County		County to County
01	Farm products		80.0	375.0	492.5				
11	Coal	0.6						2,616.0	3,563.5
13	Crude petroleum, natural gas, and gasoline		416.0						416.0
14	Nonmetallic minerals except fuels	29.2			60.0				89.2
20	Food and kindred products	33.3	200.5	7,462.3	297.8	467.5			8,461.4
22	Basic textiles	29.8							29.8
24	Lumber and wood products except furniture	0.9		6,680.0	45.0				6,725.9
25	Furniture and fixtures	9.7							9.7
26	Pulp, paper, and allied products	31.0							31.0
28	Chemicals and allied products	33.3			23.0				56.3
29	Petroleum or coal products ^a	274.7	57.0	324.0	4,034.6	1,246.0			5,940.3
30	Rubber and miscellaneous plastic products	1.5							1.5
31	Leather and leather products	6.4							6.4
32	Stone, clay, and glass products	246.9		66.0					312.9
33	Primary metal products	238.0	201.5		35.0	32.8			507.3
34	Fabricated metal products except those coded 35, 36, and 37	14.9	20.0		47.2				82.1
35	Machinery except electrical	3.2		12.8					16.0
36	Electrical machinery, equipment, and supplies		27.3						27.3
37	Transportation equipment	8.9		1.5					10.4
39	Miscellaneous products of manufacturing	3.6		122.5					126.1
40	Waste and scrap material					320.0			320.0
41	Miscellaneous freight shipments	350.4		126.5					476.9
42	Shipping containers returned empty			558.0					558.0
	Total	1,316.3	1,002.3	15,728.6	5,035.1	2,066.3		2,616.0	27,768.6
	Code not assignable	11.4		7.2	1.0				19.6
	Commodity not specified		540.0						540.0

^aWeight-distance available but not origin-destination, 4.0.

TABLE 8

TON-MILES OF COMMODITY MOVEMENTS REPORTED ON FORM C-4 IN MISSOURI
BY COMMODITY TYPE AND ORIGIN AND DESTINATION

2-Digit Code	Commodity Category	Intrastate Movement			Interstate Movement			Total
		In One City	City to City	City to County	County to County	City to City	City to County	
01	Farm products			595.5	56.2		40.5	692.2
14	Nonmetallic minerals except fuels	447.0		675.0	2.0			1,124.0
20	Food and kindred products	61.0	678.3	764.4	571.9			2,075.6
22	Basic textiles	17.8						17.8
24	Lumber and wood products except furniture				22.8			22.8
27	Printed matter	5.9						5.9
28	Chemicals and allied products	423.6			28.0			451.6
29	Petroleum or coal products	158.8	101.3	82.8				342.9
31	Leather and leather products	3.1						3.1
32	Stone, clay, and glass products	373.0	30.0	1,747.0				2,150.0
33	Primary metal products	28.1						28.1
34	Fabricated metal products except those coded 35, 36, and 37	5.6						5.6
35	Machinery except electrical	10.2				200.0		210.2
36	Electrical machinery, equipment, and supplies	167.2						167.2
39	Miscellaneous products of manufacturing	4.0						4.0
40	Waste and scrap material	5.0						5.0
41	Miscellaneous freight shipments		867.5		70.0	25.0		962.5
	Total	1,710.3	1,677.1	3,864.7	750.9	225.0	40.5	8,268.5

TABLE 9

TON-MILES OF COMMODITY MOVEMENTS REPORTED ON FORM C-3 IN WISCONSIN
BY COMMODITY TYPE AND ORIGIN AND DESTINATION

2-Digit Code	Commodity Category	Intrastate Movement				Interstate Movement			Total
		In One City	City to City	City to County	County to County	City to City	City to County	County to County	
01	Farm products			4.5	250.5				255.0
14	Nonmetallic minerals except fuels			2,030.4	720.3				2,750.7
20	Food and kindred products ^a	29.9	36.8	20.0	365.9	4,163.0			5,715.6
23	Apparel and other finished textile products	1.2							1.2
24	Lumber and wood products except furniture			5,065.0	1,515.0				6,580.0
29	Petroleum or coal products	515.0	2,556.4	2,266.0					5,337.4
32	Stone, clay, and glass products	245.0	14.7	170.0	154.0				583.7
33	Primary metal products			22.0					22.0
34	Fabricated metal products		50.0	527.5					577.5
35	Machinery except electrical			11.2		300.0			311.2
40	Waste and scrap material	27.8							27.8
	Total	818.9	2,657.9	10,116.6	3,005.7	4,463.0			22,162.1
	Code not assignable			5.0					5.0

^aWeight-distance available but not origin-destination, 1,100.0.

For this analysis, a movement was classified as city to city even if the cities were adjacent. Some of the interstate ton-miles in Missouri represent travel between Kansas City, Missouri, and Kansas City, Kansas, as well as between St. Louis, Missouri, and East St. Louis, Illinois. In a full-scale study, essentially local interstate movements should be distinguished from relatively long-distance trips.

No attempt has been made to expand these data to statewide estimates. The sample is too small to yield precise estimates of totals. The tabulations show the potential for detailed analyses that a successful large-scale study could make possible.

A measure to compare the quality of the ton-mile data from form C-3 with those from form C-4 is the percentage of the total ton-miles that is based on computed values of weight or distance. Table 11 gives the contribution of computed values to the ton-mile distributions given in Tables 7, 8, 9, and 10. The sum of the ton-miles for Missouri and Wisconsin from form C-3 is 50,495.3. Of this total, 17,102.3 ton-miles or 33.9 percent is based on computed values of weight or distance. The sum of the ton-

TABLE 10

TON-MILES OF COMMODITY MOVEMENTS REPORTED ON FORM C-4 IN WISCONSIN
BY COMMODITY TYPE AND ORIGIN AND DESTINATION

2-Digit Code	Commodity Category	Intrastate Movement				Interstate Movement			Total
		In One City	City to City	City to County	County to County	City to City	City to County	County to County	
01	Farm products			2,664.1	333.9		152.5		3,150.5
14	Nonmetallic minerals except fuels	12.2	15.0	1,005.0	1,728.0				2,760.2
20	Food and kindred products	110.2	1,345.4	1.0		1,668.8	1,200.0		4,325.4
24	Lumber and wood products except furniture			210.0	367.5				577.5
25	Furniture and fixtures	1.8	1.5						3.3
27	Printed matter					1,188.0			1,188.0
28	Chemicals and allied products	10.0	16.5						26.5
29	Petroleum or coal products	1,058.5		128.0	25.8				1,212.3
32	Stone, clay, and glass products	529.6	195.0			2,750.0			3,474.6
33	Primary metal products	0.2	1,050.0						1,050.2
34	Fabricated metal products except those coded 35, 36, and 37	31.6	361.3	307.1		198.8	3,471.3		4,370.1
35	Machinery, except electrical			1.6	1.0				2.6
36	Electrical machinery, equipment, and supplies		1.5						1.5
41	Miscellaneous freight	1.5	1.5						3.0
42	Shipping containers returned empty	11.0	85.7			37.5			134.2
	Total	1,766.6	3,073.4	4,316.8	2,456.2	5,843.1	4,823.8		22,279.9

TABLE 11
TON-MILES BASED ON COMPUTED VALUES OF WEIGHT OR DISTANCE FOR BOTH STATES
BY FORM AND ORIGIN AND DESTINATION

Form and Item Computed	Intrastate Movement				Interstate Movement			Total
	In One City	City to City	City to County	County to County	City to City	City to County	County to County	
C-3								
Weight	137.9		2,908.2	1,663.4				4,709.5
Distance	326.7	636.8	716.0	6.9	1,713.5		2,616.0	7,115.9
Weight and distance ^a	866.3	43.0	3,686.1	677.4				5,276.8
Total	1,330.9	679.8	7,310.3	2,347.7	1,713.5		2,616.0	17,102.2
C-4								
Weight	597.5	875.7	3,380.7	411.6				5,265.5
Distance	18.1		91.5		200.0			309.6
Weight and distance	1,059.6	657.5		139.5	25.0			1,881.6
Total	1,675.2	1,533.2	3,472.2	551.1	225.0			7,456.7

^aSee footnote to Table 7.

miles for both states from form C-4 is 30,548.4. Of this total, 7,456.7 ton-miles or 24.4 percent is based on computed values of weight or distance. The difference in the percentages indicate that the form C-4 elicits more detailed responses on weight and distance than does form C-3. Because the need for such data is very great, any future mail survey on truck commodity movement should adopt the more complex questionnaire despite the slightly reduced response rate noted earlier.

Table 12 gives the distribution of the percentage of ton-mile movements in each ton-mile class and the cumulated percentage distribution. More than half the reported movements do not exceed 20 ton-miles. About two-thirds of the movements do not exceed 40 ton-miles. About ten percent of the reported movements exceed 200 ton-miles.

Origin and Destination

Table 13 gives for the unweighted sample data the percentage of truck trips with load and the percentage of the corresponding ton-miles, by origin and destination. Loaded truck trips with one or both ends in an SMSA constitute 50.4 percent of the total loaded truck trips. These trips also produced 50.4 percent of the total ton-miles. That correspondence might be changed but not markedly if the trips with unknown origins and destinations could be appropriately classified. The data also show that loaded truck trips with both ends within a single city produce a relatively small proportion of the ton-miles.

The drop in the proportion of ton-miles for interstate trips with both ends in an SMSA when compared with other interstate trips may be partially accounted for by the presence of the St. Louis and Kansas City SMSA's in the 2-state sample. These SMSA's include territories in adjoining states.

TABLE 12
TON-MILE DISTRIBUTION BASED ON DATA FROM FORMS
C-3 AND C-4 IN MISSOURI AND WISCONSIN

Ton-Miles	Percent	Cumulated Percent	Ton-Miles	Percent	Cumulated Percent
0.01 to 10.0	42.00	42.00	60.01 to 70.00	3.28	74.76
10.01 to 20.00	11.75	53.75	70.01 to 80.00	1.93	76.69
20.01 to 30.00	6.17	59.92	80.01 to 90.00	0.77	77.46
30.01 to 40.00	6.17	66.09	90.01 to 100.00	2.31	79.77
40.01 to 50.00	3.08	69.17	100.01 to 200.00	9.64	89.41
50.01 to 60.00	2.31	71.48	200.01 or more	10.59	100.00

TABLE 13
TRUCK TRIPS WITH LOAD AND TON-MILES OF COMMODITY MOVEMENTS FOR
MISSOURI AND WISCONSIN BY ORIGIN AND DESTINATION

Origin and Destination	Trips (percent)	Ton-Miles (percent)	Origin and Destination	Trips (percent)	Ton-Miles (percent)
Intrastate trips—neither end in an SMSA			All other intrastate trips	<u>5.6</u>	<u>19.7</u>
Both ends in one city	7.3	0.8	Total	95.2	70.4
Each end in a different city	2.5	2.8	Interstate trips		
City-county combination	14.9	22.3	Neither end in an SMSA	1.1	9.6
County-county combination	<u>23.3</u>	<u>12.5</u>	One end in an SMSA	1.1	12.2
Total	48.0	38.4	Both ends in an SMSA	<u>2.1</u>	<u>6.2</u>
Intrastate trips—both ends in a single SMSA			Total	4.3	28.0
Both ends in one city	31.6	5.3	Unknown	<u>0.5</u>	<u>1.6</u>
Each end in a different city	3.8	2.0	Total	100.0	100.0
City-county combination	3.1	2.4			
County-county combination	<u>3.1</u>	<u>2.6</u>			
Total	41.6	12.3			

SAMPLE SIZE

The underlying purpose for the pilot study is to test techniques for increasing the response rate of a mail survey to collect data on commodity movements via highway and to compare questionnaire effectiveness. If the test indicates that at least one of the procedures is feasible, a large-scale or national sample can be designed. The problem then is how large should that sample be.

The primary statistic measuring highway use for movement of commodities is total ton-miles. Combining acceptable responses (including no travel responses) on forms C-3 and C-4 yields a total sample of 590 vehicles. The estimated squared coefficient of variation of the population of ton-miles per 24-hour day is 19. If it is desired to estimate total ton-miles with a relative error of 10 percent at the 95 percent confidence level, the sample, n , of acceptable responses is given by

$$n = \frac{K^2(CV)^2}{D^2} = \frac{4(19)}{(0.10)^2} = 7,600$$

If an 80 percent response rate is assumed for a questionnaire of the complexity of form C-4, a total sample of $(7,600)^{3/4}$ or 9,500 is required. This may be rounded to 10,000. If equally reliable estimates are wanted for regions or divisions or other sub-national levels, samples of approximately the same size must be selected for each level.

The possibility must be considered that the sample should be designed to yield estimates of a given precision for commodity groups, such as commodities that contribute about 10 percent to the total ton-miles of highway shipment. However, the distribution of ton-mile movements for a given commodity or for a given group of commodities is not necessarily the same as the distribution for some other commodity. It is unlikely that any of the distributions approach the normal.

Assignment of the presently available observations to each commodity category would provide too few cases to estimate variability with acceptable precision. A rough measure of the variability of subgroups were obtained by combining data for commodity categories into the groups given in Table 14 and by calculating the squared coefficients of variation for each. Of the 7 groups listed, groups 1, 2, 4, 6, and 7 each contributed about 10 percent to total ton-miles. The third group contributed about 30 percent and the fifth group about 20 percent to total ton-miles. The squared coefficients of variation for the 10 percent groups ranged from about 4 to 7 times that of the estimate for the total. The squared coefficient of variation for the single 30 percent group was about 5 times that for the total and that for the single 20 percent group was about 3 times that for the total.

Although the groupings combine quite different commodity categories, it is believed that the distribution of variances shown for the 10 percent groupings should be a fair

TABLE 14
GROUPS INTO WHICH COMMODITY CATEGORIES WERE COMBINED

Group	Commodity	
	2-Digit Code	Category
1	01	Farm products
2	11, 13, 14	Coal; crude petroleum, natural gas, and gasoline; nonmetallic minerals except fuel
3	20	Food and kindred products
4	22, 23, 24, 25	Basic textiles; apparel and other finished textile products; lumber and wood products; furniture and fixtures
5	26, 27, 28, 29, 30, 31	Pulp, paper, and allied products; printed matter; chemical and allied products; petroleum or coal products; rubber and miscellaneous plastic products; leather and leather products
6	32, 33	Stone, clay, and glass products; primary metal products
7	34, 35, 36, 37, 39, 40, 41, 42	Fabricated metal products; machinery except electrical; electrical machinery, equipment, and supplies; transportation equipment; miscellaneous products of manufacturing; waste and scrap material; miscellaneous freight shipments; shipping containers returned empty

approximation to the distribution of variances for individual categories or even sub-categories. The ton-miles values obtained in the study for single movements range from a low of 1 to a high of 6,804. The latter value fell in the food and kindred products category, 2-digit code 20. In all the 7 groups, relatively few high values of ton-miles provided the major contribution to the sizes of the coefficients of variation.

Six times the value for the total should be a conservative estimate of the squared coefficient variation for a commodity category contributing about 10 percent to total ton-miles. If it is desired to estimate the ton-miles for such a category with a relative error of 10 percent at the 67 percent confidence level, the sample, n , of acceptable responses is given by

$$n = \frac{K^2(CV^2)}{D^2} = \frac{1[6(19)]}{(0.10)^2} = 11,400$$

If an 80 percent response rate is assumed as before, a total sample of $(11,400)^{5/4}$ or 14,250 is required. Based on 17,885,836 registered trucks in 1969, this would require a national sample of 0.08 percent of registered trucks.

ADDITIONAL COMMENTS

The major complexity on form C-1 is the requirement for the respondent to provide an estimate of the average distance a commodity was transported if there were 2 or more movements with that commodity. In a few cases, respondents supplied total distance rather than average distance.

Forms C-2 and C-3 provided space for 5 stops and requested the respondent to provide data for any additional stops on an extra sheet of paper. A few returns contained evidence that more than 5 truck stops had occurred on the travel day but the respondent did not furnish the supplementary sheet of paper with the additional data.

All questionnaires provided spaces for the state personnel to identify the vehicle as to make, year, model, and registered weight on the basis of information on the registration application. This should be eliminated from questionnaires in future studies, but the information should be available at the office. In some states, a registration number is assigned for a number of years to a vehicle owner. He may have sold the vehicle shown in the application and put the tag on a replacement vehicle. Sometimes the registration file has not been updated at the time of sampling. The owner may return the questionnaire with the remark that he no longer has the vehicle in question. He is correct. However, the sample is based on registration numbers not vehicles. Data should have been supplied for any vehicle assigned the selected registration number. Any future form letters requesting cooperation should make that point very clear to the potential respondent.

A check box to indicate "empty" should be added to the various parts of sections B and C of forms C-4. This will clarify the status of return trips and trips for other purposes than to pickup or deliver.

Because form C-4 requests information on the first 5 stops and the last 5 stops for trucks making more than 10 stops during the day, estimation of total ton-miles is based on incomplete data. The weight of the carried load at the end of the last trips should be requested in the last box of section C of form C-4. This would be item g and might be worded, "If any load was left, what was the weight of the load left in the truck?" This will provide a check on the accuracy of the assumption of stop-to-stop similarity of operations for this vehicle class.

Some trucks operated by farmers are driven on private property for at least part of the time. The covering letter should make it clear that only data on highway use are desired. Some respondents did not report delivery or pickup of commodities because they were not operating on a for-hire basis. Any future study should make it clear that information is wanted for vehicles not operated for hire. Some fleet operators do not organize their records by registration number. Other identification should be supplied, if possible. This point requires investigation. It may not be possible to solve the problem of collecting data on rental truck usage for a specified day. However, data should be obtainable on usage of leased trucks. The owner of a leased truck can be requested to supply the name of the lessor or to forward the questionnaire to the lessor.

CONCLUSIONS

1. A mail survey using a mail or phone reminder procedure plus follow-up will yield sufficiently high response rate for valid estimates.

2. A complex questionnaire yielding fairly detailed data will reduce the response rate when compared with less detailed questionnaires, but the reduction is not excessive. The quality of the response as to weight and distance may be improved, and additional detail will be obtained.

3. A sample of about 10,000 registrations should yield an estimate of total ton-miles with a relative error of 10 percent at the 95 percent confidence level. For a commodity class contributing about 10 percent to total ton-miles, a sample of about 15,000 registrations should yield an estimate with a relative error of 10 percent at the 67 percent confidence level. A sample averaging 20 registrations per state mailed each week with a total seasonal mailing to 13,000 registrants will yield acceptable seasonal estimates and quite reliable national and regional annual estimates. A sample of 100 registrations per state mailed one week each month will also yield acceptable seasonal estimates and quite reliable national and regional annual estimates. The effort does not seem excessive in light of the need for the data.

REFERENCE

1. Highway Planning Tech. Rept. 10, April 1969.