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BEFORE THE
POSTAL RATE COMMISSION

POSTAL RATE AND FEE CHANGES, 2000	:	DOCKET NO. R2000-1

DIRECT TESTIMONY
OF
KEVIN NEELS
ON BEHALF OF
UNITED PARCEL SERVICE
ON TRANSPORTATION COSTS

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BIOGRAPHY

My name is Kevin Neels. I am a vice president at the economics consulting firm of Charles River Associates, where I direct that firm's transportation practice. I have directed and participated in numerous research projects and consulting engagements dealing with a variety of issues in transportation economics. The aviation sector has been a particular focus of my work, and I have played key roles in a variety of projects dealing with air cargo market structure, airline pricing strategy, airline industry competitive structure, airport operations and finance, and passenger travel behavior. I have also addressed topics relating to pipelines, automobile manufacturing and distribution, and urban transportation.

On a number of occasions I have been asked to offer expert testimony in legal and regulatory proceedings. In many instances, my testimony has involved calculation of the proper measure of damages. These calculations have required extensive empirical investigations of business sales, revenues, and costs, with a particular emphasis on establishing the extent to which costs vary with changes in sales and production volumes. Often my work has involved the application of econometric analysis techniques. I have played a major role in estimating damages arising from antitrust violations, patent infringement, misappropriation of trade secrets, price-fixing, and contract violations. My testimony has addressed a number of different industries, including pharmaceuticals, medical devices, commercial aviation, durable consumer products, crude oil production and refining, and automobile manufacturing and sales.

In Docket No. R97-1, I offered testimony on behalf of United Parcel Service on the Postal Service's econometric study of the volume variability of mail-processing costs. I am also submitting testimony on that subject in this proceeding.

A copy of my resume is included as Appendix A.

PURPOSE OF MY TESTIMONY

I have been asked to review the Postal Service's treatment of its dedicated air network costs. I have also been asked to review the TRACS system used to distribute purchased transportation costs. In so doing, I have reviewed the testimony of Postal Service Witnesses Pickett (USPS-T-19), Xie (USPS-T-1), and Bradley (USPS-T-18 and USPS-T-22), as well as past Commission rulings on these subjects.

I conclude that the Commission should reject the Postal Service's allocation of all network premium costs to Express Mail and should instead allocate those premium costs to both Express Mail and Priority Mail. I also conclude that the TRACS distribution keys currently used should be modified to assign the costs of empty space in purchased highway transportation to the mail that creates the need for that capacity. Finally, I point out certain shortcomings in the TRACS system and suggest ways in which the distribution of purchased transportation costs can be improved for use in future postal rate proceedings.

THE RESPONSIBILITY FOR NETWORK AIR PREMIUM COSTS SHOULD BE SHARED BY EXPRESS MAIL AND PRIORITY MAIL.

The Postal Service operates three dedicated air networks devoted solely to the transportation of mail.[1] The Eagle network is a hub and spoke operation based in Indianapolis, Indiana, which connects approximately forty cities either directly or indirectly. Response of United States Postal Service to Interrogatory UPS/USPS-T1-17. The Western network is a hub and spoke operation based on the West Coast which connects approximately a dozen cities either directly or indirectly. Id. Both of these networks operate year-round. In addition, during the Christmas season, the Postal Service operates a special Christmas network to handle the high volumes of expedited mail tendered during that time period.

The costing procedures for these dedicated air networks impute to each pound-mile of mail carried on them a cost equal to what it would have cost to transport the mail through the commercial air system. USPS-T-19, p. 1 (Pickett). These imputed costs fall far short of what it actually costs to operate these networks. The difference between the actual cost of each network and the imputed "commercial air equivalent" is referred to as the "network premium." Id. The Postal Service incurs the network premium in order to achieve the greater service reliability and quicker turnaround time that the dedicated air networks provide compared to the commercial system. Under the Postal Service's Base Year estimates for the Eagle and Western networks, the network

1. Tr. 6/2541-42. The Postal Service does not directly own or operate the aircraft used in these networks, but rather contracts with private firms to provide the required lift.

premium cost is $124.7 million, out of total network costs of $208.2 million. USPS-LR-I-57, p. 1.

In Docket No. R97-1, the Commission attributed these dedicated air network premium costs solely to Express Mail. PRC Op., pp. 221-22. That attribution was based upon Postal Service Witness Takis' statement that if Express Mail were eliminated, the Eagle network would be shut down and the Priority Mail and First Class Mail moving on that network would be diverted onto commercial flights with no degradation in service quality. Docket No. R97-1, USPS-T-41, p. 12. In adopting the Postal Service's position, the Commission broke with its prior practice, under which the Commission had attributed the premium jointly to Express Mail and Priority Mail.

The Postal Service's justification in this case for the attribution of the entire dedicated air network premium solely to Express Mail is vague at best. Mr. Pickett, who calculates the amount of the premium, cites the testimony of Professor Bradley (USPS-T-22) to support the attribution of the full premium to Express Mail. USPS-T-19, p. 2. He fails, however, to provide a page reference. A search through Professor Bradley's testimony reveals a footnote in which Professor Bradley states that it is his understanding that these networks are "sized for a [minimum] scale." USPS-T-22 at 38, n.28. Yet, Professor Bradley goes on to state that "more capacity exists than is strictly required to handle just the Express Mail." Id. In response to interrogatory UPS/USPS-T22-9, Professor Bradley stated that he "did not undertake, as it was not required for my testimony, an investigation of the nature of the Western network . . . ." Tr. 8/3267.

The information provided by the Postal Service in this case regarding the operation of these networks and the mix of mail that they carry undercuts the appropriateness of assigning all dedicated air network premium costs solely to Express Mail. As Table 1 below indicates, in the Base Year Express Mail represented only 24 percent of the volume on the Eagle network, and only 9 percent of the volume on the Western network. Tr. 8/3265. On the other hand, Priority Mail represented 47% of the volume on the Eagle network, and 54% of the volume on the Western network. Yet, under the Postal Service's approach, Express Mail would pay the entire premium cost of these networks, amounting to 60 percent of total network costs. It is highly unlikely, to say the least, that the Postal Service would incur the substantial premium costs of operating these dedicated air networks in their current configurations solely to accommodate these relatively small Express Mail volumes.

Table 1

Base Year Eagle and Western Network
Volume Percentages by Mail Class

Mail Classes	Eagle Network	Western Network	Combined Network
First Class	18.24%	26.47%	19.48%
Express	24.38%	9.36%	22.11%
Priority	47.12%	53.9%	48.14%
Other	10.27%	10.27%	10.27%
Total	100.00%	100.00%	100.00%

Note: Calculated from Xie Tables 8 and 9. Eagle network percentages equal the costs shown for that class in Table 8 divided by the total cost for all classes. The Western network percentages reflect comparable calculations based on figures in Exhibit 9. The combined percentages were calculated by summing the figures for the two networks for a class, and then dividing by the sum of the totals for the two networks. Because the costs are based upon a constant per pound mile cost, the percentage distributions of cost and volume are identical.

On August 27, 1999, the Postal Service upgraded the aircraft used on the Western network from DC-9s to much larger 727s. Tr. 6/2560-61. Professor Bradley has stated that this decision was driven by a desire to achieve efficiencies by using the same types of shipping containers on both the Eagle and the Western networks. Tr. 8/3266-69. See also Tr. 6/2560-61 (Pickett). Mr. Pickett adds that because 727s are widely used within the industry, they are competitively priced relative to DC-9s. Tr. 6/2561. Both witnesses make clear, however, that in soliciting bids for the Western network contract that took effect on August 27, 1999, the Postal Service set the bid specifications in such a way as to guarantee that bidders would offer only the larger aircraft.[2] Thus, the upgrading of capacity that occurred was the result of a Postal Service decision made in advance of the request for bids, and not in response to low bids received for higher capacity aircraft.

In discovery, Mr. Pickett provided copies of a summary of a meeting that took place in 1995 discussing the Western network. See Tr. 6/2549-53. These documents evidence a Postal Service desire to configure the Western network in order to improve service for Priority Mail. Mr. Pickett states that this proposal was not acted upon in 1995. However, one cannot help but wonder whether concerns similar to those discussed in 1995 were also expressed in the undocumented meetings held in connection with the later decisions to expand and upgrade the network. Network operations seem clearly to have been motivated at least as much by a desire to provide reliable service for Priority Mail as for Express Mail, if not more. In any event, the fact that in BY1998 -- shortly before a 1999 upgrade of the network -- Express Mail represented only 9 percent of the volume carried on the network makes it clear that the network was not sized primarily, let alone solely, for Express Mail.

The evidence shows that the Western network as it is presently configured exists to accommodate Priority Mail as much as to accommodate Express Mail. As Mr. Pickett has stated, "The daytime and nighttime Western network was reconfigured, and expanded to Spokane, Billings, and Boise for two reasons: (1) to maintain service for Express Mail and eliminate the need for air taxis and commercial air used to move First-

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2. The Postal Service required bidders to be able to transport a type of container that fits on a 727, but not on a DC-9. Tr. 6/2560-61.

Class Mail and Express Mail[;] (2) ***to provide improved service for Priority Mail.***" Tr. 6/2548 (emphasis added).

Professor Bradley suggests that the networks were "sized for a [minimum] scale," and that, by implication, the premium should be attributed solely to Express Mail. USPS-T-22 at 38, n.28. If the air networks were in fact "sized for a [minimum] scale," there should be no way for the Postal Service to construct and operate a smaller and less expensive network with enough capacity to carry Express Mail. However, the evidence suggests that the dedicated networks are sized for the combined volume of Priority Mail and Express Mail.

Smaller aircraft are generally less expensive to operate than larger aircraft. This is consistent both with common sense and with economic rationality. It would be unreasonable for an operator to spend more for an aircraft that provides less usable cargo space. While Mr. Pickett has asserted that the Postal Service has received offers to provide cargo service with 727s that were cheaper than DC-9s (Tr. 6/2651), he does not say that 727s are always cheaper, merely that some potential suppliers have in some instances quoted cheaper prices. That certainly can be true at any point in time, or in the case of a particular operator. But bid specifications written to exclude DC-9s from consideration will certainly elicit price quotations that are at best equal to, and more likely higher than, those elicited by bid specifications permitting the use of either aircraft type.

In determining whether the dedicated networks have been set up at a minimum efficient scale for Express Mail, one must consider the capacity that they provide and determine whether that is the smallest amount of capacity that can be efficiently operated. Since the smallest amount of capacity that can be provided involves the dispatch of a single aircraft, the inquiry turns naturally to consideration of the capacities of the various aircraft types that have been used in these networks, and their ability to handle the volume of Express Mail carried on the networks.

The capacity of different types of cargo aircraft can be measured in terms of weight or cubic footage. Because the maximum weight that an aircraft can carry varies with weather, altitude, length of haul, fuel requirements, and (in the case of 727s) structural considerations, no single figure for maximum weight carried can be cited for any aircraft type, or even for any aircraft. However, in response to Interrogatory UPS/USPS-T19-6, Mr. Pickett provided data measured in terms of cubic footage regarding the capacity of the various aircraft types that have been used on the Eagle and Western networks. Tr. 6/2556-59. The discussion below relies upon these cubic foot figures.

Mr. Pickett has indicated that the 727s used in the Eagle and Western networks contain from 4,640 to 6,735 cubic feet of cargo space, depending on the model and its configuration. Tr. 6/2557-58. Whether this space is fully utilized or not is not known, although Mr. Pickett notes in his response to UPS/USPS-T19-12 that FAA structural concerns relating to the conversion of these aircraft from passenger use limit the loads they can carry. Tr. 6/2567. At most, however, the 24 percent of the Eagle network's load accounted for by Express Mail would (if the aircraft were fully utilized) require only

1,616 cubic feet per aircraft.[3] This requirement could be met easily by the 2,808 cubic feet available on the DC-9-15 (the smaller of the two models formerly used on the Western network in its original configuration). Tr. 6/2558. While Mr. Pickett asserts that the 727 is favored by the cargo industry, Tr. 6/2561, DC-9s are widely used and are readily available for that purpose. One need not reach very far in order to dispense with the need even for DC-9's, given the Express Mail volume at issue. The capacity of a 727-100, the smaller of the two versions used by the Postal Service, has, according to Mr. Pickett, a capacity of at most 4,850 cubic feet. Tr. 6/2557. If these aircraft operated on average at a capacity utilization of 70 percent, the portion of their load on the Eagle network made up of Express Mail could be accommodated by a fleet of Beechcraft 1900s with a capacity per aircraft of 819 cubic feet. Tr. 6/2559.

In the case of the Western network, the figures are even more revealing. In the most extreme case, in which the fleet is made up entirely of fully utilized 727-200s, the 9 percent of the volume made up of Express Mail could be accommodated in an aircraft with a capacity of 606 cubic feet. That need could be met by a Beechcraft 1900, or even by the smaller Metro III, which has a capacity of 625 cubic feet. Tr. 6/2559. Both of those models have been used at times as part of the Postal Service's dedicated air networks.

These illustrations demonstrate the implausibility of an argument that the Eagle and Western networks exist or are sized solely to meet the needs of Express Mail. The

3. 1,616 equals 24 percent of the 6,735 cubic feet available on a 727-200.

data provided by the Postal Service leaves no doubt that these networks exist and are configured as they are to meet the needs of both Express Mail and Priority Mail.

It would be incongruous to attribute to Express Mail 60%[4] of the cost of these networks when it represents only 22% of the volume carried on them, whereas Priority Mail represents more than twice as much (48%) of the volume they handle. I urge the Commission to return to its pre-R97-1 position and attribute the dedicated air network premium to both Express Mail and Priority Mail. The results of doing so are reflected in Table 2.

Table 2

Change in Base Year Domestic Air Costs
Due to Reallocation of Network Premium

MAIL CLASS	USPS $(000)	REVISED $(000)	PERCENTAGE CHANGE
EXPRESS MAIL	155,698	62,808	-59.66%
PRIORITY MAIL	492,995	557,965	13.18%

THE COST OF EMPTY SPACE ON TRUCKS SHOULD BE ASSIGNED TO THE MAIL THAT CREATES THE NEED FOR THAT CAPACITY.

In Docket No. R97-1, the Commission expressed concern about the way in which TRACS is used to calculate distribution keys for purchased transportation costs. The Commission noted that transportation is sometimes purchased in units different from those for which TRACS samples mail. See PRC Op., R97-1, Vol. 1, at 213. In the case

4. This figure represents the sum of the network premium and the per pound-mile cost attributed to Express Mail.

of highway transportation, TRACS samples route-trip-destination-days, whereas highway transportation services are purchased "by route or in other blocks." Id. The Commission also noted that, in the simple case of a route consisting of an outhaul and a backhaul, "[t]he purchased cost of the route is a joint cost of the mail carried on both the outhaul and the backhaul." Id. Furthermore, the Commission correctly observed that "the requirements and constraints that may determine a particular route trip destination day are not limited to just the need to transport the mail found on the truck at the destination." Id. at 214.

The key issue underlying these concerns is how the cost of empty space should be apportioned. All agree that the space actually occupied by mail on a truck should be allocated to that mail. The Commission has also consistently held -- and properly so -- that the cost of empty space varies with volume and should therefore be attributed. Docket No. R90-1, PRC Op. at III-157 to 164. However, there is considerable disagreement about whether the TRACS "expansion" process properly allocates costs. See PRC Op., R97-1, Vol. 1, at 215.

While the Commission did not reach a conclusion in Docket No. R97-1 on whether a distribution key bias exists in TRACS, it did recognize that "a *potential* for bias is clearly present in the TRACS 'expansion' process." See PRC Op., R97-1, Vol. 1, at 215 (emphasis in original). In particular, "the mail sampled on a partially empty truck . . . may have little to do with the transportation requirements and operational decisions that produced a truck of a particular size running a particular route to that destination on that day." Id. at 216.

I propose below an alternative method for calculating distribution keys from the TRACS data that explicitly recognizes the fact that unused capacity on a particular route trip destination day is attributable to mail flows and capacity needs that arise elsewhere in the system. It does so by changing the expansion process for "filling" empty space to consider the mix of mail on the more heavily loaded trucks that give rise to the need for the space that is not occupied on other trucks, or on other less utilized segments of the heavily loaded truck's entire route.

As noted in the A.T. Kearney 1999 Data Quality Study, a more refined analysis could require a full transportation flow simulation model.[5] Such a model is not currently available. However, until it is, the procedure that I outline below provides a workable approximation and reduces the potential for bias in the assignment of purchased highway transportation costs.

A. The Current Method for Allocating Empty Space

The current treatment of empty space on trucks involves the expansion of the mail actually found on the sampled truck to fill the unused space. Distribution keys are then calculated from the expanded mail volume.

A truck typically makes multiple stops as it makes its way along its itinerary. Movements between successive stops are referred to as "legs." In the discussion below, the "last leg" is the leg immediately preceding the TRACS inspection in which the unloaded mail is sampled. "Prior legs" are earlier legs on the trip upon which the unloaded and sampled mail was known to have traveled. The information collected by

5. Data Quality Study, Summary Report, April 16, 1999, p. 88.

the inspector includes where each sampled mail item was loaded onto the truck, and thus enables the identification of the prior legs on which each piece of mail traveled.

The cost of the space occupied by the sampled mail is simply allocated proportionally by subclass. This includes not only the space occupied on the last leg, but also the space known to be occupied by that mail on prior legs as well.

For the last leg, the mail on the truck is "expanded" by subclass to fill the empty space on the truck. Specifically, the volume of mail that was unloaded from the truck is expanded by the ratio of the full truck volume to the occupied volume. For example, if a truck is 50 percent full when it pulls into a facility and 2/5ths of the mail on the truck (*i.e.*, a volume equal to 20 percent of the truck's full capacity) is unloaded, the cubic-foot-miles for the last leg for each subclass is doubled to assign to the offloaded mail its proportional share of the full cost of the truck, including the cost of the empty space. Thus, the cost allocation both of the portion of a truck that had been occupied by the unloaded mail and of the empty portion is determined by the mix of mail unloaded from the truck. Mail flows in other parts of the system are not taken into account.

Information on space utilization for prior legs is not available. The Postal Service's solution to this data gap is to expand the cubic-foot-miles on the prior legs associated with the mail offloaded at the end of the last leg by the average capacity utilization across all sampled trucks within the same stratum. Thus, for example, if the average capacity utilization across sampled trucks in the stratum were 75% (*i.e.*, the trucks are 3/4 utilized), the cubic-foot-miles for prior legs would be multiplied by 4/3.

This procedure places greater weight in the cost distribution process on the mail mix on trucks with lower capacity utilization. In particular, for mail on the last leg, the mechanism expands the mail on emptier trucks by much more than it expands the mail on fuller trucks. This effect is offset to some extent on prior legs, where the mechanism expands mail on fuller trucks somewhat more than it expands mail on emptier trucks. However, since the preponderance of mail travels only one leg prior to unloading, the expansion process applied to the last leg has a greater impact than the expansion process applied to prior legs. Of the 5,385 trucks tested for which some mail was unloaded, only 39 percent contained mail that traveled on a prior leg, and the unexpanded cubic foot miles traveling on prior legs comprise only 30% of total unexpanded cubic foot miles.[6] Thus, the overall effect is that mail on emptier trucks is weighted more heavily than is mail on fuller trucks.

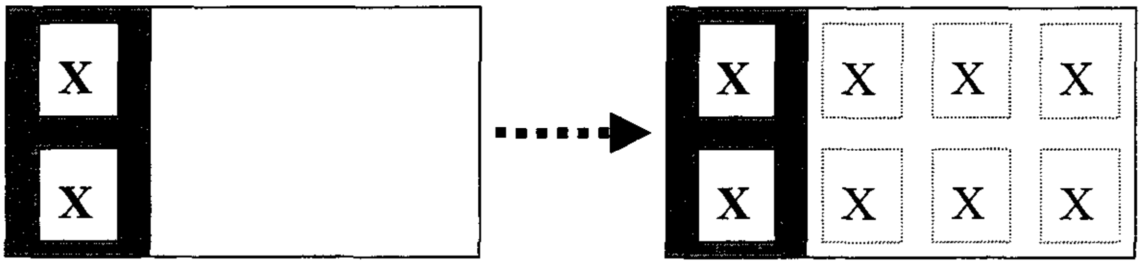
This concept is illustrated in Figure 1, below, which represents a simple system composed of two trucks, both of which are fully unloaded upon arrival at the facility where TRACS sampling is conducted.

6. Calculation using TRACS data for all four quarters, from the Z-Files submitted as part of USPS-LR-I-52.

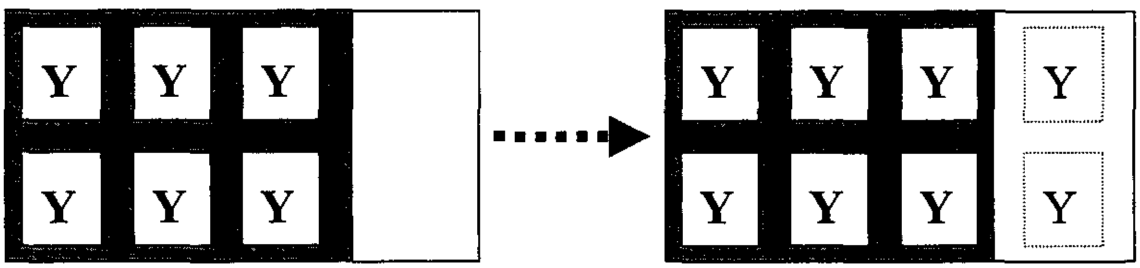
Figure 1

USPS MAIL EXPANSION MODEL

EMPTY TRUCK



FULL TRUCK



MAIL	Before Expansion		After Expansion	
	Units of Volume	Mail Mix	Units of Volume	Mail Mix
Class X	2 UNITS	25%	8 UNITS	50%
Class Y	6 UNITS	75%	8 UNITS	50%

The emptier truck has 25% of its space occupied by Class X Mail, while the fuller truck has 75% of its space occupied by Class Y Mail. The table in the exhibit indicates the units of space filled, and shows the relative proportions of system capacity filled by Class X Mail and by Class Y Mail. If one were to allocate costs based on the unexpanded mail mix, 25% of the costs would be allocated to Class X Mail and 75% would be allocated to Class Y Mail.

However, the expansion process inflates the unloaded mail to "fill" the empty space on each truck. Note that the mail on the emptier truck is expanded to four times its original volume, while the mail on the fuller truck is expanded to 4/3rds of its original volume. As a result of the expansion, Class X Mail bears 50% of the total costs, as does Class Y Mail. In other words, the weight given to Class X Mail in the cost distribution process is increased substantially.

Suppose, however, that the two trucks represent two legs of the same round-trip route rather than two different trucks making different, unconnected trips. It is clear that in such a case, the size of the truck is driven primarily by the volume of Class Y Mail carried rather than by the volume of Class X Mail carried. Nonetheless, the current procedure gives more weight to Class X Mail.[7]

Professor Bradley argues that the Postal Service has addressed the concerns of the Commission expressed in Docket No. R97-1 regarding the potential for TRACS bias. He agrees that "a potential difficulty arises if the costs on a particular leg are

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7. In Docket No. R97-1, Postal Service Witness Nieto raised similar concerns. See Tr. 7/3435-37.

imputed solely to the volumes on that leg when, in actuality, the capacity and associated costs are caused jointly with volume on other legs in the transportation mode." USPS-T-18, p. 43. He also agrees that "[a] clearly preferred approach is to distribute the jointly determined volume variable costs to the classes and subclasses that jointly determine the costs." *Id.* He argues that "[t]his is what the new TRACS distribution procedure does." Id.

Although most of Dr. Bradley's testimony addresses whether TRACS can be used to directly estimate volume variabilities, he does consider the issue of how to allocate empty space. Dr. Bradley acknowledges that "TRACS tests are designed to produce a set of proportions that accurately represent the *total* proportion of cubic-foot-miles a class or subclass causes in each specific transportation mode." USPS-T-18, p. 43 (emphasis in original). Specifically, he argues that "[t]he fact that the costs are jointly produced on a given leg does not affect this calculation." Id., p. 44. He is correct in stating that under the current approach, the fact of joint production does not affect the distribution of costs. But it should. Under the alternative approach I describe below, it does.

B. An Alternative Approach

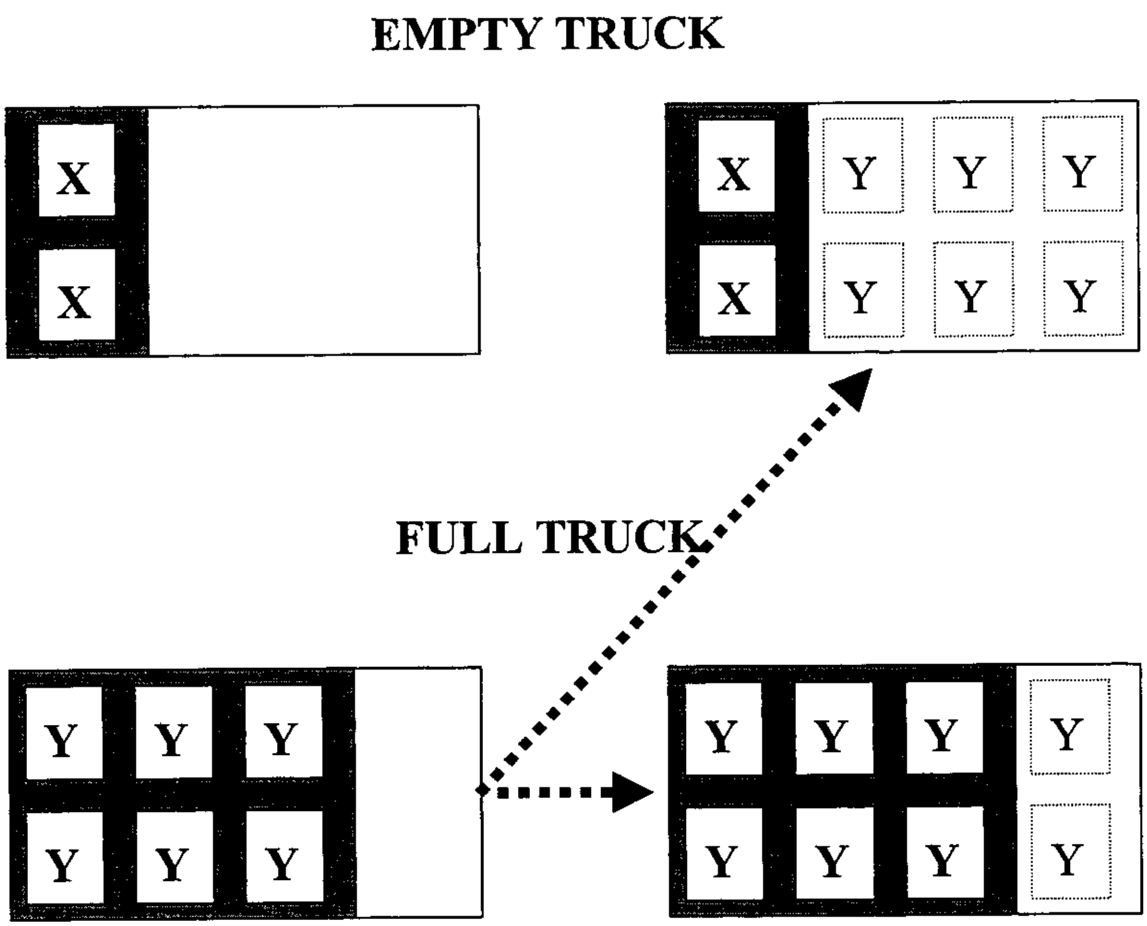
A more accurate distribution of purchased highway transportation costs requires that, in assigning responsibility for empty space, relatively more weight be given to those mail classes and subclasses that create the need for the total capacity purchased. This can be achieved by giving greater weight in the distribution process to the classes and subclasses of mail that travel on the more fully loaded trucks. These trucks are far more likely than the empty or nearly empty trucks to represent the points on the route upon which capacity purchase decisions are based. In other words, the size of the truck specified in a highway transportation contract is determined by the capacity needed on the leg of the route that carries the largest volume of mail. In the absence of a detailed transportation flow simulation model, modifying the current approach so as to give more weight to the mail moving on the more fully loaded trucks offers the best and most appropriate approximation available.

The alternative approach that I propose distributes costs for occupied space to the mail that occupies that space, while the cost of empty space is distributed to a mix of mail representative of that found on the more fully loaded trucks. This approach involves calculating the mail mix that is present on the subset of more fully loaded trucks. The calculation reflects only the mail unloaded from these trucks, and ignores the unoccupied space on them. It yields a distribution key for the "capacity-causing mail mix." I then use that distribution key to "fill" the empty space in all sampled trucks, for both the last leg and all prior legs. To complete the process, I sum the actual and "filled" mail volumes and calculate the final distribution key.

Figure 2 illustrates the calculation for the last truck legs. Since the mail on the fuller truck shown in that exhibit is more representative of the mail that leads to the need for the amount of capacity purchased, the mix of mail on it is used to "fill" both the empty space on the fuller truck and the empty space on the emptier truck. As the table in the exhibit demonstrates, the effect is to allocate a larger proportion of the total costs to the mail that is carried on the fuller truck.

Figure 2

IMPROVED MAIL EXPANSION MODEL



MAIL	Before Expansion		After Expansion	
	Units of Volume	Mail Mix	Units of Volume	Mail Mix
Class X	2 UNITS	25%	2 UNITS	12.5%
Class Y	6 UNITS	75%	14 UNITS	87.5%

This alternative approach requires a definition of what constitutes a "more fully loaded truck." I identify these trucks by arraying sampled segments in descending order of capacity utilization and then taking the upper portion of the distribution. To determine how far down the distribution to go, I assume that each trip has one segment that determines the total capacity provided on that trip, and that this segment is the segment with the highest capacity utilization. To determine the fraction of all segments to include in the calculation, I determine the average number of segments per trip. The inverse of this average determines the proportion of sampled segments to include in determining the mail mix responsible for the total amount of capacity purchased.

An example will illustrate the way this approach works. Suppose that all trips have three segments, one of which determines the total trip capacity. Then for each trip, one of the three segments determines the level of capacity purchased. I calculate the mail mix on the one-third of the tested segments with the highest capacity utilization.

This approach follows the Postal Service's methodology in calculating distribution keys separately for different groups of highway movements. I carry out each of the steps described above separately for each group of highway movements. I depart from the Postal Service's approach, however, in the way I define the groups. The Postal Service calculates distribution keys separately for each of a number of strata defined on the basis of contract type (Inter-BMC, Intra-BMC, etc.) and direction (inbound, outbound). In contrast, I aggregate strata up to the contract-type level. I aggregate in this way in order to avoid splitting apart routes and creating a situation in which the capacity-determining segment on a route may lie in a different group. For example, it may be that a route consists of an inbound leg and an outbound leg, and that capacity utilization is higher on the outbound leg. Under the Postal Service's strata definitions, these two legs will fall into different strata and an analysis limited to a single stratum would not capture the relevant mail mix. Note that this situation does not require that any specific direction comprise the binding constraint. It may well be the case that at one time of day there is high capacity utilization on inbound legs, and at another time of day on outbound legs. My alternative calculation of the capacity-determining mail mix reflects the mail mix on all high utilization legs, regardless of direction.

My alternative calculation is based on the Z-Files and SAS programs used by the Postal Service and produced as USPS-LR-I-52. I use these same data files but alter the programs to implement my alternative formula. First, I calculate the average number of stops per trip and the resulting capacity utilization threshold. Next, I create a separate database consisting only of tests of the more fully loaded trucks, and calculate a first-stage distribution key that represents the unexpanded mix of mail on those trucks. I then apply that distribution key to the appropriate portions of the empty space on all tested trucks, both on the last legs and on prior legs. Summation of the cubic-foot-miles by mail subclass for all sampled segments provides the basis for the calculation of the second-stage distribution key. I carry out these steps separately for each highway contract type: Inter-BMC, Intra-BMC, Inter-SCF, and Intra-SCF. I then enter those keys into the Cost Segment 14 Workpapers in place of the keys calculated by the Postal Service.

Appendix B to my testimony shows the details of the formulas used in the calculations, using the same notation found in the TRACS Highway Subsystem documentation (USPS-LR-I-52).

Table 4 shows the effect of this alternative method of allocating empty space on the assignment of highway costs to the major mail classes. The costs assigned to First Class Mail, Priority Mail, and Parcel Post increase. The costs assigned to Periodicals, Standard (A) Mail, and non-Parcel Post Standard (B) decline. The costs assigned to Express Mail decline sharply, although the costs involved are not large.

Table 4

Revision in Base Year Highway Costs Due to Reallocation of Empty Space Highway Costs

Class	**USPS** $(000)	**Alternative Allocation** $(000)	**Percentage Change**
FIRST CLASS MAIL	338,875	351,671	3.78%
PRIORITY MAIL	213,914	229,598	7.33%
EXPRESS MAIL	39,392	17,781	-54.86%
PERIODICALS	216,032	208,771	-3.36%
STANDARD (A)	321,490	319,793	-0.53%
PARCEL POST	241,516	247,251	2.37%
STANDARD (B) OTHER THAN PARCEL POST	108,029	104,868	-2.93%

Tables 5a-5c and 6 compare the effects of this change in the treatment of highway empty space costs on total per unit transportation costs (including all modes) for Parcel Post and for Priority Mail under the Postal Service's approach and under my alternative approach, along with the percentage change due to the new approach. Parcel Post costs per cubic foot are shown for all three types of rates: Inter-BMC, Intra-BMC, and DBMC. The transportation costs allocated to Parcel Post rise by up to 2 percent, depending on the rate type and the zone. Allocations of transportation costs to Priority Mail also rise by up to almost 6%, depending on zone. The table shows changes in Parcel Post costs per pound.

Table 5a

Parcel Post - Inter-BMC
Total Transportation Cost per Cubic Foot

Zone	USPS	Alternative Calculation	Percent Change
Local	N/A	N/A	N/A
1/2	$2.802	$2.839	1.35%
3	$3.384	$3.431	1.37%
4	$4.259	$4.318	1.38%
5	$5.888	$5.970	1.39%
6	$7.580	$7.687	1.40%
7	$9.162	$9.291	1.40%
8	$12.438	$12.614	1.41%

Table 5b

Parcel Post - Intra-BMC
Total Transportation Cost per Cubic Foot

Zone	USPS	Alternative Calculation	Percent Change
Local	$1.226	$1.245	1.52%
1/2	$2.278	$2.309	1.38%
3	$2.278	$2.309	1.38%
4	$2.278	$2.309	1.38%
5	$2.278	$2.309	1.38%
6	N/A	N/A	N/A
7	N/A	N/A	N/A
8	N/A	N/A	N/A

Table 5c

Parcel Post - DBMC
Total Transportation Cost per Cubic Foot

Zone	USPS	Alternative Calculation	Percent Change
Local	N/A	N/A	N/A
1/2	$0.862	$0.878	1.94%
3	$1.625	$1.637	0.75%
4	$2.110	$2.119	0.44%
5	$4.921	$4.913	-0.15%
6	N/A	N/A	N/A
7	N/A	N/A	N/A
8	N/A	N/A	N/A

Table 6

Priority Mail
Total Transportation Cost per Cubic Foot

Zone	USPS	Alternative Calculation	Percent Change
L, 1/2, 3	$0.220	$0.233	5.69%
4	$0.349	$0.360	3.23%
5	$0.358	$0.361	0.88%
6	$0.408	$0.411	0.75%
7	$0.511	$0.514	0.57%
8	$0.674	$0.677	0.40%

TRACS UNDERSAMPLES TIME-SENSITIVE MAIL.

The TRACS system appears to underrepresent the amount of time-sensitive mail carried on purchased highway transportation and therefore the proportion of purchased transportation costs attributable to these mail classes. This underrepresentation arises from two sources: (1) the failure of TRACS to cover emergency contracts and exceptional service movements and (2) the failure of TRACS to specify procedures for sampling items and pieces in a way that precludes the bypass of time-sensitive mail by TRACS inspectors.

A. Exclusion of Emergency Contracts and Exceptional Service Movements From the TRACS Sample

A significant source of bias in the TRACS system arises from the fact that certain types of highway contracts are systematically excluded from the universe of movements from which the TRACS sample is drawn. To the extent that these excluded movements contain a disproportionate share of time-sensitive mail, the distribution keys produced by TRACS will assign too small a share of costs to these classes. There is at least some evidence that such an understatement may actually occur.

The TRACS sample is designed to exclude "emergency" contracts and "exceptional service" highway movements. Both categories of movements represent departures from business as usual. Emergency movements are carried out under contracts issued for extraordinary circumstances under procedures different from the Postal Service's normal contracting procedures. These contracts can be up to six months in length.[8] Exceptional service movements are provided on short notice and on a short-term basis to deal with breakdowns in the normal transportation system. Response of the Postal Service to Interrogatory UPS/USPS-T18-7. Both categories of movements are also used "to offset the impact of unexpected mail volumes or operating delays." Response of the Postal Service to Interrogatory UPS/USPS-T18-9(c). The costs of these two types of movements are substantial. Together they comprise 15.7 percent of total purchased highway transportation costs.[9]

In its transportation cost analysis, the Postal Service adds the cost of emergency contracts and exceptional service movements together with the costs of the other contract types covered by the TRACS sample, and applies to them the distribution keys derived from TRACS. Thus, the cost-allocation system assumes implicitly that

8. Postal Service Purchasing Manual (January 1997), Section 4, Part 4.5.5.c.3 at 146.

9. Calculation using costs reported in the INPUTS —COSTS sheet in the Cost Segment 14 Workpapers spreadsheet.

movements made under an emergency contract or on an exceptional service basis contain on average the same mix of mail as do regular highway movements. There are good reasons to question the validity of this assumption.

When a normal highway movement fails, managers generally face two choices: either dispatch an exceptional service movement, or hold the mail for the next scheduled movement. The choice requires managers to make trade-offs between delivering the mail on time compared to the additional costs incurred in dispatching an exceptional movement. Under any economically rational system of decisionmaking, how this trade-off is made in any particular instance depends on the mix of mail whose timely delivery is at stake. It would not be surprising to find that, under these circumstances, unexpected delays to time-sensitive mail will result in an exceptional service movement, whereas a similar delay for other, less time-sensitive types of mail would not. For this reason, I would expect emergency contract and exceptional service movements to contain, on average, a mail mix with higher proportions of Express Mail, Priority Mail, and First Class Mail than do regular movements. Thus, if such mail movements were sampled in TRACS, the TRACS distribution keys would likely reflect a greater volume of mail than is now recorded for these time-sensitive subclasses, and a greater portion of the volume variable costs would be attributed to them.[10]

10. There is no apparent reason why emergency contracts in particular are excluded from TRACS sampling, since those contracts are "purchased in advance using a competitive bidding process." Response of the Postal Service to Interrogatory UPS/USPS-T18-76.

B. Inadequately Specified Data Collection Procedures Permit Inspectors to Bypass Time-Sensitive Mail.

There is an inherent tension between the fieldwork elements of the TRACS system and the constraints and pressures of postal operations. Operational personnel must unload trucks quickly in order to meet processing and dispatch windows.[11] Performed correctly, however, a TRACS inspection is a time-consuming process. The inspector must select a representative sample of containers, pallets, and loose items. The mail within the sample must be measured, and the subclass of each item determined and recorded. Containers must be opened, and mail from inside the container must be sampled. Such an inspection can take two to three hours to complete.[12] Obviously, this process interferes with the work of operational personnel. It is likely, therefore, that the need to dispatch time-sensitive mail places pressure on the TRACS data collector to take shortcuts.

To preserve the integrity of the overall TRACS process, the field inspector must randomize his selection of sampled items in order to maintain the representativeness of his sample. Thus, testing procedures need to be designed so that all classes of mail are equally treated and that random sampling procedures are followed at each step in the process. The TRACS fieldwork procedures defined in Handbook F-65 (USPS-LR-I-18) do not meet this standard. As noted in the A.T. Kearney Data Quality Study,

11. Postal Service Witness Degen states that "[t]rucks have limited windows for loading and unloading in order to stay on schedule." USPS-T-16, p. 50.

12. In Docket No. R97-1, Mr. Pickett stated, "each TRACS highway test can take hours to conduct." Docket No. R97-1, USPS-RT-2, p. 14. See also Dr. Bradley's testimony in this case, USPS-T-18, pp. 51-52.

published TRACS procedures provide inspectors with too much discretion in how they select items for testing and thereby allow operational pressures to bias the sample.[13]

TRACS rules for the inspection of mail unloaded from highway movements vary by the type of container in which the mail is loaded. The rule for choosing loose Express Mail items is strict, requiring the selection of all such items. The rule for choosing containers is also strict, as the computer used by the data collector chooses a random set of containers to test. For pallets, the inspector is to select any two at random. No instructions are given as to how this selection is to be made. For other loose items, the inspector is to select eight items, including at least one sack and at least one other loose item, if present. The ratio of sacks to other items selected should approximately equal the ratio of the truck floor space occupied by all items of each type. These instructions allow discretion in how the inspector samples pallets and loose mail items.

A potential problem arises because of the possibility that the inspector may use this discretion in a way that biases the sample. In particular, the operational conflicts described above may create pressure on the inspector to avoid the sampling of time-sensitive mail in order to avoid disrupting the flow of such mail through the system. In the case of some items—most notably, sacks—the inspector can determine prior to opening the item what kind of mail it contains. Tr. 17/6790; Response of the Postal Service to Interrogatories UPS/USPS-T1-50 and UPS/USPS-T1-66b. The TRACS fieldwork procedures are written in such a way that inspectors can avoid selecting

13. Data Quality Study, Summary Report, April 16, 1999, p. 86.

certain items containing time-sensitive mail without explicitly violating those rules. Pallets and loose items can be selected so as to avoid those containing time-sensitive mail. Unfortunately, no evidence is available one way or the other to permit any determination or quantification of the extent to which this happens.[14]

Ms. Xie notes that inspections are sometimes missed.[15] Failure to perform an inspection may be related to the mix of mail on the truck. A possible explanation for such missed inspections is that a truck arrives early at a facility and, because it contains time-sensitive mail, it is quickly unloaded. There need be no intent to "bend the rules" for this to happen. In such a case, the missed inspection would result in undersampling time-sensitive mail. Such concerns were also noted by the Commission in Docket No. R97-1. See PRC Op., R97-1, Vol. 1, at 217.

The time pressures under which TRACS inspections are conducted may also encourage inspectors not just to rely on the fuzziness of their guidelines in order to not stand in the way of the timely processing of time-sensitive mail, but also to violate those procedures. Such behavior would be an understandable human response to difficult conflicts encountered on the loading dock.

Moreover, TRACS procedures are subject to limited auditing. Managers monitor data collectors, but, for the most part, there are no management reports summarizing the outcomes of these evaluations. Tr. 21/9317-18. The single exception concerns the

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14. See Tr. 17/6811 and Response of the Postal Service to Interrogatories UPS/USPS-T1-50c(i), which discusses the handling of time-sensitive mail.

15. See Tr. 17/6788 (stating that in some cases "a data collector is unable to record the appropriate data").

inspections of TRACS testing performed at BMCs in conjunction with the audit of the Cost and Revenue Analysis system. Tr. 21/9319. However, in FY1998, only seven TRACS tests were audited and subsequently reported upon. USPS-LR-I-264; Tr. 21/9319. Thus, there is no assurance that inappropriate applications of discretion or excessive numbers of missed inspections are not occurring.

OTHER PROBLEMS WITH TRACS

My examination of the TRACS data and their supporting files and documentation has turned up a number of other problems that raise questions about the representativeness of the TRACS distribution keys. For the record, I review these problems here.

A. Misallocation of Sample to Strata

My review of the program outputs provided by the Postal Service revealed an instance in which the sampling rate for a particular stratum was extremely low. This occurred in the sampling of Intra-SCF highway movements. This category of highway movements was divided into five categories for sampling stratification purposes, according to the trip direction, the facility type, and the arrival time. The Postal Service's design called for an overall sampling rate of Intra-SCF movements of 0.07 percent, as evidenced by the SAS logs in USPS-LR-I-207.

As one might expect, the sampling rate varied to some extent across the strata. However, in some cases, sampling rates fell far below any level that could be justified on statistical grounds. One of the stratum—Inbound Other—was sampled only eight times in the first and second quarters. As shown in Table 7, the proportion of this stratum relative to the entire Intra-SCF sample, 2 percent, was extremely small in comparison to the relative proportion of movements accounted for by that stratum, 21 percent.

Table 7

TRACS Sample Design Data: First Quarter, 1998

Stratum	Inbound: BMC or SCF	Inbound: Other	Outbound: BMC or SCF	Outbound: Other: AM	Outbound: Other: PM	Total
1Q98 Coded Sampling Split	45%	2%	13%	30%	10%	
% of Total Movements	17%	21%	0.4%	39%	22%	
1Q98 # NASS movements	97,337	119,560	2,168	222,928	127,163	569,156
1Q98 Sampled Movements	182	8	53	121	40	404
% Sampled	0.2%	0.007%	2.4%	0.05%	0.03%	0.07%

Source: SAS logs in USPS-LR-I-207

This problem was apparently detected by the Postal Service after a quarter in which all of the tests conducted in that stratum were of empty trucks. As a result, the Postal Service increased the sampling rates for that stratum in the third and fourth quarters. Tr. 17/6798-99 (Xie).

Normally, a thin (too small) sample within a stratum does not affect the bias of the estimate of mail mix, only its accuracy, or variance. However, a sample that fails completely to cover movements in a stratum, as has occurred here on one occasion, will necessarily generate a biased estimate of the mail mix since, in this instance, the Postal Service will be required to assume that the mail mix in the unsampled stratum mirrors that elsewhere in the system.[16]

B. The Postal Service's Sample Design Requires Updating.

The Postal Service is apparently relying on a sample design that was prepared some time ago, and that has not been updated to reflect changes in network size or structure, or in the volume and mix of mail carried on it. Tr. 17/6751-52, 6795-96, 6855 (Xie). It is highly doubtful, therefore, that the design is optimal for the purposes for which it is currently being used. Moreover, as noted above, the existing sample design has caused sampling errors in the current analysis.

The TRACS system relies upon a multistage, stratified sample design. Although the same general approach is followed for all of the modes, for specificity my comments here will focus on the highway sample. In this sample, the Postal Service in the first stage draws a sample of trip-destination-days. The units that are sampled correspond to *stops at particular destinations as part of particular scheduled trips on particular days.* Each sampled unit directs an inspector to the unloading of a specific truck at a specific

16. Since the costs of purchased highway transportation are aggregated across strata within a contract type when the distribution key is applied, those costs will be allocated according to the average mix of mail moving within the other strata of the contract type.

location and time. At that time, the inspector in a second stage selects a sample of items (i.e., containers, pallets, sacks, etc.) to be examined. In a third stage, the inspector might also select a sample of pieces from those items.

The first-stage highway sample is based upon a stratified sample design. In such a sample design, the universe of units is divided into more homogenous subgroups, from which units are sampled at different rates. If it is appropriately optimized, a stratified sample design makes it possible to achieve greater degrees of precision at equal or lower costs. The possibility for this gain in efficiency arises when there are differences between strata in the variability of the phenomena under study. The goal of a sample design is generally to achieve the greatest possible precision of measurement for any given level of cost. Since cost is generally driven by the number of units sampled, the goal of a sample design will be to use a fixed number of sample units to maximum effect. A stratified sample design accomplishes this by recognizing and taking into account differences in variability between strata. Indeed, in an effective stratified sample, design strata will be defined so as to make each as uniform as possible.

In the present case, the relevant criterion is the uniformity of mail mix across movements within a stratum. If a particular stratum is highly uniform, a relatively small sample will suffice to provide accurate estimates of the average mail mix within that stratum. In contrast, if mail mix varies dramatically from unit to unit, a much larger sample is required to achieve the same degree of precision. An optimized sample design will allocate sample units across strata in such a way as to give relatively more weight to higher-variance strata, and thus produce the highest degree of overall precision possible for the selected sample size.[17]

Even if the original TRACS sample design were produced through a process like that described above, changes over time in the size and configuration of the network and in the volume and mix of mail will lead to its obsolescence. To avoid the resulting loss in efficiency, the sample design should be updated on a regular basis. Periodic postal rate cases provide a natural context for carrying out this updating process. Inspections carried out in preparation for a case provide the information needed to measure variances within strata and thus to update the sample design for the following rate case. Such updates should be made on a regular basis. Thus, I support the Postal Service's expressed intention to review the TRACS sample design in FY2001, Tr. 17/6852 (Xie), and I urge that the design be updated and that regular reviews and updates be conducted thereafter.

My comments thus far have focused on the first-level sample design. As I described above, the TRACS system often relies on a complex multistage sampling process. In some instances, the procedures for the selection of items and pieces are not fully randomized, leaving an undue opportunity for the exercise of too much inspector discretion in how those selections are made. Whether the specifications for sampling rates at these levels reflect a fully articulated and optimized sample design is not clear from the documentation I have been able to examine. Written instructions for

17. For overviews of stratified sampling technique, see Steven K. Thompson, Sampling, New York: John Wiley and Sons, 1992, or William G. Cochran, Sampling Techniques, 3rd edition, New York: John Wiley and Sons, 1977.

inspectors have a certain ad hoc tone, which makes one suspect that this part of the sampling process has never been analyzed from a rigorous statistical standpoint. If that suspicion is correct, these elements of the sample design should be thoroughly reevaluated. [18]

C. Adequacy of the Sampling Frames Used

Review of the programs and computer outputs from the highway subsystem of TRACS (USPS-LR-I-52 and USPS-T-1) raise some troubling questions about the adequacy of the data sources used to construct the sampling frame.[19] First, important categories of highway movements -- those designated as emergency contracts or exceptional service movements -- are excluded. Second, a substantial number of movements -- 30 percent of the total -- are dropped during processing for reasons that are unclear.

The highway sample selection procedure combines data from several management information system data bases: NASS (the National Air and Surface System), the Highway Pay Master File, and HCSS (the Highway Contract Support System). The sampling frame is developed from these data bases by a series of SAS

18. TRACS highway procedures are documented in Handbook F-65, Chapter 5 (USPS-LR-I-18). Similar concerns are raised in the A. T. Kearney Data Quality Study, Summary Report, April 16, 1999, p. 86.

19. The "sampling frame" is the list of all of the members of a population from which a sample is drawn.

programs that remove incomplete or inappropriate records and combine information from the different systems.[20]

As mentioned, one of the steps in this process results in the deletion of approximately 30 percent of the available records. These deletions are described in Ms. Xie's responses to interrogatories UPS/USPS-T1-38-41, Tr. 17/6800-03. They represent routes in NASS that fail to match routes in the Highway Pay Master File.

The reasons for these mismatches are not fully clear. In the response to UPS/USPS-T1-67, Ms. Xie listed reasons why about 27 percent of these records are dropped. Tr. 21/8590. The largest category is because they are emergency routes (13 percent of the drops).[21] Other deletions include box routes and terminated or inactive routes. The remaining 73 percent of the deletions, constituting approximately 22 percent of the records in the original NASS file, occur simply because they are "not in Highway Pay Master File."[22] This statement of fact does not explain why they are absent. To the extent these routes represent actual routes for which accounting data are temporarily missing, as opposed to, say, routes terminated long ago but never removed from NASS, they represent a significant fraction of the total system that goes unsampled. The mail mix on these routes is unknown.

20. SAS logs documenting the execution of these programs appear in USPS-LR-I-207.

21. As noted above, the failure of TRACS to sample emergency contracts and exceptional service movements is a major shortcoming of the system.

22. (30% of available records dropped) X (73% of deletions unexplained) = 22% of records in original file.

Other deletions are due to the extraction of "the regular routes from the Highway Pay Master File." Tr. 17/6800 (Xie). No description is given, however, as to what the nonregular routes represent. To quote Ms. Xie, "We only sample regular non-box routes, but NASS includes more than that. Although I have not reviewed why each record is dropped, the dropping rate is fairly consistent across time. We do have a process to check various non-matching rates every time the sample selection programs are run." Tr. 17/6803. Thus, the Postal Service has failed to explain what is dropped at this stage of the process, yet it appears not to be concerned that the high drop rate has prevailed for some time.

The effect of dropping such a high fraction of routes is not clear. There is no way to ascertain what these routes represent, nor whether they contain the same mix of mail as the sampled routes. To the extent that these routes include emergency routes (as confirmed by Ms. Xie, Tr. 17/6810), then a share of these dropped records simply represents the implementation of the omission described in the previous section, and thus the arguments on the effect of the omission made in that section pertain.

Due to concerns about the potential for bias created by the deletion of so many records from the sampling frame, I sought information with which to assess the representativeness of the final highway sample.[23] I thought that by looking at variables that were not used directly in the sample selection process, I could gain some insight into how the records that were dropped may have differed from those that were

23. *See* Interrogatories UPS/USPS-T1-2, 3, 5, 6, 8, 9, 11, 12, 14, 15, 18, 19, 22, 25–27, and 77.

retained. The Postal Service balked at providing the requested information.[24] However, statements made in the course of this exchange made it clear that the information necessary to carry out such an analysis did not exist, at least for this proceeding.

In particular, the Postal Service has failed to retain copies of the raw data upon which the sample selection process is based. Response of the Postal Service to Interrogatories UPS/USPS-T1-2, 5, 8, 11, and 14. The NASS and HCSS files used in generating the highway and commercial air samples are dynamic data bases that are continually updated to reflect ongoing changes to the transportation system. Sample selection is based on versions of these data bases as of the instant the samples are drawn. The ongoing updating process begins to alter these files almost immediately, and, over time, they diverge more and more from the versions that existed as of the time of sample selection. Thus, the version of the file that exists currently differs from that used in the sample selection process, and there is no way in which to evaluate the representativeness of movements selected.

That need not be the case, however. To permit an appropriate evaluation of the accuracy and reliability of the TRACS samples, the Postal Service could and should, in future rate cases, retain full copies of the files used to create the sample frames as of the points in time when the samples are drawn.

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24. Partial Objection of USPS to UPS/USPS-T1-2, 3, 5, 6, 8, 9, 11, 12, 14, and 15; Supplemental Responses of USPS to UPS/USPS-T1-18, 22, 25–27, after a UPS motion to compel, and Partial Objection of USPS to UPS/USPS-T1-77.

IMPROVING THE TRACS PROCESS

My criticisms of TRACS as it is currently implemented naturally lead me to consider ways in which its accuracy and reliability might be improved. In this final section, I present a number of suggestions for improvement. The list presented below is not intended to be comprehensive.

A. Supplementing TRACS with Information from Administrative Data Bases

The analysis of mail volumes could be improved greatly by the use of data from an existing management data base, the Transportation Information Management Evaluation System ("TIMES"). Data from TIMES could be used to evaluate the accuracy of the TRACS system, given minor revisions in data base procedures. Furthermore, as long as they are excluded from the TRACS process, TIMES data could be used to partially evaluate the mail mix on emergency contracts and in exceptional service movements in a way that would determine whether sampling bias exists in the TRACS system. Finally, for at least some facilities, TIMES could provide information on the universe of mail movements that could be used as part of the process of estimating subclass distributions.

Professor Bradley finds TIMES to be inadequate to allow development of distribution keys for purchased highway costs. USPS-T-18, pp. 57-59. His evaluation is incomplete, however, as it was limited in two crucial respects. First, he considered only the system as it is currently implemented, and failed to consider modest changes that might greatly improve its utility. Thus, he observes that information for certain fields containing load information is not required to be recorded, but his evaluation does not take the simple additional step of considering the usefulness of TIMES if steps were taken to require the recording of load information. Second, he evaluates the use of TIMES solely as a replacement for TRACS. This limited evaluation ignores the possibility of using TIMES to ***supplement*** TRACS.

I propose that two changes be made in TIMES and TRACS.[25] First, the recording of load information in TIMES should be made mandatory. The extra burden of recording container counts in TIMES by container type seems not to be onerous. In addition, recording this information for all movements in TIMES increases the value of the information that is already being recorded some of the time.

Second, the same coding should be used for both the TIMES and the TRACS systems. Both TIMES and TRACS currently record information about containers, but they do so in inconsistent ways. TIMES identifies containers by type: GPC, BMC, Amtrak, hampers, and pallets, as well as Express Mail items. TRACS also records container information by type, but uses a different set of categories: Wiretainer, GPC/GPMC/APC, Short or Tall Postal Paks, and a number of other types (Handbook F-65, Figure 5-44, p. 5-73, USPS-LR-I-18). Changing the coding of containers in either TIMES or TRACS does not seem like a major change.

TIMES can act as a supplement to TRACS because it records information on all movements at the locations at which it is implemented, and it records information for a wider variety of highway movements. The potential benefits of using this additional

25. To the extent that VTAPS serves a function similar to TIMES at BMCs, that system should also be modified and used. Tr. 21/9355.

information are twofold. First, data on container movements in TIMES can be used to determine whether the TRACS sample is unbiased. Specifically, one can compare the proportions of containers used by type recorded in TIMES with those recorded in TRACS. The TIMES data are not sampled, but rather represent a population against which the TRACS sample can be compared. It is also possible that information from the two sources could be used in an integrated fashion, with TIMES providing information on container counts for the facilities it covers, and the role of TRACS changing to one of measuring contents by container type.

Second, TIMES can be used to evaluate the mix of mail on emergency contracts and in exceptional service movements. Emergency contracts and exceptional service movements are an important component of overall highway costs, as described above; yet, they are not sampled in TRACS. Using TIMES, one can estimate the mail mix on such movements by multiplying measures of container movements by measures of average mail mix within each container type. The latter information can be calculated from TRACS data, as long as it has the same container type coding as TIMES does.

There will certainly be limitations that constrain the usefulness of TIMES. Most important, TIMES is not implemented systemwide, but is used only at locations where container use is relatively high. Thus, it is unlikely to provide much useful information about Intra-SCF movements. But it is highly likely to provide complete information about Inter-BMC movements. The availability of complete information for a part of the highway network would be a significant improvement over the current system. The fact that mail volumes by subclass are not recorded may be seen as a limitation as well, but in fact it is not. Since the TIMES data would be used as a supplement to TRACS rather than as a replacement for TRACS, the detailed subclass information would not be essential.

B. Changing Sampling Procedures

My suggested improvements to the approach used to assign empty space costs derive from the essential fact that the individual segments on a route are interrelated and hence cannot properly be viewed in isolation. The alternative procedure I present is designed to respond to this criticism in a way that is practical, given the existing data. For the next rate case, however, some relatively simple changes to TRACS would permit a much more accurate treatment.

Specifically, I recommend that TRACS sample all segments on a trip. Armed with full information on all segments of a trip, one can more directly determine the mail mix to which costs on the trip should be allocated, by considering the characteristics of the mail on all of the segments.

Note that this recommendation is not the same as sampling all trips and stops on a contract, which Dr. Bradley criticizes in his testimony (in considering a method to more closely integrate TRACS with HCSS). USPS-T-18, p. 43 n.42, 55-56. His criticisms are based on the need to sample an average of 11.2 stops per primary sampling unit (contract) tested. USPS-T-18, p. 56. That would require the presence of large numbers of data collectors in the same area and would substantially reduce the range of primary sampling units (contracts, in this case) tested.

By contrast, my recommendation is to sample all segments on a trip, not in a contract. The reduction in the range of tested primary sampling units associated with this proposal is much smaller than in the case of the proposal which Dr. Bradley rejects. Furthermore, the concentration of data collectors over which he expresses concern need not necessarily occur. Since most trips are repeated, one could conceivably sample different segments on different weeks. Under such a system, the workload concentration problems cited by Dr. Bradley would not occur.

CONCLUSION

The Postal Service's approach of imposing the entire network premium costs of the Eagle and Western networks solely on Express Mail ignores current operational realities. Priority Mail represents more than 48% -- almost half -- of the volume carried on those networks, whereas the Express Mail volume carried on them is less than half of that (22%). Moreover, those networks as they currently exist have been configured with Priority Mail as well as Express Mail in mind. As a result, I recommend that the Commission allocate the network premium costs to both Priority Mail and Express Mail, as shown in my testimony.

The Commission should also modify the current method of distributing the costs of empty space in purchased highway transportation. Those costs are incurred because of the need to purchase sufficient capacity to accommodate the mail volumes carried on the transportation legs with the greatest capacity utilization. I recommend to the Commission an alternative approach to the distribution of the costs of empty space which recognizes that reality.

Finally, there is substantial evidence that TRACS undersamples time-sensitive mail. As a result, I suggest a number of methods for improving the distribution of purchased transportation costs.

Appendix A

Kevin Neels — Vice President

Ph.D. Cornell University
A.B. Cornell University

Kevin Neels has over twenty years of economic research and consulting experience. He has worked on behalf of numerous public and private sector clients in a wide range of industries. A skilled econometrician, he specializes in the use of quantitative techniques to resolve practical business, legal and regulatory problems. His extensive practical experience in the use of economic analysis to inform business decision making and win the support of legislative, legal and regulatory authorities has taught him how to effectively communicate analytical results in laymen's terms.

Dr. Neels has offered expert testimony on a number of occasions, either in the form of an expert report, in deposition or orally. He has also supported leading academic expert witnesses. Dr. Neels has played a key role in legal and regulatory proceedings for which the financial stakes have often run into tens or hundreds of millions of dollars. His work in support of counsel has touched all phases of the legal process, including discovery, development of theory, preparation of expert testimony, examination of opposing witnesses, preparation of trial exhibits and development of cross-examination strategy.

A frequent focus of Dr. Neels' work has been estimation of economic damages. He directed the team of economists working for the Plaintiff in the trial that resulted in the largest damage judgment ever awarded in a patent infringement lawsuit. On many occasions he has developed econometric models to support economic damage claims and testimony in antitrust litigation. He has also frequently been responsible for review and analysis of damage estimates put into evidence by opposing experts and for development of strategies for refuting these claims.

Dr. Neels has extensive experience in the areas of antitrust economics and damage estimation. He has been designated as an expert witness and has offered deposition testimony in a number of antitrust disputes. His work has addressed issues of both geographic and product market definition, as well measurement of antitrust damages. His work in support of clients involved in antitrust litigation has touched all phases of the process, from earliest discovery through closing arguments at trial.

Dr. Neels possesses particular expertise in the analysis of spatial economic relationships. His work has addressed questions of geographic market definition, intraurban and interurban travel behavior, relationships between freight transportation costs and product prices, determinants of location decisions and relationships among spatially differentiated products. His work has assisted clients in diverse sections of both the passenger and freight transportation industries.

Among the projects Dr. Neels has successfully concluded are:

- For a group of automobile dealers he conducted an econometric analysis to quantify the extent to which these dealers had suffered economic injury as a result of a scheme in which executives of the auto manufacturer accepted bribes from a subset of dealers in exchange for providing them with extra allotments of highly profitable car models. The settlement of this litigation awarded a payment of several hundred million dollars to the non-bribe paying dealers.

- For an express package delivery carrier intervening in a rate case before the U.S. Postal Rate Commission he conducted a critical review of econometric studies of cost variability introduced into evidence by a witness testifying on behalf of the U.S. Postal Service. He identified a number of serious conceptual and methodological flaws in this analysis, and demonstrated that the substantive conclusions of the analysis were sensitive to relatively minor change in its design. On the basis of his testimony the Commission rejected the arguments of the Postal Service in the Commission's final ruling.

- For a major international air carrier accused of monopoly leveraging and attempted monopolization of a key market he prepared a report analyzing the carrier's use of corporate discounts and travel agent override commissions to help rebut arguments that these agreements constituted exclusive dealings.

- He played a major role in the preparation of expert testimony on behalf of a group of major domestic oil companies accused of conspiring to depress the prices paid to producers of a major input to tertiary oil recovery projects. This testimony focused on an examination of purchase contracts involving the defendants to establish market prices for the input in question over the alleged damage period.

- For the International Air Transport Association he conducted an analysis and critique of a proposed change in the structure of air traffic control user charges levied on foreign carriers entering the U.S. and overflying its territory. He pointed out a number of serious flaws in the empirical analysis that formed the basis for the new system of charges. Implementation of the new charges was halted by a federal judge.

- For a manufacturer of class III medical devices he conducted a series of statistical analyses of turnover in the population of patients using a number of the company's key products. This analysis produced a profile of how patients clinical situation and needs evolved over time. These results provided the basis for a redirection of the company's product development strategy.

- Working for plaintiffs in an antitrust lawsuit involving the petroleum industry, he prepared an expert report criticizing analyses and testimony of defendants' experts. This report reviewed flaws in defendants' geographic market definition and rebutted criticisms made by defendant experts of plaintiffs' damage calculations.

- In support of a key economic witness in a hearing regarding refined petroleum product pipeline rates before the Federal Energy Regulatory Commission, he conducted an analysis the relationship between product prices in the different geographic areas linked by the pipeline system. He also examined alternative transportation modes and concentration in the pipeline's origin markets.

- For a major international oil company, he offered advice on econometric issues raised by an empirical study of the determinants of fair market value for a specific grade of crude oil.

- For the U.S. Department of Energy, he conducted an extensive investigation of the technological, institutional and economic factors influencing the demand for residential heating fuels.

- For a Gas Research Institute study of natural gas usage in the steel industry, he provided consultation on statistical issues and worked closely with a team of analysts examining the economics of fuel substitution.

- For a small package express company, he conducted a detailed analysis of the economic incentives created by alternative regulatory frameworks. This effort focused on the effects of proposed regulatory changes on entry by new firms, on the competitive structure of the market and on the potential for cross-subsidy by multi-product firms with diverse offerings.

- He played a critical role in a project for the Air Transport Association (ATA) of the United States to evaluate proposals for reforming the nation's air traffic control (ATC) system and to develop an effective financial and organizational structure for a reformed ATC. The plan, developed under extremely tight deadlines, required an assessment of ATC technological capabilities, estimation of the cost effects of ATC on the airline industry, an economic analysis of current and proposed ATC organizational forms and detailed financial assessment of proposed ATC entities. Dr. Neels presented his analysis and proposal to airline chief executive officers at a meeting of the ATA board.

- Working of behalf of a major air carrier in an antitrust case involving allegations of predatory pricing, he worked directly with the lead litigator to develop a strategy to guide the discovery portion of the case. Subsequently, he conducted a variety of econometric analyses measuring the extent to which plaintiffs were harmed by the alleged predation.

- For a consortium of major U.S. air carriers accused of engaging in collusion and price fixing, he directed a major economic analysis of industry pricing strategy and dynamics. Drawing upon detailed data on daily fare changes, he prepared testimony and exhibits demonstrating the difficulty of engaging in coordinated pricing behavior.

- For a major U.S. air carrier, he conducted an extensive empirical investigation of the responses of travel agents to carriers' incentive and override programs. Using the results of this investigation, he evaluated his client's sales force management and travel agent incentive strategies to identify specific ways in which redesign and or retargeting could increase their net revenue yields.

- He assisted in the preparation of statistical exhibits and an expert affidavit for submission by a major U.S. carrier in a rulemaking proceeding regarding airline computerized reservation systems conducted by the U.S. Department of Transportation.

- He provided expert deposition testimony on geographic market definition in an antitrust lawsuit between a regional medical center and a physician-owned health clinic. To support his opinions he analyzed the structure of competition between alternative hospitals within the area and conducted an empirical analysis of patient decisions regarding choice of hospital for the service in question.

- For a biotechnology company involved in a trade secret misappropriation dispute with a competitor, he offered expert deposition testimony on potential fields of application for the technology in question and on the factors that influenced customer decisions to incorporate the new technology in their products. As part of this case he also conducted an empirical investigation in the role that technology licensing deals play in the financing of biotechnology start-up companies.

- To support expert testimony in an antitrust case between two major U.S. air carriers he developed and estimated a set of statistical models for estimating the effects of CRS display bias on the booking patterns and revenues of the affected airlines. As part of this effort he conducted an extensive analysis of the histories of the carriers in questions and of the development of computerized reservation systems as the primary channel of distribution for airline tickets. He also prepared damage estimates, assisted in the deposition of opposing expert witness, prepared trial exhibits and advised counsel on cross-examination strategy during the course of the trial.

- He directed the team of economists responsible for conduct of the damages study for plaintiff in a major patent infringement lawsuit in the consumer products industry. His work included development of econometric models to forecast product sales in eight major world markets, analysis of the effects of incremental changes in sales volumes on company profits, review of historical pricing strategies and calculation of economic damages for a wide range of "but-for" pricing and product introduction strategies. He and his team also played a key role in the analysis of the case put forth by the opposing side and in the development of cross-examination strategies for opposing expert witnesses. He was designated as an expert witness in this matter, but was not called upon to testify.

- For the public authority responsible for the operation of one of the largest international gateway airports in the country, he conducted a comprehensive review of sources of information on air cargo movements. Based upon the results of this review, he worked with authority staff to devise a strategy for monitoring trends in shipments by ultimate origin and destination, commodity, carrier and type of service, and for factoring this information into an improved process for planning and executing air cargo facility improvements.

- Working under extreme deadline pressure for a European pharmaceutical company, he estimated savings in total medical costs from pharmacological therapy for chronic occlusive arterial disease in order to provide input to a key regulatory dossier. Results were subsequently published in a peer-reviewed journal.

- To support the development of an airport system plan for a major metropolitan area, he prepared long-range activity forecasts for air carriers, regional airlines and general aviation.

- For the developer of a medical device-based pain management therapy, he conducted a cost-effectiveness analysis for internal use. He built upon this work to develop a reimbursement and marketing strategy for the product.

- For the top management of an emerging health care company, he prepared an analysis and briefing to review the market implications of health care reform and the strategies adopted by competing firms in response.

- For a regional air carrier accused of engaging in predatory pricing, he assisted counsel in defining the relevant product and geographic markets and in developing estimates of the short-run marginal costs of serving those markets. He also prepared evidence on the ease of entry and on the likely behavior and strategies of potential entrants.

- For the operator of a system of outpatient medical clinics, he conducted an analysis of the economic incentives created by investments by referring physicians. His conclusions were summarized in a written report, along with discussion of their implications for policy regarding regulation of such investments by the federal government.

- For a major manufacturer contemplating litigation over an alleged theft of trade secrets, he developed a system of economic forecasting models to calculate the effects of the theft of sales of the company's products in a number of major international markets. Results of this confidential investigation played a key role in the company's subsequent decision to seek redress through the courts.

- For a group of physicians involved in a health insurance-related private antitrust lawsuit he conducted a critical review and analysis of damage models prepared by opposing experts. His findings provided the basis for expert testimony by a leading university-based economist. In addition, he provided assistance to counsel in the deposition of opposing economic experts.

- For the plaintiff in an antitrust suit involving an important line of biotechnology products, he conducted an analysis of therapeutic substitution possibilities to support development of testimony regarding product market definition.

- As leader of a project funded jointly by the Ford Foundation, the U.S. Department of Housing and Urban Development and a consortium of local corporations, he directed a year-long study by the Rand Corporation of strategies for privatizing municipal services in Saint Paul, Minnesota. A major component of this project was a detailed analysis of the incentives created by different financing mechanisms, organizational structures and personnel management systems. Findings of the study were published in a major report entitled *The Entrepreneurial City*.

- For the developer of a new cardiac diagnostic imaging agent, he used meta-analysis and receiver operating characteristic curve techniques to measure the accuracy of procedures using the agent relative to competing diagnostic techniques.

- For an arm of the National Academy of Sciences, he conducted an investigation of the innovation process in medical technology and analyzed how that process has been effected over time by changes in the institutional and economic environment.

- Working under a federally funded research grant, he served as a key staff member of a Rand Corporation study of the equity implications of substituting user charges for tax funding of public services.
- For the developer of a new orphan drug, he conducted a cost-benefit analysis, a review of political and legislative trends and a hedonic analysis of existing orphan drug prices to support development of a defensible pricing strategy.
- For a medical device company, he prepared a payor education brochure describing the results of a cost-effectiveness study of a new therapy, which allows payors to calculate the savings they could realize by granting coverage of the therapy.

Before returning to Charles River Associates to lead our Transportation Practice, Dr. Neels held a variety of responsible positions within the research and consulting industry. He was a vice president at PHB Hagler Bailly, Inc., and the vice president for Health Economics and managing director of the Cambridge office of Quintiles Inc., where he directed a team of economists serving a worldwide clientele of pharmaceutical and biotechnology, and medical device companies. Previously, he was vice president in charge of the pharmaceutical consulting practice at Charles River Associates. He has also served on the research staffs of the Rand Corporation, the Urban Institute and Abt Associates.

PROFESSIONAL AFFILIATIONS

American Economic Association

American Law and Economics Association

National Association of Business Economists

National Health Lawyers Association

International Health Economics Association

Drug Information Association

KEVIN NEELS

PUBLICATIONS AND TESTIMONY

Articles

"Estimating the Effects of Display Bias in Computer Reservation Systems." With Franklin Fisher, In *Microeconomics Essays in Theory and Applications*. Ed. Maarten-Pieter Schinkel. Cambridge University Press, 1999.

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KEVIN NEELS

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KEVIN NEELS

Before the U.S. District Court, Central District of California, Testimony in the matter of Blecher & Collins vs. Northwest Airlines. Case No. 92-7073-RG (SHx). November 15, 1993.

Before the U.S. District Court, District of Maine, Testimony in the matter of Penobscot Bay Women's Health Center vs. Penobscot Bay Medical Center. Civil Action No. 86-0110-8. July 19, 1990.

APPENDIX B:

DISTRIBUTION KEY FORMULAS

This appendix provides the formulas used to calculate the purchased highway transportation distribution keys used in my testimony. It is based on the description of the Postal Service formulas given in the TRACS Highway Subsystem Statistical and Computer Documentation (USPS-LR-I-52) and uses the same notation and language, wherever possible.

I produce quarterly distribution keys for four contract types, just as the Postal Service does (Inter-BMC, Intra-BMC, Inter-SCF, and Intra-SCF). The data are expanded in a five-step process, incorporating two stages of distribution key calculations, to obtain cubic foot miles by mail category for each contract type.

The formulas below are altered versions of those shown in USPS-LR-I-52, sections VII-2-3. Where equations have been changed, their number is now indicated with a prime, for the first stage, and a double prime, for the second stage. Thus, in section 2 below, Postal Service equation (11) becomes my equation (11'). Where new equations are included, their number is shown with a suffix as well as a prime. Thus, in section 4 below, equations (10a") and (10b") are replacements for Postal Service equation (10).

1. Expanding to Unloaded Truck Capacity

My first step is the same as that used by the Postal Service: test data are expanded to the unloaded truck capacity. I use the same formulas as the Postal Service for expanding mail to fill the enclosures (containers, pallets, loose items), as described in USPS-LR-I-52, section VII-1. At the end of this step, one has determined the cubic feet of the mail which was loaded on the truck at origin o and unloaded at the test stop, $cuft_{iro}$, for all origins o, mail categories r, and tested vehicles i.

2. First Stage: Cubic Foot Mile Calculation

My method begins to differ from the Postal Service's method at the second and third steps, where I calculate a first-stage distribution key. This key differs from the final Postal Service key in two important ways. First, it does not expand the mail into any empty space; this is done in the fourth step. Second, it considers only the mail found on trucks whose capacity utilization lies above a certain threshold. The purpose of this first-stage key is to determine how to "fill" the empty space on the trucks.

The first-stage cubic foot miles are not expanded to fill empty space. When summed across all the origin facilities up to a specific leg, equation (9) from USPS-LR-I-52 produces the cubic foot estimates for the mail traveled on the leg:

$$cuft_{irs} = \sum_{o=1}^{s} cuft_{iro} \ . \qquad (10)$$

Each sample record contains a complete list of legs the mail item traveled on the vehicle. For each leg, the sample record also specifies its origin and destination facilities and the highway miles between the two. The cubic foot miles for each leg is the product of the cubic feet estimates and the highway miles for the leg. The cubic foot miles is the sum of such products across all legs:

$$cfm_{ir} = \sum_{s=1}^{S} cuft_{irs} \times mile_{is} \qquad (11')$$

where mile is assumed equal to 1 for legs within Intra-SCF contracts. No equation (12) or (12') is used.

3. First Stage: Distribution Key for Heavily Loaded Trucks

I expand the test level cubic foot miles obtained from equation (11') in the previous section to the stratum level and sum across strata, including only those tests where capacity utilization exceeds the pre-specified threshold T. The distribution key is a set of ratios of the unexpanded cubic foot miles for an individual mail category to the total unexpanded cubic foot miles summed across all the mail categories. I calculate one key for each contract type, regardless of stratum.

$$\breve{y}_r = \frac{\sum_{h=1}^{H}\left(\sum_{i=T}^{n_h} cfm_{ir} \times T\right) w_h}{\sum_{r \in R}\sum_{h=1}^{H}\left(\sum_{i=T}^{n_h} cfm_{ir} \times T\right) w_h} = \frac{cfm_r}{\sum_r cfm_r} = \frac{cfm_r}{cfm}, \qquad (13')$$

where the stratum weights

$$w_h = \frac{\sum_{I=1}^{N_h} Day_I \times Q}{n_h}, \qquad (14')$$

and where the dummy variable T takes the value one if

1 - %Empty$_i$ > 1 - 1/(average number of legs per trip within the contract type), and zero otherwise.

4. Second Stage: Cubic Foot Mile Calculation

In my fourth step, I use the first-stage distribution key to "fill" the empty space in the trucks, by calculating the number of empty cubic foot miles to allocate to each mail category, based on the first-stage distribution key. My definition of empty space is only slightly altered from the Postal Service's definition. For the last, observed leg on a trip, it is the observed empty space on the vehicle. For earlier legs on the same trip, it is the average empty space on all vehicles in the same contract type; this measure differs from that used in the Postal Service's approach, which uses all vehicles in the same stratum.

Each sample record contains a complete list of legs the mail item traveled on the vehicle. For each leg, the sample record also specifies its origin and destination facilities and the highway miles between the two. The full, or occupied, cubic foot miles for each leg are the product of cubic feet and highway miles for the leg. The full cubic foot miles are the sum of such products across all legs:

$$fullcfm_{ir} = \sum_{s=1}^{S} cuft_{irs} \times mile_{is} \qquad (10a'')$$

The allocated empty cubic foot miles are determined by calculating total empty cubic foot miles, and then applying the first stage distribution key:

$$emptycfm_{ir} = \breve{y}_r \times capacity_i \times \sum_{s=1}^{S} empty_{is} \times mile_{is} \qquad (10b'')$$

where

$$empty_{iS} = \%Empty_i \times \frac{\%Unloaded_i}{\%Unloaded_i + \%Remain_i} \quad \text{and}$$

$$empty_{is} = \frac{\sum_{i=1}^{n} \%Empty_i}{n} \times \frac{\sum_{r} cuft_{irs}}{capacity_i \times (\%Unloaded_i + \%Remain_i)} \quad for\ s < S,$$

mile is = 1 for legs within Intra-SCF contracts, and n is the number of tests within a contract type.

Summing actual cubic foot miles and expanded cubic foot miles yields total cubic foot miles by mail category:

$$totcfm_{ir} = fullcfm_{ir} + emptycfm_{ir} \qquad (11'').$$

Again, no equation (12) or (12") is used.

5. Second Stage: Distribution Key

My fifth step follows the same process as the Postal Service's third step. The test level cubic foot miles obtained from equations (11") in the previous section are expanded to the stratum level and summed across strata. The distribution key is a set of ratios of the expanded cubic foot miles for an individual mail category to the total expanded cubic foot miles summed across all the mail categories.

$$y_r = \frac{\sum_{h=1}^{H}\left(\sum_{i=1}^{n_h} totcfm_{ir}\right)w_h}{\sum_{r\in R}\sum_{h=1}^{H}\left(\sum_{i=1}^{n_h} totcfm_{ir}\right)w_h} = \frac{totcfm_r}{\sum_r totcfm_r} = \frac{totcfm_r}{totcfm}, \qquad (13'')$$

where the stratum weights are the same weights defined previously:

$$w_h = \frac{\sum_{I=1}^{N_h} Day_I \times Q}{n_h}. \qquad (14')$$

6. Zero-Volume Tests

Note that roughly 20 percent of the tests are zero-volume tests. In these cases, nothing was unloaded from the truck at the delivery point. In the Postal Service's calculations, the data from these tests have no impact on the distribution key calculation. Since all of the highway costs are distributed according to the calculated distribution keys, this lack of impact means that the costs of empty movements are attributed according to the average mix of mail (actually, the final distribution key mix, which is the average expanded mix of mail). In my version, the costs are also attributed according to the final distribution key mix, but the mix is the average empty-space-allocated expanded mix of mail.

7. Notation

The following notation, much of which is taken from USPS-LR-I-52, page 15, is used in this appendix to explain the expansion process:

h	stratum. For Inter-SCF and Inter-BMC, h=1,2,3. For Intra-SCF and Intra-BMC, h=1,2,3,4,5;

n	number of tests performed in a quarter;

i	test index within the stratum;
N	number of frame units for the quarter;
I	frame index;
Day	number of days in a week that a vehicle operates;
Capacity	vehicle capacity in cubic feet;
%Empty	percent of vehicle space that is empty;
%Remain	percent of vehicle space occupied by mail remaining on the truck;
%Unloaded	percent of vehicle space occupied by mail unloaded;
S	total legs traveled on this trip, up to the test stop;
s	segment index, or leg, on the trip {s=1,2,…,S};
o	origin index—the segment of the origin facility where the item was loaded onto the vehicle {o∈1,2,…,S};
miles	segment mileage;
r	mail category, r∈R;
cuft	mail cubic feet;
cfm	mail cubic foot mile;
y	second-stage, or final, distribution key for the quarter;
$\check{y}$	first-stage distribution key for the quarter; and
Q	weeks in the quarter {Q=12 for Q1, Q2, Q3; Q=16 for Q4}.