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BEFORE THE
POSTAL RATE COMMISSION
WASHINGTON DC 20268-0001

POSTAL RATE AND FEE CHANGES, 2000 | Docket No. 2000-1

REBUTTAL TESTIMONY OF
MICHAEL D. BRADLEY
ON BEHALF OF
UNITED STATES POSTAL SERVICE

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PURPOSE AND SCOPE

The purpose of my testimony is to review, analyze, and determine the accuracy and acceptability of three proposed changes to the established methodology for calculating attributable costs in purchased highway transportation.

The first challenge to the established methodology is an econometric analysis presented by MPA witness Nelson with the goal of calculating lower variabilities for purchased highway transportation. As I show below, Mr. Nelson's testimony includes several types of serious mistakes: (1) the specified model is not consistent with basic economic theory nor is it based upon an operational analysis, (2) the model has neither an analytical (mathematical) basis nor a statistically based specification, (3) the correct "cost per run" model has a different functional form from the one Mr. Nelson estimated, (4) the econometric methods contain several mistakes and do not conform with established econometric practices, (5) the econometric results are internally inconsistent and do not comport with operational experience, and (6) the regression programs contain serious computer programming errors. This last set of mistakes alone means that witness Nelson's actual results are not what he presents and that the variabilities that he recommends to the Commission are unreliable. In sum, Mr. Nelson's econometric work, unfortunately, falls below the standards set by the Commission for econometric studies, and does not present the Commission with useful information.

The second proposed change that I review is also put forward by Mr. Nelson. Mr. Nelson observes that the average cost per cubic foot-mile is higher for contracts that have been renewed at some point in their history as compared with those that have not. He conjectures, without evidence, that this difference is due to inefficiencies in the Postal Service contracting system and asserts that the Postal Service is overpaying for renewal contracts. Mr. Nelson recommends that the Commission discard the actual cost of renewal contracts in calculating accrued highway costs and replace that actual cost with a synthetic cost calculated under the assumption that each renewal contract should have been purchased at the overall average cost per cubic foot-mile for non-renewal contracts.

This recommendation is flawed because Mr. Nelson apparently failed to recognize that differences in cost per cubic foot-mile between the two groups of contracts may be for reasons other than the way they are contracted. The different groups may have different combinations of contract specifications and conditions that cause the cost differential. I demonstrate that when this basic point is taken into account, support for Mr. Nelson's conjecture dissipates.

The last proposed change that I review is a proposal by United Parcel Service witness Neels to change the method by which TRACS allocates empty space to classes and subclasses of mail. Dr. Neels observes that the current Postal Service method is incomplete because it fails to account for the possibility that the capacity on a given trip may be caused by volumes on different segments of the route. He proposes a method that allocates empty space solely on the basis of the mail carried on "more fully loaded" trucks. While Dr. Neels' general point is well taken, his proposed method goes too far and excuses the mail actually carried on a truck from all responsibility for the empty space on the truck.

Trucks in the Postal transportation network often must leave because of the service standards and mail processing schedules for the classes of mail being transported. If the transportation of these classes did not have to be expedited, then the Postal Service could simply let the truck wait at the dock until it is full. Thus, the observed empty space in the Postal Service transportation network is at least partly caused by the fact that the truck must leave before it is full, due to the service standards and mail processing requirements for the classes and subclasses of mail on that truck. It is in this sense that the mail on the truck being observed bears some or all of the responsibility for the empty space observed on the truck. Dr. Neels' method ignores this characteristic and disregards this important aspect of the causality of empty space. I propose a compromise method that bridges that gap between the current Postal Service method and Dr. Neels' proposed method.

A CONCORDANCE OF LIBRARY REFERENCES AND WORKPAPERS

The following Library Reference is associated with my testimony:

LR-I-452 Electronic Version of Programs for USPS-RT-8 (Bradley Rebuttal)

This library reference is a diskette that contains the electronic versions of program and spreadsheets used in my rebuttal analysis.

My testimony relies upon the following workpapers:

RWP-1 Listing Of Erroneous Observations Included And Excluded In MPA Witness Nelson's Intra-PDC Regression And A Corrected Estimation Of That Model

RWP-2 Estimation of a Corrected Version MPA Witness Nelson's Cost per Run Specification

RWP-3 Estimation of a Restricted Version the Corrected MPA Witness Nelson's Cost per Run Specification

RWP-4 Investigation of the Effect of Renewals -- Econometric Tests

RWP-5 Investigation of the Effect of Renewals -- Matched Pairs Tests

I. MR. NELSON'S ECONOMETRIC ANALYSIS SUFFERS FROM ERRORS IN MODELS SPECIFICATION, ECONOMETRIC METHODS, AND COMPUTER PROGRAMMING. THESE ERRORS RENDER HIS RESULTS UNRELIABLE AND UNACCEPTABLE TO THE COMMISSION.

In this section of my testimony, I review and evaluate the econometric analysis included in MPA witness Nelson's testimony. This section is broken into two parts. The first part describes Mr. Nelson's econometric testimony and summarizes his arguments and results. The second part evaluates the relevant parts of his testimony and describes the various errors that he makes.

A. A Description of Mr. Nelson's Econometric Testimony.

Mr. Nelson challenges the established Commission model for estimating the variability of purchased highway transportation. Interestingly, he does not challenge or refute the evidence on the record from the many previous cases that lead the Commission to adopt the current approach. Instead, he speculates (without evidence) about USPS operating procedures and, based upon that speculation, presents his own alternative regression analysis.

Witness Nelson's attack on the established models is based upon two speculations that he makes about USPS transportation operations. Surprisingly, he provides no basis for these speculations. He presents no study of Postal Service purchased highway transportation, cites no Postal Service source documents, and provides no references other than witness Young's testimony from R97-1. This last citation is unusual because witness Young's testimony is entirely consistent with the Postal Service's and Commission's approach to estimating variability for purchased highway transportation. It was presented by the Postal Service and accepted by the Commission for that purpose.

Mr. Nelson's first speculation is that the established Commission models overstate the variability of cost with respect to capacity because they fail to reflect the propensity of the Postal Service to adjust capacity through changes in vehicle size rather than changes in trip frequency (to accommodate volume changes on a given transportation schedule).[1] This claim is made despite the fact that the data used to estimate the established model is not a special database constructed just for variability analysis, but rather is a census of all Postal Service purchased highway transportation contracts. As such, it reflects actual Postal Service experience and embodies all historical changes in both vehicle size and trip frequency (as well as routing). The propensity of the Postal Service to change capacity in any particular method is embodied in these data. Moreover, these types of data have been collected for different years over a decade apart, allowing plenty of time for changes in highway contracts by all methods. The econometric results on these different data sets present a consistent pattern of results. There is no need to modify the specification to take into account specific ways the Postal Service adjusts capacity. These methods are already embodied in the estimated cost function.

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[1] See, Direct Testimony of Michael A. Nelson on Behalf of MPA et. al., MPA-T-3, Docket No. R2000-1 at 6.

Witness Nelson's second speculation is based upon his claim that the elasticity of "gross cubic foot-miles" with respect to "net cubic foot-miles" is less than 100 percent. If this is true, he claims that the established models overstate the "true" variability.[2] While there may be some merit to Mr. Nelson's point about "gross" and "net" cubic foot-miles, this point does not imply any change in the existing econometric models.[3] The established models are not designed to estimate the response in "gross cubic foot-miles" with respect to "net cubic foot-mile" or more accurately, they are not designed to estimate the response in cubic foot-miles with respect to volume. Instead, they are designed to estimate the response in cost to changes in cubic foot-miles.

Mr. Nelson may be correct that response of cubic foot-miles with respect to volume is less than the assumed one hundred percent, but this does not imply adjusting existing econometric models. Rather it implies estimating the correct variability (which Mr. Nelson fails to do) of cubic foot-miles with respect to volume and then applying that variability in the costing procedure.

To see how this would be done, one must recognize that the volume variability of purchased highway transportation has two parts, the variability of cost with respect to cubic foot-miles and the variability of cubic foot-miles with respect to volume:[4]

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2 See, Direct Testimony of Michael A. Nelson on Behalf of MPA et. al., MPA-T-3, Docket No. R2000-1 at 7.

3 The Commission explicitly acknowledged this point in the last docket. See, PRC Op., R97-1, Vol.1, at 212.

4 See, PRC Op., R97-1, Vol.1, at 211.

$$\varepsilon_{C,V} = \varepsilon_{C,CFM} * \varepsilon_{CFM,V}$$

The first of the two variabilities is estimated using the established models. Mr. Nelson's concern about "net" and "gross" cubic foot-miles is actually a concern about the assumption that the second variability is equal to one. Disappointingly, he provides no evidence on what he thinks this variability should be.

Mr. Nelson also devotes a section of this testimony to making two specific criticisms of the accepted empirical methods.[5] As these are his only formal critique of the established econometric methodology they deserver mention and review. As it turns out, neither of the two criticisms is accurate. Ironically, these two misplaced criticisms lead Mr. Nelson into making two actual mistakes in his own econometric procedures.

First, Mr. Nelson claims that the established treatment of power-only contracts is "circular" at best because it use a single cubic foot term in calculating cubic foot-miles for power-only contracts within an area while the established equation already includes a constant (dummy variable) for each area:[6]

> The treatment of power-only contracts appears to be circular at best, as a constant cubic foot estimate is developed for each area, then used in a model that contains a constant term for each area.

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5 See, Direct Testimony of Michael A. Nelson on Behalf of MPA et. al., MPA-T-3, Docket No. R2000-1 at 7.

6 See, Direct Testimony of Michael A. Nelson on Behalf of MPA et. al., MPA-T-3, Docket No. R2000-1 at 7.

Although Mr. Nelson never explains what he means by "appears to be circular" or "at best," he apparently thinks that this treatment of power only contracts has negative implications for the econometric model. Mr. Nelson never even hints what those implications are, but on this basis he deviates from accepted practice and eliminates the power-only contracts from the data used to estimate the regressions. Apparently, he thinks that using the power-only contracts will cause an econometric problem because the constant cube will somehow (and this is not explained in his testimony) interact with the area specific dummy variables. This assertion is wrong. There is no econometric problem from using the constant cube for power-only contracts and there is no basis for eliminating the power-only contracts.

To make such an assertion, Mr. Nelson would seem to either misunderstand the construction of cubic foot-miles or misunderstand how regression analysis works. The fact that a constant cube is used in calculating cubic foot-miles for a subset of contracts within an area does not impinge upon the role of the area specific dummy variables in any way. For the inter-BMC, intra-BMC, and plant load account categories (were power only contracts are at issue) there are only a few different cube sizes for trailers. This means that there several groups of non-power-only contracts with a "constant" cube. What matters, of course, for the regression is whether or not <u>cubic foot-miles</u> (the actual variable in the regression) are constant across contracts within an area.

As Mr. Nelson has admitted, they are not.[7] In addition, the cubic foot-miles for power only contracts themselves are not constant within area.

Mr. Nelson's point is therefore without substance and he has failed to present an acceptable justification for deviating from the established practice of using the power only contracts. By eliminating them, he is excluding hundreds of observations from the estimation of the intra-BMC, inter-BMC and plant load regressions.

In a similar vein, Mr. Nelson claims that the established methods of identifying and controlling for a small number of atypical observations "appear in some instances to exclude good data."[8] This one sentence of muted criticism is the entire analysis and discussion contained in Mr. Nelson's testimony of the established method of identifying unusual observations. He does not identify the good data points that he thinks are excluded, and his testimony does not explain why he thinks the established methods excludes good data points. Finally, he does not even identify how many good data points he thinks have been excluded.

When asked to identify the instances in which the methods at issue excluded "good data," Mr. Nelson admitted that he had not identified when good data were eliminated.[9] He claimed instead that his "concern" was based upon the presentation in USPS-LR-I-86, that some of the observations were noted as

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7 See, Response of MPA Witness Nelson to USPS/MPA-T3-52.

8 See, Direct Testimony of Michael A. Nelson on Behalf of MPA et. al., MPA-T-3, Docket No. R2000-1 at 7.

9 See, Response of MPA Witness Nelson to USPS/MPA-T3-49.

"accurate." But this claim misses the point. The issue was not whether or not the data for the unusual observations are "accurate." The data for the contracts that transport baby chicks, used a wind-sled, or for which 45% of the annual contract cost is tolls are all "accurate." The fact that the data were recorded accurately does not preclude them from being unusual and not typical of the transportation mode in which they are included. It also does not prevent them from distorting the estimation of the true cost relationship.

In fact, Mr. Nelson could identify only one observation that "concerned" him.[10] As it turns out, that observation is for the inter-BMC account category. Table 10 of my direct testimony shows that elimination of unusual observations (including this one) for the inter-BMC account category had no effect on the estimated variability.[11] Thus, Mr. Nelson's "concern" is void of empirical content and provides no basis for substituting his own arbitrary method. The drawbacks and implications of Mr. Nelson's proposed method are presented below, but Table 1 presents a comparison of Mr. Nelson's proposed method and the approved method for identifying and excluding unusual observations. This table makes clear that there is no justification for substitution of Mr. Nelson's method for the approved method.

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[10] See, Response of MPA Witness Nelson to USPS/MPA-T3-49.

[11] See, Direct Testimony of Michael D. Bradley on Behalf of the United States Postal Service, Docket No. R2000-1, USPS-T-18 at 40.

Table 1 A Comparison of Mr. Nelson's and the Approved Methods for Identifying Unusual Observations		
	Nelson Method	Approved Method
Method of identifying unusual observations.	Application of a set of arbitrary rules with no justification or analysis.	Review of all individual data points. Identification based upon an explained and justified set of criteria.
Separate identification and presentation of the unusual observations?	No	Yes
Investigation of each of the unusual observations and presentation of the results of that investigation?	No	Yes
Identification of the total number of unusual observations?	No	Yes
Presentation of the number of unusual observations in each of the regression equations?	No	Yes
Investigation of the effects of elimination of the unusual observations on the results?	No	Yes
Estimation of the regressions with and without unusual observations included?	No	Yes
Number of observations eliminated	202*	233

* This is my calculation of number eliminated observations. Mr. Nelson never presents such a number, even in response to an interrogatory requesting him to do so. See, Response of MPA Witness Nelson to USPS/MPA-T3-23.

Mr. Nelson's testimony discusses regression equations that are supposed to remedy his conjecture that the established variabilities are overstated. In doing, so he presents three sets of estimations. In all three sets, he attempts to identify the contract cost segments with the largest capacity vehicles and arbitrarily sets the variability for those contracts cost segments at 100 percent.[12] The regressions are then supposed to be estimated with the data from the contracts with smaller than the largest capacity vehicles.[13] In this section of my testimony, I review and explain the three models that Mr. Nelson estimates.

MODEL 1. Estimation of a translog model with cost per run as the dependent variable and cubic foot-miles per run and route length as right hand side variables.

Mr. Nelson states that he estimated this model for only two account categories, inter-BMC and inter-Area. [14] The coefficient on cubic foot-miles in the inter-BMC regression is negative and not significant. Mr. Nelson then abandons this approach apparently because of this result.[15]

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12 See, Direct Testimony of Michael A. Nelson on Behalf of MPA et. al., MPA-T-3, Docket No. R2000-1 at 7.

13 See, Direct Testimony of Michael A. Nelson on Behalf of MPA et. al., MPA-T-3, Docket No. R2000-1 at 8.

14 See, Workpaper WP-4 of Michael A. Nelson to Accompany MPA-T-3 at 2. Mr. Nelson complains in this workpaper, at page 2, about having to estimate a model for so many "disaggregations" and how having to do so increases the likelihood of obtaining "anomalous" results. Of course, this could be looked at as an opportunity to test the robustness of a proposed model. The established model does quite well when facing this challenge. What Mr. Nelson is apparently complaining about is having to subject his model to a rigorous test.

15 It is curious that witness Nelson also obtains negative variabilities for certain account categories for his other two models, but does not abandon them. See, Workpaper WP-4 of Michael A. Nelson to Accompany MPA-T-3 at 4 and 5. He does not explain why his standard for the second and third models is lower than it is for his first model.

In an attempt to paper over the deficiencies of the cost-per-run specification, Mr. Nelson claims that this result is due to the method of evaluating the equation (after it is estimated):[16]

> I concluded from this that witness Bradley's approach of evaluating the elasticity only from the first-order term may produce implausible and unusable in the context of the modified specification.

Of course, Mr. Nelson is in error when he claims that mean centering the data to calculate the variability uses "only the first order term" to calculate the elasticity. It can be demonstrated mathematically that mean centering is equivalent to estimating the equation without mean centering the data and then using all of the coefficients to estimate the variability at the arithmetic mean. Mean centering is convenience that simplifies that calculation.

While Mr. Nelson may wish to abandon this model due to poor performance, he cannot justify that abandonment on the method of evaluation. His poor econometric results exist <u>before</u> the equation is evaluated; the coefficient on cubic foot-miles is negative and insignificant regardless of the method of evaluation used.

Mr. Nelson also uses his poor results to arbitrarily eliminate all higher order terms from subsequent regressions and uses a simple "log/log" model. This elimination is in violation of accepted econometric practice and is at odds with his own results. That is, he eliminates higher order terms despite the fact

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[16] <u>See</u>, Workpaper WP-4 of Michael A. Nelson to Accompany MPA-T-3 at 2.

that he found that Model 1 had "good statistical significance for the squared cross-product terms that contain the CFM variable."[17]

MODEL 2. Estimation of a "log-log" model in which cost per run per route length is the dependent variable and cubic capacity and the inverse of run length are the right hand side variables.

Mr. Nelson estimated this model for the entire set of transportation categories. Here, he divided the cost per run by route length so the dependent variable is now apparently cost per run per mile. This model gives a range of variabilities from –2 percent to 429 percent. This model seemed to have particular trouble in the transportation categories with longer route lengths (for example, the inter-Area tractor-trailer variability was estimated to be one tenth of one percent)[18] so Mr. Nelson tried yet a third model.

MODEL 3. Estimation of a "log-log" model with cost per run as the dependent variable and cubic foot-miles per run and route length as right-hand-side variables.

This model appears to be Mr. Nelson's preferred model, but even here the econometric results are internally inconsistent and unreliable. For example, Mr. Nelson must abandon his preferred model for 1/3 of his regressions and has to use "proxy variabilities." Moreover, even when Mr. Nelson uses the model, the results have great and unexplained variability. For example, consider the results for tractor-trailer transportation. Mr. Nelson's estimated variabilities range from a

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17 See, Workpaper WP-4 of Michael A. Nelson to Accompany MPA-T-3 at 2.

18 See, Workpaper WP-4 of Michael A. Nelson to Accompany MPA-T-3 at 4.

low of 16 percent to a high of over 500%. For purposes of comparison, I include in Table 2 the tractor-trailer variabilities from my direct testimony:

Table 2
Tractor Trailer Variabilities

	MPA-T-3	USPS-T-18
Intra-CSD	540.3%	109.6%
Intra-PDC	87.5%	86.8%
Inter-PDC	123.5%	96.3%
Inter-Cluster	45.2%	96.2%
Inter-Area	109.3%	94.4%
Intra-BMC	56.0%	98.3%
Inter-BMC	19.3%	97.9%
Plant Load	16.2%	89.8%

Sources: Workpaper WP-4 of Michael A. Nelson to Accompany MPA-T-3 and Direct Testimony of Michael D. Bradley on Behalf of the United States Postal Service, Docket No. R2000-1, USPS-T-18.

B. An Evaluation of Mr. Nelson's Testimony

1. Standards of Evaluation

This section of my testimony will evaluate the models and empirical results put forth by witness Nelson. That evaluation will be based upon the following standards:

1. Is the specified model based upon or consistent with economic theory?
2. Are the results consistent with a reasonable operational interpretation of Postal Service activities?
3. Does the model have a sound mathematical basis?
4. Does the econometric analysis apply well established, if not state of the art, econometric practice?
5. Are the computer programs without error? Do they produce what the analyst thinks that they do?
6. Are the empirical results robust and consistent?

2. Deficiencies in model specification

An important starting point for econometric modeling is the specification of the model to be estimated. Generally, the modeler uses economic theory or some other analytical basis for constructing the model. Unfortunately, Mr. Nelson' s model has neither underlying economic theory nor an analytical basis. He presents no justification for the functional form that he chooses, other than it is non-controversial to calculate the relevant elasticity.[19]

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[19] See, Direct Testimony of Michael A. Nelson on Behalf of MPA et. al., MPA-T-3, Docket No. R2000-1 at 8.

Mr. Nelson's model is not a cost function. The established model is a cost function. Mr. Nelson's model is not an input demand function; it does not have an input as the dependent variable. Moreover, Mr. Nelson specifies "cost per run" as a dependent variable but does not make clear why the Commission should be interested in the variability of the "cost per run." Purchased highway transportation is generally purchased on an annual basis, not on a "run" basis. In addition, the costing issue before the Commission is to find the percentage response in total purchased highway transportation cost from a given percentage change in volume. Mr. Nelson's equations do not provide that. Instead, he attempts to estimate the volume variability of the "cost per run" but does not explain how changes in cost per run translate into changes in total cost.[20]

Mr. Nelson also claims that his various models capture only changes in truck size, but as I demonstrate below, they also include the effect of changes in runs. He asserts, but provides no analytical justification for why the cost per run would not depend upon the number of runs. If it does (and subsequent empirical evidence shows that it does) then his assertion that his regressions capture only the effect of truck size is false. As a result, his artificial partitioning of the data does not provide the control that he asserts it does.

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[20] At one point Mr. Nelson appears to be attempting to justify his general approach (although not the functional form) on the basis that the Postal Service does not minimize purchased transportation costs without reference to overall costs. This comment simply confuses unconstrained optimization with constrained optimization. As witness Young explained in Docket No. R97-1, the Postal Service attempts to minimize its transportation cost subject to the constraints of service standards and operational mail processing schedules. See, Rebuttal Testimony of James D. Young on Behalf of the United States Postal Service, Docket No. R97-1, USPS-RT-3 at 8.

Although he fails to incorporate economic theory into his specification, Mr. Nelson could still have provided a mathematical or operational basis for the functional form he chose. Again, unfortunately, he did not.

For example, a widely used approach when the true functional form is unknown is the transcendental logarithmic function (the "translog"). The translog is a "flexible" functional form that provides a good approximation to the unknown true functional form. This is one of its major advantages. It permits estimation of parameters like cost elasticity (volume variability) without first requiring knowledge of the underlying functional form. Mr. Nelson rejects the flexible functional form and specifies an exact function to be estimated. This specification choice compounds the error of omitting economic theory or a mathematical basis. Mr. Nelson is specifying an exact functional form with no analytical basis for that form.

The function that Mr. Nelson specifies has the following form (omitting the region specific dummies):

$$\frac{Cost}{Frequency} = \lambda \left(\frac{Cube * Route\ Length}{Frequency} \right)^{\eta} (Route\ Length)^{\delta}$$

Mr. Nelson provides no reason why this functional form is correct or even applicable. In fact, it is not the functional form that would be derived if one were attempting to estimate an equation for cost per run in the "log/log" world. To derive the correct functional form for that exercise, one starts with the "log/log" total cost function:[21]

$$Cost = \alpha\,(Cubic\ Foot\ Miles)^{\beta} = \alpha\,(Cube * Frequency * Route\ Miles)^{\beta}$$

One then divides both sides by "Frequency" (number of runs) to obtain the associated function for "cost per run":

$$\frac{Cost}{Frequency} = \frac{\alpha\,(Cube * Frequency * Route\ Length)^{\beta}}{Frequency} = \alpha\,(Frequency)^{\beta-1}\,(Cube * Route\ Length)^{\beta}$$

Taking logarithms of both sides of the equation puts the equation in "log/log" format. The equation then becomes:

$$ln\left[\frac{Cost}{Frequency}\right] = ln\,\alpha + (\beta - 1) * (Frequency) + \beta\,(Cube * Route\ Length)$$

This specification suggests that if the variability of cost with respect to cubic foot-miles is less than one hundred percent, then "Frequency" (or the number of runs) should have a negative coefficient. Said otherwise, a variability less then one hundred percent implies that the cost per run declines as the number of runs

[21] This derivation is not intended to suggest that the log/log approach is the correct one. Statistical tests conclusively demonstrate that this is not the appropriate functional form. Instead, the derivation is designed to demonstrate that even within the class of mis-specified models, Mr. Nelson did not derive the correct functional form for his regression equation.

increases. It also means that the overall variability can be extracted from a "per run" regression by adding one to the estimated coefficient on frequency (number of runs).[22] While I am not endorsing this approach or this functional form, I do think that if one is going to pursue the "cost-per-run" approach, then the appropriate equation should be estimated.

Finally, it is also important to note the witness Nelson does not provide a statistical basis for the functional form he proposes. One could start with a general flexible form like the translog and then test various restrictions on that general form. For example, the double log specification is nested within the translog and could be justified if the data fail to reject the restriction that the coefficients on the higher order terms are equal to zero. Unfortunately, Mr. Nelson undertakes no such tests but the empirical evidence he does present from Model 1 suggests that the restriction would be rejected. Thus, there is no empirical basis for Mr. Nelson's functional form.

One thus comes to the conclusion that there is no economic, operational, or statistical basis for the functional form that Mr. Nelson estimates. Perhaps it should not be surprising, as a result, that it performs so poorly.

3. Deficiencies in econometric procedures

Mr. Nelson's econometric procedures are plagued with many deficiencies. They include both errors of commission and errors of omission. In this section, I

[22] An alternative estimate could be obtained by simply taking the coefficient on the "cube times route length variable." However since the focus of this equation is on cost per run, it seems appropriate to use the coefficient on number of runs.

review several of these deficiencies. Any one of these deficiencies is sufficient to disqualify Mr. Nelson's regression analysis; taken together, they help explain the internally inconsistent and operationally illogical results that Mr. Nelson obtains.

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3.a. Mr. Nelson failed to consider, let alone control for, heteroscedasticity.

It is a common characteristic of cross-sectional regressions that they are subject to heteroscedasticity, non-constant error variances. The HCSS data are known to suffer from heteroscedasticity which has important implications for hypotheses testing. As I explained in my Docket No. R97-1 testimony:[23]

> Heteroscedasticity is the condition of non-constant variance in the residuals. Ordinary Least Squares (OLS) estimates will be unbiased and consistent in the presence of heteroscedasticity, but they will be inefficient.
>
> In practical terms, this means that the OLS point estimates or estimated coefficients are not influenced by heteroscedasticity, but their estimated standard errors are. It can be shown that, under heteroscedasticity, the standard errors estimated by OLS will be biased downward. This means that inferences using those standard errors may be invalid. In particular, understated standard errors imply overstated t-statistics. Thus, heteroscedasticity may cause the analyst to attribute causality to variables where it is not justified. The equation may include variables that are not statistically significant.

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23 See, Direct Testimony of Michael D. Bradley on Behalf of the United States Postal Service, Docket No. R97-1, USPS-T-13 at 41.

It is standard econometric practice to test for and correct for heteroscedasticity in cross sectional regressions.[24] However, Mr. Nelson admits that he did not test for heteroscedasticity [25]and he made no adjustment to the regression analysis for its presence.[26] This means that all of his statistical tests are suspect. For example, when Mr. Nelson claims that the coefficient on cubic foot-miles is positive and significant in a particular regression, the Commission cannot accept that inference as valid. Because Mr. Nelson does not correct for heteroscedastictity, his standard errors are understated and t-tests are biased upward. That means he could be appearing to reject the null hypothesis of no significance even though it is true. Failure to correct for heteroscedasticity is a serious deficiency that, by itself, seriously undermines Mr. Nelson's econometric work.

3.b. Application of an arbitrary and unknown data scrub.

In preparing his data for regression analysis, Mr. Nelson applies an arbitrary and unjustified data scrub. The first part of the scrub is reasonable -- it eliminates any observations for which the vehicle capacity is zero and it is not a power only contract. More problematic are his cost scrubs, for which he has a

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[24] See, William Greene, Econometric Analysis, Macmillan, New York, 1993, at Chapter 14, "Heteroscedasticity" or Jan Kmenta, Elements of Econometrics, Macmillan, New York, 1971 at Section 8.1, "Heteroskedasticity."

[25] See, Response of MPA Witness Nelson to USPS/MPA-T3-21.

[26] See, Response of MPA Witness Nelson to USPS/MPA-T3-25.

high and low cutoff. These are mechanical scrubs eliminating any observations for which the cost per run is either greater than "50 + 3 x run length" or less than "0.3 x run length."[27] Mr. Nelson gives no justification for these cutoffs except that in his view they "reflect a priori bounds on plausible unit pricing levels."[28] Mr. Nelson does not explain why 50 is the correct cutoff rather than 40 or 75. In addition, he does not explain why 3 is the correct number to multiply by route length. Why not 2.5 or 3.5? Why is a multiplicative relationship on run length (presumably average route length) appropriate for this cutoff?

Mr. Nelson was forced to admit that he did not inspect the data before establishing these cutoffs so he does not know whether or not these cutoffs identify unusual observations that are different from the rest of the data.[29] Thus, he cannot be sure that his cutoffs eliminated the truly unusual observations from the data. For example, in his intra-BMC data set, Mr. Nelson included an observation that had a route length of one mile, annual miles of 27,393 miles, a cost of $342,422 and a cost per mile of $12.50.[30] As it turns out, this contract is a "trailer rental contract" and the "cost per mile" is actually the daily unit rate for each trailer.[31] This is clearly an atypical non-transportation contract that should be eliminated from the data set. Mr. Nelson's scrubs did not eliminate it.

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27 See, Workpaper WP-4 of Michael A. Nelson to Accompany MPA-T-3 at 1.

28 See, Workpaper WP-4 of Michael A. Nelson to Accompany MPA-T-3 at 1.

29 See, Response of MPA Witness Nelson to USPS/MPA-T3-20.

30 See, Response of MPA Witness Nelson to USPS/MPA-T3-48.

31 See, USPS-LR-I-86 at 29.

This omission is not of purely academic interest as this single unusual observation has a dramatic impact on Mr. Nelson's regression results. With the observation included Mr. Nelson estimates an intra-BMC variability of 56 percent. When this single observation is removed and nothing else changes, the estimated variability falls in half to 28 percent. This result demonstrates the fragility of Mr. Nelson econometric results.

In addition, Mr. Nelson did not identify the observations he omitted and never reviewed them after applying his scrubs. In fact, he did not even generate a list of the scrubs and could not provide an enumeration of the number of observations eliminated.[32] Finally, he never investigated the impact of his omissions on the regressions. That is, he never estimated the regressions with all data points to provide a basis for comparison.[33]

In sum, Mr. Nelson's scrubs are mechanical, arbitrary, unjustified, and ineffective. They cast further doubt on the reliability of his results.

3.c. *Mr. Nelson did no testing for higher order terms and imposed an arbitrary and inappropriate exclusion of those terms.*

Because of his inability to fit an acceptable model (perhaps due to model mis-specification and econometric deficiencies) Mr. Nelson was forced into arbitrary truncation of the translog model. As discussed above, his argument that he was not able to evaluate the mean centered translog holds no water because

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32 See, Response of MPA Witness Nelson to USPS/MPA-T3-23.

33 See, Response of MPA Witness Nelson to USPS/MPA-T3-23c.

evaluation comes after estimation. Moreover, even without mean centering, the coefficient of cost with respect to cubic foot-miles would still have been negative in Mr. Nelson's equation.

For whatever reasons, Mr. Nelson arbitrarily excludes all higher order terms and estimates a log/log model. He did not test this specification and admits that he did not undertake any tests of the significance of higher order terms.[34] This exclusion is not justified unless one has a theoretical model the produces this specific functional form. Mr. Nelson does not. The arbitrary exclusion is particularly egregious in this case because higher order terms were shown to be significant in Dockets No. R87-1 and R97-1. In addition, higher order terms were significant in my testimony in this docket. Finally, in Mr. Nelson's own preliminary regressions the higher order terms were statistically significant.

This evidence makes clear that arbitrary elimination of statistically significant higher order terms caused Mr. Nelson to mis-specify his models. The estimated coefficients from witness Nelson's model are thus subject to bias and are unreliable.

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[34] See, Response of MPA Witness Nelson to USPS/MPA-T3-26.

4. Mr. Nelson's computer programs contain numerous programming errors.

Mr. Nelson's regression analysis is marred by numerous computer-programming errors. I'm not sure that I detected them all and, by his own admission, several remain unexplained.[35]

I was able to identify several specific programming errors and they are presented in this section. First, following the established procedure, Mr. Nelson attempts to estimate separate equations for straight truck (van) and tractor-trailer (trailer) transportation. This requires segregation of observations by cubic capacity of the trucks used on the contract cost segments. Trucks with a cubic capacity greater than or equal to 1,650 cubic feet are considered tractor-trailers. Mr. Nelson attempts to go farther in this segregation by cubic capacity by eliminating, from both the van and trailer data subsets, those trucks with the largest possible cubic capacity. This is done by identifying those trucks that have a capacity within 300 cubic feet of the maximum listed capacity and excluding their observations from the data set.[36]

Unfortunately, neither of these segregations was correctly carried out in the computer code. Because of programming errors, for example, Mr. Nelson has straight body trucks in his tractor-trailer regressions. To observe this error,

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[35] See, for example USPS/MPA-T3-27, ("The data set 'Work.Plant2 may be incomplete") or USPS/MPA-T3-28 for unexplained programming errors.

[36] No reason or justification is provided for this 300 cubic foot cutoff. Witness Nelson does not explain why 300 is appropriate or why he did not simply eliminate those trucks with the largest listed cubic capacity.

consider the intra-PDC tractor-trailer regression. That regression is based upon 709 observations,[37] which should represent the number of tractor-trailer contract cost segments in the account, excluding those in the largest truck category. As it turns out there are only 666 such observations. How then does witness Nelson end up having 709 observations? By including 76 van contract cost segments in the tractor-trailer regressions. Twenty examples of such erroneous observations are included in the following table. The complete set is presented in Workpaper RWP-1.

Table 3
Examples of Van Contract Cost Segments Erroneously Included in Nelson's Intra-PDC Tractor Trailer Regression

Observation	HCRID	Truck Capacity
1	48734	800.0
2	25562	825.0
3	26339	825.0
4	28340	825.0
5	39431	850.0
6	47934	850.0
7	47938	850.0
8	48688	850.0
9	71241	850.0
10	50053	872.5
11	56032	872.5
12	24032	900.0
13	25531	900.0
14	27930	900.0
15	38371	900.0
16	39435	900.0
17	43431	900.0
18	47433	900.0
19	62536	900.0
20	95274	900.0

Source: Workpaper RWP-1.

[37] See, Workpaper WP-3 of Michael A. Nelson to Accompany MPA-T-3 at 54.

A check of the arithmetic presented above suggests that another problem exists. If one takes Mr. Nelson's 709 observations and subtracts the 76 van contract cost segments mistakenly included in the data set, one obtains 633 observations, not the 666 available observations. This second discrepancy arises because witness Nelson also erroneously excluded contract cost segments whose trucks were <u>not</u> in the largest group (by his own definition). As it turns out, Mr. Nelson excluded 33 observations for tractor-trailer contract cost segments that have a cubic capacity less than 3001 cubic feet (his tractor trailer cutoff). The difference between the 76 van observations erroneously included and the 33 tractor-trailer observations erroneously excluded is the 43 observation difference between 709 and 666.

Examples of the types of observations erroneously excluded from the regressions are presented in the following table. It is clear that contract cost segments with truck capacities well below the maximum were erroneously excluded from the regression.

Table 4 Examples of Non-Maximum Capacity Tractor Trailer Contract Cost Segments Erroneously Excluded from Witness Nelson's Intra-PDC Tractor Trailer Regression		
Observation	HCRID	Truck Capacity
1	00630	1800
2	00683	1850
3	86012	2025
4	90230	2025
5	90234	2025
6	90235	2025
7	90240	2025
8	91733	2025
9	78035	2070
10	33549	2122
11	72010	2150
12	72762	2150
13	90233	2175
14	91739	2175
15	91741	2175
16	91763	2175
17	92030	2175
18	92041	2175
19	92635	2175
20	94530	2175

Source: Workpaper RWP-1

I also discovered three other programming errors in witness Nelson's programs. First, in some instances Mr. Nelson miscalculates cubic foot-miles. Whenever there is a contract cost segment that has multiple truck sizes, Mr. Nelson's computer program overstates the number of runs on that contract cost segment by the number of different truck sizes. For example, suppose that a contract cost segment has a 2400 cube trailer with a frequency of 305 runs per year and a 2700 cube trailer with a frequency of 270 runs per year. The total number of runs for this contract cost segment is 575 per year. In calculating cubic foot-miles for this contract cost segment, witness Nelson's computer code assumed that there were 1,150 runs. He thus overstated cubic foot-miles for those observations. In similar fashion, for this type of observation he understated cost per run because his program divides by the wrong (too large) number of runs. Finally, misstating the number of runs also causes the weights he uses in his regressions to be in error as he uses excessive weights for multiple truck size contract cost segments.

These mistakes can have a material effect on witness Nelson's results. Simply correcting these programming errors and making no other changes has the following material effect on witness Nelson's results for the intra-PDC account:[38]

Table 5
Effects on the Intra-PDC Regressions of Correction Programming Errors In Witness Nelson's Programs

	Corrected Results		Nelson Erroneous Results	
	Estimated Variability	Number of Obs.	Estimated Variability	Number of Obs.
City	0.2601	388	0.1356	388
Van	0.2266	5,201	0.2250	5,115
Tractor Trailer	-0.1686	666	0.8750	709

Source: Workpaper RWP-1.

[38] Because of the possibility of remaining computer-programming errors, I cannot assure the Commission that the corrected results have removed all errors. I thus would strongly caution the Commission from relying upon them in any way.

5. Correcting Mr. Nelson's mistakes shows that the cost-per-run analysis actually corroborates the results from the established model.

I am not endorsing the "cost per run" or the "double log" approach proffered by Mr. Nelson. As I demonstrated above this approach has fundamental flaws and does not meet the basic standards for econometric work set by the Commission. The Commission most definitely should not adopt the results of this approach. However, I must admit to being curious about what sort of results one would get if one followed Mr. Nelson's cost-per-run approach, but corrected his substantial errors.

To satisfy that curiosity, I corrected his programming errors, derived the analytically correct functional form, and excluded truly unusual observations. I then re-estimated the cost per run equations with Mr. Nelson's deficiencies removed. Note, to ensure consistency with Mr. Nelson's approach, I did not use power only contracts and did not remove Mr. Nelson's filters.[39] I also maintained (and corrected) Mr. Nelson's segregation by truck capacity. That is, these regressions are estimated only on those data that according to Mr. Nelson allow for changes in capacity, not frequency.

Recall that the model to be estimated was derived above as:

$$ln\left[\frac{Cost}{Frequency}\right] = ln\,\alpha \; + (\beta - 1) * \left(Frequency\right) + \beta\left(Cube * Route\ Length\right)$$

Results of the estimation are given in Table 6 below:

39 These defects alone disqualify these results from consideration.

Table 6
Empirical Results of a Per Runs Equation Correcting
Mr. Nelson's Programming Errors

		Estimated Coefficient for # of Runs	Implied Variability	USPS-T-18 R2000-1
Intra-PDC	City	-0.2634	0.7366	0.661
	Van	-0.2535	0.7465	0.646
	Tractor Trailer	-0.1051	0.8949	0.868
Intra-CSD	City	-0.2250	0.7750	0.734
	Van	-0.3514	0.6486	0.508
	Tractor Trailer	-0.0699	0.9301	1.096
Inter-PDC	Van	-0.3065	0.6935	0.645
	Tractor Trailer	-0.0254	0.9746	0.963
Inter-Cluster	Van	-0.2105	0.7895	0.685
	Tractor Trailer	-0.0546	0.9454	0.962
Inter-Area	Van	-0.2226	0.7774	0.671
	Tractor Trailer	-0.0535	0.9466	0.944
Intra-BMC	Tractor Trailer	-0.0176	0.9824	0.983
Inter-BMC	Tractor Trailer	-0.0023	0.9977	0.979
Plant Load	Tractor Trailer	-0.0554	0.9447	0.898
Avg. For Van			0.662	0.631
Avg. For Tractor Trailer			0.952	0.962

Sources: Workpaper RWP-2 and Direct Testimony of Michael D. Bradley on Behalf of the United States Postal Service, Docket No. R2000-1, USPS-T-18.

Note that in all instances, the estimated coefficient on the number of runs is negative as predicted by economic theory. Also note the consistency across transportation types. These results are not as accurate or reliable as the established model and should not be used, but they do generally corroborate those results. They thus demonstrate that fundamental results of the established approach, higher variabilities for tractor trailer transportation and van variabilities well below one hold despite the distortions placed on the data by the "per run" specification and the "log/log" model.

As explained above, the cost-per-run model actually provides two ways to estimate the variability of cost with respect to cubic foot-miles. In addition to examining the coefficient on the number of runs, one can examine the coefficients on the other variable, (cube times route length). Examination of these estimated coefficients shows that they suggest substantially lower variabilities than the coefficients on runs. (They are still well above Mr. Nelson's recommended variabilities and continue to reflect the fundamental pattern of results). This difference in results reflects the weaknesses of this econometric approach.

One way to reconcile the two different sets of estimates is to estimate a restricted model in which the coefficient on runs is set equal to the coefficient on cube times route length minus one. In other words, the model is estimated under the restriction that both variables yield the same estimated variability. In technical terms, this means that the model is restricted to allow only one value for β in the equation listed above.

Those results are presented below. In estimating the restricted model, one can test whether or not the data reject the restriction. In all cases, the restriction was rejected, indicating that the "cost per run - log/log" specification is inappropriate. That is yet one more reason why these results must be viewed with great caution and should not be adopted by the Commission. Note, however, that all of these estimated variabilities are far from what witness Nelson has presented.

Table 7 Econometric Results from the Restricted Model			
		USPS-T-18 R2000-1	Restricted Variability
Intra-PDC	City	0.661	0.5297
	Van	0.646	0.5016
	Tractor Trailer	0.868	0.7652
Intra-CSD	City	0.734	0.5284
	Van	0.508	0.4088
	Tractor Trailer	1.096	0.7686
Inter-PDC	Van	0.645	0.4951
	Tractor Trailer	0.963	0.8713
Inter-Cluster	Van	0.685	0.5338
	Tractor Trailer	0.962	0.8704
Inter-Area	Van	0.671	0.5323
	Tractor Trailer	0.944	0.8464
Intra-BMC	Tractor Trailer	0.983	0.8768
Inter-BMC	Tractor Trailer	0.979	0.9620
Plant Load	Tractor Trailer	0.898	0.9183
Avg. Van		0.631	0.4943
Avg. Trailer		0.962	0.8599

Sources: Workpaper RWP-3 and Direct Testimony of Michael D. Bradley on Behalf of the United States Postal Service, Docket No. R2000-1, USPS-T-18.

6. Overall Assessment

Given the foregoing investigation we can now assess Mr. Nelson's regression analysis relative to the standards of evaluation put forth in section 1. For convenience, I repeat each of the standards, followed by the relevant assessment.

1. Is the specified model based upon or consistent with economic theory?

No, as explained above the model is not a cost function or any other recognizable economic relationship. Mr. Nelson provides no theoretical justifications for his choice of variables or functional forms.

2. Are the results consistent with a reasonable operational interpretation of Postal Service activities?

No, the results seem at odds with all previous interpretations of Postal Service activities. For example, high variabilities are consistent with long haul, tractor-trailer transportation like inter-BMC in which there are relatively few options for dealing with capacity changes. Mr. Nelson finds low variabilities for this type of transportation.

3. Does the model have a sound mathematical basis?

No, as demonstrated above the model is not correctly derived even in the restrictive "log/log" framework the Mr. Nelson chose. Mr. Nelson provides neither a mathematical nor a statistical basis for his model.

4. Does the econometric analysis apply well established, if not state of the art, econometric practice?

No, there are many violations of established econometric practice like failing to control for heteroscedasticity and failure to test for the presence of higher order terms.

5. Are the computer programs without error? Do they produce what the analyst thinks that they do?

No, the computer programs contain many programming errors, some unexplained. The identifiable errors include things like miscalculating cubic foot-miles and including van contracts in tractor-trailer regressions.

6. Are the empirical results robust and consistent?

No, the results are wildly inconsistent and can change significantly by the *elimination of a single observation. For example, Table 2 above shows the Mr.* Nelson estimates tractor-trailer variabilities ranging from 16 percent to over 500 percent.

II. MPA WITNESS NELSON'S CONJECTURES ABOUT THE "PREMIUM" FOR RENEWAL CONTRACTS ARE SPECULATIVE, UNSUPPORTED BY EVIDENCE, AND UNUSABLE BY THE COMMISSION.

MPA witness Nelson proffers a speculative conjecture about the role of contract renewals. Despite his familiarity with of the Postal contracting system and the absence of empirical support for this speculation, Mr. Nelson suggests a costing change of over $100 million.[40] His entire analysis of this issue amounts to 3 paragraphs of conjecture about what the Postal service "may pay" [41] or "should be paying."[42]

His story is simple but unsupported: Contracts that have been renewed at some point in their history have a higher average cost per cubic foot -mile than contracts that have not been ever renewed. Consequently, he asserts, the Postal Service must be overpaying for contracts that were renewed because of incompetence in its contracting procedure.

Mr. Nelson then goes further and asserts that he can calculate how much the Postal Service is overpaying due to this alleged incompetence. His answer? The entire cost per cubic foot-mile difference between renewed and non-renewed contracts.

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40 Mr. Nelson provides no basis for his conjectures about the Postal Service contracting system. MPA did not ask any interrogatories on this subject and Mr. Nelson's testimony provides no citations to Postal Service documents to support his claims.

41 See Direct Testimony of Michael A. Nelson on Behalf of MPA, et al., at 12, line 24.

42 Id. Direct Testimony of Michael A. Nelson on Behalf of MPA, et al., at 13, lines 10-12.

According to Mr. Nelson, the Commission should not use the actual cost that the Postal Service pays for purchased highway transportation when determining the attributable cost of purchased highway transportation. Instead, Mr. Nelson would have the Commission use a synthetic cost that he calculates under the assumption that each renewal contract should have been contracted at the average cost per cubic foot-mile from all non-renewal contracts.[43]

Mr. Nelson is apparently unconcerned about the likely possibility that at least some, if not all, of the difference in the average cost per cubic foot-mile between renewal contracts and non-renewal contracts is due to factors other then the fact that contracts in the former group had been renewed at some point in their history. For example, the composition of the contracts in the former group may be different than the composition in the latter group. One crude approach at examining this issue is to look at the distribution of contracts across the renewal and non-renewal contract categories. Mr. Nelson is recommending the substitution of non-renewal contract costs for renewal cost costs. It would be informative to see how much of a substitution this implies. Table 8 provides the proportion of regular contracts that are renewals in each of the purchased highway transportation accounts. That table shows that a very high percentage of regular contracts are renewal contracts. This means that Mr. Nelson's proposed adjustment takes the cost from a small percentage of contracts and

43 Mr. Nelson undertakes this calculation for the each of the old account groups (inter and intra SCF and BMC) and for 3 mileage blocks within each account.

then applies it to a large percentage of contracts -- an outcome that increases the importance of ensuring the accuracy of the proposed adjustment.

Table 8
Proportions of Renewal Contracts By Accounts

Account Number	Account Name	% Renewal Contracts
53601	Intra-PDC	87.1%
53605	Intra-CSD	75.2%
53609	Inter-PDC	75.2%
53614	Inter-Cluster	85.1%
53618	Inter-Area	75.1%
53127	Intra-BMC	98.1%
53131	Inter-BMC	99.4%
53135	Plant Load	47.8%

Source: HCSS data.

Mr. Nelson's testimony does not contemplate the possibility that the contracts in the renewal group may well have had a higher cost per cubic foot-mile, even if they had not been renewed, simply because of different contract specifications or conditions. If one was speculating about this cost per cubic foot-mile difference, one could come up with a variety of reason why the cost per cubic foot-mile for renewed contracts was higher. Suppose, for instance, that the Postal Service found that it could obtain <u>lower</u> costs per cubic foot-mile by the renewal process and that it applied this procedure to its most expensive (in terms of cost per cubic foot-mile) contracts. It would thus be <u>saving</u> cost by applying the renewal process to its most expensive contracts, yet an external observer would notice that the cost per cubic foot-mile was higher on the renewed contracts and could mistakenly assume that was the result of the renewal process. This is not to say that this speculation is accurate but rather to point out that, without investigation, many different and contradicting stories about the difference in cost per cubic foot-mile are plausible.

It is therefore essential that before the Commission undertake this $100 million cost change that it be presented with some analysis to help it evaluate Mr. Nelson's speculation. Because Mr. Nelson failed to present any analysis in his direct testimony, I will present some in my rebuttal testimony. For Mr. Nelson's conjecture to be accurate, two conditions must hold:

Condition 1: One must not be able to explain the difference between the cost per cubic foot-mile for renewed contracts and not renewed contracts on the basis of observed variables that describe the characteristics of the two sets of contracts. In other words, there must be a statistically significant difference between the costs per cubic foot-mile for the two groups once observed differences in the contracts are controlled for.

Condition 2. Any unexplained difference in the cost per cubic foot-mile must be due to the renewal process and not any other unobserved variables in the two sets of contracts. The existence of unexplained differences in the cost per cubic foot-mile does not establish that the cause of the difference is due to the renewal process. Additional evidence must be brought to bear to support this specific reason for the unexplained difference.

I take two different approaches to analyzing Condition 1, a regression approach and a matched pairs approach. Both of these approaches are designed to first control for differences in observed variables like cubic foot-miles or route length and then investigate whether there is a statistically significant difference in cost between the two groups of contracts.

In the regression approach, I re-estimated the seventeen translog equations that I used to estimate the purchased highway transportation variabilities in my direct testimony in this docket.[44] To investigate the role of renewals, I augment those equations by adding a categorical variable that takes on the value of 1 if the contract is a renewal contract and a value of zero if it is not. Recall that the econometric equations have cubic foot-miles and route-length as right hand side variables. The categorical variable thus measures whether there is a significant difference in the cost of renewal contracts and non renewal contracts for a given amount of cubic foot-miles and a given route length. Three relevant questions can be investigated with the regression method:

1. Is there a statistically significant difference in the cost for renewal and non-renewal contracts after differences in cubic foot-miles and route length are accounted for?

   This question is answered by evaluating the statistical significance of the estimated coefficient. If the coefficient is statistically significant then the answer is yes.

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44 See, Direct Testimony of Michael D. Bradley, USPS-T-18, Docket No. R2000-1 at 20-21.

2. Is the cost per cubic foot mile higher on renewal contracts?

   This question is answered by observing the sign on the estimated coefficient. If the estimated coefficient is positive then the answer is yes.

3. How much larger is the cost for a given cubic foot-miles on a renewal contract?

   This question is answered by observing the magnitude of the estimated coefficient. In a translog equation, the coefficient on the categorical variable is an estimate of the percentage difference between the cost of renewal and non-renewal contract of equal cubic foot-miles and route length.

The results of the regression analysis are presented in Table 9.[45]

45 The full set of results is presented in Workpaper RWP-4.

Table 9
Results of the Regression Approach To Investigating Renewals

Account	Type	Renewal Coefficient	Chi-Square	P-Value
Inter-Area	Vans	0.0599	1.0396	0.3079
Inter-Area	Tractor Trailer	0.0837	16.8444*	0.0000
Inter-BMC	Tractor Trailer	0.1800	7.6531*	0.0057
Inter-Cluster	Vans	0.1657	7.7495*	0.0054
Inter-Cluster	Tractor Trailer	0.1054	8.2741*	0.0040
Inter-PDC	Vans	0.0214	0.2230	0.6367
Inter-PDC	Tractor Trailer	0.0502	2.1217	0.1452
Intra-BMC	Tractor Trailer	0.1139	8.3304*	0.0039
Intra-CSD	Box Route	-0.0141	1.3066	0.2530
Intra-CSD	Intra-City	0.1145	1.2114	0.2711
Intra-CSD	Vans	0.1194	7.4149*	0.0065
Intra-CSD	Tractor Trailer	-0.5709	5.6208*	0.0177
Intra-PDC	Box Route	0.0435	6.7927*	0.0092
Intra-PDC	Intra-City	0.1233	5.529*	0.0187
Intra-PDC	Vans	0.0928	72.1439*	0.0000
Intra-PDC	Tractor Trailer	0.0208	0.4157	0.5191
Plant Load	Tractor Trailer	-0.0915	3.1085	0.0779

* -- the asterisk indicates a statistically significant difference.
Source: Workpaper RWP-4

The table presents several sets of interesting results. In just over half of the cases (10 of 17) is there a significant coefficient indicating a difference in cost between renewal and non-renewal contracts once variation in cubic foot-miles and route length are taken into account.[46] In one of those ten cases, the cost for

[46] Traditional t-tests of significance are not appropriate here because of the presence of heteroskedasticity. I thus used the Chi-Square test based upon the heteroskedasticty-corrected variance covariance matrix. The Chi-Square test works like a t-test. The calculated chi-square statistic can be compared to a critical value to test the null hypothesis at a particular level of signficance. In

renewal contracts was significantly below, not above the cost for non-renewal contracts. Consequently, the answer to the first question (is there a significant difference in cost between renewal and non-renewal contracts) is a qualified "maybe." There is mixed evidence in favor of the hypothesis that such a difference exists. In many instances the observed differences in cost per cubic foot-mile between renewal and non-renewal contracts are due to differences in cubic foot-miles or route length, not differences in the contracting procedure. Certainly there is not sufficient evidence to justify a wholesale substitution of non-renewal costs per cubic foot mile for the actual renewal costs per cubic foot-mile on the allegation of inefficient procurement.

The results do tend to the support the assertion that where a statistically significant difference in cost between the two groups of contracts exists, it is the renewal contracts that tend to be more expensive. In 8 of the 9 cases in which there was a significant coefficient, the sign of that coefficient was positive. This brings us to the third question, how much larger is the cost for a given cubic foot-miles on a renewal contract? The answer to this question is difficult to obtain because there is so little evidence that cost per cubic foot-mile is significantly greater for renewal contracts. One way to get an angle on the answer would be to restrict the question. Suppose the question was narrowed to the following: among those accounts that had a significant difference in cost, what was the average amount of that difference? Because each of the estimated coefficients is a measurement of the percentage difference due to renewal, one could

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Table 9, a large chi-square value implies a low probability value and rejection of the null hypothesis of a zero coefficient (no difference).

average those coefficients that are statistically significant to get a measure of the effect of the renewal status.[47] Averaging the statistically significant coefficients yields an average cost difference of 3.3 percent higher for the renewal contract group. [48]

The second approach to investigating the source of difference between renewal and non-renewal contracts is the matched pairs approach. In this analysis, pairs of observations, one from the renewal contract group, and one from the non-renewal contract group are identified. These matched pairs can then be investigated to see if there is significantly higher cost per cubic foot-mile for renewal contracts. The idea is to identify contracts that are similar for all observed variables (account category, vehicle size, annual miles, number of trips and number of trucks) and to test for differences in their cost per cubic foot mile.[49]

In order to identify matched pairs, all highway contracts within each contract type (Inter-BMC, Intra-BMC, Inter-SCF, Intra-SCF, and Plant Load) were separated into two groups: renewal and non-renewal. Next, each non-renewal

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47 Note that this exercise does not demonstrate that the renewal procedure causes the cost to be higher on renewal contracts. It only indicates that in those instances in which the coefficient is significant, any difference in cost is not caused by variations in cubic foot-miles or route length.

48 Alternative methods of calculating this average include cost weighting the coefficients or setting the insignificant coefficients equal to zero ("accepting" the null hypothesis) and recalculating the average. This latter approach yields a difference of 2.2 percent.

49 Mr. Nelson chose do make his comparison at the level of the old account groupings (intra and inter SCF, inter and intra BMC). For purposes of comparison, a similar grouping is used in the matched pairs analysis.

contract was compared to every renewal contracts across the following variables: account, route type, area, contract type, vehicle group, number of trucks, annual miles, vehicle size, and route length. In each instance where a non-renewal contract matched a renewal contract across all of the variables listed above, the two contracts were identified as a matched pair.

For the last three variables mentioned above (annual miles, vehicle size, and route length) it was highly unlikely that any two observations would match exactly due to the fact that these variables have decimal values. Therefore, a threshold parameter was used to determine how close the values of these variables must be in order to consider them a matched pair. Ideally, this threshold parameter would be set relatively low in order to ensure that the identified matched pairs have similar values across all variables. For example, in the case of inter-SCF the threshold was set at 1 percent, which resulted in 265 matched pairs. In the other contract categories, small values of the threshold parameter resulted in no or few matched pairs. In these instances, the threshold was gradually increased up to 20 percent. At this level, 39 matched pairs were identified for Inter-SCF, 11 for Plant Load, and none for Intra-BMC and Inter-BMC. Beyond 20 percent, the differences in variable values become large enough that their inclusion as matched pairs is questionable.[50]

I pursued two matched pairs methods for testing the hypothesis that renewal contracts have higher cost per cubic foot mile than non-renewal

[50] Even if these three variables (annual miles, vehicle size, and route length) were not were not required to be matched, there would still be no Inter-BMC matched pairs and only 6 Intra-BMC matched pairs.

contracts. The first makes use of the t-distribution and the second makes use of the binomial distribution. The first method uses a tradition t-test of the difference in cost per cubic foot-miles between the two types of contracts. Define μ as the difference between the cost per cubic foot-mile on renewal contracts and non-renewal contracts:

$$\mu = \frac{Cost}{CFM}_R - \frac{Cost}{CFM}_{NR}$$

The null hypothesis is that the cost per cubic foot mile is the same for both types of contracts with the alternative hypothesis that cost per cubic foot-mile is more expensive for renewals:

$$H_0: \ \mu = 0; \ \ H_a: \ \mu > 0$$

One then calculates the mean difference and standard error of the mean difference and then uses that information to calculate a t-statistic. The calculated t-statistic is compared it with a critical value based upon a t-distribution with n-1 degrees of freedom, where n is the number of matched pairs.

The results of the tests using the t-distribution are included in Table 10.

Table 10
Matched Pairs Results (t-test Method)

Contract Type	Mean Difference In Cost/CFM	Std. Dev. Of The Mean Difference	t Statistic	P-Value
Inter-BMC	N/A	N/A	N/A	N/A
Intra-BMC	N/A	N/A	N/A	N/A
Inter-SCF	0.000776	0.003372	1.4183	8.21%
Intra-SCF	0.001533	0.018549	1.3425	9.03%
Plant Load	0.003300	0.013573	0.7687	22.99%

Source: Workpaper RWP-5

Table 10 shows that there are no instances in which the cost per cubic foot-mile is significantly greater for the renewal contracts. For the inter-BMC and intra-BMC categories, the renewal and non-renewal categories are so different that insufficient matched pairs exist for the test. This is evidence in itself that there are major differences in the characteristics of contracts in the two groups and that one cannot reliably ascribe that difference to the contract renewal process. For the remaining three accounts where sufficient matched pairs exist, the null hypothesis of no difference in cost per cubic foot-mile cannot be rejected.

The second method, called the sign test is, is a test of how often observed difference can be said to have a positive or negative sign. Essentially, this approach counts the number of positive differences and relates that to the probability of getting a positive difference under the binomial distribution. If there is no true difference, then the probability of finding that the renewal cost per CFM is greater than the non-renewal cost per CFM equals one half. The null hypothesis that $\mu = 0$ thus follows a binomial distribution B(n, ½) where n is the number of matched pairs in which some difference is observed.

To implement this test one counts the number of pairs in which some difference is observed (this may be all the pairs for us) and then counts the number of positive differences, θ. One then determines the probability of observing θ differences for a B(n, ½) distribution and use this as the probability value for the null hypothesis.

The results of the sign tests using the binomial distribution are presented in Table 11.

Table 11
Matched Pairs Results (Sign Test)

Contract Type	Total Pairs w/Observed Difference in Cost/CFM	Pairs with Renewal Cost/CFM > Non-Renewal	Binomial Probability
Inter-BMC	N/A	N/A	N/A
Intra-BMC	N/A	N/A	N/A
Inter-SCF	39	31	0.00%
Intra-SCF	262	139	14.68%
Plant Load	11	8	3.27%

Source: RWP-5

To interpret these results one should consider what the two different tests reveal. The sign test reveals whether or not there is a prevalence of positive or negative differences, when differences occur. The results show that in two of the five categories there is evidence that cost per cubic foot-mile for renewal contracts tends to be higher than cost per cubic foot-mile for non-renewal contracts among the matched pairs. But the sign test does not indicate by how much larger the cost per cubic foot-mile is in these instances. The size of the difference is tested by the t-test. The t-test indicated that the differences in cost per cubic foot-mile are so small that in no instances were the costs significantly different.

The empirical evidence presented above thus shows mixed support, at best, for the condition that the differences in cost per cubic foot-mile on renewal contracts is determined by unobserved factors. In many cases, the differences are explained by observed variables and once those factors are accounted for, the remaining differences appear to be small. Nevertheless, I will consider the second condition required for Mr. Nelson's proposed cost reallocation. To apply his procedure it is not enough to identify some unexplained difference between renewal and non-renewal contracts but it is also essential to provide some positive evidence that this difference is due to the renewal process itself. Mr. Nelson provides none. In addition, the empirical evidence provided above conflicts with this condition.

If the unexplained cost difference were due to the renewal process, one would expect to observe it for all accounts and transportation types. After all, the cost difference is allegedly a function of the contracting procedure that covers all accounts. The results are just the opposite. Consider, for example, the account categories that make up the inter facility (non-BMC) segment of purchased highway transportation. There are three account categories in this group, inter-PD&C, inter-Cluster and inter-Area. Within each account category there are both van and tractor trailer transportation modes. If the renewal process was inefficient and was the cause of higher costs per cubic foot-mile, we would expect to see evidence of this cause across account categories and transportation types. Yet no such pattern exists. In the regression tests, there is no evidence of higher cost per cubic foot mile in the inter-PDC categories and the inter-Area account is split with van transportation showing no difference in cost per cubic foot mile and tractor trailer transportation showing an unexplained higher cost per cubic foot-mile for tractor trailer transportation. Given that both van transportation and tractor trailer transportation could be provide by the same contract within this account, this last result seems directly contradictory to the hypothesis that the cost difference is due to the renewal process.

In sum, there is mixed evidence that there are significant unexplained differences in cost per cubic foot-mile between renewal and non-renewal contracts and there is no evidence that this difference is due to the renewal process. Mr. Nelson's proposed adjustment is not justified by the evidence.

III. DR. NEELS' PROPOSAL FOR ALLOCATING EMPTY SPACE HAS A SERIOUS DRAWBACK AND FALLS SHORT OF ITS GOAL.

In this proceeding, the Commission has been presented with two methods for allocating empty space on trucks; one by the Postal Service and one by UPS witness Neels. In this section, I review and compare both of these methods, highlight their weaknesses and propose a compromise that I believe to be more accurate than either one. This compromise is consistent with the idea that empty space is jointly caused by volumes and transportation requirements throughout the Postal Service purchased highway transportation network. It is also consistent, in part, with the Commissions stated desire to disengage the TRACS calculation of utilized cubic foot-miles from the "expansion process."[51]

When TRACS was introduced in Docket No. R90-1, the Postal Service proposed a method of allocating unused or empty space to classes and subclasses that relied upon the identification of classes of mail utilizing space on trucks being tested. The method was considered and accepted by the Commission:[52]

> From time to time, proposals have been made that the costs thought to be associated with this [empty] space should be treated as institutional. The problem is particularly difficult because the capacity not holding mail can be expected to change, even on one trip. On the many contracts that involve more than one stop, mail is loaded and unloaded at various

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[51] See, PRC Op., R97-1, Vol1. at 217. There are two parts to the expansion process, the "filling" of partially full containers and the allocation of unused space on the truck to subclasses of mail. The former procedure is not at issue in this case and my analysis is limited to the latter issue.

[52] See, PRC Op., R90-1, Vol1. at III-161.

> facilities. Therefore, at some points the truck may more full than at others. See Tr. 5/1538.
>
> With TRACS, all unused capacity is accounted for and distributed to the mail on a sampled vehicle. The sampled mail is allocated its"fair share" of empty space by multiplying a ratio of the percent unloaded divided by the percent unloaded plus the percent remaining items that percent empty. The mail that is loaded on the truck further upstream is charged more.

However, in the most recent two cases this approach has been questioned. Although the Commission used the Postal Service method in Docket No. R97-1, it raised several some concerns about it:[53]

> If it was not apparent before, it is certainly apparent now from the rebuttal testimony of Postal Service witness Young that postal transportation is contracted and scheduled in response to a very complex set of requirements and constraints. Among the considerations are "the requirements of downstream mail processing and delivery facilities," "service commitments to customers," "how many containers of mail each downstream facility normally receives on the busiest day or night of the week," "what plants can handle which types and sizes of highway equipment," "downstream facilities operating plans," and meeting "the last scheduled dispatch, called the dispatch of value" to avoid delaying the mail. Tr. 35/18855-56. These scheduling considerations are in addition to matching truck capacities on individual legs of a route to the volume of mail being carried. Or, to put it somewhat differently, a schedule that meets witness Young's considerations is bound to include truck movements that are undertaken for reasons that go beyond just transporting the mail found on the truck at its destination.

[53] See PRC Op., R97-1, Vol. 1 at 216.

In addition, in this docket United Parcel Service witness Neels has raised concerns about the method and has proposed an alternative method. To understand how the two methods compare, I first lay out the analytical bases for each and then discuss each one.

A. The Postal Service Method

The Postal Service method makes use of information on the trips sampled to allocate empty space. Its working assumption is that the empty space on a given trip is the responsibility of the classes of mail on the trip. The final distribution key reflects this working assumption. Analytically, the final distribution key for a given class (δ_j) can be described as:

$$\delta_j^P = \frac{TCFM_j^P}{TCFM},$$

where TCFM stands for total cubic foot-miles including empty space and is defined for class j in the Postal Service method as:

$$TCFM_j^P = CFM_j + ECFM_j^P.$$

CFM_j is just the sampled cubic foot miles for class j and is the result of summing across all tests (T):[54]

$$CFM_j = \sum_{t=1}^{T} CFM_{jt} .$$

Similarly, the total cubic foot-miles across all classes is just the sum of the TCFM measures across all N classes:

$$TCFM = \sum_{j=1}^{N} TCFM_j^P$$

Finally, ECFM stands for empty cubic foot-miles and is defined in the Postal Service method as:

$$ECFM_j^P = \sum_{t=1}^{T} CFM_{jt} * \frac{\% \, Empty_t}{1 - \% \, Empty_t}$$

B. The UPS Method

United Parcel Service witness Neels criticizes the Postal Service method and proposes a different empty space adjustment. His main justification for recommending this different method is the assertion that empty space is jointly

[54] This measurement is not disputed and is the same in all methods. Thus, no superscript is required.

determined by all the legs of a route and his claim that the current Postal Service method does not take this into account:[55]

> I propose 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 need arising elsewhere in the system.

Unfortunately, Dr. Neels' proposed adjustment does not quite get at this issue and itself contains a serious drawback. This drawback arises because his proposed method is based upon a false premise. This premise is succinctly stated:[56]

> 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.

While this premise may seem plausible at first blush, upon reflection it becomes clear that it is misses an important part of causality. An accurate distribution of purchased highway transportation costs requires that empty space be assigned to those classes and subclasses that caused the empty space, not just those that caused capacity. Dr. Neels is implicitly assuming that the classes that "caused the capacity" are the same classes that caused the empty space. But this is not

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[55] See, Direct Testimony of Kevin Neels on Behalf of United Parcel Service, Docket No. R2000-1 at 13.

[56] See, Direct Testimony of Kevin Neels on Behalf of United Parcel Service, Docket No. R2000-1 at 18.

always the case and misses an essential characteristic of Postal Service transportation.

Trucks in the Postal transportation network must leave because of the service standards and mail processing schedules for the classes of mail being transported. If the transportation of those classes did not have to be expedited, then the Postal Service could simply let the truck wait at the dock until it is full. Thus, the observed empty space in the Postal Service transportation network is at least partly caused by the fact that the truck must leave before it is full, due to the service standards and mail processing schedules for classes and subclasses of mail on that truck. It is in this sense that the mail on the truck being observed bears some or all of the responsibility for the empty space observed on the truck. Dr. Neels' method ignores this characteristic disregards and thus disregards this important aspect of the causality of empty space.[57]

The most obvious case of this phenomenon is Express Mail. To make its service standard, Express Mail must often be transported on relatively empty trucks. Under Dr. Neels' approach, this characteristic of Express Mail would be ignored and it would bear a relatively small responsibility for empty space, as it is rarely on full trucks. Despite the fact that Express Mail truly caused the empty space because of its service requirements, the UPS method would relieve it of its obligation to pay for that empty space.

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[57] The Commission also indicated its belief that empty space is also caused by a network-wide "set of requirements and constraints." These include not only service commitments and mail processing schedules but things like "what plants can handle which types and sizes of equipment." See PRC Op., R97-1, Vol. 1 at 216-217.

Dr. Neels raises the legitimate issue that the current Postal Service method of expanding empty space may be biased because it does not account for the possibility that some of the responsibility for the empty space may not lie with the mail on the truck when it is observed. Dr. Neels' proposed solution for this problem, however, goes to the other extreme. It assumes that the mail observed on the truck bears no responsibility for the empty space on that truck. Dr. Neels' proposed method thus suffers from the same conceptual defect that he claims for the existing Postal Service method -- it misses an important part of empty space causality. The fact that mail on other legs may bear some responsibility for the amount of empty space on an observe leg does not justify Dr. Neels' assertion that "relatively more" weight should be given to those volumes rather than the volumes actually observed on the transportation movement. While it may be true that the capacity on a specific leg is jointly determined by all trips on a route, Dr. Neel's method does not determine which legs on a particular route are responsible for the capacity determination on that route. His method instead uses information on "high volume" legs on other contacts.

A real concern with this approach is that Dr. Neels, like the Postal Service, does not know the space used by volumes on the leg or legs that actually caused the capacity on any given contract cost segment. Unlike the current Postal Service method, that can at least accurately determine the actual space required for mail being transported on the observed leg, Dr. Neels uses a broad generalization. He uses an average of "high volume" legs to determine the volume mix that he hypothesizes to cause the capacity requirements on the observed leg. Thus, his method not only misses the responsibility of the mail observed on a leg causing empty space, but also misses measuring the mail actually responsible for determining capacity on that leg.[58]

Consequently, it is quite possible that Dr. Neels is assigning the responsibility for empty space on a particular leg to classes that have nothing to do with determining the capacity on that leg. Consider an example in which there are two contract cost segments, each with three legs. Suppose that the first contract cost segment has a relatively constant amount of volume per day and per leg and carries only Class A. Suppose that the second contract cost segment carries only Class B, and has a highly variable daily volume profile, and has one leg that tends to have the largest volume flows. Finally, suppose that TRACS does not sample this leg, so the TRACS test for the second contract cost segment shows a relatively high amount of empty space.

Under Dr. Neels method, the "more fully loaded trucks" would occur on the first contract as the relatively small variation in leg and daily volume would generate a relatively high average capacity utilization. This means that, under Dr. Neels' method, the empty space on the second contract cost segment would

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[58] Dr. Neels' method also suffers from the flaw of assuming that a "fuller" truck on a given day is "more likely" to have caused the capacity on an observed leg. This is pure speculation and Dr. Neels presents no evidence to support it. It is quite possible that the peak volume occurs on the observed leg on a different day of the week from which the test was taken and that the volume on the relatively full leg he refers to bears no responsibility for the capacity determination. Given that the capacity is determined by a complex set of criteria over a long period of time, it is difficult to accept that the fullest leg on a single TRACS test is "likely" to be the leg that caused the capacity on the observed leg.

be assigned to Class A even though Class A did not cause the capacity and was never transported on that contract cost segment.

Using the notation derived above, the UPS method can be describe analytically:

$$\delta_j^U = \frac{TCFM_j^U}{TCFM},$$

where TCFM stands for total cubic foot-miles and is defined for class j in the UPS method as:

$$TCFM_j^U = CFM_j + ECFM_j^U.$$

The empty space assigned top class j under the UPS method is found using a distribution key (θ_j) based upon the "more fully loaded truck" segments.[59] Analytically, this is expressed as:

$$ECFM_j^U = \sum_{t=1}^{T} \theta_j ECFM_t = \theta_j \sum_{t=1}^{T} ECFM_t = \theta_j ECFM$$

59 This calculation illustrates another drawback of Dr. Neels' approach. He assumes that a single segment cause the capacity on a truck and thus rule out the possibility that the capacity is jointly cause by several segments on a route. This is the very assumption (that capacity is caused on a single leg on a route) that the Postal Rate Commission criticized in discussing the Postal Service approach. Dr. Neels' method does not address this criticism.

The last expression shows that the empty space allocated to class j is just equal to the product of all empty space (ECFM) and class j's distribution key from the sample of "more fully loaded trucks."

C. A Compromise Method

Neither the Postal Service method on the UPS method completely addresses the issue of empty space. The Postal Service method focuses solely on the role of volume on the tested leg on causing the empty space and ignores the role played by volumes on other legs. The UPS method focuses solely on volume on "more fully loaded trucks" and ignores the volume on tested legs. These differences in approach are what cause the differences in the final distribution keys

As the Commission has indicated, empty space causality is complex and a careful tracing of the causality of empty space for each contract within the TRACS dataset is likely to be prohibitively expensive. More importantly, such information is not currently available.

To remedy the potentially extreme positions of the Postal Service and UPS positions, I recommend a compromise approach that makes use of the information on both the tested leg and more fully loaded trucks. The compromise approach has several advantages.

1. It allows for the joint determination of capacity and empty space across the entire purchased highway transportation network.

2. It generates distribution keys that moderate the effects of the two extreme assumptions embodied in the current Postal Service and UPS methods.

3. It provides results that are consistent with the actual volumes of mail found on trucks.

The compromise method starts with the UPS method but replaces the "more fully loaded trucks" distribution key with one based upon all of the segments, including the one on which the empty space occurs. In the compromise method:

$$\delta_j^C = \frac{TCFM_j^C}{TCFM},$$

where TCFM stands for total cubic foot-miles and is defined for class j in the compromise method as:

$$TCFM_j^C = CFM_j + ECFM_j^C.$$

The empty space assigned to class j under the compromise method is found using a distribution key based upon the all segments. Analytically, this is expressed as:

$$ECFM_j^C = \sum_{t=1}^{T} \tilde{\theta}_j ECFM_t = \tilde{\theta}_j ECFM$$

where:

$$\tilde{\theta}_j = \frac{\sum_{t=1}^{T} CFM_{jt}}{\sum_{j=1}^{N} \sum_{t=1}^{T} CFM_{jt}}$$

To see why this approach provides a compromise between the Postal Service and UPS positions, we can consider Dr. Neels' example.[60] Dr. Neels posits two trucks, each holding up to eight "units" of transportation capacity.[61] The system thus has a total of 16 units of transportation capacity. The "empty" truck has two units filled with class X and six empty units. The "full" truck has 6 units filled with class Y and 2 empty units. The issue is how to allocate the 8 empty units.

Under the Postal Service method, the volumes on each truck bear the responsibility for the empty space on the truck, so the volume on the empty truck, class X, receives 6 units of empty space and the volume on the full truck, class Y, receives 2 units of empty space. Class X receives a total of 8 units (50 percent of cost) and class Y receives a total of 8 units (50 percent of cost). Dr. Neels complains that this is unfair to class X as it did not cause the capacity to arise. Dr. Neels speculates that the fuller truck with six units caused the excess capacity of the trucks to arise.[62]

Consequently, Dr. Neels would assign none of the empty space to the volumes on the empty truck, absolving them of any responsibility for the empty space in the system. All eight units of empty space are assigned to the volume

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60 See, Direct Testimony of Kevin Neels on Behalf of United Parcel Service, Docket No. R2000-1 at 16 and 20.

61 This can also be thought of as two legs of the same route.

62 Dr. Neels' own example demonstrates one of the weaknesses of his approach. In this example, neither of the trips required an eight-unit truck because neither trip is full. Neither trip can be said to have caused the specification of a truck of this size. Thus, the use of the "more full truck" approach does not capture the actual causality between volume and capacity.

on the more full truck, class Y. Under this method, class X receives only 2 units of space (12.5 percent of the cost) and class Y receives 14 units (87.5 percent of the cost).

Under the compromise approach, each class would receive an allocation of empty space consistent with its overall usage of transportation capacity. Class X uses 25 percent of the utilized space, so it receives 25 percent of the empty space, or 2 units. A similar calculation is performed for class Y and it receives 6 units of empty space. Under the compromise approach, class X receives 4 units of capacity (25 percent of cost) and class Y receives 12 units of capacity (75 percent of cost). These results are summarized in Table X.

Table 12
Allocations of Empty Space Under Three Methods

	Utilized Capacity	**Allocated Capacity Under the Postal Service Method**		**Allocated Capacity Under the UPS Method**		**Allocated Capacity Under the Compromise Method**	
		Units	Percent	Units	Percent	Units	Percent
Class X	2	8	50.0%	2	12.5%	4	25.0%
Class Y	6	8	50.0%	14	87.5%	12	75.0%
Empty Units	8						
Total Units	16	16	100.0%	16	100.0%	16	100.0%

The intermediate position of the compromise approach does not exist only in the example. It also exists in the actual cost allocations. Table 13 provides a comparison in the Base Year purchased highway transportation costs for the Intra-SCF, Inter-SCF, Intra-BMC and Inter-BMC categories under the Postal

Service, UPS and compromise methods. That table shows the compromise approach bridges the gap between the Postal Service and UPS approaches.

Table 13
Attributable Cost for the Intra-SCF, Inter-SCF, Inter-BMC, and Intra-BMC Accounts Under Three Different Empty Space Allocation Approaches

	UPS APPROACH	COMPROMISE APPROACH	USPS APPROACH
FIRST-CLASS MAIL	$347,810	$345,434	$342,195
PRIORITY MAIL	$227,353	$225,853	$216,293
EXPRESS MAIL	$17,630	$21,071	$34,730
PERIODICALS	$185,269	$187,691	$190,080
STANDARD (A)	$301,545	$300,920	$300,303
STANDARD B	$339,370	$337,704	$335,566
PARCELS ZONE RATE	$241,844	$239,836	$235,173
OTHER STANDARD (B)	$97,525	$97,868	$100,393

Source: LR-I-452

A final characteristic of the compromise approach needs to be discussed. Because the compromise approach allocates empty space to classes based upon an overall distribution key, it introduces no distortions from the pre-empty-space distributions of costs. The allocation of empty space does not change the relative proportions of costs borne by any class. In this way, the empty space is allocated but the allocation method does not impart any distortion to the pre-expansion distribution key. This characteristic can be demonstrated analytically. The pre-empty-space distribution key is given by:

$$\delta_j = \frac{CFM_j}{CFM},$$

where CFM is the total utilized CFM. Now recall the compromise distribution key:

$$\delta_j^C = \frac{TCFM_j^C}{TCFM}.$$

Also, note that:

$$\begin{aligned} TCFM_j^C &= CFM_j + ECFM_j^C \\ &= CFM_j + \sum_{t=1}^{T} \tilde{\theta}_j ECFM_t = \tilde{\theta}_j ECFM \\ &= CFM_j + \frac{CFM_j}{CFM} ECFM \\ &= \left(1 + \frac{ECFM}{CFM}\right) CFM_j \end{aligned}$$

Substituting this expression into the distribution key definition yields:

$$\begin{aligned} \delta_j^C &= \frac{\left(1 + \frac{ECFM}{CFM}\right) CFM_j}{TCFM} \\ &= \frac{\frac{TCFM}{CFM} CFM_j}{TCFM} \\ &= \frac{CFM_j}{CFM}. \end{aligned}$$

The last equality shows the compromise distribution key maintains the relative proportions determined by the pre-empty-space distribution key.