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Docket No. R97-1

DIRECT TESTIMONY OF
DONALD M. BARON
ON BEHALF OF
UNITED STATES POSTAL SERVICE

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Autobiographical Sketch

My name is Donald M. Baron. I have over 12 years experience in the study of postal economics. I have on several occasions provided assistance to the United States Postal Service in the preparation of testimony on topics relating to postal cost attribution and productivity. Examples include analyses of purchased transportation cost, mail processing labor productivities, post office box costs, and city carrier operations. I have also published articles for economics journals on various postal costing and productivity issues.

I am currently a Vice President with Foster Associates, Inc., an economics consulting firm in Bethesda, MD. Since the late 1960s, Foster Associates has assisted the Postal Service in a wide variety of studies to measure and analyze product and operations costs. Other areas of practice at Foster Associates include finance and valuation, litigation economics, regulatory economics, and resource economics.

Prior to joining Foster Associates, I worked for 9 years in the Washington, DC office of Arthur D. Little, Inc., where I also specialized in the analysis of postal costs, as well as the development of econometric models of postal demand and operational productivity.

From 1982 to 1984, I was a load research analyst with the Potomac Electric Power Company in Washington, DC. I developed and implemented econometric and other statistical analyses to estimate and forecast system loads and energy consumption.

From 1977 to 1982, I was an economist with the Economic Research Service of the United States Department of Agriculture, Washington, D.C. I worked on projectsto evaluate the efficiency of farm operations and help develop strategies for improvement, and to study long term trends in farm ownership and leasing patterns.

My educational background consists of a B.A. in economics from Grinnell College (Phi Beta Kappa), an M.A. in economics from the University of Michigan (Ann Arbor), and a J.D. from Washington University (St. Louis).

PURPOSE OF THE TESTIMONY

This testimony is divided into three parts. Part 1 evaluates alternative methods for calculating volume-variable load-time costs generated on city carrier letter routes. Part 2 analyses running-time costs and access costs on these routes. Part 3 presents a minor adjustment to the current method for calculating volume-variable costs for rural routes.

Part 1

Part 1 proposes a new method for calculating volume-variable load-time costs. Section I presents this method, and applies it to the estimation of FY 1996 load-time elasticities and volume-variable costs. Section II presents the previous method that the Postal Service applied to estimate load-time elasticities and volume-variable costs in its Docket R94-1 rate filing, in all subsequent rate cases, and in the Cost and Revenue Analyses. Section III compares the results produced by these new and previous *methodologies, identifies theoretical flaws in the previous approach, and explains how* the new approach corrects these flaws, thereby producing more accurate elasticity and volume-variable cost estimates.

Part 2

Part 2 evaluates alternative methods for splitting accrued letter route running-time cost into variable-access and fixed-route portions. Section II reviews the field study which collected the data used to analyze running-time costs. Section III compares alternative methods for using these data to estimate equations defining running time as a function of actual stops. The quadratic equations estimated by USPS-T-7 in Docket R90-1 are evaluated relative to more complex quadratic equations estimated by PRC

LR-10 for that Docket. Each set of equations produces an alternative set of elasticities of running time with respect to actual stops, where each elasticity provides the so-called split factor, which divides running-time cost for a given route group into access cost and route cost.

Section IV summarizes the statistical and theoretical arguments in support of the proposed application of the initial, basic quadratic model for estimating running-time elasticities for base year FY 1996.

Part 3

Part 3 proposes a modification to the current procedure for measuring the volume variability of rural carrier labor costs. Section II describes this procedure, and section III presents the proposed change.

PART 1 - SECTION I. MEASURING VOLUME-VARIABLE LOAD-TIME COSTS: A NEW APPROACH

In this section, a new approach to the analysis of carrier load time on city delivery letter routes is presented. This approach builds directly on the previous Postal Service methodology. In particular, it uses the same equations that were recommended by the Commission in Docket No. R90-1, and that have been used ever since by the Postal Service. In part, the new approach is a matter of interpretation of these equations, but one new step is also added at the beginning.

As in the past, accrued load-time costs generated on letter routes are first separated into three pools, depending on the type of stop. The three types of stop, and their corresponding, initial accrued FY 1996 load-time costs (in thousands of dollars) are presented below[1]:

Single delivery residential stops (SDRs)	*$995,848*
Multiple delivery residential stops (MDRs)	$600,905
Business and mixed stops (BAMs)	$186,333

The purpose of the load time analysis is to determine the portions of these costs that are volume-variable. To do so, the new approach measures two separate effects for each of the three types of stop. For MDR and BAM stops, which can have more than one delivery at each stop, a third effect is also measured.

[1] These are derived in USPS-T-5, WP-B at Worksheet 7.0.4.2, lines 45-48.

1. Volume effect. The volume effect is the direct effect of volume on carrier time: as volume increases at deliveries that had already been receiving mail, more load time is required to enter the mail into and to collect mail from containers. This effect is measured by the direct elasticity of load time with respect to volume.

2. Stops effect. This is the effect of the number of stops on carrier time: as the number of stops increases, more carrier time is required to prepare to load and collect mail at those stops. It is commonly accepted that this time increment is independent of the amount of mail delivered at the stop, and should therefore equal a fixed time at each stop. Thus, it should not vary as volume loaded at a given stop changes.[2] In the approach used here, this fixed time per stop is estimated directly. However, as explained in Part 1-Section II, the previous methodology's measure of fixed time per stop actually **can** vary with volume.

3. Deliveries effect. The deliveries effect applies to MDR and BAM stops only, since they may have more than one delivery per stop. It is an indirect effect: As volume increases, the number of actual deliveries increases and, hence, carrier load time increases as well. This effect is measured by the elasticity of load time with respect to actual deliveries multiplied by the elasticity of actual deliveries with respect to volume (i.e., by the chain rule). In the previous methodology, this effect is conflated with the stops effect (as is explained in Part 1-Section II). The new approach presented here makes clear the distinction.

[2] See for example, the Postal Rate Commission's Docket No. R90-1, Opinion and Recommended Decision, at III-58, paragraph 3125.

In this section, each of these effects is explained in turn, and then the new methodology is applied to the FY 1996 accrued cost pools, shown above.

A. Measuring the Volume Effect

For SDR stops, load time (LT) is a function of volume. Volume is defined here in terms of (1) three different shape categories, (2) accountable services rendered, and (3) volumes collected from mailboxes and other types of receptacle. The three shape categories are letters, flats, and parcels. The function is specified as quadratic in the volume terms, and includes dummy variables for receptacle type and for container type:

$$LT = \alpha + \sum_{i}^{N} \gamma_i * R_i + \sum_{j}^{J} \delta_j * C_j + \sum_{k}^{K} \beta_k * V_k + \sum_{k}^{K} \beta_{kk} * V_k^2 + \sum_{k}^{K} \sum_{l}^{L} \beta_{kl} * V_k * V_l \qquad (1)$$

In this expression, R is a dummy variable representing receptacle type, C is a dummy variable representing container type, and V stands for volume by shape category, volume for accountables, and collections. γ and δ are coefficients measuring the effects of receptacle type and container type on load time. β_k, β_{kk}, and β_{kl} measure the response of load time to a change in volume, where β_{kk} accounts for the quadratic effects of each volume term, and β_{kl} accounts for cross-product effects between different pairs of volume terms.[3]

The elasticity of load time with respect to volume, which defines the percentage of costs that are volume variable, is derived from equation 1. It is defined by the following expression:

[3] Equation 1 is the model form recommended by the Postal Rate Commission in Docket No. R90-1, Opinion and Recommended Decision.

$$\varepsilon_{LT,V_k} = (\partial \hat{LT} / \partial V_k) * (V_k / \hat{LT}), \qquad (2)$$

ε_{LT,V_k} in this equation is the elasticity of load time with respect to the kth volume term. On the right hand side, $\partial \hat{LT} / \partial V_k$ is the marginal load time with respect to a change in volume for the kth volume term.

There are five separate elasticities so derived, one for each volume term: letters, flats, parcels, accountables, and collections. In the previous methodology, and in the new methodology used here, each elasticity is multiplied by the appropriate accrued cost to produce a corresponding volume-variable cost.

For MDR and BAM stops, the approach is identical, but the expression of load time in terms of volume is slightly more complicated. Additional terms are required to account for variations in the number of possible deliveries (PD) across stops. For both MDR and BAM stops, the expression for load time has the form:

$$LT = \alpha + \sum_{i=1}^{N} \gamma_i * R_i + \sum_{j=1}^{J} \delta_j * C_j + \sum_{k}^{K} \beta_k * V_k + \sum_{k}^{K} \beta_{kk} * V_k^2 + \sum_{k}^{K} \sum_{l}^{L} \beta_{kl} * V_k * V_l +$$

$$+ \theta_1 * PD + \theta_{11} * PD^2 + \sum_{k}^{K} \phi V_k PD \qquad (3)$$

The first line of this expression is exactly the same as in equation 1. The second line accounts for the effect of possible deliveries - PD - at an MDR or BAM stop. θ_1 and θ_{11} measure the linear and quadratic responses of load time to a change in possible deliveries, and ϕ accounts for the interaction between PD and the volume variables.

Estimation of the volume effect for MDR and BAM stops is accomplished exactly the same way as it is for SDR stops, and, in this respect, the approach used here is again the same as the previous methodology. Equation 2 is used to calculate the elasticities, and each elasticity is multiplied by the appropriate accrued cost to produce a corresponding volume-variable cost.

In summary, the procedure applied by the new approach to estimate the volume effect is identical to the one applied by the previous approach. Even the equations used are the same. The new and previous approaches differ only with respect to the pool of accrued costs to which the elasticities are applied. This difference is described more fully in the next subsection. Details of the procedures used to estimate and apply equations 1, 2, and 3 to elasticity calculation are presented in USPS LR-H-137.

B. Measuring the Stops Effect

The stops effect is the increase in carrier time that occurs solely as a result of an *increase in the number of stops that receive mail. It is the* ***additional*** *time resulting from* the conversion of a previously uncovered stop into a covered stop. The activity encompassed by this time increment includes all the work that a carrier performs to prepare for loading receptacles and collecting mail.

This time has always been viewed as a constant amount per stop. The new increment of time that results from a new stop is the same fixed time that has been observed for this preparatory activity at all previously covered stops.

The most direct method for quantifying the stops effect is to measure directly the average amount of time carriers spend prior to loading the mail; in effect, to measure the time spent at "zero volumes" loaded. There are no actual data available on the "zero-volume" time interval, but a reasonable proxy can be constructed from the 1985 load time study, which conducted a field survey to perform load time tests at a sample of SDR, MDR, and BAM stops.[4] These tests recorded times spent by carriers in actually loading or collecting at least some mail. In some tests, however, load time was recorded for the loading of only a single piece of letter mail. These tests provide an upper bound *to the time spent by the carrier up to the point just prior to loading.*

Technically, this upper bound would be calculated as the lowest amount of time recorded across all tests of carriers loading just one letter. For example, for SDR stops, 1,373 tests (out of a grand total of 16,037 tests) recorded load time for carriers delivering one letter.[5] Of these 1,373 tests, the lowest recorded load time was 0.4 seconds. However, load times at one-letter stops varied from this low up to a high of 6.34 seconds. Now, clearly, 6.34 is too high as an approximation of the amount of time spent prior to loading a single letter. Indeed, it is clear that if the 0.4 seconds is accurate, then, by definition, it **must** equal the upper bound for pre-loading time. Recall that, by definition, pre-loading time is fixed time at a stop - specifically, time that is fixed with respect to volume. It is, in particular, time spent before loading begins. So once its value is accurately determined, any amount of time recorded above that value must necessarily be regarded as time spent **after** loading has begun.

Thus, among the set of all accurate measures of load time at a one-letter stop, the **minimum** time recorded must be the true upper bound on pre-loading time. That is,

[4] See Exhibit USPS-8-C, USPS LR-E-38, and USPS LR-G-140 of Docket No. R87-1 for descriptions and analyses of the 1985 field survey and survey data set.
[5] USPS LR-H-140 presents the SAS program which reads in the 1985 test data set, and creates the SDR, MDR and BAM subsets that contain data only from tests performed at one-letter stops. As discussed in

it must be the fixed load time at a stop. If this minimum time is accurate, any amount above it can only be time incurred after loading has begun - time which does vary with volume. Thus, if 0.4 is viewed as an accurate measure of fixed time, all records for one-letter stops recording more than 0.4 seconds must be including time spent after loading has begun, in addition to fixed load time.

The difficulty with citing 0.4 seconds as the true fixed time per SDR stop is that it may not be as accurate as we would like. The concern here is that 0.4 seconds is the time observed at only 5 out of the 1,373 SDR tests conducted at one-letter stops.[6] A better approach to ensure greater accuracy is to first array these 1,373 SDR tests from lowest to highest load time recorded. A subset of tests reporting the lowest load times that contains a sufficiently large number of tests to produce a reliable average load time can then be selected.

To apply this approach to the current analysis, the lowest 20th percentile of the tests was selected. This produced a subset of 275 SDR tests out of the total of 1,373 tests of carriers loading only one letter. 275 was viewed as more than enough to produce as average load time that accurately measures the upper bound of pre-loading, fixed time at stop. The average fixed time at an SDR stop, calculated as the simple arithmetic mean of these 275 load times, equals 1.052 seconds.

Table 1 shows this result, plus comparable results for the MDR and BAM groups. The first data column reports the total number of tests for each of the three stop types. The second shows the number of tests recording time for loading a single piece of letter-

this library reference, the three data subsets were downloaded into an EXCEL workbook for further statistical analysis.

mail. The third column shows the subset of these tests (the lowest quintile) that was used to compute average fixed time at stop. This average is listed in the last column.

Table 1. Measurement of the Stops Effect				
Stop Type	No. of Tests	One-Letter Deliveries	Lowest Quintile	Fixed Time at Stop (seconds)
SDR	**16,037**	**1,373**	**275**	**1.052**
MDR	**1,442**	**49**	**10**	**1.110**
BAM	**1,412**	**80**	**16**	**0.919**

The average load times shown in this last column of table 1 are reasonable estimates of the "zero-volume" load times, or fixed times per stop, that the definition of the stops effect requires.

In the new approach, the initial pool of accrued costs (listed on page 5 for each stop type) now equals the sum of two components: (1) the cost of these fixed-time (non-volume related) activities (the stops effect) and (2) the cost of loading and collecting mail. The ratios of the fixed times in table 1 to the corresponding total load times per stop shown in that table (and measured at the same time) give the percentages of total initial accrued costs that should be considered as measures of the stops effect. The products of these percentages and total accrued costs give the corresponding total fixed-time costs.

Table 2 shows these fixed-time percentages and costs by stop type. The third data column lists the fixed-time percentages. The last column lists the fixed-time costs

[6] See USPS LR-H-140.

obtained through the multiplication of these percentages by the initial accrued costs shown on page 5.

Table 2. Fixed-Time Costs due to Stops Effect				
Stop Type	Fixed Time (sec)	Total Time (sec)	Percentage Fixed-Time Costs	Fixed-Time Costs ($000)
SDR	1.052	7.515	13.999 %	$139,405
MDR	1.110	50.432	2.201%	$ 13,226
BAM	0.919	15.971	5.754%	$ 10,722

Note that the critical factor in this analysis is the complete independence of the fixed time per stop and the volume of pieces loaded or collected. This independence clearly implies that the fixed time at a stop is the same activity as is the traditional access time defined in the segment 7 CATFAT analyses. Thus, to properly account for the volume variability of fixed-time costs, the analysis must remove these costs from the load-time cost pool, and add them to the FY 1996 access costs which have been derived through application of CATFAT split factors to SDR, MDR, and BAM running-time costs.[7] Table 3 shows the results of these additions. Column 2 shows the FY 1996 initial amounts of accrued access costs, which equal the product of FY 1996 split factors and running-time costs. This calculation is presented in more detail in Part 2 of this

[7] Split factors are elasticities of letter route running-time costs with respect to actual stops. They depend on both route type and stop type, and are derived from regression equations estimated with data obtained by the 1989 CATFAT study. USPS Library References F-187, F-188, F-189, F-190, and F-191 of Docket No. R90-1 describe the study, the data files it produced, and the initial regression analyses of these data.

testimony.[8] Column 3 of table 3 shows corresponding fixed load-time costs from table 2. Column 4 shows the sum of these two costs.

Table 3. Total FY 1996 Access Costs			
Stop Type	Accrued Access Cost ($000)	Fixed-Time Cost ($000)	Total ($000)
SDR	$1,404,804	$ 139,405	$1,544,209
MDR	$ 124,793	$ 13,226	$ 138,019
BAM	$ 197,923	$ 10,722	$ 208,645

The new higher access costs in column 4 are split into volume-variable and non-volume-variable portions through application of the same procedures that have always been applied to accrued access cost. The product of the elasticities of actual stops with respect to volume by subclass and subclass group and the new access costs produce new estimates of volume-variable access cost for these subclasses and subclass groups.[9]

The costs that remain in the load-time pool after the transfer of fixed-time costs to access are strictly load-time costs, generated by the activity of loading and collecting mail. These remaining load-time costs are the accrued cost pools to which the elasticities derived from application of equation 2 should be applied. The standard procedure used in previous proceedings remains in effect, but the cost pool is decreased.

[8] FY 1996 running-time and access costs are derived in USPS-T-5, WP-B at Worksheet 7.0.4.1.
[9] USPS-T-5, WP-B, Worksheets 7.0.4.1 and 7.0.4.2 derive these volume-variable access costs.

In summary, the new procedure is as follows. Apply the fixed-time percentages given in table 2 to the accrued cost pools shown on page 5. Transfer the resulting fixed-time costs to the access cost pool, as shown in table 3, and then apply the standard procedures for measuring volume-variable access costs. The remaining costs then constitute the pool of load-time costs, which vary with volume. Finally, apply the elasticities of load time with respect to volume to determine the volume-variable load-time costs due to the volume effect, as in the standard methodology. This last step is performed on FY 1996 load-time costs later in this section.

C. Measuring the Deliveries Effect

The deliveries effect is measured through a different interpretation of terms that already appear in the load time equation for MDR and BAM stops. These are the terms on the second line of equation 3. All MDR stops, and many BAM stops, have more than one delivery. Possible deliveries appears as an additional explanatory variable in equation 3 to account for the increase in load time per stop that occurs when the number of deliveries accessed by carriers at a given stop increases. This increase in load time might occur even if total volume delivered to the entire stop remains constant. Suppose, for example, that 30 pieces of mail are loaded at 10 deliveries at one MDR stop, and that another, identical batch of 30 pieces are loaded at 12 deliveries at a second MDR stop. One would clearly expect that total loading time would be higher at the second stop, due to the higher deliveries alone, even though total volume and volume mix are the same as at the first stop.

An actual deliveries variable would account for this effect on load time more accurately. The only reason possible deliveries instead of actual deliveries appears on the right hand side of equation 3 is that the 1985 study that produced the data to estimate the load time equations recorded only possible deliveries.

Nevertheless, possible deliveries operates as an effective proxy for actual deliveries in the regression estimations, since these two variables are highly correlated. Generally, a stop that has more possible deliveries will have more actual deliveries as well. Therefore, the coefficients in equation 3 that account for the effects of changes in possible deliveries also measure the effects of corresponding changes in actual deliveries. To reflect this, the variable PD (possible deliveries) is replaced by AD (actual deliveries) in the analysis that follows.

This new interpretation of equation 3 implies a corresponding new application to the calculation of volume-variable costs. In the previous methodology, equation 3 is used only to measure the volume effect. But as interpreted here, equation 3 is also used to measure the effect on load time of an increase in actual deliveries that volume growth will cause – the deliveries effect. The elasticities of MDR and BAM load times with respect to the five volume terms are still derived from equation 3, as in the previous approach, and account for the volume effect. In addition, an elasticity of load time with respect to actual deliveries is calculated as

$$\varepsilon_{LT,V_k} = [(\partial LT / \partial AD) / (LT / AD)] \qquad (4)$$

This elasticity measures the percentage increase in load time resulting from the percentage increase in actual deliveries that occurs in response to a volume increase.

This response of actual deliveries to a volume increase is, in turn, derived from the standard "deliveries" equation, which defines actual deliveries as a function of both volume and possible deliveries. This equation, which has also been applied in the previous load time analysis, has the form:

$$AD = (1 - Exp^{\sum_{i=1}^{N} \beta_i * (V_i / PD)}) * PD \qquad (5)$$

where AD is actual deliveries, V_i is volume for mail subclass i, PD is possible deliveries, and β_i is the coefficient quantifying the effect on actual deliveries of changes in volume for subclass (or subclass group) i.[10] The elasticity of AD in equation 5 with respect to volume, $[(\partial AD/\partial V)/(AD/V)]$, measures the percentage increase in actual deliveries resulting from an equal-proportional increase in volume over all mail subclasses.

The deliveries effect itself - the deliveries elasticity of load time - is estimated through use of the chain rule of calculus, and the two elasticities just defined:

$$\varepsilon_{LT,V_k} = [(\partial LT/\partial AD)/(LT/AD)]*[(\partial AD/\partial V)/(AD/V)] \qquad (6)$$

Thus, the deliveries elasticity of load time equals the elasticity of load time with respect to actual deliveries times the elasticity of actual deliveries with respect to an equal percentage increase in volumes across all subclasses.[11]

The total elasticity of load time at MDR or BAM stops with respect to volume captures both this delivery effect and the volume effect. It is derived from equation 3 as

$$(\partial LT/\partial V)/(LT/V) = \sum_{k=1}^{K=5}(\partial LT/\partial V_k)/(LT/V_k) + [(\partial LT/\partial AD)/(LT/AD)]*[(\partial AD/\partial V)/(AD/V)] \qquad (7)$$

In this expression, PD (possible deliveries) is now viewed as AD (actual deliveries), as explained above. $(\partial LT/\partial V)/(LT/V)$ is the total elasticity of load time (LT) with respect to a proportional increase in volume (V) across all mail subclasses, and V_k is volume for volume term k. On the right hand side, the first term, $\sum_{k=1}^{K=5}(\partial LT/\partial V_k)/(LT/V_k)$, is the

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[10] The current specification and method of estimation of the actual delivery equations for MDR and BAM stops is presented in the Direct Testimony of Michael D. Bradley, USPS-T-5, Docket No. R94-1.

[11] *An important difference between the deliveries effect and the stops effect is that the stops effect is*, by definition, a fixed amount of additional time resulting from loading mail at each new actual stop. In contrast, the additional, "delivery effect" increment of time resulting from loading at a new actual delivery is **not** constrained to be constant as existing actual deliveries increase. Indeed, the Postal Rate Commission's estimates of the MDR and BAM load time equations produce negative coefficient estimates

sum of the five elasticities of load time: letters, flats, parcels, accountables, and collections. It captures the volume effect. The second term, $[(\partial LT / \partial AD) / (LT / AD)] * [(\partial AD / \partial V) / (AD / V)]$, is, as noted above, the deliveries effect - the elasticity of load time with respect to an increase in volume through the effect of this volume increase on actual deliveries.

In summary, a "new" effect – the deliveries effect -- has been identified and a method of measurement proposed. More precisely, a new interpretation has been given to a delivery term that all along has appeared in the regression estimations of equation 3 measuring the effect of volume changes on load time. In the past, the use of this term has been conflated with the effect of increasing the number of stops, leading to confusion and error. In this new approach, a clear distinction is made between the stops and delivery effects. The stops effect is properly measured as a constant amount of time at each stop. The delivery effect is properly measured as the second line of equation 7.

D. Applying the New Methodology

To apply this new approach to FY 1996 costs, the first step is to subtract from the initial measures of accrued load-time cost the costs of fixed time at stop. These fixed-time costs, shown in the second data column of table 4, were added to letter-route access costs in table 3. The initial measures of accrued load-time costs (from page 5 of this testimony) are shown in the first data column of table 4. The right column of table 4 gives the true accrued load-time costs - the costs that remain after fixed-time costs are

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for the square of the deliveries variable, indicating that marginal load time for covering each successive new delivery at a stop actually falls as total deliveries already accessed increases.

subtracted from the initial accrued costs. These new accrued costs are generated strictly by the activity of loading and collecting mail.

Table 4: Defining Accrued Load-Time Costs by Deleting Fixed-Time Costs

Stop Type	Initial Accrued Cost ($000)	Fixed-Time Cost ($000)	Remaining Cost I.E. Accrued Load-time Cost ($000)
SDR	$995,848	$139,405	$856,443
MDR	$600,905	$ 13,226	$587,679
BAM	$186,333	$ 10,722	$175,611

The next step is to separate these accrued load-time costs into volume-variable and non-volume-variable components through application of the load-time elasticities. For SDR stops, the load-time elasticities are derived through differentiation of equation 1, and application of the resulting elasticity formula, shown in equation 2. The SDR elasticities, and the volume-variable costs estimated through multiplication of these elasticities by the accrued SDR cost of $856,443, are shown in Table 5 below.[12]

[12] See USPS LR-H-137 for a comprehensive presentation of how equation 1 is estimated, and how equation 2 applies the coefficient estimates from equation 1 plus average values for the right hand side variables to compute SDR load time elasticities.

Table 5: FY 1996 Volume-Variable Load-Time Costs, SDR Stops		
Variable	**Elasticity**	**Volume-Variable Cost ($000)**
Letters	**0.26807**	**$ 229,587**
Flats	**0.19272**	**$ 165,054**
Parcels	**0.08789**	**$ 75,273**
Accountables	**0.03539**	**$ 30,310**
Collections	**0.02610**	**$ 22,353**
Total	**0.61017**	**$ 522,577**

The procedure applied to accrued costs of $587,679,000 for MDR stops and $175,611,000 for BAM stops is the same, except that now equation 3 is used to derive the elasticity formula, shown in equation 7. Tables 6 and 7 show the volume-variable MDR and BAM costs, respectively, which result from multiplication of the elasticities produced from this elasticity formula by the accrued costs. The volume effect equals the sum of the five elasticities of load time with respect to the volume terms. The delivery effect - obtained from the second line of equation 7 - is the elasticity of load time with respect to actual deliveries times the elasticity of actual deliveries with respect to volume.[13]

[13] USPS LR-H-137 presents a comprehensive description of the regression estimation of equation 3, and the substitution of the regression coefficients along with average values for the right hand side variables in equation 3 into the elasticity formula to produce elasticities of MDR and BAM load time with respect to the volume terms and actual deliveries. USPS LR-H-139 estimates MDR and BAM versions of equation 5, and uses these estimates to derive the elasticities of MDR and BAM actual deliveries with respect to volumes.

Table 6. FY 1996 Volume-Variable Load-Time Costs, MDR Stops		
Variable	**Elasticity**	**Volume-Variable Costs ($000)**
Letters	**0.51709**	**$ 303,883**
Flats	**0.10640**	**$ 62,529**
Parcels	**0.06610**	**$ 38,846**
Accountables	**0.01284**	**$ 7,546**
Collections	**0.00783**	**$ 4,602**
Volume Effect	**0.71026**	**$ 417,405**
Delivery Effect	**0.07672**	**$ 45,087**
Total	**0.78698**	**$ 462,492**

Table 7. FY 1996 Volume-Variable Load-Time Costs, BAM Stops		
Variable	**Elasticity**	**Volume-Variable Costs ($000)**
Letters	**0.13979**	**$ 24,549**
Flats	**0.00931**	**$ 1,635**
Parcels	**0.05999**	**$ 10,535**
Accountables	**0.30941**	**$ 54,336**
Collections	**0.00815**	**$ 1,431**
Volume Effect	**0.52665**	**$ 92,486**
Delivery Effect	**0.01173**	**$ 2,060**
Total	**0.53838**	**$ 94,546**

PART 1 - SECTION II. MEASURING VOLUME-VARIABLE LOAD-TIME COSTS: THE PREVIOUS POSTAL SERVICE APPROACH

The previous method for measuring volume-variable letter-route load-time cost begins with the same three cost pools shown on page 5 and in the first data column of table 3. The functional expressions – equation 1 for SDR stops and equation 3 for MDR and BAM stops – are the same as in the proposed new analysis. Volume-variable load-time costs are computed in two steps.

1. Volume Effect. In the first step of the previous approach, the elasticities of load time with respect to the five volume terms, derived from equation 1 or equation 3, are used to calculate the volume-variable costs for the volume effect. The only difference between this procedure and that proposed in Part 1-Section I, is the size of the cost pool by which the volume elasticities are multiplied to determine the volume-variable costs. The previous approach uses the entire initial cost pool, whereas, the proposed new approach uses the cost pool that remains after fixed-time costs have been transferred to access cost.

2. Coverage Effect. In the second step of the previous Postal Service approach, the volume-variable load-time costs that account for the volume effect are first subtracted from the initial, total accrued costs. The remaining costs - called "accrued coverage-related" load-time costs - are then multiplied by the elasticity of actual stops (AS) with respect to volume in the case of SDR stops, and by the elasticity of actual deliveries (AD) with respect to volume in the case of MDR and BAM stops, to produce "volume-variable coverage-related" load-time costs. These costs are purported to measure the additional load time produced by the conversion of previously uncovered

stops into covered stops that occurs when volume increases. Moreover, accrued coverage-related load-time costs are also purported to be fixed at a stop. That is, for a given stop type, it is claimed that coverage-related load time is a constant amount per stop - invariant with respect to total volume loaded. Furthermore, presentations of the previous analysis have always claimed that the increase in coverage-related load time that occurs when a previously uncovered stop is converted into an actual stop is the same amount no matter how much volume is delivered at that new stop.[14] Thus, the coverage effect in the previous analysis is purportedly equivalent to the stops effect in the proposed new methodology presented in the last section. It is the same amount of time at each existing actual stop and at each new stop.

A. Applying the Previous Approach - SDR Stops

The previous approach as applied to SDR stops first applies the elasticities derived from equation 1 to again produce five pools of volume-variable cost, one for each of the volume terms: letters, flats, parcels, accountables, and collections. Each pool of volume-variable cost equals the product of one of the elasticities and total SDR accrued cost, which is measured as the total initial accrued cost, as shown on page 5. This accrued cost equaled $995,848,000 in FY 1996. Table 8 presents the SDR elasticities with respect to the five volume terms, and the resulting volume-variable load-time costs, which together account for the SDR volume effect.[15]

[14] See, for example, paragraph 3125 of the Postal Rate Commission's Docket No. R90-1 Opinion and Recommended Decision, where the Commission states that coverage-related load-time "is independent of the amount of mail delivered at a stop, [and] depends, instead, [only] on whether or not the stop receives mail at all."
[15] These elasticities are derived in USPS LR-H-137.

Table 8: FY 1996 Volume-Variable Load-Time Costs, SDR Stops		
Variable	**Elasticity**	**Volume-Variable Cost ($000)**
Letters	**0.26807**	**$ 266,957**
Flats	**0.19272**	**$ 191,920**
Parcels	**0.08789**	**$ 87,525**
Accountables	**0.03539**	**$ 35,243**
Collections	**0.02610**	**$ 25,992**
Total	**0.61017**	**$ 607,637**
Residual	**NA**	**$ 388,211**

The SDR coverage effect is calculated first through the subtraction of the total volume-effect costs, $607,637,000, from the initial total accrued cost, which produces $388,211,000 in accrued coverage-related load-time cost for FY 1996, as shown in table 8. This accrued coverage-related cost is often referred to as the "residual."

This residual is then multiplied by the elasticity of actual SDR stops with respect to a proportional increase in volumes across all mail subclasses to produce the volume-variable, coverage-related SDR load-time cost.

This elasticity of SDR stops with respect to total volume is, in turn, derived from the following equation, which is used in the Postal Service's letter-route access-time analysis:

$$AS = (1 - Exp^{\sum_{i}^{N} \beta_i * (V_i / PS)}) * PS \qquad (8)$$

In this equation, AS is the number of actual SDR stops accessed by carriers, V_i is the volume for mail group i, PS is possible SDR stops, and β_i is the coefficient quantifying the effect on actual stops of changes in volume for subclass i.[16] Note the similarity to equation 5, which is defined for actual deliveries.

Table 9 shows the elasticities of SDR actual stops with respect to the various mail subclasses and subclass groups, as derived from equation 8.[17] The volume-variable SDR coverage-related load-time costs in the adjoining column equal the product of these elasticities and the accrued coverage-related (i.e. residual) load-time cost of $388,211,000. The last row shows the sum of the elasticities of actual stops with respect to volume, and the corresponding total volume-variable coverage-related load time cost.

[16] Equation 8 shows the specification of the stops equation presented in the Direct Testimony of Michael D. Bradley, USPS-T-5, Docket No. R94-1.

[17] The procedure to derive stops elasticities from equation 8 is presented in the Direct Testimony of Michael D. Bradley, USPS-T-5, Docket No. R94-1 at 29-43, and in Workpaper W-1, which accompanies that testimony. USPS LR-H-138 presents the analysis which applies FY 1996 CCS data to reestimate the stops equation, and to derive the new stops elasticities shown in table 9.

Table 9. FY 1996 Volume-Variable Coverage-Related Load-Time Costs, SDR Stops

Volume Variable	Elasticity of Actual Stops with Respect to Volume	Volume-Variable Coverage-Related Load-Time Cost ($000)
Single-Piece Letters, Flats, and IPPs	0.01593	$ 6,184
Presort Letters, Flats, and IPPs	0.01817	$ 7,054
Carrier Route Presort Letters	0.00162	$ 629
Second Class Mail	0.00334	$ 1,297
Standard A Bulk Regular Other	0.01269	$ 4,926
Standard A Bulk Regular Enhanced Carrier Route	0.02520	$ 9,783
Standard A Bulk Nonprofit Other	0.00081	$ 314
Standard A Bulk Nonprofit Enhanced Carrier Route	0.00155	$ 602
Standard B	0.00028	$ 109
All Other Mail	0.00369	$ 1,432
Total	0.08327	$32,330

B. MDR and BAM Analysis

The previous load-time analysis for MDR and BAM stops follows the same basic procedure as that just presented for SDR stops. A load-time equation (equation 3) is estimated for each stop type. This equation is used to derive load-time elasticities with respect to the volume terms to account for the volume effect. These elasticities are multiplied by accrued load-time costs to produce volume-variable cost by volume term. Elasticities are also computed to account for the coverage effect, and are used to estimate volume-variable coverage-related load-time costs.

1. Volume Effect. Table 10 shows the MDR elasticities with respect to the volume terms, and the corresponding volume-variable load-time costs. The previous approach estimates these volume-variable costs as the products of the elasticities and the total FY 1996 accrued MDR cost of $600,905,000.

Table 10. FY 1996 Volume-Variable Load-Time Costs, MDR Stops		
Variable	Elasticity	Volume-Variable Cost ($000)
Letters	.47724	$286,776
Flats	.09256	$55,620
Parcels	.06100	$36,655
Accountables	.01307	$7,854
Collections	.00742	$4,459
Total	.65129	$391,364
Residual	NA	$209,541

Table 11 shows the BAM elasticities with respect to the volume terms, plus corresponding volume-variable load-time costs produced through multiplication of these elasticities by the total accrued FY 1996 BAM cost of $186,333,000.[18]

Table 11. FY 1996 Volume-Variable Load-Time Costs, BAM Stops		
Variable	Elasticity	Volume-Variable Cost ($000)
Letters	.14157	$26,379
Flats	.01024	$1,908
Parcels	.05790	$10,789
Accountables	.30317	$56,491
Collections	.00819	$1,526
Total	.52107	$97,093
Residual	NA	$89,240

2. Coverage Effect. Calculation of the MDR and BAM coverage effects follows the same procedure just presented for SDR stops. First, the total of the volume-variable costs that account for the volume effect are subtracted from the initial total accrued costs to produce accrued coverage-related load-time costs. These residual costs are shown at the bottom of Tables 10 and 11 for MDR and BAM stops, respectively. Next, the elasticities of actual deliveries with respect to a proportional

[18] The MDR and BAM load time elasticities with respect to the volume terms are derived in USPS LR-H-137.

increase in all volumes are derived from the estimated actual deliveries equation. This equation (equation 5) was described in Part 1-Section I, and is repeated here:

$$AD = (1 - Exp^{\sum_{i=1}^{N} \beta_i * (V_i / PD)}) * PD \qquad (5)$$

Again, AD is actual deliveries made to MDR or BAM stops, V_i is volume for mail subclass or subclass group i, PD is possible deliveries, and β_i is the coefficient quantifying the effect on actual deliveries of changes in volume for subclass i.[19]

Table 12 shows FY 1996 estimates of the elasticities of MDR actual deliveries with respect to volumes.[20] The second data column shows volume-variable coverage-related load-time costs that are obtained through multiplication of these elasticities by the accrued coverage-related load-time cost shown at the bottom of table 10.[21]

Table 13, on the following page, shows comparable delivery elasticities and volume-variable coverage-related costs for BAM stops.[22] The volume-variable costs are obtained through multiplication of the elasticities by the total BAM accrued coverage-related load-time cost that is shown at the bottom of table 11.

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[19] The current specification of the delivery equation for MDR and BAM stops is presented in the Direct Testimony of Michael D. Bradley, USPS-T-5, Docket No. R94-1. In Workpaper W-4, which accompanies this testimony, Dr. Bradley estimates the deliveries equations, and uses them to calculate elasticities of deliveries with respect to volumes by mail subclass and subclass group.

[20] USPS LR-H-139 uses FY 1996 CCS data to reestimate the deliveries equation, and implements the Bradley procedure (from Workpaper W-4, Docket No. R94-1) to calculate the FY 1996 delivery elasticities for MDR and BAM stops.

[21] At paragraphs 3120-3121 of its Docket No. R90-1 Opinion and Recommended Decision, the Postal Rate Commission proposed that SDR and MDR coverage-related load-time costs should include not only the volume-variable costs computed by the Postal Service's previous approach (which, for FY 1996, equal the costs shown in tables 9 and 12), but also the costs of single subclass deliveries. The Postal Service analysis has, however, never added single subclass delivery costs to volume-variable costs for rate-making purposes.

[22] These are derived in USPS LR-H-139.

Table 12. FY 1996 Volume-Variable Coverage-Related Load-Time Costs, MDR Stops		
Volume Variable	Elasticity of Actual Deliveries with Respect to Volume	Volume-Variable Coverage-Related Load-Time Cost ($000)
Single-Piece Letters, Flats, and IPPs	.00872	$1,827
Presort Letters, Flats, and IPPs	.02438	$5,109
Carrier Route Presort Letters	.00149	$312
Second Class Mail	.01981	$4,151
Standard A Bulk Regular Other	.02309	$4,838
Standard A Bulk Regular Enhanced Carrier Route	.06362	$13,331
Standard A Bulk Nonprofit Other	.00732	$1,534
Standard A Bulk Nonprofit Enhanced Carrier Route	.00265	$555
Standard B	.00139	$291
All Other Mail	.01433	$3,003
Total	.16680	$34,951

Table 13. FY 1996 Volume-Variable Coverage-Related Load-Time Costs, BAM Stops		
Volume Variable	Elasticity of Actual Deliveries with Respect to Volume	Volume-Variable Coverage-Related Load-Time Cost ($000)
Single-Piece Letters, Flats, and IPPs	.006390	$570
Presort Letters, Flats, and IPPs	.002967	$265
Carrier Route Presort Letters	.000495	$44
Second Class Mail	.004966	$443
Standard A Bulk Regular Other	.000000	$0
Standard A Bulk Regular Enhanced Carrier Route	.002615	$233
Standard A Bulk Nonprofit Other	.000908	$81
Standard A Bulk Nonprofit Enhanced Carrier Route	.000768	$69
Standard B	.000000	$0
All Other Mail	.000000	$0
Total	.019109	$1,705

PART 1 - SECTION III. EVALUATION AND COMPARISON

A. A Critique of the Previous Approach

Until this case, the Postal Service had applied the previous costing methodology just presented in Part 1-Section II to calculate volume-variable load-time costs in all rate cases, beginning with Docket No. R94-1, as well as in the development of Cost and Revenue Analyses (CRA). However, recent evaluations by this witness have revealed certain theoretical deficiencies in this old methodology.

The first problem with the previous approach relates to the calculation of accrued coverage-related load-time costs. These costs are supposed to measure the time that carriers spend on activities prior to the point when carriers begin loading or collecting mail. Thus, this time increment is supposed to be fixed with respect to volume at any given stop. That is, for a given stop type, coverage-related load time at each stop is supposed to be the same fixed value no matter how much volume is delivered. Moreover, the added coverage-related load time resulting from a newly covered stop must also equal this same fixed value.

However, the traditional coverage-related load-time cost - the residual that's left after volume-variable costs accounting for the volume effect are subtracted from initial accrued cost - is a flawed measure of fixed time at a stop. The residual fails the key criterion for any measure of "fixed" time per stop: it isn't fixed with respect to volume. As traditionally measured, coverage-related load-time costs can easily change from year to year in response to changes in volume that do **not** cause changes in actual stops covered.

To illustrate this point, suppose that the initial accrued load-time cost at SDR stops equals $800,000,000 for a given number of stops. Using the aggregate of the SDR elasticities with respect to volumes, as shown in table 8, the previous approach would multiply $800,000,000 by 61% to produce aggregate volume-variable load-time costs of $488,000,000. This amount would then be subtracted from $800,000,000 to produce $312,000,000 in accrued coverage-related load-time cost. Now suppose that in the ensuing year, volume increases by 1 percent across all volume categories, and that the number of actual stops remains fixed. The aggregate elasticity of 61% would imply a resulting increase in cost of 0.61%, or about $4,880,000, bringing the total accrued cost to $804,880,000. Since the number of actual stops covered remains unchanged, coverage-related costs should, theoretically, remain constant as well. As traditionally estimated, however, coverage-related costs would increase substantially. The volume-variable load-time cost would equal 804,880,000 times 0.61, or $490,976,800. The new accrued coverage-related load-time cost would then become

$$\$313,903,000 = \$804,880,000 - \$490,976,800,$$

which is an increase of $1,903,200, or about 0.61%, over the initial accrued coverage-related cost.

Thus, accrued coverage-related load-time cost, as traditionally measured, **can** change in response to volume independently of any resulting change in coverage. It is clearly an inaccurate measure of what is supposed to be a fixed amount of time per stop that can change **only** when coverage changes. Clearly, a better way of measuring the cost of this fixed time is a method which ensures, *a priori*, that the cost cannot change in response to volume if actual stops remain constant, but only in response to changes in the number of actual stops. The new method, proposed in Part 1-Section I, which produces the estimated fixed time at stop costs shown in the last column of table 2, does satisfies this criterion. The fixed time at stop costs in table 2 are independent of the amount of volume loaded at a stop, are thus they are same amount per stop at all existing stops and for each new actual stop.

Another problem associated with the traditional coverage-related load-time measure of fixed time at a stop is the ambiguity concerning what block of time it really measures at multi-delivery stops. Past rate case testimonies and Commission Recommended Decisions define this time increment both as the additional load time that results from one new actual stop, **and** the additional time that results from one new actual delivery.[23] This definition states that the coverage-related increase in load time caused by a carrier loading mail at a new delivery in the mailroom of an apartment or business stop previously receiving mail is the same as the increase in load time caused by a carrier loading mail at an entire new MDR or BAM stop. Such a result is clearly implausible. There is no evidence that the additional block of time resulting from the

[23] For example, the Commission's Docket R90-1, Opinion and Recommended Decision at para. 3125 describes the single traditional measure of coverage-related load time as both a stop-related and delivery-related measure. Thus, in one sentence, it refers to coverage-related load time as being "independent of the amount of mail delivered at a **stop**." Two sentences later, if refers to coverage-related load as "a measure of the sensitivity of the number of actual **deliveries** to changes in volume." (Emphasis is added).

coverage of a new delivery at an existing actual stop must be the same as the additional block of time that results from coverage of a whole new MDR or BAM stop.[24] Yet the traditional approach measures both blocks of time through the same coverage-related load-time formula, equating the cost of both time increments to the single residual cost left from the subtraction of the "volume effect" volume-variable cost from the initial accrued cost.

The proposed new approach avoids this error. The new coverage time resulting from an entire new multi-delivery actual stop is clearly distinguished from the new coverage time associated with a new actual delivery at an existing stop. The former is recognized as simply a component of access time. Its cost is measured directly as a fixed amount of time per stop, and subsequently moved into the standard CATFAT access cost pool. The latter is accounted for through the measurement of MDR and BAM elasticities of load time with respect to volume through the positive effect of volume increases on actual deliveries, as calculated through application of the elasticity formula of equation 6.

B. Comparison of Volume-Variable Costs From the Two Methodologies

Tables 14-16 summarize the FY 1996 volume-variable costs produced by the two methodologies for each stop type. The first data column of each table presents the

[24] Note, in particular, that the regression estimates of the MDR and BAM load time equations produce negative coefficients for the square of the deliveries variable, indicating that the rate of increase in time expended to cover each new actual delivery falls as numbers of actual deliveries increase. In contrast, the stops effect - the additional time of covering a whole new stop - is constant over all actual stops. This difference between the delivery and stop effects is clearly inconsistent with the traditional assumption that the added coverage time to cover a new delivery at an existing multi-delivery stop equals the added time to cover an entire new stop.

traditional costing procedure. The adjoining column presents the proposed new procedure.

Table 14, for SDR stops, draws data from tables 8 and 9 for the previous analysis and from Tables 3, 4, and 5 for the new approach. The total volume-variable cost from the new methodology is calculated to be $105,782,000 less than the total calculated by the old procedure, as shown on the bottom line of table 14.

This difference occurs for two reasons. First, a total of $139,405,000 was transferred from the load time to the access cost pool. Since volume-variability is lower in the latter, this transfer results in a smaller total for volume-variable costs. Second, the volume-effect elasticities are applied to a smaller accrued load-time cost pool than in the old procedure.

Table 15, for MDR stops, draws data from tables 10 and 12 for the previous analysis and from Tables 3, 4, and 6 for the new approach. The total volume-variable cost from the new methodology is calculated to be $36,178,000 more than the total calculated by the old procedure, as shown on the bottom line of table 15.

Table 16, for BAM stops, draws data from tables 11 and 13 for the previous analysis and from tables 3, 4, and 7 for the new approach. The total volume-variable cost from the new methodology is calculated to be $3,915,000 less than the total calculated by the old procedure, as shown on the bottom line of table 16.

Table 14. Comparison of FY 1996 Volume-Variable Costs, SDR Stops Previous vs. New Methodology ($000)			
Cost Element	**Previous**	**New**	**Difference**
Total Accrued Costs	**$995,848**	**$995,848**	
Fixed-Time Costs (to Access)		**$139,405**	
Volume-Variable Fixed-Time Costs[25]		**$11,608***	
Load-Time Costs	**$995,848**	**$856,443**	
Volume Effect Costs	**$607,637***	**$522,577***	
Coverage-Related Costs	**$388,211**		
Volume-Variable Coverage-Related Costs	**$32,330***		
Total Volume-Variable Costs	**$639,967**	**$534,185**	**-$105,782**

* included in total

[25] Volume-variable fixed-time costs equal total fixed-time costs ($139,405,000) times the aggregate elasticity of SDR stops with respect to volume of 0.08327 shown in table 9.

Table 15. Comparison of FY 1996 Volume-Variable Costs, MDR Stops Previous vs. New Methodology ($000)			
Cost Element	**Previous**	**New**	**Difference**
Total Accrued Costs	**$600,905**	**$600,905**	
Fixed-Time Costs **(to Access)**		**$13,226**	
Volume-Variable **Fixed-Time Costs**[26]		**$1***	
Load-Time Costs	**600,905**	**$587,679**	
Volume Effect Costs	**391,364***	**$417,405***	
Delivery Effect Costs		**$45,087***	
Coverage-Related Costs	**209,541**		
Volume-Variable **Coverage-Related Costs**	**34,951***		
Total Volume-Variable Costs	**$426,315**	**$462,493**	**$36,178**

*included in total

[26] Volume-variable fixed-time costs equal total fixed-time costs ($13,226,000) times the aggregate elasticity of MDR stops with respect to volume of .000069. This elasticity is calculated in USPS LR-H-138.

Table 16. Comparison of FY 1996 Volume-Variable Costs, BAM Stops Previous vs. New Methodology ($000)			
Cost Element	**Previous**	**New**	**Difference**
Total Accrued Costs	**$186,333**	**$186,333**	
Fixed-Time Costs (to Access)		**$10,722**	
Volume-Variable, Fixed-Time Costs[27]		**$337***	
Load-Time Costs	**$186,333**	**$175,611**	
Volume Effect Costs	**$97,093***	**$92,486***	
Delivery Effect Costs		**$2,060***	
Coverage-Related Costs	**$89,240**		
Volume-Variable Coverage-Related Costs	**$1,705***		
Total Volume-Variable Costs	**$98,798**	**$94,883**	**- $3,915**

* included in total

[27] Volume-variable fixed-time costs equal total fixed-time costs ($10,722,000) times the aggregate elasticity of BAM stops with respect to volume of .031408 This elasticity is calculated in USPS LR-H-138.

PART 1 - SECTION IV. CONCLUSION

Overall, the new approach proposed in this testimony leads to significant changes in cost allocations. For SDR stops in FY 1996, the new procedure estimates volume-variable costs that are about $106 million less than under the previous procedure. For MDR and BAM stops combined, FY 96 volume-variable costs are about $32 million higher under the new procedure, implying a net overall reduction of about $74 million across all stop types.

These changes are compelled by the need to correct conceptual flaws in the previous approach. The old measurement of coverage-related load-time cost as the difference between the initial total accrued cost and volume-variable load-time costs that account for the volume effect is an inaccurate formula for calculating a fixed amount of time per stop - a time interval, which, by definition, cannot vary with volume loaded or collected. The new procedure recognizes this concept, and directly estimates the time spent performing a fixed-time, coverage activity. The new procedure also explicitly accounts for a factor ignored in the old procedure: the effect that increased delivery coverage has on load time at existing MDR and BAM stops. Moreover, the new procedure, unlike the previous approach, clearly and explicitly distinguishes between the new time increment that results from the coverage of a new MDR or BAM stops from the additional time that results from coverage of a new delivery at an existing stop. The new approach provides separate, distinct measures of the cost of each of these time increments.

The new methodology therefore more effectively accounts for all carrier functions performed prior to or during the loading and collection activity. Fixed time at stops is identified correctly. And the new delivery-coverage measure ensures a more accurate estimation of the total elasticity of load time with respect to changes in volume.

PART 2 - SECTION I. OVERVIEW

This part of the testimony reviews the method used by the Commission to split segment 7 running-time costs on city carrier letter routes into fixed route and variable access components. The review examines the traditional regression analysis that produces elasticities used to calculate route-access splits. Problems affecting this analysis are described, and an alternative approach is proposed to produce more accurate elasticity and cost estimates.

PART 2 - SECTION II. THE CATFAT STUDY

Elasticities of running time with respect to actual stops are derived from regression analysis of data collected in a 1988 survey known as the Curbline and Foot Access (i.e. CATFAT) Study.[28] This study evaluated carrier activity on a random sample of 438 city carrier routes: 161 curbline routes, 78 foot routes, and 199 park and loop routes. Carriers were observed traveling over a designated portion of each test route five different times, making a different, randomly determined pattern of stops on each run. The carriers delivered no mail, but paused at each stop to mark a data collection sheet. Of the five runs conducted on each route, one was at 100% coverage, one at 90%, and one each at 80%, 70%, and 60%. For each run, data collectors recorded the time expended by the carrier (i.e. the running time), the possible stops on the test route, and the number of actual stops - that is, the number of possible stops accessed.[29]

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[28] The CATFAT study is described in the Direct Testimony of Jeffrey L. Colvin, Docket No. R90-1, USPS-T-7 at 28-29.

[29] See Direct Testimony of Jeffrey L. Colvin, Docket No. R90-1, USPS-T-7 at 28-29. The details of the CATFAT test implementation, field instructions, and data collection and recording are presented in Docket No. R90-1, Exhibit USPS-7A, and USPS LRs F-187 through F-190.

In Docket No. R90-1, two different approaches were presented for using these data to quantify the relationship between running time and stops, and for deriving running-time elasticities. The first was presented in USPS-T-7, and the second in PRC LR-10. Up until this rate case, the second model has been used by the base year model to compute all running-time elasticities and accrued access costs. The remainder of this testimony describes these two methods, compares the elasticities they produce, and evaluates their relative merits for purposes of estimating accrued access costs.

PART 2 - SECTION III. ESTIMATION OF ELASTICITIES OF RUNNING TIME WITH RESPECT TO ACTUAL STOPS

A. The Quadratic Model

The first model to be considered defines running time as a basic quadratic function of actual stops:

$$RUNTIME_{it} = \alpha_0 + \beta_1 * STOPS_{it} + \beta_2 * STOPS_{it}^2 + \sum_{i=2}^{n} \alpha_i * ROUTE_i + \sum_{t=2}^{5} \gamma_t * RUNUM_t \quad (9)$$

In this equation, there are n routes indexed by i, and 5 runs for each route, indexed by t. The variables in this equation are defined as follows:

$RUNTIME_{it}$	=	the time taken to perform the t^{th} run on the i^{th} route.
$STOPS_{it}$	=	the number of actual stops made on the t^{th} run on the i^{th} route.
$ROUTE_i$	=	1 if the run observation comes from the i^{th} test route, 0 otherwise.
$RUNUM_t$	=	1 if the observation comes from the t^{th} run, 0 otherwise.

Note also that $ROUTE_1$ and $RUNUM_1$ are excluded from the estimation to ensure that the independent variable data set is nonsingular.

This functional form is appropriate because, while one would expect running time to rise as the number of stops accessed increases, it is also expected that the rate of increase in running time should fall as more and more stops are accessed. In particular, as coverage increases, additional accesses are less likely to cause large increases in access time because these new actual stops are more likely to be found between already-covered stops. Thus, the estimated coefficient on STOPS is expected to be positive, while the estimated coefficient on $STOPS^2$ is expected to be negative.

Because each test route in the CATFAT study had unique characteristics, dummy variables were included to control for route specific factors. Finally, to control for any "learning curve" effect that would influence running time, a dummy variable was included to control for the run number.

Docket No. R90-1, USPS-T-7 presented the estimation of three versions of this model - one for each of three different route groups: curbline, foot, and park and loop.[30] Ordinary least squares regression results from these estimations are shown in table 17.[31]

[30] The derivation of these regression equations is summarized in Docket No. R90-1, USPS-T-7 at pages 29-34. A more comprehensive documentation of the regressions is presented in Docket No. R90-1, Exhibit USPS-7-B and USPS LR-F-192.

[31] As explained in Docket No. R90-1, USPS-T-7, the t statistics shown for curbline and foot access routes are asymptotic t statistics computed from a variance matrix that corrected for heteroskedastic error terms. Coefficient estimates for ROUTE variables do not appear here, but can be found in Docket No. R90-1, Exhibit USPS-7-B, which accompanies USPS-T-7.

Table 17. Quadratic Model Regression Results (t-statistics are in parentheses)

	INTERCEPT	STOPS	$STOPS^2$	$RUNUM_2$
CURBLINE ROUTES	318.308 (4.857)	12.869 (7.924)	-0.039 (3.759)	-16.413 (1.489)
FOOT ROUTES	391.595 (3.104)	25.480 (6.764)	-0.071 (2.574)	-40.309 (2.343)
PARK & LOOP ROUTES	283.743 (6.164)	28.580 (18.648)	-0.126 (9.570)	-33.549 (2.668)

	$RUNUM_3$	$RUNUM_4$	$RUNUM_5$	ADJ. R^2
CURBLINE ROUTES	-9.282 (0.953)	-27.114 (3.250)	-27.552 (2.332)	0.9333
FOOT ROUTES	-24.678 (1.303)	-35.641 (1.703)	-68.784 (3.467)	0.9595
PARK & LOOP ROUTES	-45.679 (3.061)	-52.134 (3.991)	-58.290 (4.446)	0.9520

The coefficients estimated for both STOPS and $STOPS^2$ have the expected signs, and are statistically significant at the 95 percent level. This result indicates that the coefficients can be used to estimate running-time elasticities with a high degree of confidence. In addition, the adjusted R^2 values are well above 90 percent in all three regressions, suggesting that the model fits the data well and can be used to accurately predict running time.

B. The Quadratic Model With Interactions

Docket No. R90-1, PRC LR-10, presents an alternative model for estimation of running-time elasticities.[32]

$$\begin{aligned} RUNTIME_{it} = \alpha_0 &+ \sum_{i=1}^{n} \beta_{1i} * STOPS_{it} * ROUTE_i + \sum_{i=1}^{n} \beta_{2i} * STOPS_{it}^{\,2} * ROUTE_i + \\ &\sum_{i=1}^{n-1} \alpha_i * ROUTE_i + \sum_{j=1}^{8} \sum_{t=1}^{4} \gamma_{jt} * RUNUM_t * RTYPE_j \end{aligned}$$

where there are n routes, indexed by i, 5 runs for each route, indexed by t, and 8 route types, indexed by j. The variable definitions are as follows:

$RUNTIME_{it}$	=	the time taken to perform the t^{th} run on the i^{th} route.
$STOPS_{it}$	=	the number of actual stops made on the t^{th} run on the i^{th} route.
$ROUTE_{it}$	=	1 if the run observation was made on the i^{th} test route, 0 otherwise.
$RUNUM_t$*$RTYPE_j$	=	1 if the run observation was made on the t^{th} run conducted on a route of type j, 0 otherwise.

[32] See Docket No. R90-1, Opinion and Recommended Decision at III-22, and PRC LR-10.

Note also that $ROUTE_n$ and $RUNUM_5$ are excluded from the estimation, again to ensure that the independent variable data set is nonsingular. In addition, $RTYPE_j$ is excluded from the estimation when there are no routes of this type observed.[33]

The critical difference between this interactions model and the simple quadratic model of equation 9 is that n slope coefficients, one for each route, are estimated for both STOPS and $STOPS^2$ in the interactions model, whereas only one slope coefficient is estimated for each of these two variables in the simple quadratic model. In other words, in the interactions model, STOPS and $STOPS^2$ are interacted with ROUTE. In addition, a separate intercept coefficient is estimated not for each run, but for each combination of a run and a route type.

PRC LR-10 of Docket No. R90-1 estimates the quadratic model with interactions for the three route groups - curbline, foot, and park & loop - producing one regression for each group. Because each regression produces so many parameter estimates across the numerous test routes, the complete set of results are reported in USPS LR-H-142. Only a summary is presented here, in table 18.

[33] Docket No. R90-1, PRC LR-10 estimated this model through application of the SAS GLM (Generalized Linear Model) procedure. In carrying out the estimation, the GLM procedure eliminates linear dependencies among independent variables inherent in the original PRC model specification.

Table 18. Quadratic Model With Interactions Regression Summary, Percentages of Coefficient Estimates With Positive Sign, Negative Sign, and With Significant T-Statistics At The .01 Level

	STOPS	$STOPS^2$
CURBLINE ROUTES		
POSITIVE COEFFICIENT	60%	48%
NEGATIVE COEFFICIENT	40%	52%
T-STATISTIC SIGIFICANT	4%	4%
FOOT ROUTES		
POSITIVE COEFFICIENT	53%	48%
NEGATIVE COEFFICIENT	47%	52%
SIGNIFICANT T-STATISTIC	7%	7%
PARK & LOOP ROUTES		
POSITIVE COEFFICIENT	47%	59%
NEGATIVE COEFFICIENT	53%	41%
SIGNIFICANT T-STATISTIC	7%	7%

Recall that $STOPS^2$ is included in both model specifications because, while it is expected that running time will increase as the number of stops accessed increases, it is also expected that the rate of increase in running time should fall as more and more stops are accessed. Thus, it would be expected that the estimated STOPS coefficients in the quadratic model with interactions would be positive, whereas estimated $STOPS^2$ coefficients would be negative. However, table 18 shows that, contrary to these expectations, the regression estimates of the interactions model for curbline and foot routes produce a coefficient set in which 40% or more of the STOPS coefficients are negative, and close to 50% of the $STOPS^2$ coefficients are positive. In the case of the park & loop group, 53% of the estimated STOPS coefficients are negative, and 59% of the $STOPS^2$ estimates are positive.

Thus, clearly, the quadratic model with interactions produces operationally implausible results. The statistical properties of these results are equally troublesome. In the Postal Rate Commission's Docket No. R90-1 Opinion and Recommended Decision, the Commission presented its justification for using a quadratic model with interactions rather than the quadratic model presented in USPS-T-7. The following is an excerpt from that document:

> "It is our impression that the topography varies greatly across routes, as do the number of stops . . . Therefore, we tested whether generalizing the [quadratic] model to allow the coefficients of the STOPS and $STOPS^2$ terms to vary by individual route would result in improved fit.
>
> We found the fit much improved. The coefficients of both the linear and the squared terms were significantly different from each other (and from zero) at the confidence level of .01 or better, across routes within each route type and stop type."[34]

In fact, the fit is not "much improved". Rather, statistical tests demonstrate that the route-specific coefficients estimated for both STOPS and $STOPS^2$ are **not** in general statistically significant at the confidence level of .01 or better. As shown in table 18, only a small minority of the STOPS and $STOPS^2$ coefficients have t statistics that are statistically significant at the .01 level.[35] In particular, only 4% of the curbline route coefficient estimates are significantly different from zero at the .01 level. Therefore, 96% of the curbline STOPS and $STOPS^2$ coefficient estimates are statistically invalid.

The above excerpt from the Postal Rate Commission's Docket No. R90-1 Opinion and Recommended Decision also states that "the linear and squared terms were significantly different from each other." Although no evidence is presented to directly

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[34] See Docket No. R90-1, Opinion and Recommended Decision, at III-23.

[35] The Commission chose to measure statistical significance at the .01 level. However, even at the significance level of .05, only a small minority of the STOPS and $STOP^2$ coefficients are statistically significant.

support this assertion, the statement is presumably referring to F-statistic tests that were conducted in Docket No. R90-1, PRC LR-10. F-tests conducted in that library reference tested the hypothesis that all $STOPS^2$ coefficients for a given route type are equal to each other. The F-statistics were found to be statistically significant, and therefore PRC LR-10 concluded that the quadratic model with interactions is statistically superior to the quadratic model.

In fact, the statistically significant F-statistics merely demonstrate that **some** of the $STOPS^2$ coefficients are statistically significantly different from each other. And, as shown in table 18, t-statistics further demonstrate that only 4% of curbline, 7% of foot, and 7% of park and loop $STOPS^2$ coefficients are statistically significant at the .01 level. Therefore, had PRC LR-10 correctly applied these statistical tests, it would have eliminated at least 96% of curbline, 93% of foot, and 93% of park & loop ROUTE interacted STOPS and $STOPS^2$ coefficients before using the coefficient estimates to compute elasticities.

It is not surprising that such a large percentage of the STOPS and $STOPS^2$ coefficient estimates generated from the quadratic model with interactions are statistically insignificant. Each of the route specific coefficient estimates is based upon only five observations, namely the five test runs of the route. A model that is designed such that the majority of coefficient estimates are based upon such a small number of observations is almost certain to produce statistically invalid results. Thus, it is the inherent structure of the quadratic model with interactions that generates the statistically invalid results.

Finally, statistical arguments aside, there are no persuasive a priori reasons to estimate separate STOPS and $STOPS^2$ slope coefficients for n different routes. The ROUTE intercept variables, which are included in both model specifications, already control for any route specific effects on running time. Also, it is more reasonable to estimate only one set of STOPS and $STOPS^2$ coefficients, because only one elasticity is estimated by stop type for each route group..

C. Comparison of Elasticities

In Docket No. R90-1, USPS-T-7 applied the regression estimations of equation 9, which produced the coefficient estimates shown in table 17, in order to calculate elasticities of running time with respect to actual stops for base year FY 1989.[36] For each route group, three elasticities were calculated - one each for SDR, MDR, and BAM stops. The elasticity formula that was applied, and that was derived through differentiation of equation 9 is:

$$\hat{\varepsilon}_{RT,STOPS} = (\partial \hat{RT} / \partial STOPS) * (\hat{STOPS} / \hat{RT}) \qquad (11)$$

where $\hat{\varepsilon}_{RT,STOPS}$ is the estimated elasticity, $\partial \hat{RT} / \partial STOPS$ is estimated marginal running time with respect to a change in actual stops, and $\hat{STOPS}$ and $\hat{RT}$ are estimated values for actual stops and running time.

The formula in equation 11 highlights the fact that to use quadratic equations such as equation 9 and equation 10 to derive a single elasticity for each route group - stop type combination, the cost analysis must evaluate each equation at specific values

[36] See Docket No. R90-1, USPS-T-7, Exhibit USPS 7-B, and USPS LR-F-192.

for the right hand side variables. Thus, in order to derive FY 1989 SDR, MDR, and BAM elasticities for each of the three route groups - curbline, foot, and park & loop, USPS-T-7 had to first estimate the values of stops and running time for each stop type in each of the three route group regressions. To do so, FY 1989 CCS data were first used to estimate ratios of actual stops to possible stops by stop type across the three route groups. The results are shown in table 19 under the heading MEAN COVERAGE, USPS ANALYSIS. Each coverage ratio within each route group was then multiplied by the average number of possible stops within that group, as reported in the CATFAT data set. This produced an estimate of actual stops for the stop type within the given group. Each of the three route group regressions also included intercepts for individual curbline, foot, or park & loop routes in the CATFAT data file, and four run number coefficients. Therefore, the averages of these intercepts, and the averages of the run number coefficients were substituted into the right hand sides along with the estimated values for actual stops to produce corresponding estimates of curbline, foot, and park & loop running times by stop type.

$\widehat{\partial RT / \partial STOPS}$ was also estimated for each stop type for each of the route group regressions. This was done through evaluation of the partial derivative of running time with respect to stops at each stop type's estimated number of stops. Finally, substitution of these estimated partial derivatives, along with estimated stops and estimated running times, into equation 11 produced quadratic model elasticity estimates for the nine route group - stop type combinations.[37]

These nine FY 1989 elasticities are reproduced in table 19 under the heading QUADRATIC MODEL ELASTICITY, USPS ANALYSIS. The third data column of this table shows the FY 1989 CCS coverage ratios of actual to possible stops that were used in USPS-T-7 to estimate actual stops by stop type for each route group.

To produce alternative elasticities, Docket No. R90-1, PRC LR-10 applied regression estimates of equation 10. The coverage ratios used to estimate values for actual stops in the elasticity formula are shown in the last column under the heading, MEAN COVERAGE, PRC ANALYSIS.[38] The resulting elasticity estimates produced are shown in table 19 under the heading QUADRATIC MODEL WITH INTERACTIONS ELASTICITY, PRC ANALYSIS.

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[37] USPS LR-H-141 presents a more comprehensive explanation of the quadratic model elasticity estimation.

[38] Note that, as shown in the last column of table 19, the Commission calculated only one FY 1989 system-wide coverage level for each of the stop types - SDR, MDR, and BAM - in order to predict actual stops for the curbline, foot, and park & loop groups. For example, it multiplied possible stops in all three route groups by only a single SDR coverage ratio, 0.924, in order to estimate actual SDR stops for these groups.

Table 19. FY 1989 Estimated Running-Time Elasticities (Split Factors)

	QUADRATIC MODEL ELASTICITY, USPS ANALYSIS	QUADRATIC MODEL WITH INTERACTIONS ELASTICITY, PRC ANALYSIS	MEAN COVERAGE, USPS ANALYSIS	MEAN COVERAGE, PRC ANALYSIS
CURBLINE ROUTES				
SDR	.493	.444	.943	.924
MDR	.487	.403	.985	.979
BAM	.470	.449	.919	.921
FOOT ROUTES				
SDR	.598	.696	.909	.924
MDR	.602	.732	.976	.979
BAM	.586	.694	.912	.921
PARK & LOOP ROUTES				
SDR	.479	.563	.924	.924
MDR	.470	.616	.979	.979
BAM	.455	.561	.921	.921

To calculate these elasticities, PRC LR-10 utilized the basic elasticity formula shown in equation 11, and used in USPS-T-7. However, because the quadratic model with interactions estimates separate STOPS and $STOPS^2$ for each of n routes in each route group, the application of equation 11 to the calculation of elasticities is not straightforward. There are many paths that can be followed to aggregate the individual STOPS and $STOPS^2$ coefficients into a single elasticity for each route group. The method chosen in PRC LR-10 to evaluate equation 11 to estimate running-time elasticities is just one of these many alternative methods that could have been implemented. Yet there are no criteria available to determine which alternative was really the best.

A more complete examination of the method actually chosen by PRC LR-10 will demonstrate this problem more clearly. This method first multiplies coverage ratios by stop type by the average number of possible stops located at each CATFAT route within each of the three route groups. This produces estimates of average actual SDR, MDR, and BAM stops for each CATFAT route, $\hat{STOPS}_i$, within each route group. Next, a separate partial derivative of running time with respect to actual stops, $(\widehat{\partial RT / \partial STOPS})$, is estimated by stop type for each CATFAT route within a route group. These two values are multiplied together to determine $((\widehat{\partial RT / \partial STOPS}) * (\hat{STOPS}))_i$ for each CATFAT route. This result is then averaged over all CATFAT routes within a given stop type-route group combination to arrive at:

$$(\widehat{\partial RT / \partial STOPS}) * (\hat{STOPS}) \qquad (12)$$

for that combination. Running times are also estimated for each individual CATFAT route within a given stop type-route group combination. In particular, route-specific intercepts are substituted into the right hand sides of the three route group regressions along with the estimated values for actual stops to produce corresponding estimates of curbline, foot, and park & loop running times by stop type. These running-time estimates are then averaged over all CATFAT routes within a given stop type – route group combination. This average is referred to as $\hat{RT}$. Finally, division of the term in expression 12 by this $\hat{RT}$ produces the single aggregate running-time elasticity for the given stop type-route group combination.[39]

PRC LR-10 did not explain why this particular method was chosen over alternative methods of using the quadratic model with interactions to calculate running-time elasticities. Yet these alternative methods produce much different elasticities. Moreover, there is no evidence or theoretical basis for concluding that the elasticity estimates produced in PRC LR-10 are preferred to these alternative estimates.

For illustration, this testimony will consider one alternative method. This method computes separate partial derivatives of running time with respect to stops for each route within each stop type-route group combination and then averages these to arrive at one partial derivative. An average number of actual stops is also computed for each route and then averaged across all routes within each stop type-route group combination. Finally, an estimated running time is computed for each route and then averaged across all routes within each stop type-route group combination. Elasticities are computed for each stop type-route group combination by multiplying the average partial derivative by the average value of actual stops and dividing the result by the average estimated running time.

The resulting nine elasticity estimates differ greatly from those produced by the PRC LR-10 method applied to the interactions model. This is demonstrated in table 20,

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[39] Comprehensive presentations of the procedures implemented in Docket No. R90-1, USPS-T-7 and PRC LR-10 to derive elasticities are provided by USPS LR-H-141 (The Quadratic Model) and USPS LR-H-142 (The Quadratic Model With Interactions). Note that PRC LR-10 did not use RUNUM*RTYPE coefficients to estimate elasticities, because it believed the estimation should occur at run number 5 levels, and $RUNUM_5$ is excluded from the regression.

which reports FY 1996 elasticities calculated through application of both the PRC LR-10 method, and the alternative method just presented.[40] The elasticities from the PRC LR-10 method, listed in the first data column, are much lower for the foot group than are comparable results produced by the alternative interactions model methodology. Yet there are no reasons for choosing the PRC LR-10 results over these new alternatives.

Table 20. FY 1996 Estimated Running-Time Elasticities, Quadratic Model With Interactions

	ELASTICITY FROM PRC LR-10 METHOD	ELASTICITY FROM ALTERNATIVE METHOD
CURBLINE ROUTES		
SDR	.439	.467
MDR	.396	.336
BAM	.463	.499
FOOT ROUTES		
SDR	.666	.859
MDR	.679	.815
BAM	.683	.800
PARK & LOOP ROUTES		
SDR	.562	.604
MDR	.616	.596
BAM	.546	.598

There is one more important difference between the methods used to estimate elasticities in Docket No. R90-1, USPS-T-7 and in PRC LR-10. USPS-T-7 estimates running time and running-time elasticities by evaluating each of the curbline, foot, and

[40] Documentation of these calculations is provided in USPS LR-142.

park & loop equations at the mean values of the run number dummies. PRC LR-10, however, evaluates each equation at run number five. Recall that run number dummy variables are included in both model specifications to control for a learning curve effect. The Commission's Docket No. R90-1 Opinion and Recommended Decision and PRC LR-10 argue that it is appropriate to measure running-time as though all learning had taken place. Thus, it should be measured at run number 5 levels. However, this is only appropriate if the learning curve is reflective of the experience that an actual carrier gains by repeatedly servicing a route over a long period of time – say for at least several months. In fact, it is unlikely that the learning that took place over the course of five test runs conducted in a 1988 one-time simulation of carrier activity on a CATFAT test route accurately measured this type of real life learning experience. Thus, it is appropriate to simply correct for any CATFAT test learning effect – which is different than the learning effect on real routes – through evaluation of running time at the average of the run number dummy variables. This is the methodology implemented to estimate quadratic model running-time elasticities.

Table 21 compares the FY 1996 elasticities produced by the quadratic model with those produced through application of the PRC LR-10 methodology (as opposed to the alternative methodology discussed earlier) for aggregating the coefficients in the quadratic model with interactions into a single elasticity per stop type - route group combination.[41] The latter elasticities are taken from the first data column of table 20. The associated Fiscal Year 1996 mean coverages are also listed.[42]

Table 21. Comparison of FY 1996 Running-Time Elasticities

	QUADRATIC MODEL ELASTICITY	QUADRATIC MODEL WITH INTERACTIONS ELASTICITY	MEAN COVERAGE
CURBLINE ROUTES			
SDR	.494	.439	.934
MDR	.487	.396	.988
BAM	.498	.463	.904
FOOT ROUTES			
SDR	.596	.666	.879
MDR	.597	.679	.899
BAM	.598	.683	.904
PARK & LOOP ROUTES			
SDR	.480	.562	.922
MDR	.470	.616	.980
BAM	.482	.546	.905

A comparison of tables 19 and 21 reveals that elasticities did not change significantly from 1989 to 1996. The comparison also raises additional concerns relating to the quadratic model with interactions. Both the quadratic model and the quadratic model with interactions are used to estimate only one regression for each route group. Each regression is applied to all three stop types - SDR, MDR, and BAM.

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[41] The FY 1996 quadratic model and quadratic model with interactions elasticities are derived in USPS LR-H-141 and USPS LR-H-142, respectively.

[42] These are calculated in USPS LR-H-143.

Thus, both models assume that the relationship between running time and actual stops is the same across stop type within each route group. This implies that the elasticities of running time with respect to actual stops should also be at least roughly the same within each group.

This is indeed the case for the quadratic model elasticities. For both FY 1989 and FY 1996, the quadratic model produces elasticities which vary across stop type by only two percentage points or less within each route group - curbline, foot, and park & loop. However, the elasticities produced by the quadratic model with interactions in some cases do differ significantly by stop type. In particular, FY 1996 MDR elasticities differ substantially from BAM elasticities within the curbline group, and differ substantially from both BAM and SDR elasticities in the park & loop groups (see table 21). For the curbline group, the quadratic model with interactions produces an MDR elasticity that is significantly lower than the BAM elasticity. For the park & loop group, the quadratic model with interactions produces an MDR elasticity that is significantly higher than both BAM and SDR elasticities.

The inconsistencies in the deviations of the MDR elasticities from the BAM and SDR estimates are also cause for concern. Even if it is accepted, for the moment, that the MDR elasticity should differ significantly from the SDR and BAM elasticities, say because of the much higher MDR coverage level, it still makes little sense that this higher MDR coverage leads to a lower elasticity for MDR versus SDR and BAM on curbline routes, and a relatively higher MDR elasticity on park & loop routes.

Table 22 calculates accrued access costs through multiplication of the elasticities in table 21 by accrued running-time costs. Total FY 1996 accrued running-time costs equaled $630,541,000, $303,380,000, and $2,645,352,000, respectively, for the curb, foot, and park & loop route groups.[43] From these totals, the quadratic model elasticities (split factors) produce access costs that are higher for curb routes, and lower for foot and park & loop routes, than are the access costs produced by the quadratic model with interactions split factors. Overall, accrued access costs derived from the quadratic model elasticities are $211,822,000 less than those derived from the quadratic model with interactions.[44]

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[43] USPS-T-5, WP-B at Worksheet 7.0.4.1.

[44] The access costs shown in table 22 for the quadratic model differ slightly from those reported in USPS-T-5, WP-B at Worksheet 7.0.4.1, because of corrections made to the regression estimates after the worksheet had been completed.

Table 22. FY 1996 Accrued Access Costs. ($000)

	QUADRATIC MODEL ELASTICITY	QUADRATIC MODEL WITH INTER-ACTIONS ELASTICITY	ACCRUED RUNNING-TIME COSTS	QUADRATIC MODEL ACCRUED ACCESS COSTS	QUADRATIC MODEL WITH INTER-ACTIONS ACCRUED ACCESS COSTS
CURBLINE ROUTES					
SDR	.494	.439	$ 542,638	$ 268,193	$ 238,399
MDR	.487	.396	$ 34,550	$ 16,813	$ 13,671
BAM	.498	.463	$ 53,353	$ 26,563	$ 24,681
TOTAL			$ 630,541	$ 311,570	$ 276,751
FOOT ROUTES					
SDR	.596	.666	$ 177,844	$ 105,938	$ 118,497
MDR	.597	.679	$ 49,342	$ 29,471	$ 33,525
BAM	.598	.683	$ 76,194	$ 45,543	$ 52,059
TOTAL			$ 303,380	$ 180,953	$ 204,081
PARK & LOOP ROUTES					
SDR	.480	.562	$2,202,723	$1,056,426	$ 1,237,479
MDR	.470	.616	$ 172,629	$ 81,077	$ 106,410
BAM	.482	.546	$ 270,000	$ 130,191	$ 147,318
TOTAL			$2,645,352	$1,267,694	$ 1,491,207
TOTAL					
SDR			$2,923,205	$1,430,557	$ 1,594,375
MDR			$ 256,521	$ 127,361	$ 153,606
BAM			$ 399,547	$ 202,298	$ 224,058
GRAND TOTAL			$3,579,273	$1,760,217	$ 1,972,039

PART 2 - SECTION IV. ELASTICITY PROPOSAL

It is proposed that the quadratic model should be used to estimate Fiscal Year 1996 running-time elasticities and accrued access costs. The quadratic specification produces STOPS and $STOPS^2$ coefficient estimates which confirm the common sense expectation that running time will rise as the number of stops accessed increases, and that the rate of increase in running time will fall as more stops are accessed. These coefficient estimates are also statistically significant, and can therefore be used with confidence to compute elasticities.

The quadratic model with interactions produces coefficient estimates for STOPS and $STOPS^2$ that are operationally indefensible. A large percentage of the estimated STOPS coefficients are negative, implying the improbable result that running time goes down as actual stops go up. Also, a large percentage of estimated $STOPS^2$ coefficients are positive, contradicting the operationally sensible view that marginal running time with respect to actual stops should decline as actual stops increase.

Moreover, only the elasticities estimated from the quadratic model are consistent with the operational basis of the CATFAT analysis. Separate running-time equations are not estimated for each stop type, and therefore there is no operational reason to expect running-time elasticities to differ across stop types. This logic is confirmed by the quadratic model elasticities, which are predominantly uniform across stop type within each route group. Yet, the MDR elasticities computed from the quadratic model with interactions sometimes do differ significantly, and in an inconsistent manner, from the SDR and BAM elasticities.

The operational anomalies of the quadratic model with interactions are matched by equally troublesome statistical properties. The t statistics for the STOPS and $STOPS^2$ coefficients estimated for all the different CATFAT routes within each route group indicate that almost all of these route-specific coefficients are statistically insignificant. Therefore, any elasticities that are computed through substitution of these coefficients into the myriad of elasticity formulas that can be applied to the interactions model are also statistically insignificant, and cannot be applied with confidence to estimate accrued access costs.

Finally, since aggregation must be performed in applying both the quadratic model with interactions equation as well as the basic quadratic equation to elasticity estimation, it is simply more reasonable to use a model that estimates only one coefficient for each of the stops terms. This also avoids the problem of having to choose one of multiple methods for computing elasticities, when no criteria are available to suggest which alternative is best.

Therefore, both statistical and operational logic establishes that the quadratic model produces more accurate and believable results. FY 1996 running-time elasticities generated by that model should be applied to calculate accrued access costs.

PART 3 - SECTION I. OVERVIEW

This part of the testimony revises the current procedure for measuring the volume-variable costs of segment 10 rural carrier labor. Section II reviews the current procedure. Section III proposes a modification to produce volume-variable costs that are consistent with the Postal Service's position that volume-variable costs per unit should measure marginal costs.

PART 3 - SECTION II. THE PREVIOUS PROCEDURE

The previous rural carrier cost analysis first splits total carrier labor costs into two categories. These categories, and their FY 1996 accrued costs (in thousands of dollars), are as follows:[45]

Evaluated Routes	$2,801,424
Other Routes	$ 273,010

A. Evaluated Routes

Evaluated routes are served by carriers whose annual salary costs are determined by the application of standard time allowances. The previous procedure for measuring these allowances, and for using them to calculate volume-variable costs was accomplished through a four step process.

[45] See USPS-T-5, WP-B at Worksheets 10.0.1 and 10.2 1

First, carrier workload is categorized into 31 distinct cost drivers. These drivers are defined as various carrier activities and workload factors which determine the total office and street time required to service a route. 16 of these drivers are activities for which the time required for completion varies proportionately with volume delivered on the route. Examples include activities such as the delivery of letters, the delivery of flats, and the collection of letters and flats. These volume-variable drivers are referred to as variable evaluation items.

The remaining 15 drivers are a combination of fixed route characteristics, such as route mileage and numbers of rural boxes served, and other carrier activities for which the time required for completion is unaffected by route volume. These drivers are called fixed evaluation items.

Step 2 assigns each of the 31 drivers an "evaluation factor," which is a measure of the standard amount of time that one unit of the driver requires. For variable evaluation items, this factor is expressed as minutes per unit of activity. For example, the factor for the delivery of letters item is expressed as 0.0791 minutes per letter delivered. For fixed evaluation items, the evaluation factor is expressed as either minutes per unit of activity, or minutes per unit of the factor which generates the workload. An example is the factor for route miles, which equals 12 minutes per mile.[46]

Step 3 applies these evaluation factors to the calculation of average weekly carrier times per route for each of the 31 evaluation items. To do this, the Postal

[46] This process implies a linear rural cost function, in which cost is equal to the sum of the variable factors and the nonvariable factors.

Service conducts periodic "National Mail Counts," which record the levels of activity and numbers of units by workload factor for all 31 items on each of a large sample of all rural routes in the system. These measures are then aggregated to produce estimates of average FY 1996 activity levels and units served per week per route over all rural routes.[47] The product of each such estimate and the corresponding evaluation factor produces an estimate of average weekly minutes for the given item. For example, the average weekly activity level estimated for the letters delivered item equals 5,713 letters per week per route. The product of this level and the evaluation factor of 0.0791 minutes per letter equals an estimated 452 minutes per week per route for delivering letters in FY 1996.[48]

Step 4 uses these estimated average minutes per week across all 31 evaluation items to calculate volume-variable costs. A simulation is performed in which a 10 percent increase in volume, and a resulting 10 percent increase in all evaluation amounts are hypothesized for all rural routes. For the 16 variable evaluation items, this 10 percent increase, by definition, results in a corresponding 10 percent increase in variable evaluation minutes per week. Thus, the volume variability for this group of items is 0.10/0.10 or 100%. For the 15 fixed evaluation items, the 10 percent workload increase has no effect on minutes per week, indicating a volume variability of 0 for these items.

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[47] These estimates, along with the values for the corresponding evaluation factors, are presented in USPS-T-5, WP-B at Worksheet 10.1.1.

[48] See USPS-T-5, WP-B at Worksheet 10.1.1 for a complete listing of these average minutes per week estimates across all 31 evaluation items. Note also that the calculation of minutes per week for the 31 items for each individual rural route produces the time allowance data needed to determine the annual carrier salary for that route.

These results suggests that the overall volume variability estimate produced by the simulation analysis should simply be calculated as the 100% variability defined for variable evaluation items times the ratio of total variable evaluation minutes per week to total variable plus fixed evaluation minutes per week.[49] This, of course, implies a simple equality between the ratio of variable to total minutes and the volume variability. However, as is explained in section III, whereas the ratio of variable to total evaluation minutes is the overwhelming determinant of the volume variability, a second factor causes the variability estimate to differ slightly from that ratio.

B. Other Routes

The traditional cost analysis for "other routes" implements the same procedure just described for evaluated routes. Indeed, the difference between the evaluated and other route categories relates only to how individual carriers are paid - not to how their aggregate annual costs are allocated into the volume-variable and non-volume-variable cost pools.[50] Thus, "National Mail Counts" are again conducted to produce estimates of average weekly activity and factor levels per other route for each of 31 evaluation items. These are multiplied by the same evaluation factors used for evaluated routes

[49] This ratio of variable to total evaluation minutes per week is derived in USPS LR-H-189.

[50] For evaluated routes, individual annual salaries are determined through the same multiplication of evaluation factors by average weekly evaluation levels that is used for product cost allocation. However, this is not the case for rural carriers assigned to "other routes." These carriers are compensated on an hourly or on the basis of route mileage, even though their total annual salary costs are split into volume-variable and non-volume-variable portions through the same procedure that is applied to evaluated route costs.

to produce average weekly minutes per item.[51] Finally, the ratio of the total variable evaluation minutes to the total variable plus fixed evaluation minutes is again applied in a 10 percent simulation analysis to help estimate a volume variability.

C. The Calculation of Volume Variability

The previous Postal Service approach to deriving the volume variabilities is presented in Appendix J of the Postal Rate Commission's Docket R90-1, Appendices to Opinion and Recommended Decision. As noted earlier, a simulation is performed to determine the effects of a 10 percent increase in volume on rural carrier salaries. In particular, the simulation accounts for the fact that when volume and therefore workload increase by a significant amount on evaluated and other routes, the structure and classification of certain routes change.[52] These changes imply that cost increases will be slightly different than the increases implied by the ratio of variable evaluation minutes to total evaluation minutes. In particular, increases in variable evaluation minutes will be slightly less than proportional to increases in workload.

PART 3 - SECTION III. THE PROPOSED NEW PROCEDURE

This testimony proposes a modest change in this traditional volume variability calculation. It proposes to no longer account for route reclassifications that occur in response to large discrete volume and workload changes.

[51] These are derived in USPS-T-5, WP-B at Worksheet 10.2.1.

[52] A more complete description of these changes that can occur in response to significant volume and workload growth is presented in Section 10 of USPS LR-H-1, Summary Description of USPS Development of Costs by Segment and Component.

This proposal is compelled by two reasons. First, the calculation of volume variability under the simulation approach is critically dependent upon the arbitrary assumption of a 10 percent volume increase. Different assumptions about volume changes will lead to different volume variabilities, and there is no basis for selecting a 10 percent increase in all classes of mail, as opposed to smaller increases. In fact, assuming a more modest and thus realistic increase in volume will generate a volume variability virtually equal to the ratio of variable evaluation minutes to total minutes.

More importantly, the finite incremental approach embodied in the simulation model is inconsistent with the calculation of marginal cost, and it has been rejected by the Commission in other areas. In Docket No. R87-1, the Commission rejected the application of the finite incremental method to load time analysis in favor of the so-called "exact variability" approach, which measures variability as the elasticity of the underlying cost equation evaluated at mean levels of volume.[53]

Application of this exact approach to rural carriers requires evaluation of the implicit rural carrier cost equation at mean volumes. Moreover, because the rural carrier equation is linear, this produces a variability exactly equal to the ratio of variable evaluation time to total time. Observe, in addition, that the product of this ratio and total accrued cost produces a volume-variable cost that does equal, per unit, marginal rural carrier cost, thus satisfying a key criterion of the Postal Service costing model.[54]

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[53] See Docket No. R87-1, Opinion and Recommended Decision, para. 3363, p. 246.

[54] For a more complete explanation of this criterion, the association of volume-variable costs with marginal costs, and the distinction between marginal and incremental costs, see Direct Testimony of Dr. John C. Panzar, Docket No. R97-1, USPS-T-11, and Direct Testimony of Dr. John C. Panzar, Docket No. R90-1, USPS-REM-T-2.

Table 23 shows the values of the ratio of variable evaluation time to total evaluation time presented in USPS-T-5, WP-B, Worksheet 10.0.1 for FY 1996.[55] It is proposed that these ratio values now be used as the volume variabilities for evaluated routes and rural routes that are applied to produce the FY 1996 volume-variable rural carrier costs shown in the last column of table 23.

Table 23. Proposed FY 1996 Volume Variabilities and Volume-Variable Costs for Rural Carriers

Route Category	Volume Variability = Equals the Ratio of Variable Evaluation Minutes to Total Variable Plus Fixed Evaluation Minutes	Volume-Variable Cost ($000)
Evaluated Routes	**0.4904**	**$ 1,373,846**
Other Routes	**0.4987**	**$ 136,139**
Total	**NA**	**$ 1,509,985**

[55] These are derived in USPS LR-H-189.