USPS-T-22

BEFORE THE
POSTAL RATE COMMISSION
WASHINGTON, D.C. 20268-0001

Postal Rate and Fee Changes, 2000	Docket No. R2000-1

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

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AUTOBIOGRAPHICAL SKETCH

My name is Michael D. Bradley and I am Professor of Economics at George Washington University. I have taught economics there since 1982 and I have published many articles using both economic theory and econometrics. Postal economics is one of my major areas of research. I have presented my research at various professional conferences and I have given invited lectures at both universities and government agencies. Beyond my academic work, I have extensive experience investigating real-world economic problems, as I have served as a consultant to financial and manufacturing corporations, trade associations, and government agencies.

I received a B.S. in economics with honors from the University of Delaware and as an undergraduate was awarded both Phi Beta Kappa and Omicron Delta Epsilon for academic achievement in the field of economics. I earned a Ph.D. in economics from the University of North Carolina and as a graduate student I was an Alumni Graduate Fellow. While being a professor, I have won both academic and nonacademic awards including the Richard D. Irwin Distinguished Paper Award, the American Gear Manufacturers ADEC Award, a Banneker Award and the Tractenberg Prize.

I have been studying postal economics for about fifteen years, and I have participated in many Postal Rate Commission proceedings. In Docket No. R84-1, I helped in the preparation of testimony about purchased transportation and in Docket No. R87-1, I testified on behalf of the Postal Service concerning

the costs of purchased transportation. In Docket No. R90-1, I presented rebuttal testimony in the area of city carrier load time costs. In the Docket No. R90-1 remand, I presented testimony concerning the methods of city carrier costing.

I returned to transportation costing in Docket No. MC91-3. There, I presented testimony on the existence of a distance taper in postal transportation costs. In Docket No. R94-1, I presented both direct and rebuttal testimony on an econometric model of access costs.

More recently, in Docket R97-1, I presented three pieces of testimony. I presented both direct and rebuttal testimony in the area of mail processing costs. I also presented testimony on the costs of purchased highway transportation

Beside my work with the U.S. Postal Service, I have served as a expert on postal economics to postal administrations in North America, Europe, and Asia. Of particular relevance to this testimony, I have worked with Canada Post for a decade on their incremental cost system. I provided the original analytical basis for their incremental cost model when it was first constructed and have provided them with methodological advice as the model has been refined. I currently serve as Canada Post's External Methodological Advisor.

PURPOSE AND SCOPE

The purpose of my testimony is to present and explain the Postal Service's new method for calculating incremental costs. I describe how the new method improves upon the previous method and I demonstrate that it is consistent with the established Postal Rate Commission methodology for estimating test-year attributable costs. I also provide the mathematical basis for the calculations.

It is my goal to encourage the Commission to adopt incremental costs in place of attributable costs in its costing analysis. Incremental cost is a more accurate measure of the total cost caused by a product and in the postal context incremental cost will exceed attributable cost. It is thus a better basis for analyzing if a product's revenue is sufficient to cover its cost when testing for cross subsidy.

There are no library references or workpapers directly associated with this testimony. Application of the methods described in this testimony is presented by witness Kay, USPS-T-23.

I. INCREMENTAL COSTS ARE ESSENTIAL FOR GUARDING AGAINST CROSS SUBSIDY. THE NEW POSTAL SERVICE METHOD IS ACCURATE, FLEXIBLE, AND CONSISTENT WITH ESTABLISHED COMMISSION COSTING METHODS.

In Docket No. R97-1, the Postal Service presented a new cost measure, known as incremental cost, for the Commission's consideration.[1] Although the concept of incremental cost had been presented to the Commission in previous cases, Docket No. R97-1 was the first time actual incremental costs were calculated.[2]

The Postal Service introduced incremental costs in Docket No. R97-1, because of their essential role within the regulatory framework for a multi-product firm. As is well known, incremental cost measures the *total* cost caused by a product. It is therefore the ideal cost measure for testing for cross-subsidy or for ensuring that a product's revenue covers its cost.[3] Because there is no properly calculated total product cost measure that can exceed a product's incremental

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[1] See, Direct Testimony of William M. Takis on Behalf of the United State Postal Service, Docket No. R97-1, USPS-T-41 and Direct Testimony of John C. Panzar on Behalf of the United States Postal Service, Docket No. R97-1, USPS-T-11.

[2] For an early discussion of the concept of incremental cost and its role in the regulatory framework, see Direct Testimony of William J. Baumol on Behalf of the United States Postal Service, Docket No. R87-1.

[3] The incremental cost of a product is the total additional cost caused by adding that product to the existing product mix. For example, suppose that a firm produces two products, X and Y. The incremental cost of Y is the total cost of increasing the output of Y from zero to its current level, Y*, while holding the level of X constant. Note that the incremental cost of Y depends upon both any fixed cost devoted to producing Y and the current level of production of X.

cost, any test of cross-subsidy that does not make use of incremental cost is subject to error. For example, it is possible for a product's revenue to cover its "attributable cost" as measured by the Postal Rate Commission, but still be below its incremental cost.

In the last rate case, the Commission endorsed the effort to calculate incremental cost but did not accept the Postal Service's measurements because of certain perceived deficiencies in the method of calculation. Nevertheless, the Commission made clear that is was interested in receiving an improved version of the Postal Service's incremental cost calculation:[4]

> Witness Takis' attempt to develop the incremental costs of postal services directly responds to Commission interest expressed in Docket No. R94-1, PRC Op. R94-1, Appendix F, paras. 167 and 170. It clearly represents a serious effort to examine an extraordinarily complex and difficult problem. In reviewing this testimony, the Commission has had to bear in mind how the line of inquiry represented by witness Panzar's theories and witness Takis' applications might develop into a useful tool for identifying cross-subsidy in future proceedings. Would a future Commission wish to be alerted to the possibility of a cross-subsidy as identified by a more acceptable and applicable successor to witness Takis' incremental cost test? Clearly, the answer is "yes."

The Postal Service has produced such an improved version in this case. The Commission was very clear in describing the concerns it had with the old method of calculation. This clarity permitted the Postal Service to modify its methods of calculation so that the new methods are consistent with established

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[4] See PRC Op., R97-1, at 248.

Commission methods of product cost measurement. For example, the primary concern that the Commission voiced about the Postal Service's previous effort was that it would have been forced to use incremental costs that were critically dependent upon untested (and ultimately rejected) costing studies:[5]

> In witness Takis' own words, "it is imperative that any approach to estimating incremental costs starts with, and ultimately is consistent with, the analyses that determine volume variable cost in BY 1996." *Id.* at 8. Since the Commission has rejected the model proposed by witness Baron with respect to load time cost variability, and that of witness Bradley with respect to mail processing cost variability, it would be inconsistent for the Commission to depend upon evidence supplied by witness Takis that rests upon these rejected models.

While I concur with witness Takis' admonition about the consistency of volume variable costs and incremental costs, I would point out that such consistency does not require reliance upon untested cost studies. In fact, the new method of calculating incremental costs, like the Commission's calculation of attributable costs, relies upon only the variabilities from such cost studies, not the cost studies themselves. Thus, as I demonstrate below, under the new method it will be quite easy for the Commission to calculate incremental costs for any set of variabilities/cost studies it chooses. The objection that incremental costs are predicated upon a specific set of cost studies is no longer a barrier to the Commission's use of incremental costs.

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[5] Id.

The Commission also rejected the use of incremental cost in Docket No. 97-1 because the calculated incremental costs were related to the Postal Service's proposed rates, not the rates the Commission ultimately chose:[6]

> Also, the Commission's recommended rates differ from those requested by the Postal Service in this proceeding. Consequently, the Commission makes no use of witness Takis' estimates of incremental cost and relies instead on attributable costs, as it has in past proceedings, to demonstrate that its recommended rates are free of cross-subsidies.

This concern is also alleviated by the new method of calculation. Because the new method requires the same information to calculate test-year incremental costs that are required to calculate test year attributable costs, the incremental cost test can now be performed on any after-rates test-year volumes. Just as the Commission has checked its after-rates revenues against attributable costs in the past, it now can check its after-rates revenues against incremental costs.

In sum, the new method of calculating test-year incremental costs is flexible and entirely consistent with established costing methodology. It has the same information requirements as test-year attributable costs and it addresses the concerns the Commission raised in the last case.

To understand the new method and how it works, we must first understand, from a macro perspective, how the current costing methodology works. That is accomplished in the next section of my testimony. The

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[6] Id.

subsequent section explains and discusses the new method for calculating test year incremental costs. The analytical structure of the cost calculations is then presented and the testimony ends with a review of the Commission's concerns about how incremental costs were calculated in Docket No. R97-1 and a discussion of how the current method addresses those concerns.

II. THE CURRENT METHOD FOR ESTIMATING TEST- YEAR ATTRIBUTABLE COSTS.

A. The Method Use for Calculating Attributable Cost Is Known as "Calibration."

The current method of calculating attributable costs depends upon a "calibrated" cost model as opposed to an "estimated" cost model.[7] An estimated model has its parameters estimated econometrically from a single set of data. A calibrated model has its parameters determined from a variety of sources, with some estimated econometrically, some determined from engineering studies, and some established by judgment.

In the calibration approach, the structure of the model is first determined and then the models is "calibrated;" that is, the structure of the model is populated with chosen values for the parameters. After calibration, the model can than be solved (or simulated) for the desired variables. In the case of the

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[7] For some introductory discussions of calibration, see, Adrian Pagan, "Calibration and Econometric Research: An Overview," Journal of Applied Econometrics, Dec. 1994 or Danny T. Quah, Business Cycle Empirics: Calibration and Estimation: An Introduction, Economic Journal, November 1995, p 1594-1596.

attributable cost model, the model is populated with variabilities and distribution keys from a variety of sources and is then "solved" to calculate both base-year and test-year attributable costs.

The calibration methodology can be illustrated through a simple example. Suppose that the postal costing structure had three products: Class A, Class B and Class C and four cost pools: Pool 1(Retail), Pool 2 (Transportation), Pool 3 (Mail Processing), and Pool 4 (Delivery). The structure of the product cost model in this simple case can be envisioned as a 4 X 3 matrix with the rows representing the cost pools and the columns representing the classes. Such a matrix can be represented as:

	Product A	Product B	Product C
Retail Cost	VVC_{RA}	VVC_{RB}	VVC_{RC}
Transportation Cost	VVC_{TA}	VVC_{TB}	VVC_{TC}
Mail Processing Cost	VVC_{MA}	VVC_{MB}	VVC_{MC}
Delivery Cost	VVC_{DA}	VVC_{DB}	VVC_{DC}

For each cell, the volume variable cost for the individual class is given by the product of the cells accrued cost, (C), its variability (ε) and the class' share of the distribution key (θ). For example, Class A's volume variable retail cost is given by the product of accrued cost for retail, (C_R), the variability for retail (ε_R) and

Class A's share of the retail distribution key (θ_{RA}). Mathematically, the volume variable retail cost for Class A is given by:

$$VVC_{RA} = C_R \varepsilon_R \theta_{RA}. \quad (1)$$

The product cost model, in this case, can be represented by four equations, one for each of the cost pools. The first equation represents the retail cost pool, the second the transportation cost pool, the third the mail processing cost pool and the fourth represents the delivery cost pool.

$$\begin{aligned} C_R &= C_R \varepsilon_R \theta_{RA} + C_R \varepsilon_R \theta_{RB} + C_R \varepsilon_R \theta_{RC} \\ C_T &= C_T \varepsilon_T \theta_{TA} + C_T \varepsilon_T \theta_{TB} + C_T \varepsilon_T \theta_{TC} \\ C_M &= C_M \varepsilon_M \theta_{MA} + C_M \varepsilon_M \theta_{MB} + C_M \varepsilon_R \theta_{MC} \\ C_D &= C_D \varepsilon_D \theta_{DA} + C_D \varepsilon_D \theta_{DB} + C_D \varepsilon_D \theta_{DC}. \end{aligned} \quad (2)$$

The structure of the model is determined by the cost pool breakout and product definitions. The Postal Service accounting system typically provides the cost pools but the model must be calibrated by selecting the values for the variabilities (the εj) and the distribution keys (the θij).[8]

The above model provides volume variable cost, but can be easily

[8] There are instances in which the cost pool definition depends upon systems other than the pure accounting system. For example, in mail processing, cost pools may in part be defined by MODS data or IOCS data.

augmented to provide attributable cost. Suppose that there are specific fixed costs for Class B in transportation and for Class C in delivery. The analogous attributable cost model is given by:

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\begin{aligned}
C_R &= C_R\varepsilon_R\theta_{RA} + C_R\varepsilon_R\theta_{RB} + C_R\varepsilon_R\theta_{RC} \\
C_T &= C_T\varepsilon_T\theta_{TA} + F_{TB} + C_T\varepsilon_T\theta_{TB} + C_T\varepsilon_T\theta_{TC} \\
C_M &= C_M\varepsilon_M\theta_{MA} + C_M\varepsilon_M\theta_{MB} + C_M\varepsilon_R\theta_{MC} \\
C_D &= C_D\varepsilon_D\theta_{DA} + C_D\varepsilon_D\theta_{DB} + F_{DC} + C_D\varepsilon_D\theta_{DC}.
\end{aligned}
\tag{3}
$$

In this set of equations F_{TB} represents the specific fixed cost for Class B in transportation and F_{DC} represents the specific fixed cost for Class C in delivery.

To be more precise, we will review the current method for calculating attributable costs and then consider those methods though the lens of a calibration exercise. Before pursuing that detail, however, a final issue must be addressed. Although the Commission and Postal Serve have differed on the calibration of the cost model, there is generally little disagreement about the structure of that model. That is, there is general agreement about the structure of the cost components and there is a common overall method for calculating base-year and test-year costs.

The differences between the Commission and the Postal Service have typically arisen because of divergent views over the choice of the variabilities and distribution keys required to calibrate the model. Once those choices are

made, however, a common method is used to calculate test year costs. It is true that the Postal Service calculates "volume variable" costs and the Commission calculates "attributable" costs. The difference between these cost measures is only specific fixed costs, so there is no fundamental conflict in methodology; the Commission simply takes volume variable costs and adds specific fixed costs to them to calculate attributable costs.[9] In what follows, therefore, I can safely refer only to "the" cost model without reference to whether it is "the Commission's model" or "the Postal Service's model."

B. The Steps Through Which Test-Year Attributable Costs are Estimated.

The established methodology for estimating test year attributable costs can be described in five steps.

Step 1: Data collection

The process starts with the collection data by the Postal Service. In some cases, this is an ongoing process in which the same systems are used to collect product and cost data on an annual basis. In other instances, special data sets are collected and used to estimate new parameters. Examples of ongoing systems are IOCS and TRACS. An example of a special data set is HCSS.

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[9] The term "specific fixed" cost may have been the source of some confusion in the past as it may have been applied to some costs that were not fixed. As I explain below, there are some cost that are neither fixed nor volume variable but should be included in a product's incremental cost.

Step 2: Special studies to update and improve the model's parameters.

Postal Service analysts, intervenor analysts, and Commission staff produce special studies based upon the data the Postal Service collects. These studies typically produce either estimates of variabilities or estimates of distribution keys for the various components.

Step 3: Commission selection of its preferred values for the parameters.

During the ten-month period of the rate case, the Commission will select specific values for the parameters required to calibrate the model. It will chose its preferred values for specific fixed costs, variabilities and distribution keys from the studies presented by the Postal Service or intervenors, or it will rely upon parameters produced by its own staff or consultants.[10] Finally, the Commission may choose to retain the old parameters.

It is important to note that this process does not require including the new *studies* in the cost model – it only requires including the values

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[10] For examples of the Commission choosing a set of parameters produced by the Postal Service see the adoption of TRACS distribution keys in Docket No. R90-1 (See PRC Op., R90-1 at 154). or the adoption of new variabilities for purchased highway transportation in Docket No. R97-1 (See PRC Op., R97-1 at 205). For examples of the Commission choosing parameters estimated by its own staff or consultants see the adoption of purchased highway transportation variabilities in Docket No. R87-1 (See PRC Op., R87-1 at 314) or the choice of city carrier load time variabilities in Docket No. R90-1 (See PRC Op., R90-1 at III-85).

for the *parameters* that have been produced. This means that the studies (and analytical structures) underlying the chosen parameters are not explicitly used in the calculation of attributable costs. It matters not in the calculation of attributable cost whether the estimated parameters came from an engineering study, from judgment, or from an econometric study using a linear function, a quadratic function, or a translog function.

Step 4: Calculate base- year attributable costs.

Once the model's structure has been populated with the chosen parameters, the model is used to calculate base year attributable costs. The first step is to calculate base-year volume variable costs. This requires combining the accrued cost in each component with the relevant elasticity to determine the pool of volume variable costs. These costs then are distributed to products based upon the chosen distribution keys. Total volume variable cost for a particular subclass is found by summing the component specific volume variable costs for that subclass.

A product's total base-year attributable cost is calculated by first identifying any specific fixed costs for that product and then adding them to the products total volume variable cost. Unit base-year attributable (volume variable) cost is found by dividing total base-year attributable (volume variable) cost by base-year RPW volume.[11]

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[11] A review of these steps may leave one with the question of how the Postal Service could calculate volume variable costs *before* culmination of a rate case. Yet, the Postal Service requires these costs before proposing new rates.

Step 5: Calculate test- year attributable costs.

The cost model estimates or forecasts the test-year attributable costs by a process known as "rolling-forward" the base-year attributable costs. To calculate the test-year costs, the base year costs are adjusted for anticipated changes expected to take effect between the base year and the test year. These anticipated changes include volume changes, input price changes and productivity changes. In roll-forward terminology, the base-year costs are adjusted by applying volume effects, cost level effects, non-volume workload effects, and special program effects. These adjustments are applied in a specific manner. In most components, the base year volume variable costs are adjusted upward or downward, in a multiplicative manner, for the anticipated change.

For example, in a component that gets a volume effect, each product's volume variable (and thus the volume variable portion of attributable) cost is multiplied by the expected volume growth rate for that product. If this were the only change in cost circumstances between the base year and test year, this calculation would produce test year volume

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The Postal Service's proposed volume variable costs differ from the volume variable costs calculated by the Commission solely in the choice of the parameters used to calibrate the model. Thus, if one replaces "the Commission chooses" with "the Postal Service chooses" in Step 3, the same process applies. In this way, the Postal Service determines its proposed rates before the case is filed. As the Postal Service does not calculate attributable costs, it is my goal to compare the Commission's calculation of attributable costs with the Postal Service's new method of calculation of incremental costs.

variable cost. This also means that the ratio of test-year to base-year attributable cost would be equal to the growth rate in volume. Note that all of the parameters of the model are held constant during the calculation of test-year costs.

There are some components, however, whose test year costs are calculated externally to the cost model. I am informed, for example, that test year workman's compensation costs are not determined through the roll forward process but are determined outside the model.

The established methodology is thus based upon constructing a model of attributable costs using parameters from special studies to embody the Commission's beliefs about the relationships between products and their costs. Once that structure is put into place, it is used to calculate both base-year and test-year costs without reference to the special studies. Moreover, the test-year costs are consistent with the base-year costs, in the sense that the test-year costs are just transformations of the base-year costs based upon anticipated changes in volumes, input costs, non-volume workload, and special programs or projects.

As we will see in the next section, the new method of calculating test-year incremental costs directly replicates this established methodology and is therefore entirely consistent with it. In this way, it mitigates the concerns raised by the Commission Docket No. R97-1 about the old method of calculating incremental costs.

III. THE NEW METHOD FOR CALCULATING INCREMENTAL COSTS.

To ensure that the calculation of incremental cost does not require any information beyond that required for the calculation of attributable cost, the new method of calculating incremental cost relies upon and parallels the established methodology. In fact, the first three steps of the incremental cost calculation are identical to the first three steps in the attributable cost calculation. Consequently, I begin the discussion of incremental cost calculation with step 3.

The similarity between incremental cost calculation, even under the old method, and attributable cost calculation has already been acknowledged by the Commission:[12]

> Witness Takis works within the same cost accounting framework as the Commission. It is the same accounting framework that is followed by the Service in its data collection and cost reporting systems and that is used by Postal Service witness Degen whose cost pools and attributions have been largely accepted by the Commission.
>
> At the subclass level the approach is identical in many of its assumptions and calculations to the Commission's calculations of attributable cost. Specific fixed costs are identified and used in the same way. Other information such as the single-subclass stop information is also used in the same way. The approach taken by witness Takis parallels the Commission's calculation of attributable cost in many important respects.

The concordance that the Commission has already recognized has been

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[12] See PRC Op., R97-1, Vol. 1 at 249

maintained in the new method of incremental cost calculation. Indeed, the Postal Service's modifications to the incremental cost calculation have increased the consistency between the methods of incremental cost calculation and the established methodology.

A. The Steps Through Which Test-Year Incremental Costs are Estimated.

The steps required to calculate test-year incremental cost are described below:

Step 1: Data collection

Same as in the Commission's attributable cost calculation.

Step 2: Special studies to update and improve the model's parameters

Same as in the Commission's attributable cost calculation.

Step 3: Commission selection of its preferred values for the parameters.

Same as in the Commission's attributable cost calculation.

Step 4: Calculate base-year incremental costs.

Incremental costs are calculated from the same base-year model as attributable costs. There is an essential difference in the method of calculation, however. Attributable costs incorporate only the cost of the last unit produced, whereas incremental costs incorporate the costs of all of the units produced.

To see how this works, consider the purchased highway transportation cost pool. There are no specific fixed costs in this cost pool, so attributable cost equals volume variable cost. The cost driver in this cost pool is cubic foot-miles (CFM) of transportation. Attributable cost if found by multiplying the variability of the cost driver (CFM) times accrued cost. Mathematically, this is the same as multiplying the marginal cost of the last CFM provided times the total number of CFMs.[13] The attributable cost is then distributed to products with the TRACS distribution key.

Incremental cost, on the other hand, recognizes the fact that not all CFM cost the same amount to produce. Incremental cost is found by multiplying each CFM times its own marginal cost, not the marginal cost of the last CFM.[14] Incremental costs thus allows for the fact that the marginal cost changes over the range of the product's output.

In any cost component for which the variability is less than one hundred percent, like in purchased highway transportation, the marginal cost of the driver (CFM) declines with increases in the driver (CFM). In other words, the cost of obtaining an additional CFM falls as the number of purchased CFMs increases. This means the cost to the Postal Service

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[13] The mathematics of the volume variable and attributable cost calculations are provide in the next section.

[14] The mathematics of incremental cost calculation are also given in the next section.

of providing the last CFM of transportation is below the cost of providing previous CFMs of transportation. It also means that a product's incremental purchased highway transportation cost will exceed its volume variable purchased highway transportation cost.

More generally, this means that for any cost component with a variability less than one hundred percent the incremental cost of a product in that cost component must exceed its volume variable cost in the component. If the variability in a cost component equals one hundred percent then the product's incremental cost equals its volume variable cost as the driver's marginal cost is constant.

To understand the calculation of incremental cost, we must consider the structure of the product cost model. Formally speaking, the calibrated model has a "constant elasticity" structure. That is, when the product cost model is used to calculate attributable cost, in either the base year or the test year, the elasticity parameters are held constant. For example, the same elasticity parameters are used to calculate both base-year and test-year attributable costs.[15] As was explained above, when the elasticity parameter is less than one, then the model implies that the

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[15] A bit of care in terminology is essential to avoid confusion here. Typically the terms 'elasticity" and "variability" are used interchangeably but in this instance they should not be treated so. Although the model has a "constant elasticity" structure as described above, it does not have a constant variability structure. A component's overall variability is sometimes calculated as the ratio of volume variable costs to accrued costs. A divergence between the two concepts occurs in the roll-forward process, where the variability ratio will change with volume changes, even within the model's constant elasticity framework.

marginal cost of producing another unit declines as the number of units produced increases. This characteristic is exactly what is required to calculate incremental cost and the incremental cost calculation takes advantage of this aspect of the constant elasticity form of the model, an aspect that the attributable cost calculation ignores. It is at this point in the calculations that incremental cost begins to exceed volume variable cost.

Step 5: Calculate test-year incremental costs.

The calculation of test-year incremental parallels the calculation of test-year attributable cost. The same set of volume effects, cost level effects, non-volume workload effects, and special program effects that are used to roll forward attributable costs are also use to roll forward incremental costs. This means that the same set of assumptions and methods used to calculate test-year attributable cost are now used to calculate test-year incremental costs.

B. The Relationship Among Incremental Cost, Volume Variable Cost and Attributable Cost.

In this section, I discuss the relationship among the three widely used postal cost measures, volume variable cost, attributable cost and incremental cost. Volume variable and incremental costs are calculated by the Postal Service and attributable cost is calculated by the Commission. To

understand the relationship among these cost measurements, I first observe that there are eight different types of cost pools in the cost model. The eight cost pool types are defined by the nature of the cost generating process causing costs to arise. A cost pool can be assigned to one of the eight types by answering a series of questions about the nature of the costs in the pool. The decision tree relating the set of questions is presented in Figure 1.

The first question to be asked is whether or not the costs are fixed or variable. A **fixed cost** is one that does not vary with the level of output:[16]

> A good example of a fixed cost is the fee a government charges for a firm to incorporate and conduct business. Whether the firm produces a lot or a little, it must pay the fee. Another example is the monthly rent that a lawyer must pay for an office after signing a one-year lease. The monthly rent must be paid regardless of how much business the lawyer does.

In contrast, a **variable cost** is one that does vary with the level of output. If the costs in the cost pool are fixed, then they are clearly not volume related and the volume related causality link can not be applied to calculate incremental cost. Instead, the nature of the costs must be examined to find out if there are any specific-fixed costs. Specific-fixed costs do not vary with the level of volume but are associated with only one product. They are caused by the provision of that product and that product alone; they are thus included in that product's incremental cost. Fixed and common costs neither vary with the level of volume

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[16] See, Jeffery M. Perloff and Dennis W. Carlton, Modern Industrial Organization, HarperCollins, 1994, at 51.

nor are they caused by the provision of single product. They are not included in the incremental cost of any product.

When a cost pool contains variable costs, the choices, in terms of tracing cost causality, are more extensive. Consequently, a series of questions are required to determine the correct cost allocation method. The first question in the series asks whether on not only one product is handled in the cost pool. If so, then the entire cost in the cost pool is incremental to the product being handled. In fact, incremental cost equals the accrued cost for the cost pool. The only remaining issue is whether or not incremental cost equals volume variable cost. If the variability in the cost pool is equal to one, the two are equal. If the variability is less than one, incremental costs exceed volume variable cost in the cost pool. There are no specific fixed costs in this cost pool, by definition, so attributable cost will equal volume variable cost. Thus, if the variability is less than one, then incremental cost will exceed attributable cost.

For many cost pools, there is more than one product handled, so cost attribution is not so straightforward. In these cost pools, two questions must be answered to determine proper cost attribution. The first question is whether or not there are any intrinsic costs. An **intrinsic cost** is a variable cost, in the sense that it varies with the level of output, but it does not vary at the margin.[17] By that, I mean that these costs are not increased by additional volume of the product. Nevertheless, the are caused by the provision of the entire volume of

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[17] Intrinsic costs would include things like the premium costs associated with an expedited air transportation network.

the product and are thus incremental to that product. When there are intrinsic costs in a cost pool, then both the volume-related costs and the intrinsic costs are attributed to the product that caused them to arise. Other products in the cost pool will cause volume-related incremental costs but will not generate intrinsic costs.

An example of this type of cost pool is given by the manual Priority Mail cost pool. All costs are labor costs and are variable costs. However, the cost pool arises because of the intrinsic characteristics of Priority Mail and would not exist but for that product. If there were no Priority Mail, this cost pool would disappear. The volume variable costs for non-Priority Mail products would not disappear, but both the Priority Mail's volume variable cost and all of the institutional cost would disappear. This latter set of costs are intrinsic to Priority Mail so the incremental cost for Priority Mail in this cost pool is the sum of Priority Mail's volume variable cost and all of the institutional cost. In this instance, the institutional costs are intrinsic costs.

The final set of cost pools include variable costs, include more than one product, but have no intrinsic costs. In these cost pools incremental costs are all volume related. The relationship between incremental costs and attributable costs depends upon the estimated variability for the cost pool. If the variability is equal to one incremental cost will be equal to volume variable and attributable cost as the marginal cost is constant. On the other hand, incremental costs in these cost pools will exceed both volume variable and attributable cost (they are the same) when the variability is less than one because incremental cost will

account for the fact that some volume is produced at a higher marginal cost.

Table 1 presents the eight cost pools, the characteristics of each and the relationship between incremental, volume variable, and attributable costs in each case. That Table shows that in all instances in which the variability is one, incremental cost equals attributable cost and in all instances in which the variability is less than one, incremental cost exceeds attributable cost.

Table 1
Cost Pools and The Relationship Among Cost Measurements

Cost Pool	**Cost Types**	**Cost Relationship**
Type 1	Fixed and Common	IC = ATRC = VVC = 0
Type 2	Fixed and Specific	IC = ATRC > VVC
Type 3	Variable, One Product, Variability = 1	IC = ATRC = VVC
Type 4	Variable, One Product, Variability < 1	IC > ATRC = VVC
Type 5	Variable, More than 1 Product, Intrinsic Costs, Variability = 1	IC = ATRC > VVC
Type 6	Variable, More than 1 Product, Intrinsic Costs, Variability < 1	IC >ATRC = VVC
Type 7	Variable, More than 1 Product, No Intrinsic Costs, Variability = 1	IC = ATRC = VVC
Type 8	Variable, More than 1 Product, No Intrinsic Costs, Variability < 1	IC > ATRC = VVC

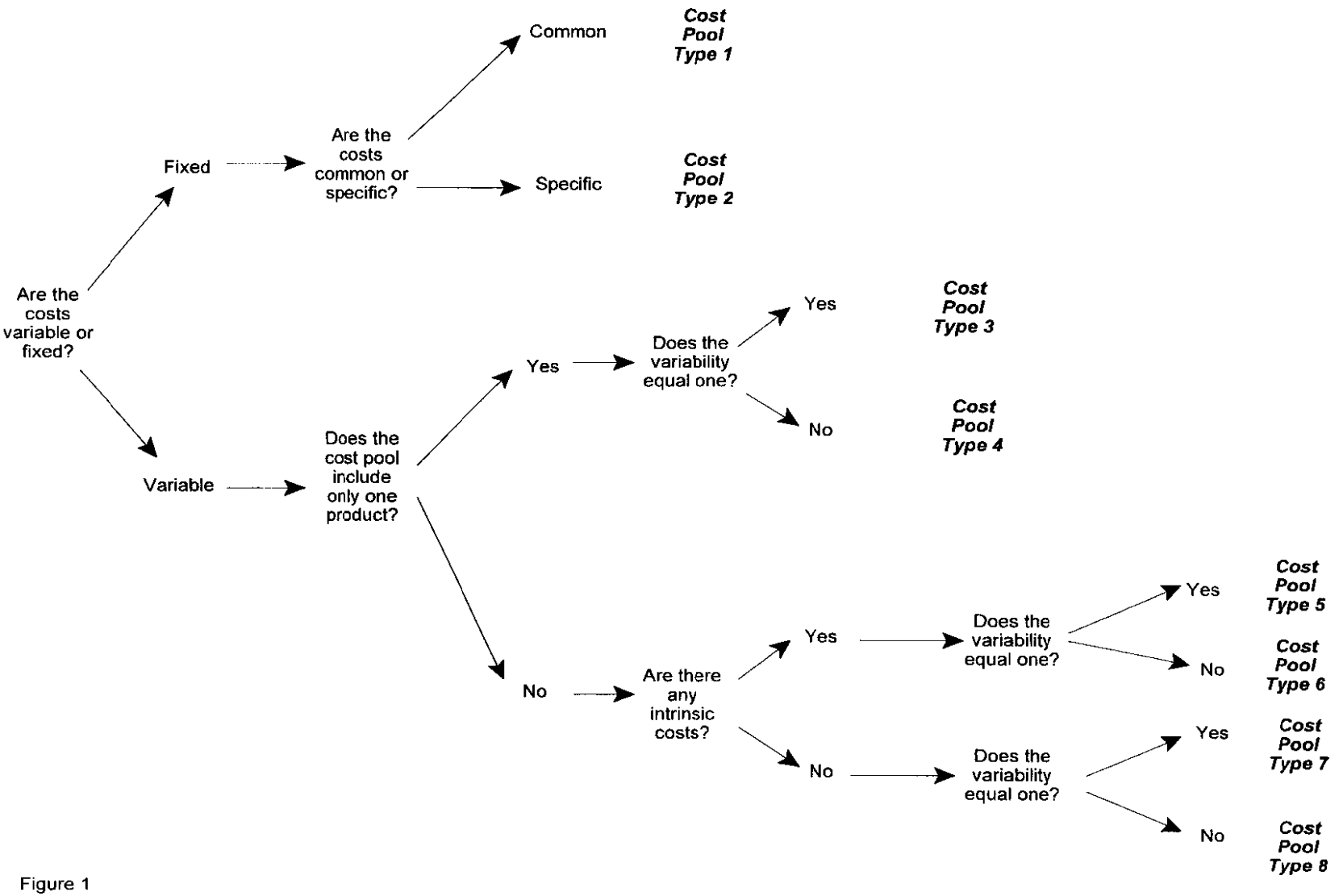
Are the costs variable or fixed?
Fixed
Are the costs common or specific?
Common
Cost Pool Type 1
Specific
Cost Pool Type 2
Variable
Does the cost pool include only one product?
Yes
Does the variability equal one?
Yes
Cost Pool Type 3
No
Cost Pool Type 4
No
Are there any intrinsic costs?
Yes
Does the variability equal one?
Yes
Cost Pool Type 5
No
Cost Pool Type 6
No
Does the variability equal one?
Yes
Cost Pool Type 7
No
Cost Pool Type 8

Figure 1

C. Comparing the Old and New Methods of Calculating Test-year Incremental Costs.

The old method of calculating incremental cost deviated from the established methodology in two ways. First, the old method used the underlying functions from the special studies used to estimate the variabilities instead of just using the parameters from those studies. Recall that the roll-forward model used to estimate test-year attributable costs applies only the parameters from the studies but not the underlying functions. From a methodological perspective this means that the roll-forward model does not embody the structural assumptions inherent in the underlying studies.

To understand what this means, consider the following example. Suppose that the variability for a particular component had been estimated with a generalized quadratic econometric function and that the estimated variability from that special study had been found to be 74 percent. Then suppose that after several years the study was updated, with a new set of data and with a new translog functional form. The new variability was found to be, say, 81 percent. The only change that would be required in the attributable cost calculation would be the substitution of the new variability for the old. The fact that a new functional form was being used to estimate the variability would not affect the structure of the model.

In contrast, the old method of incremental cost calculation explicitly used the underlying functional form. From a methodological perspective, this means that the old incremental cost model did embody the structural assumptions

inherent in the underlying special studies. Because the old incremental cost model embodied this structure, it was difficult for the Commission to accept the incremental cost calculations without accepting the special studies that created the structure.[18] The new method of calculation alleviates this potential difficulty by following the established methodology of using only the parameters from the studies. In this way it makes the calculation of incremental cost far more flexible.[19]

The second deviation from the established methodology contained inf the old method of calculating incremental cost was its technique for calculating test-year incremental cost. The old method first calculated, for each subclass, the

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[18] See PRC Op., R97-1, Vol 1. at 248.

[19] Unlike the established methodology, if one would make the assumption that the true structure of the cost model was described by the functional forms underlying the special studies, then the new method of incremental cost calculation would have to be considered an approximation of the "true" incremental costs. Recent research has shown, however, that for the Postal Service's cost model, this approximation is quite close and the increased ease of calculation would justify it use. (See Michael D. Bradley, Christopher S. Brehm, Jefferey Colvin and William M. Takis, Empirical Estimation of Incremental Costs for the U.S. Postal Service, in Emerging Competition in Postal and Delivery Services, Kluwer Academic Publishers, 1999 at 89, and Michael D. Bradley, Jeff Colvin and John Panzar, "Issues in Measuring Incremental Cost in a Multi-function Enterprise, Managing Change in the Postal and Delivery Industries, Kluwer Academic Publishers, 1997 at 3.)

More important is the fact that the underlying equations could be used only for calculating base-year incremental costs, not test-year incremental costs. When the equation-based approach is used (as in the old method), an approximation must be applied to transform base-year incremental costs into test-year incremental costs. There is no basis, therefore, in asserting that the equation-based test-year incremental costs are more accurate than the cost-model-based test-year incremental cost.

simple ratio of subclass' base-year incremental cost to base-year volume variable cost. It then multiplied this aggregate ratio times the previously calculated test-year volume variable cost. The Commission noted that this approach "has the unappealing property that both variable and fixed costs are changed proportionately from the base year to the test year."[20] The new method avoids this drawback and applies separate factors to variable and fixed costs. It does so by using these same factors, when going from base year to test year, that are used in the test-year attributable cost calculation

IV. THE ANALYTICAL STRUCTURE OF INCREMENTAL COSTS

To promote a better understanding of how incremental costs are calculated and to show their correspondence to attributable costs, in this section I present the analytical structure of the incremental cost model. That structure will make more sense, however, if we first describe the analytical structure underlying volume variable and attributable costs. Consequently, in this section I present the analytical structure of base year volume variable, attributable, and incremental cost. This is followed by a presentation of the analytical structure of the same three cost measurements for the test year.

A. Calculating Base-Year Costs

As discussed above, variability and distribution key studies are used to

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[20] See PRC Op., R97-1, Vol 1. at 250.

calculate the parameters needed for calibrating the cost model for the cost components, but the underlying studies themselves are not used. To organize the description of the base-year calculations, we need some notation that will permit construction of the analytical structure. Let us start with the volume variable costs of component j:

$$VVC_j = \varepsilon_j C_j, \quad (4)$$

where C_j is the accrued cost for the component and ε_j is the component's elasticity. Note that once the model is calibrated, this elasticity is a parameter and is not an explicit function of volume. That is to say that the variability is constant with respect to volume changes.[21] At the component level, the effect of volume changes on cost is captured through the response of a cost driver to those volume changes. In the cost model, the relationship between cost and volume in broken into its two components, (1) the relationship between cost and the cost driver and (2) the relationship between the cost driver and volume.

As a result, the volume variable cost will be distributed to individual products based upon the products' shares of the cost driver in the component,

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[21] For example, a set of elasticities for purchased highway transportation were selected by the Commission in Docket No. R87-1. These elasticities were applied in both Docket No. R90-1 and Docket No. R94-1 despite the fact that volume changed. It is in this regard that the elasticities are "constant." This is not to say the calibration of the model is never changed. In Docket No. R97-1 the Commission selected a new set of variabilities and the model was recalibrated.

D_j. A data collection effort or special study is required to determine these distribution keys and each volume's distribution share becomes a parameter in the product cost model. The volume variable cost for product *i* in component *j* can thus be expressed as::

$$VVC_{ji} = \varepsilon_j C_j \frac{D_{ij}}{D_j}. \quad \textbf{(5)}$$

With this notation, we can express both the component's total volume variable cost as well as the product's overall volume variable in cost simple formulas:

$$VVC_j = \sum_{i=1}^{m} \varepsilon_j C_j \frac{D_{ij}}{D_j}, \quad \textbf{(6)}$$

and,

$$VVC_i = \sum_{j=1}^{n} \varepsilon_j C_j \frac{D_{ij}}{D_j}. \quad \textbf{(7)}$$

We can be more formal by constructing an explicit cost function that embodies the essential characteristic of the model that the elasticity does not depend upon the amount of volume or the cost driver. We can also use the

explicit cost function to highlight the difference between attributable cost, as defined by the Commission, and volume variable cost.

Specifically, we recognize that the total cost in a component is the sum of the variable cost, which is related to the total amount of the driver and any fixed costs that occur in the component. These fixed costs might be associated with individual products or they might be common to all products in the component. We can express total component accrued cost, C_j as their sum:

$$C_j = \sum_{i=0}^{n} F_{ij} + \alpha_j D_j^{\varepsilon_j}, \quad (8)$$

where the new notation in this formula includes F_{ij} as the specific fixed cost in the component for product *i*, F_{0j} as the fixed and common cost in the component, and α_j as a measure of the cost of inputs. With this structure, we can define the volume variable cost for product *i* in component *j* as:

$$VVC_{ij} = \varepsilon_j \alpha_j D_j^{\varepsilon_j} \frac{D_{ij}}{D_j}. \quad (9)$$

We can also define the attributable cost for product *i* in component *j*:

$$ATRC_{ij} = F_{ij} + \varepsilon_j \alpha_j D_j^{\varepsilon_j} \frac{D_{ij}}{D_j}. \quad (10)$$

where F_{ij} is the specific fixed cost for product *i* in this component.

Lastly, we can use this function to define the incremental cost of product *i*. It is the cost that is caused by the inclusion of product *i* in the output vector.

$$IC_{ij} = C_j - C_j(D_j - D_{ij})$$

$$= \sum_{i=0}^{n} F_{ji} + \alpha_j D_j^{\varepsilon_j} - \left[\sum_{i=0}^{n} F_{ji} - F_{ij} + \alpha_j (D_j - D_{ij})^{\varepsilon_j}\right] \quad (11)$$

A little algebra leads to a simpler expression:

$$IC_{ij} = F_{ij} + \alpha_j D_j^{\varepsilon_j}(1 - (1 - \theta_{ij})^{\varepsilon_j}), \quad (12)$$

where $\theta_{ij} = D_{ij} / D_j$, the product's proportion of the driver. We can now examine the relationship between incremental cost and attributable cost. Incremental cost will exceed attributable cost when:[22]

$$\frac{(1 - (1 - \theta_{ij})^{\varepsilon_j})}{\varepsilon_j \theta_{ij}} > 1. \quad (13)$$

We can see from this expression that the ratio depends upon only two things, the

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[22] This result can be derived by setting the conditional inequality such that IC > ATRC, subtracting the specific fixed portion from both sides and dividing through by remaining, volume-related, part of ATRC. Cancelling like terms yields the above expression.

elasticity of the cost component and the proportion of the driver caused by the product in question. This means that the ratio depends only upon the mix of volume in the component and not the absolute amount. It also means that if we make use of the values of the parameters from the cost model, can put boundaries on the size of the ratio and understand what makes it change.

In particular, we know that generally:[23]

$$\begin{aligned} 0 < \varepsilon_j \leq 1 \\ 0 < \theta_{ij} \leq 1. \end{aligned} \qquad \textbf{(14)}$$

These limits put bounds on the ratio.[24] For example, it is clear that under these limits, the ratio is never less than one. Under the conditions listed above, the denominator of the ratio can be no larger than one, and will be less than one in the typical case that either the variability or distribution key is less than one.

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[23] The elasticity for a cost component would be greater than one if there are decreasing returns to scale. However, I am informed that there is only one such cost pool in the Postal Service version and no such pools in the Commission version. The cost pool with a variability greater than one is the RBCS cost pool that has a variability of 100.5%. Because this variability of 100.5% is virtually the same as 100%, this *de minimis* violation of the above condition has no measurable impact on the relationship between incremental and attributable cost. The distribution share is always between zero and one by definition.

[24] If the parameters are zero, the ratio is undefined. If either the elasticity or the distribution key is zero then incremental cost and attributable cost will only be defined if there are specific fixed cost. If so, the two will be equal.

However, the numerator is bounded from below by one.

As the distribution key cannot exceed one, the parenthetical expression in the numerator is between zero and one. Morever, as the elasticity is non-negative, the fraction is raised to a positive power, the outcome of which can not exceed one. Thus the largest possible value for the parenthetical expression is less than one. This means the numerator is never less than one. If the numerator is never less than one and the denominator is never greater than one, then incremental cost can never be less than attributable cost. This relationship is highlighted in Table 2 which shows the calculation for the ratio for the range of values for θ and ε between zero and one.

Table 2

Ratio of The Volume-Related Portion of Incremental Cost to Attributable Cost

	Values for Theta									
Values for Epsilon	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
10%	1.05	1.10	1.17	1.24	1.34	1.46	1.62	1.86	2.29	10.00
20%	1.04	1.09	1.15	1.21	1.29	1.40	1.53	1.72	2.05	5.00
30%	1.04	1.08	1.13	1.18	1.25	1.34	1.44	1.60	1.85	3.33
40%	1.03	1.07	1.11	1.16	1.21	1.28	1.36	1.48	1.67	2.50
50%	1.03	1.06	1.09	1.13	1.17	1.23	1.29	1.38	1.52	2.00
60%	1.02	1.04	1.07	1.10	1.13	1.17	1.22	1.29	1.39	1.67
70%	1.02	1.03	1.05	1.07	1.10	1.13	1.16	1.21	1.27	1.43
80%	1.01	1.02	1.03	1.05	1.06	1.08	1.10	1.13	1.17	1.25
90%	1.01	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.08	1.11
100%	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

The base year volume variable, attributable and incremental cost for products is found by simply summing the component specific costs across all of the base-year components:

$$ATRC_i = \sum_{j=1}^{m} \left[F_{ij} + \varepsilon_j \alpha_j D_j^{\varepsilon_j} \frac{D_{ij}}{D_j} \right]. \quad \textbf{(15)}$$

$$IC_{ij} = \sum_{j=1}^{m} \left[F_{ij} + \alpha_j D_j^{\varepsilon_j} (1 - (1 - \theta_{ij})^{\varepsilon_j}) \right]. \quad \textbf{(16)}$$

B. The Role of Product Specific Costs.

An important part of the calculation of incremental cost is the role of product specific costs. When considering only volume related costs, incremental cost can be calculated by finding the marginal cost of each unit produced and summing those marginal costs over the range of production for the product being measured. When there are product-specific costs, this basic procedure must be augmented. Product-specific costs are treated in a consistent manner in the incremental cost framework, but their treatment bears further discussion.

Before discussing their role in the incremental cost calculation, we should probably be clear as to what product specific costs are. Product-specific costs are incurred if any amount of a the product is provided, but they do not increase at the margin with additional units of that product.

There are two types of product specific cost in the Postal Service cost structure: specific fixed costs and intrinsic costs. Specific-fixed costs do not vary

with variations in the product's volume; indeed, they would be incurred even if the product's volume fell to zero. However, they are caused by the provision of just one product and would not exist if the product was not part of the Postal Service's output vector.[25]

The other type of product-specific costs can be called intrinsic costs. These are variable costs that arise because of the particular characteristics of a product but do not vary at the margin. Consider two instances of intrinsic costs in the postal cost structure; these instances occur in the Priority Mail distribution operations and in network air transportation. The Priority Mail distribution operations exist for the purpose of expediting the handling of Priority Mail. They can and do sort other classes of mail, but without Priority Mail, those classes would be sorted in other operations. Consequently, if the Postal Service decided not to provide Priority Mail, the institutional costs for these operations would not exist. These costs thus are part of Priority Mail's incremental cost.

In similar fashion, the network costs exist for the transportation of expedited mail. For example, it is my understanding that the Eagle Network exists for the purpose of providing air transportation for Express Mail. Network air transportation is more expensive than commercial air transportation and this additional expense, in the case of the Eagle network, is caused by Express Mail.

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[25] Note that producing a product at zero volume and eliminating a product from the output vector are not the same thing. Product-specific advertising expenses are incurred before the fact and exist even if no units of the advertised product are sold. On the other hand, if the firm did not plan to sell the product at all, no advertising would be incurred.

Regardless of what mail is actually carried on the network, the intrinsic costs exists because of the characteristics of Express Mail.

The roles of specific fixed costs and intrinsic costs in the incremental cost calculation can be illustrated analytically. The total cost in a cost component can be divided into fixed cost and variable cost.[26] This is described analytically as:

$$C_j = F_{0j} + \sum_{i=1}^{m} F_{ij} + VC_j. \qquad \textbf{(17)}$$

Note the two types of fixed cost F_{oj} and F_{ij}. The former represents fixed and common cost, which exist for the provision of all product and are not part of the incremental cost of any. The F_{ij} represent specific-fixed costs. Within the postal costing structure, variable costs are well defined and this equation can be rewritten as:

$$C_j = F_{0j} + \sum_{i=1}^{m} F_{ij} + \alpha_j D_j^{\varepsilon_j} \qquad \textbf{(18)}$$

To see the correspondence with familiar Commission costing terms, we can break down these costs into their "institutional" and "attributable" portions. As defined by the Commission, the first two terms in the following equation

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[26] Variable cost is not the same thing as "volume variable cost." In fact, volume variable cost is a subset of variable cost found by multiplying the total variable cost times the relevant "volume variability" or cost elasticity.

represent "institutional" cost and the sum of the two terms in the parentheses represent "attributable" costs.

$$C_j = F_{0j} + (1 - \varepsilon_j)\alpha_j D_j^{\varepsilon_j} + \sum_{i=1}^{m} \left(\varepsilon_j \alpha_j D_j^{\varepsilon_j} \theta_{ij} + F_{ij} \right). \quad \textbf{(19)}$$

Recall that the incremental cost for product *i* measures the cost caused solely by that product, and is calculated by the difference between total current costs and the total costs of producing all products but product *i*. This "decremental"calculation highlights the fact F_{ij}, the specific-fixed cost for product *i*, is part of its incremental cost. When the decremental calculation is applied to equation 19, above, one obtains the expression for incremental cost for product *i*:

$$IC_{ij} = F_{ij} + \alpha_j D_j^{\varepsilon_j} (1 - (1 - \theta_{ij})^{\varepsilon_j}). \quad \textbf{(20)}$$

The first of our two instances of intrinsic costs arise in the Priority Mail distribution operations. As explained above, other classes of mail are handled in these operations, but they are designed primarily for the handling of Priority Mail. That is, the operations were created because of the existence of Priority Mail and would not exist otherwise. The incremental cost calculation reflects

this. From the base-year cost model, one obtains the volume variable costs of the individual products handled in a Priority Mail operation. One also then identifies the institutional cost. The incremental cost for Priority Mail in a Priority Mail operation is thus calculated as its volume variable cost and the total institutional costs. Mathematically, the incremental cost of Priority Mail (IC_{1j}) in one of these operations is given by:[27]

$$IC_{1j} = \alpha_j D_j^{\varepsilon_j}\left(1 + \varepsilon_j(\theta_{1j} - 1)\right). \quad \textbf{(21)}$$

where θ_{1j} is Priority Mail's share of the driver.

The other instance of intrinsic cost is for dedicated air network transportation. In these cost components, the volume variable cost is found by multiplying the amount of the driver (pound-miles) times the (constant) marginal cost of commercial air transportation, (β_j). In product cost model, the cost function for the dedicated air network is thus given by:

$$C = \alpha_j \bar{D}_j, \quad \textbf{(22)}$$

where the bar on the driver indicates that its amount is fixed with respect to small changes in volume and α_j represents the cost of a pound mile of dedicated

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[27] Note that there are no fixed costs in these components.

network air transportation.[28] One can express the volume variable cost for Express Mail as the product of the cost of a pound-mile of commercial air transportation times the number of pound-miles required:[29]

$$VVC_{1j} = \beta_j D_{1j}. \quad \textbf{(23)}$$

The incremental cost of Express Mail in this component adds in the intrinsic cost to the volume variable cost:

$$IC_{1j} = \beta_j D_{1j} + (\alpha_j - \beta_j)\bar{D}_j. \quad \textbf{(24)}$$

C. Calculating Test-Year Costs

When moving from the base year to the test year, the product cost model must forecast the volume variable and attributable costs that will be associated with the volumes extant at test year rates. In similar fashion, the incremental cost model must forecast the incremental costs associated with those volumes. The forecast must take into account four factors:

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[28] It is my understanding that the air network is sized for a minium scale and more capacity exists than is required to handle just the Express Mail. Thus marginal increase in Express Mail volume do not affect the capacity of network.

[29] The volume variability of commercial air transportation is one.

A. Changes in volume

B. Changes in cost levels

C. Changes in non-volume workload

D. Special programs.

The factors are distinguished because they either affect a cost component or they affect a product. For example, changes in cost levels would affect the accrued cost in a component, based upon the resource mix in that component. In contrast, changes in volume are product specific and the volume growth for each product is the same regardless of which component is being analyzed. Depending on the nature of the activity, some components receive a non-volume workload factor while others do not.[30] Finally, special programs affect the accrued test year in a component reflecting a change in technology, production methods, or productivity.

We can examine these factors more closely by considering the formula for test year volume variable cost. Test year volume cost for product *i* in cost component *j* is found by applying the relevant factors to base year volume variable cost. Test year volume variable cost (VVC_{ijT}) is thus given by:

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[30] For example, I am informed that both the Postmasters EAS 23 and Below Cost pool and the City Carrier Access Cost pool receive a non-volume workload adjustment

$$VVC_{ijT} = \left[\varepsilon_j \alpha_j D_j^{\varepsilon_j} \theta_{ij}\right](1 + g_i)(1 + \pi_j)(1 + \phi_j)(1 + \eta_j). \quad \textbf{(25)}$$

where volume growth is represented by g_i, cost level changes are represented by π_j, non-volume workload changes are represented by η_j, and the effect of special programs is captured by ϕ_j[31].

Test year attributable cost include test year volume variable costs, but also include test year specific fixed costs:

$$ATRC_{ijT} = F_{ijT} + \left[\varepsilon_j \alpha_j D_j^{\varepsilon_j} \theta_{ij}\right](1 + g_i)(1 + \pi_j)(1 + \phi_j)(1 + \eta_j). \quad \textbf{(26)}$$

We can now determine the formula for test year incremental cost calculated in a manner that is consistent with the established roll-forward methodology. The test year costs would embody the volume, cost level, non-volume workload and special program effects, but would do so in a manner which is consistent with the actual generation of cost. Specifically, test year incremental costs would not be calculated by applying a simple ratio test year

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[31] Special programs are not necessarily implemented in terms of percentage growth or decline in cost. However, a finite cost change can always be expressed as a percentage change. That is, the amount of the program-induced cost change can be expressed as a percentage of base year costs. The same is true for non-volume workload changes.

volume variable costs. Rather, to the level of detail supported by the product cost model, test year incremental costs would be calculated on a component by component basis according to the following formula:

$$IC_{ijT} = [IC_{ij} - F_{ij}](1 + g_i)(1 + \pi_j)(1 + \eta_j)(1 + \phi_j) + F_{ijT}. \quad \textbf{(27)}$$

where F_{ijT} is the test-year product specific costs for class *i* in cost component *j*.[32] One obtains the test-year incremental cost by adding across the components:

$$IC_{iT} = \sum_{j=1}^{n} [IC_{ij} - F_{ij}](1 + g_i)(1 + \pi_j)(1 + \eta_j)(1 + \phi_j) + F_{ijT}. \quad \textbf{(28)}$$

Note that the volume growth rate (g_i) is the same for all components, so that term can be extracted from the summation, as all components (that get a non-zero volume effect) get the same volume growth rate.

[32] Note that in the incremental cost calculation we must allow for both specific fixed costs and intrinsic costs. Thus, F_{ij} in equation 27 refers to product specific costs. The test year values for product specific costs may be directly available from the roll forward or may have to be calculated. Either way, they will not receive a volume adjustment.

V. HOW THE NEW METHOD OF INCREMENTAL COST CALCULATION ADDRESSES THE CONCERNS RAISED BY THE COMMISSION IN DOCKET R97-1.

In its Docket No. R97-1 Opinion, the Commission described three deficiencies and discussed three other concerns. Those deficiencies and concerns are each presented in this section, followed by a discussion of how the new method of incremental cost calculation address them.

A. A Discussion of the Three Deficiencies In the Calculation of Incremental Costs Cited by the Commission.

1. The incremental cost calculations were based upon cost studies that the Commission had rejected:[33]

The most important deficiency that the Commission identified was the fact that the Postal Service's incremental cost calculations were based upon cost models that the Commission had rejected. Consequently, the Commission could not calculate incremental costs. The new method of incremental cost calculation is flexible enough to allow calculation of incremental costs with either the Postal Service's choices of variabilities or distributions keys or the Commission's choice of variabilities and distribution keys. This deficiency is thus no longer a barrier to the calculation of incremental costs by the Commission. The new method greatly facilitates calculating incremental costs, as one must only enter the preferred parameters to calculate the costs.

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[33] See PRC Op., R97-1, at 248.

2. A "simple ratio method" in which both volume variable and specific fixed costs were changed by the same proportion was used in going from base-year costs to test-year costs.[34]

The Commission also cited the deficiency that the calculation of incremental costs by the Postal Service in the last case relied upon a "simple ratio" that changed both volume variable and fixed costs by the same proportions. The new method of calculating incremental cost is entirely consistent with the established methodology for calculating test-year attributable costs. The incremental cost calculation uses no more assumptions then are used in the attributable cost calculation. Moreover, the new method explicitly separates volume variable and fixed costs and uses the appropriate roll-forward factor for each. It does not apply the same simple ratio to volume variable and fixed costs and this objection is removed.

3. The Postal Service never performed the incremental cost tests.[35]

The Commission observed that although the Postal Service calculated incremental costs, it never performed the formal incremental cost test. This deficiency was remedied as the incremental cost test is now presented in the testimony of witness Mayes.

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[34] See PRC Op., R97-1, Vol. 1 at 250.

[35] Id.

B. A Discussion of the Three Additional Concerns about the Incremental Cost Calculation Cited by the Commission.

1. Not all possible combinations of products were tested or could be tested.[36]

In writing its Opinion, the Commission indicated that it has contemplated the issue of whether or not all possible combinations of products must be tested:[37]

> In principle the approach should consider all possible combinations of subclasses and services for cross-subsidy as required by the theory. In practice this is neither necessary nor likely to be entirely feasible.

Moreover, the Commission commended the Postal Service for going beyond calculation of only subclass incremental costs:[38]

> In addition to the subclasses taken singly, witness Takis has actually considered only six combinations of subclasses and services. This small set was selected by identifying "groups that share operations" and "highly competitive groups of products" according to criteria provided by Postal Service witness Baumol for Docket No. R90-1. *See* Tr. REM2/1040-2. Although six combinations fall considerably short of the theory, and may even be short of all of the combinations suggested by witness Baumol's criteria, it is still a more inclusive application of the incremental cost test than a simple subclass-by-subclass application.

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[36] See PRC Op., R97-1, Vol. 1 at 249.

[37] Id.

[38] Id.

In this case, the Postal Service extends even further this approach by calculating the incremental costs for a large vector (twenty-six) of two-product combinations. These new combinations are being calculated in addition to extending the combinations calculated by witness Takis. The calculation of these addition combinations shows the flexibility of the new method of incremental cost calculations.

2. When econometric functions were used, the incremental costs depend upon the accuracy of the underlying cost functions over "considerable ranges."[39]

Under the old method, incremental costs were calculated along the surface of the underlying cost function by removing the amount of the cost driver caused by a particular product and then calculating the reduction in total cost. The Commission raised the concern that there might be cases in which the calculation of incremental cost required extension of the underlying functional forms beyond the ranges of the data use to estimate them.

The are two main responses to this concern. First, the new method of incremental cost calculation does not depend upon moving along the estimated cost surface; it just uses the elasticity derived from the function. It is true that the new method does require assuming constant elasticity over the range of analysis but previous research has shown that incremental costs are not sensitive to this

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[39] See PRC Op., R97-1, Vol. 1 at 250.

assumption.[40]

Second, it is important to keep in mind that the incremental cost calculation does not generally require going beyond the range of experience in terms of the amount of the driver analyzed. The incremental cost calculation for each product begins at the current level of the driver and then removes only that part of that driver associated with the product. This means that the incremental cost calculation typically involves recalculating total cost component cost for a level of the driver which is up to 50 percent below the current level. This range of variation would typically be within the range of data in the analysis data set.

Table 3 presents the cost components in which equations are used to calculate incremental costs.[41] It also presents the largest product, as measure by the percentage of the distribution key generated by the product, in each of the cost components. Finally, it presents the share of the cost driver (as represented by the distribution key) for the largest product. Table 3 shows that the volume reductions are typically within the range of data in the data sets used to calculated the variabilities. In other words, data sets like HCSS, CCS and MODS all have variations in their "volume" variables that exceed 50 percent of the mean value.

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[40] See, Bradley, Colvin and Panzar at 10-13.

[41] In other components incremental cost is equal to volume variable cost or incremental costs are product specific costs.

Table 3
A Listing of the Largest Product in Cost Components that Use Equations to Calculate Incremental Cost

Cost Component	Largest % of Distribution Key	Product With Largest %
C/S 1.1 POSTMASTERS, EAS 23 & BELOW	36.9%	First Class Single Piece
C/S 2.5 HIGHER LEVEL SUPERVISORS	37.4%	First Class Single Piece
C/S 3.1 MAIL PROCESSING VARIABLE DIRECT LABOR	42.8%	First Class Single Piece
C/S 3.2 WINDOW SERVICE	53.2%	First Class Single Piece
C/S 3.3 ADMIN CLERKS - QUALITY CONTROL	42.8%	First Class Single Piece
C/S 3.3 ADMIN CLERKS - DATA COLLECTION	27.6%	First Class Single Piece
C/S 4 CLERKS AT CAG K POST OFFICES	58.3%	First Class Single Piece
C/S 7.3 CITY DELIVERY CARRIERS, LOAD	20.2%	Standard A ECR
C/S 7.2 ACCESS	28.2%	First Class Single Piece
C/S 7.1 ROUTE	18.2%	Standard A ECR
C/S 8 VEHICLE SERVICE DRIVERS	16.1%	Standard A ECR
C/S 11.1.1 CLEANING & PROTECTION	32.4%	First Class Single Piece
C/S 11.2 OPERATING EQUIPMENT MAINTENANCE	49.4%	First Class Single Piece
C/S 11.3 PLANT & BUILDING EQUIP MAINT	32.4%	First Class Single Piece
C/S 14. PURCHASED TRANSPORTATION, HIGHWAY	16.1%	First Class Single Piece
C/S 14. PURCHASED TRANSPORTATION, RAILROAD	29.3%	Periodicals Regular
C/S 14. PURCHASED TRANSPORTATION, DOMESTIC WATER	24.4%	Standard A Regular
C/S 16.3.2 EQUIPMENT SUPPLIES & SERVICES	42.0%	First Class Single Piece
C/S 20.3 EQUIPMENT DEPRECIATION	47.9%	First Class Single Piece
C/S 20 EQUIPMENT INTEREST	47.9%	First Class Single Piece

3. The incremental cost approach of allowing no reconfiguration is acceptable for small classes but less tenable for large classes.[42]

The incremental cost test is designed to compare a product's revenue with its incremental cost, given the existing vector of other products being produced. In this regard, the incremental cost for product A is best thought of as the additional cost of providing product A, given that the firms other products are already being provided. Computationally, it is much easier to actually calculate "decremental" costs by "removing" product A from the vector of products and recalculating total costs. Implicit in this calculation is the assumption that the costs of producing the other products are not affected by the addition of product A in ways not captured in the incremental cost calculation. This is witness Takis' "no reconfiguration assumption" presented in the last case.

The Commission noted that this assumption is quite reasonable for classes or groups of classes that do not make up an extremely large portion of the driver. However, as the Commission pointed out, when a single product or single combination of products that is being "removed" makes up an extremely large proportion of the components driver, then the "no reconfiguration" assumption is less palatable.

However, this problem may not be as general as it first seems. As Table 3 illustrates there are relatively few instances in which a very large proportion of the driver is caused by a single subclass. Moreover, Table 3 shows that this

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[42] See PRC Op., R97-1, Vol. 1 at 249.

issue is confined mainly to First Class.

Finally, one must recognize that the incremental cost test that is relevant for the Commission is the examination of cross-subsidy among existing products within the current methods of production. This use of the incremental cost test argues for maintaining the "no reconfiguration" assumption in the calculations but keeping it in mind when interpreting the incremental cost test for "large" products.