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POSTAL RATE AND FEE CHANGES, 2006	Docket No. R2006–1

DIRECT TESTIMONY
OF
A. THOMAS BOZZO
ON BEHALF OF THE
UNITED STATES POSTAL SERVICE

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USPS-LR-L-56 Programs and Electronic Input Data for Mail Processing Volume Variability Analysis (Bozzo)

Autobiographical Sketch

My name is A. Thomas Bozzo. I am a Vice President with Laurits R. Christensen Associates (LRCA), which is an economic research and consulting firm located in Madison, Wisconsin. My education includes a B.A. in economics and English from the University of Delaware, and a Ph.D. in economics from the University of Maryland-College Park. My major fields were econometrics and economic history, and I also completed advanced coursework in industrial organization. While a graduate student, I was the teaching assistant for the graduate Econometrics sequence at Maryland. In the 1995-1996 academic year, I taught undergraduate microeconomics and statistics at Maryland, and monetary economics at the University of Delaware. I joined LRCA as an Economist in June 1996, was promoted to Senior Economist in January 1997, and to my present position in January 2003.

Much of my work at LRCA has dealt with theoretical, statistical, and measurement issues related to Postal Service cost methods, particularly for mail processing. I worked with the team that produced, tested, and implemented the In-Office Cost System (IOCS) data collection instrument from the start of the project. I have presented five pieces of testimony in previous rate cases. In Docket No. R2005-1 and Docket No. R2001-1, I gave direct testimony on mail processing volume-variability factors (Docket No. R2005-1, USPS-T-12 and Docket No. R2001-1, USPS-T-14). In Docket No. R2000-1, I gave direct and rebuttal testimony on econometric estimates of volume-variability factors for mail processing labor costs (USPS-T-15 and USPS-RT-6) and rebuttal testimony on the Postal Service's estimates of costs by weight increment (USPS-RT-18). In Docket No. R97–1, I worked in support of the testimonies of witnesses Degen (USPS–T–12 and USPS–RT–6) and Christensen (USPS–RT–7). Other postal projects have included econometric productivity modeling for Postal Service field units, analysis of In-Office Cost System data, estimation of standard errors of Cost and Revenue Analysis (CRA) inputs for the Data Quality Study, and surveys of Remote Barcode System and rural delivery volumes. I have also worked on telecommunications costing issues and on various litigation support projects.

In this proceeding, I am also presenting testimony on the redesign of the In-Office Cost System (IOCS) instrument for Base Year (BY) 2005 (USPS-T-46).

Purpose and Scope of Testimony

My testimony presents elements of the Postal Service's volume-variable cost analysis for mail processing labor. The purpose of this testimony is to present the econometric estimates of volume-variability factors used in the Postal Service's BY 2005 Cost and Revenue Analysis (CRA) for a group of "Function 1" mail processing labor cost pools representing letter, flat, bundle, and parcel sorting operations at facilities that report data to the Management Operating Data System (MODS). According to witness Van-Ty-Smith (USPS-T-11), the labor costs associated with those cost pools total $4.86 billion for BY 2005. I also describe the operational, economic, and econometric motivations for the analysis.

The results presented in this testimony update results previously presented in my direct testimony from Docket No. R2005-1, USPS-T-12, to incorporate more recent data from MODS and other sources. The econometric models continue to employ the significant changes to econometric methods introduced in Docket No. R2005-1.

I sponsor Library Reference USPS-LR-L-56, which contains background material for the econometric analysis reported in this testimony. USPS-LR-L-56 has four main parts: (1) descriptions of the computer programs used to estimate the recommended volume-variability factors; (2) descriptions of the computer programs and processing procedures used to assemble the data set used in the estimation procedures; (3) a description of the methods used to develop MODS productivity data for use in several cost models; and (4) a description of additional variables used to extend Prof. Mark Roberts's (2006[1]) mail processing models with FY 2005 data and in related analysis of Prof. Roberts's models and methods presented in Section VII of this testimony. The accompanying USPS-LR-L-56 CD-ROM contains electronic versions of the econometric computer programs, econometric input data, and full econometric output.

My BY 2005 variabilities are used by witness Van-Ty-Smith (USPS-T-11) to compute volume-variable costs by cost pool for the Postal Service CRA. I provide witnesses Miller (USPS-T-20 and USPS-T-21), Abdirahman (USPS-T-22), and Page (USPS-T-23) with MODS productivity data described in Section III of USPS-LR-L-56.

[1] Mark J. Roberts (2006), "An Economic Framework for Modeling Mail Processing Costs," at http://www.prc.gov/OCA/papers/framework/mailprocessfinal.pdf.

I. Introduction

I.A. Overview and Review of Research Through Docket No. R2005-1

This testimony presents econometric estimates of volume variability factors ("variabilities") for a collection of mail processing labor cost pools representing sorting and cancellation operations at MODS plants, totaling $4.86 billion in clerk and mail handler labor costs in BY 2005. The composite of the econometric estimates is also used to determine volume-variable cost for much of the rest of the mail processing cost component. Variabilities are essential inputs into the measurement of marginal (i.e., unit volume-variable) cost and incremental cost for postal products. See USPS-LR-L-1, App. H and App. I. The recommended variabilities for use in the BY 2005 CRA are presented in Table 1, below.

Table 1. BY 2005 recommended variabilities (USPS version)

Cost pool	Variability Factor
D/BCS*	0.88
OCR/	0.78
FSM/1000	0.72
AFSM100	0.99
SPBS	0.87
Manual flats	0.94
Manual letters	0.89
Manual parcels	0.80
Manual Priority	0.75
Cancellation	0.50
Composite**	0.85

* Weighted average of D/BCS Incoming and D/BCS Outgoing variabilities. See Section VI.A.
** Witness Van-Ty-Smith (USPS-T-11) applies the composite variability to most other cost pools; see Section VI.B.7.

A cost pool's volume-variability factor ("variability") is, in economic terms, the elasticity of cost with respect to volume, or the (relative) percentage change in cost that would result from a given percentage change in volume, holding other factors equal. So, if the volume-variability factor for a cost pool is *v*, and volume increases by *X* percent, then the resulting percentage increase in costs for that cost pool would be by *vX* percent. In practice, it is desirable to measure the variability of cost with respect to operation-specific—and thus analytically more useful—"cost drivers" or "intermediate outputs."[2] In the case of mail sorting operations, the intermediate outputs are the sorts (handlings) performed in various mail processing operations in the course of producing the "final output" of the mailpiece delivered to its destination. The volume-variable costs from the first ("variability") step are then distributed to subclasses of mail via "distribution keys." My testimony addresses the first step of the two-step "volume-variability/distribution key" method; witness Van-Ty-Smith (USPS-T-11) presents the In-Office Cost System (IOCS)-based distribution key step and the calculations of volume-variable cost by cost pool and subclass.

Economic theory does not determine specific values for mail processing variabilities *a priori*, so variability measurement is an empirical matter. Economic production theory implies that costs are non-decreasing in outputs, which implies only that variabilities should be positive. There is no dispute that mail processing variabilities may take values other than 100 percent. See Docket No. R2000-1, Tr. 27/12989 (UPS witness Neels); Tr. 27/13212-3 (OCA witness Smith); Prof.

[2] While "cost driver" is a term of art from activity-based cost accounting and "intermediate output" is economics terminology, the terms are often used synonymously in Postal Service costing; I use the terms synonymously here.

Roberts (2006). However, as witness McCrery (USPS-T-29) notes, it is very difficult to operationally justify variabilities greater than 100 percent.[3]

The Commission's cost methodology treats nearly 100 percent of these costs as volume-variable under assumptions for clerk and mail handler mail processing labor cost variability that date to Docket No. R71-1.[4] Since the BY 1996 cost presentation in Docket No. R97-1, the Postal Service's CRA has incorporated econometric variability estimates for a subset of the mail processing cost pools.

The 100 percent variability assumption for mail processing and distribution activities had been justified prior to Docket No. R97-1 by a qualitative analysis of mail processing cost causation.[5] It states, in essence, that because distribution workloads ("handling at each work center") vary with volume (to an unspecified degree), mail processing and distribution costs are therefore 100 percent volume-variable. The 100 percent variability assumption was originally adopted

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[3] It is possible for the costs of specific mail processing activities to increase proportionally faster than volumes over narrow volume ranges, and much less than proportionally over larger volume ranges. The former effect should not dominate the data at the level of aggregation employed in the variability analysis, though if it did, the estimation procedures should capture it.

[4] Several mail processing activities defined by IOCS activity codes are assumed to be non-volume-variable in the "100 percent variability" method. However, the costs associated with the non-volume-variable activities are small relative to total costs in the operations analyzed here. See Appendix D, Table D-1.

[5] The qualitative description supporting the 100 percent variability analysis was last presented in Docket No. R97-1, USPS-LR-H-1, which described FY 1996 CRA methods. FY 1996 was the last Postal Service CRA to employ the 100 percent variability assumption in mail processing. Prior to Docket No. R71-1, Postal Service economists had conducted limited econometric time-series analysis of clerk and mail handler costs and volumes that led them to reject empirical variability analysis for Cost Segment 3. See Docket No. R2000-1, USPS-T-15 at 10-13.

in Docket No. R71-1 because no other party had presented a viable alternative, not because it had been shown to be correct empirically. See Docket No. R2000-1, USPS-T-15 at 6-9.

Statements about the relationship between processing and distribution workloads and costs are quantitatively testable. For the cost pools under study here, MODS measures the “handlings at each work center” and the associated labor workhours. If true, the 100 percent variability assumption must manifest itself in the Postal Service’s operating data.

In Docket No. R2005-1, the Postal Service adopted a significantly different estimation method for manual operations, based on the instrumental variables (IV) approach presented by Prof. Roberts in 2002 but retaining other features of the Postal Service’s previous modeling approach, notably the use of MODS total piece handlings as the output measures for sorting operations. See Docket No. R2005-1, USPS-T-12 at 12-16. In the absence of evidence of bias for automated operations’ variabilities, the BY 2005 CRA continued to use the previous translog/fixed effects estimation methodology. See Docket No. R2005-1, USPS-T-12 at 57-58.

I.B. Research Since Docket No. R2005-1

The variabilities I recommend for use in the BY 2005 CRA incorporate two major changes relative to the BY 2004/R2005-1 analysis. First, I reorganized the BCS and MPBCS cost pools into Outgoing D/BCS and Incoming D/BCS groups (I refer to these collectively as D/BCS below) encompassing both types of equipment. This change addresses instability in the MPBCS data related to the gradual withdrawal of MPBCS equipment from service in favor of DBCS equipment. I estimate separate elasticities for the two groups, but recommend that witness Van-Ty-Smith (USPS-T-11) use the weighted average result until additional results from the new groupings confirm that the difference between the incoming and outgoing elasticities is stable. I also recommend the use of a model of AFSM operations featuring outgoing and incoming AFSM handlings as separate drivers. I discuss the changes further in section IV, below.

Prof. Roberts presented an update to his mail processing model in March, 2006. Reviewing Prof. Roberts's recent work, the main area of disagreement between Prof. Roberts's approach and the Postal Service's is in the characterization of the "outputs" of sorting operations. Prof. Roberts greatly improved his models by incorporating a refined characterization of sorting output that partly accounts for the amount of sorting improvement in addition to the number of unique pieces sorted. However, he continues to prefer MODS First Handling Pieces (FHP) as an output measure.

In Sections II and III, below, I discuss how the nature of sorting work and the organization of sorting mailflows supports the Postal Service's characterization of sorting outputs and show how the output characterizations and the MODS piece handling measures relate. Both the FHP volumes preferred by Prof. Roberts and the total piece handling (TPF and TPH)[6] used by the Postal Service differ from Prof. Roberts's output definition, but the differences largely reflect differences in sort depth not explicitly incorporated in Prof. Roberts's

[6] Total Pieces Fed (TPF) is a count of all pieces processed on automated sorting equipment. Total Piece Handlings (TPH) counts successfully sorted pieces on automated equipment, and total processing volume in manual operations where TPF is not measured.

model. I also show that with additional disaggregation of sorting stages in Prof. Roberts's characterization of output, MODS TPF and TPH would more directly measure Prof. Roberts's outputs than FHP.[7] As defined, TPF and TPH track actual differences in sort depth better than FHP, but the measures are often reasonably consistent in their characterization of sorting output. The similarities of the MODS sorting volumes help explain why, despite some markedly different fundamentals, the Postal Service models and Prof. Roberts's models yield relatively similar results.

While Prof. Roberts is highly critical of what is termed the "proportionality assumption" in the "volume variability/distribution key" approach to calculating volume-variable costs (see, e.g., Roberts (2006) at 32), I show that the "assumption" has strong operational foundations in Sections II.E and III.A, below. I also show that viewed in a multiproduct cost setting, Prof. Roberts's models as implemented are appropriately viewed as a component of an alternative implementation of the "volume variability/distribution key" approach (see Section III.C).[8] Thus, while Prof. Roberts is highly critical of the assumptions underlying the volume-variable cost calculations, his models actually are subject to essentially the same assumptions. As use of the "distribution key" method does not bias the costs (see Appendix A), that all feasible mail processing cost

[7] However, it is not necessarily the case that further disaggregation is necessary to produce more reliable and efficient results.

[8] Prof. Roberts describes an idealized version of his model that would constitute a form of "constructed marginal cost" analysis; such an analysis would not require a distribution step. However, a "constructed marginal cost" model would depend on non-existent data and is thus infeasible. Additionally, because of the greatly differing data demands of the models, it is not a given that avoiding the distribtution key step with an analysis such as Prof. Roberts proposes actually would result in superior cost estimates compared to the distribution key method.

methods are in the “distribution key” boat should not be considered a significant flaw in the models.

In other fundamentals of the economic labor demand model and estimation approach, and even the general features of the labor demand function specification, I substantially agree with Prof. Roberts. I believe that the OCA’s research efforts should greatly narrow the scope of the mail processing volume-variability controversy and, at a minimum, allow the Commission to settle at least some of the issues that have been obstacles towards adoption of an empirical mail processing variability analysis.

For this testimony, I estimate an update to Prof. Roberts’s (2006) models employing data through FY 2005, investigate the effect of substituting additional elements of Prof. Robert’s specification (notably capital variables) in models using the TPF and TPH output measures I recommend for the BY 2005 CRA, and present results employing alternative capital input series intended to address issues raised by Prof. Roberts regarding the timing of capital equipment inventory updates and the start of MODS data derived from operations with the equipment. The updated Roberts models yield FY 2005 output elasticities of 87 percent for letters and 78 percent for flats, versus 99 percent and 70 percent, respectively, from Roberts 2006; the corresponding average elasticities are 88 percent and 92 percent using the Postal Service BY 2005 methodology. The same method applied retroactively to the 1999-2004 period analyzed by Prof. Roberts yields statistically similar results to the FY 2005 update.

Because of the timing of Prof. Roberts’s presentation, the related analysis was not available in time for the BY 2005 CRA production cycle; I discuss the results in Sections VII.C, VII.F, and VII.G, below. In response to issues raised in the Commission's R2005-1 Opinion and Recommended Decision, I also investigated the effects of alternative methods for screening the MODS data for errors that may not be apparent in quarterly data; see section VII.E.

II. Operational Foundations of the Analysis

II.A. Nature of Sorting Operations

The Postal Service accepts mail with various physical characteristics (e.g., shape, weight, presence of barcodes), and presort levels ranging from unsorted collection mail to mail in carrier routes' walk sequence. As of January, 2006, the Postal Service sorted mail to nearly 145 million delivery points and/or 250,000 delivery routes[9] with sorting equipment making no more than about 225 separations.[10] The mail sorting system, therefore, necessarily uses multiple processing stages (or sort "passes") to sort mail from its origin to its destination. Some elementary mathematics establishes the absolute minimum number of processing stages required, given the number of separations that can be made per pass. For instance, with 225 separations,[11] it is possible to sort to 225 destinations with the first pass, 50,625 destinations with two passes, 11.4 million destinations with three passes, and 2.56 billion destinations with four passes. Efficient organization of processing actually entails additional sorting steps—for example, it would be grossly inefficient to run 11.4 million DPS schemes rather than the much smaller number of 2-pass DPS processes that actually run on the few thousand DBCS machines in the Postal Service inventory.

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[9] The counts were obtained from the Address Management System.

[10] In letter-shape operations, Delivery Barcode Sorter (DBCS) equipment provides the most separations to permit the two-pass delivery point sequencing (DPS) process. In flat operations, the AFSM 100 provides approximately 120 separations.

[11] In practice, the number of available sort destinations is reduced by separations used for rejected pieces.

Each successful sorting pass advances the piece to the next node of the processing network en route to its destination. The sort passes are thus highly analogous to the ton-miles (or cubic foot-miles, etc.) of transportation services employed in moving goods over a hub-and-spoke network. Much as some quantity of ton-miles of transportation services is required to move a shipment from the origin to the hub, and an additional amount to move the shipment from the hub to the destination, so do sequential sort passes move a piece of mail from one node of the Postal Service’s sorting network to the next. In the end, the number of sort passes and the cost of performing them depend on factors including the entry point into the sorting network (which may be affected by worksharing activities), the exit point, and the sorting technology employed. Again, the analogy to transportation, where the costs depend on the origin and destination points, the layout of the transportation network, and the mode of transport, is clear. Pieces with some degree of presortation enter sorting process at “downstream” network nodes closer to their destination, bypassing “upstream” sorts and, of course, the cost associated with the avoided sorting work.

II.B. Overview of the Sorting Network

The sorting operations I study occur in plants that serve one (or more) of three functions. First, plants sort their originating mail, including collection mail, to the “rest of the world”—typically some nearby (or high volume) plants, as well as facilities designated as Area Distribution Centers (ADCs) or Automated Area Distribution Centers (AADCs). Origin plants also separate “local” mail, i.e., mail addressed to locations within the plants’ own service territories. Second, the

Postal Service's sorting equipment does not have sufficient separations to allow mail to be sorted to all possible destination plants in a single sort pass, so facilities designated as ADCs and AADCs serve in part to consolidate mail that cannot be efficiently separated to individual plants and perform additional sorting to destination facilities. Third, destination plants (which may or may not be different from the originating plant and/or ADC/AADC, depending on the exact origin-destination combination for a given piece) "finalize" the mail to varying levels of sortation—as fine as carrier routes for flats, and delivery point sequence for letters.

My understanding is that the Evolutionary Network Development (END) changes may alter the identities of origin and destination plants (LPCs and DPCs[12]), and that Regional Distribution Centers (RDCs, generally created from existing facilties) will assume ADC and AADC functions. See Docket No. N2006-1, USPS-T-1 at 11-12. However, existing sorting technologies will remain in use, and the general organization of sorting activities appears likely to undergo evolutionary rather than revolutionary changes in the near future. In particular, the basic organization of processing at originating, destinating, and transfer facilities will remain largely intact.

II.C. Sorting Mailflows for Letters and Flats

The Postal Service organizes its sorting operations by shape and, in some cases, the class of mail being processed (e.g., Priority Mail operations). While the Postal Service's mail processing plants (P&DCs and P&DFs) usually house

[12] Local Processing Centers and Destination Processing Centers.

combinations of letter, flat, and parcel-shape operations under the same roof, mail does not flow between the shape-based mailstreams. This is in part because the operations have limited technical substitutability—as with non-letter-shape mail that is physically incompatible with automated letter-sorting equipment. In other cases, the operations are not economically substitutable. As a result of the shape-based mailstreams being operationally separable, most recent analysis of mail processing costs, including Prof. Roberts's models, has treated them as analytically separable. Extensive additional discussion of the equipment used in and the organization of the letter-shape and flat-shape mailstreams may be found in witness McCrery's testimony, and detailed shape-based mailflow models are presented by witnesses Abdirahman and Miller (respectively, USPS-T-22 and USPS-T-20).

II.C.1. Letter-Shape Mailflows

Letter-shape mail arrives at plants in several forms: unsorted collection mail, letters bulk-entered by mailers or presort bureaus (presented in trays), and trays of mail sorted to the plant's service territory by other Postal Service facilities. The vast majority of letter-shape mail is compatible with the Postal Service's automated sorting equipment, which comprises most of the Postal Service's letter-sorting capacity. Since the cost of sorting a letter in an automated operation is a small fraction of the cost of sorting the piece in a manual operation, mail is directed to sorting operations on the basis of physical characteristics, most significantly automation compatibility and barcode presence.

Automation-compatible letters—the vast majority of the letter mailstream by volume—enter barcode sorting (BCS) operations via one of three flows. From the Advanced Facer/Canceler (AFCS), which obtains images of pieces for Remote Barcode System coding, pieces that are not prebarcoded flow to BCS/OSS operations for barcode application and an initial sort.[13] Non-barcoded pieces that do not require cancellation flow to ISS (OCR) operations, and subsequently to BCS or BCS/OSS operations. Pre-barcoded pieces, including bulk-entered mail and pieces separated by the AFCS, flow directly to BCS operations for sorting. Mailflows are organized to keep barcoded pieces in BCS operations unless rejected by the equipment. Most automation-compatible pieces will be "finalized" at the plant to delivery point sequence (DPS), though non-DPS zones and zones using CSBCS equipment at the destination post office, station, or branch to sort letters to DPS will be finalized to carrier route.

Manual operations are limited to processing non-machinable mail and machine rejects. (Witness McCrery provides additional details in USPS-T-42.) Manual operations finalize mail to the carrier route or 5-digit ZIP Code level. My understanding from Witness McCrery is that the Postal Service has removed manual sorting capacity as automation capacity and capabilities have expanded. Indeed, comparing my observations on recent plant visits[14] to visits earlier in my

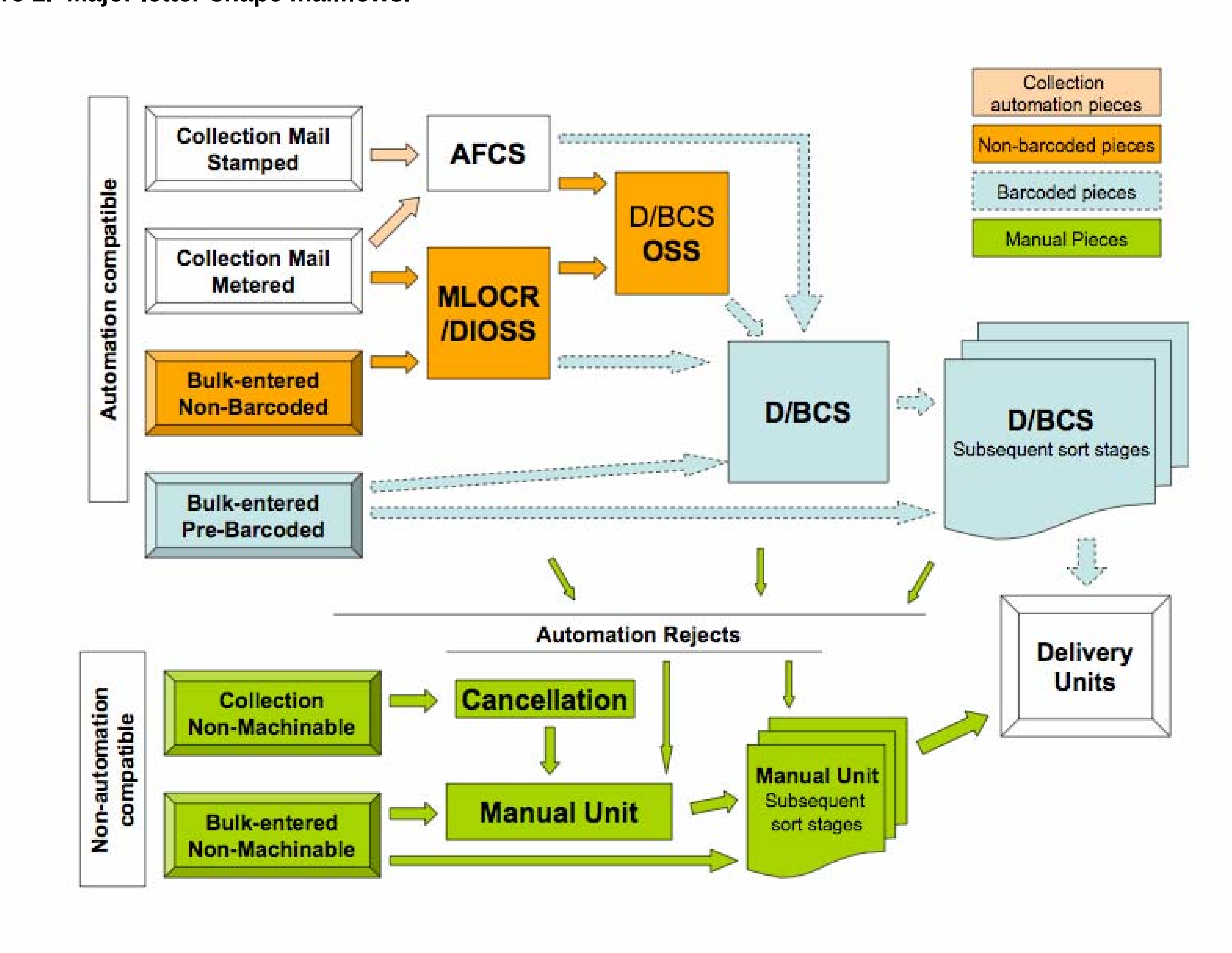
[13] My understanding is that metered collection mail now is also processed on the AFCS for security purposes; AFCS equipment has been retrofitted with biohazard detection systems.

[14] In preparation for this testimony, I visited the Southern Maryland, Kansas City KS, Kansas City MO, and Chicago (Cardiss Collins) P&DCs, and the Kansas City Bulk Mail Center.

career (when the DPS program was expanding rapidly), the displacement of manual sorting in favor of automation is immediately apparent.

Figure 1 presents a schematic diagram of the main mailflows within the group of letter-shape sorting operations.

Figure 1. Major letter-shape mailflows.



II.C.2. Flat-Shape Mailflows

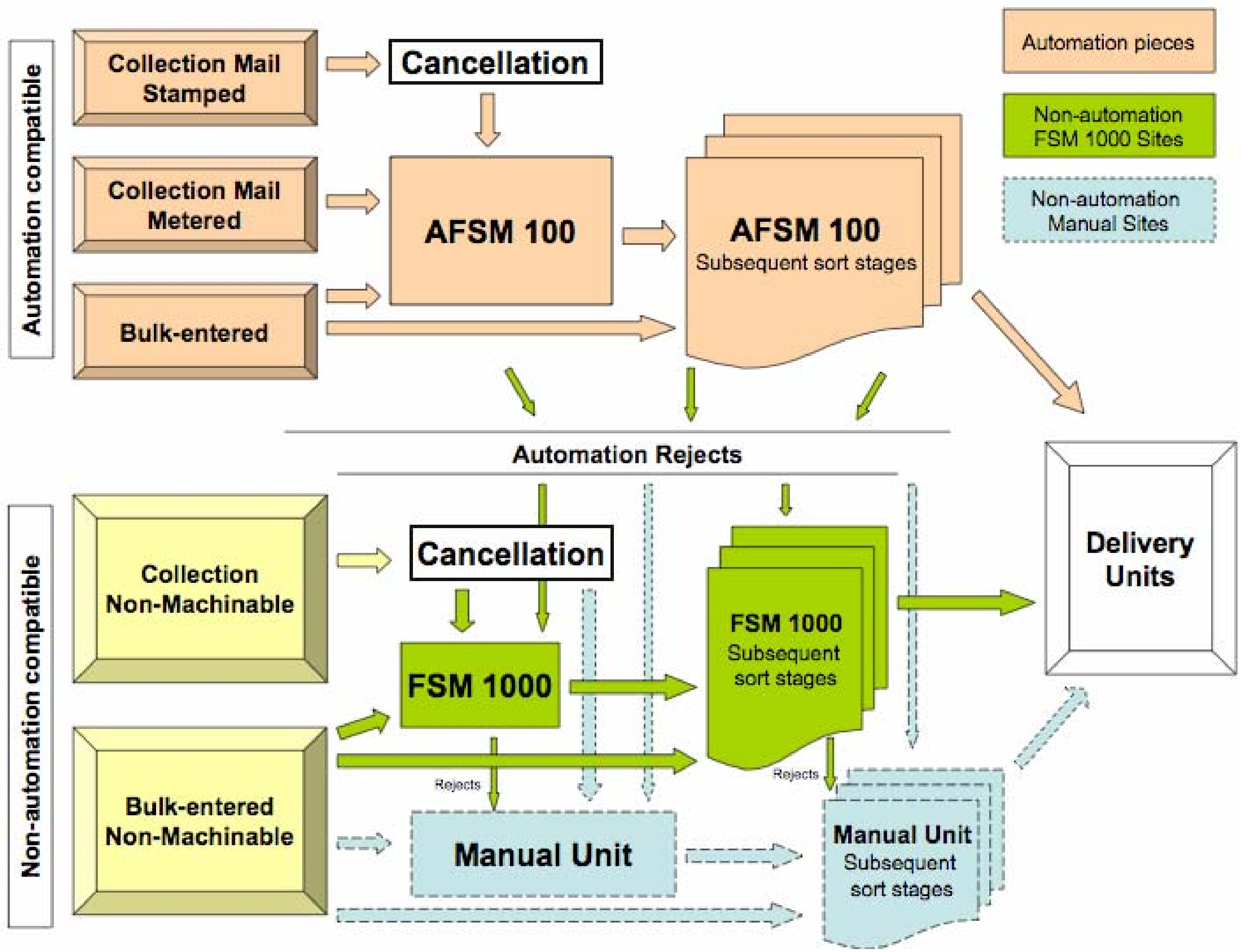
The organization of flat sorting is broadly similar to that of letter sorting. Flat-shape mail enters sorting operations as collection mail, presorted bundles from mailers (commonly prepped for piece sorting in the ‘035’ operation), and trays of mail processed in upstream flat sorting operations. Most flat-shape mail is compatible with the AFSM 100. The AFSM 100 incorporates OCR and barcode sorting capabilities, and uses remote encoding to sort pieces that cannot be resolved by the machine’s OCR or barcode sorting systems. The AFSM can apply a label and barcode to flats, so more costly remote encoding (or less successful OCR) methods do not need to be used for subsequent handlings. This also helps keep AFSM 100-compatible pieces in the AFSM operations.

Most flats that are not compatible with the AFSM 100 are compatible with the UFSM 1000; manual flat casing operations are also used to some extent. As with manual letters, the Postal Service has been sharply reducing its manual flat sorting capacity as the AFSM has expanded the Postal Service’s flat automation capacity, especially capacity for performing automated secondary sorts.

Since the AFSM makes fewer separations than the DBCS—120 AFSM separations versus 200+ for the DBCS—my understanding from witness Miller is that the flat sorting mailstream involves additional sorting stages relative to letters. That is, flat sorting operations make more extensive use of outgoing secondary and distinct SCF and 3-digit incoming “primary” schemes. However, the organization is otherwise analogous to letters with the AFSM 100 in the DBCS’s role as the main sorting technology, with manual and UFSM 1000 serving the “nonmachinable” portion of the mailstream as well as automation rejects.

A schematic diagram of the major flat-shape sorting mailflows is presented in Figure 2.

1 **Figure 2. Major flat-shape mailflows.**

2 

II.D. Relevance of Cost Pools; Input and Output Jointness

That the letter- and flat-sorting mailstreams can be separately analyzed for mail processing costing is not a matter of controversy between Prof. Roberts's models and the Postal Service approach. Nor does there appear to be a material dispute over input jointness (see, e.g., Docket No. R2000-1, USPS-T-15 at 43)—Prof. Roberts's model posits non-joint labor inputs for manual and automated operations within the shape-based mailstreams (Roberts [2006] at 7). Prof. Roberts is also correct, as a matter of theory, that treating letter and flat sorting as having separable operation-specific outputs may be restrictive within a joint production model.[15] However, the restrictions are justified operationally, a situation that Prof. Roberts's modeling effort does not recognize.

As Figure 1 (above) shows, certain letter operations such as AFCS and OCR are located "upstream" of D/BCS operations and exist to process specific subsets of the automation-compatible, letter-shape mailstream. Prof. Roberts's model indicates that the operational structure does not matter; all letter handlings—including the handlings of tens of billions of pieces bearing no relationship to the AFCS and OCR mailflows—are needed to explain labor demand in those operations. Likewise, the organization of D/BCS operations with (non-reject) downflows to subsequent D/BCS sort stages and no significant flows of pieces "upgraded" from manual sorting does not matter; handlings in the manual mailstream are needed to adequately explain D/BCS labor demand. The "need" does not go deeper than the statement of the restriction, however. Prof.

[15] This does not imply that output jointness necessarily leads to Prof. Roberts's specific joint output formulation.

Roberts makes no serious attempt to determine what the appropriate amount of output structure within the mailstream is.

In appealing to the "substitutability" of operations to justify his model structure, Prof. Roberts also does not appear to have adequately considered the extent to which automated (e.g., AFSM 100 and D/BCS) sorting operations and manual operations are technically substitutable or—at least as important—whether the operations actually are close economic substitutes. The very large magnitudes of the differences in the marginal cost per sort between automated and manual operations (see Table 8, Section VI.A) show that manual sorting is not, to say the least, an economical substitute for automated sorting when the latter is technically feasible. Correctly recognizing the per-sort cost differentials among various automated, mechanized, and manual operations is a major purpose of, and advantage of, conducting the variability modeling exercise at the cost pool level with operation-specific output measures.

By estimating the marginal costs of sorts by cost pool (i.e., processing mode), the Postal Service econometric models may be combined with mailflow models such as those presented by witnesses Miller (USPS-T-20) and Abdirahman (USPS-T-22) to estimate cost savings from substituting processing modes and/or avoiding sorting stages. The Postal Service models are structured to recognize that a shift among processing modes involves a change in the composition of the plant's output, whether or not the total plant output changes. For instance, substituting automated for manual processing of a piece involves a decrement of sorting output from manual operations and an increment of sorting output in automated operations. The cost savings may then be calculated from the marginal sorting costs by mode. Of course, similar methods also allow calculation of cost avoidances for bypassing sort stages in the various processing streams. In contrast, Prof. Roberts's models do not recognize any variation in output composition, and in fact imply—in the absence of an unspecified cost de-averaging exercise—that shifting a piece of mail from one processing mode to another has no cost consequence on the margin at all.

As I show in Section II.F, below, evaluating how mail volumes relate to the constituent activities within sorting operations leads to the conclusion that the pieces sorted within the cost pool should be the main—if not the only—way in which mail volumes cause sorting operations' labor requirements. To a considerable extent, this is simply to say that the Postal Service and Commission methods for developing distribution keys for sorting operations, which employ IOCS tallies representing handlings of mail within the cost pool to distribute the volume-variable costs of the operations back to the subclasses causing the costs, has been correct all along. However, the degrees of cross-operation output effects are measurable in principle, and I discuss results from alternative specifications in Section VII.B.

II.E. Relationship Between Mail Volumes and Piece Handlings

The Postal Service employs three variables defined in the MODS system to measure sorted pieces: First Handling Pieces (FHP), Total Pieces Handled (TPH), and Total Pieces Fed (TPF). MODS records FHP counts in the first operation in which pieces are successfully sorted in a facility, but FHP is not recorded in subsequent sorting stages within a facility. TPH counts are recorded for every successful sort, so TPH theoretically is the sum of FHP and subsequent handlings. MODS also records cancellation workloads using TPH. TPF, which is recorded only for automated and mechanized sorting operations, includes handlings for rejected pieces in addition to the successful sorts measured in TPH; accordingly, TPF is the broadest measure of handlings in MODS.

FHP counts are measured by converting the weight of mail into piece counts as mail first enters a plant's sorting operations. The weight conversion method is necessary because, for most sorting stages, pieces eligible for FHP counts are mixed with pieces receiving subsequent handlings not included in FHP. Once mixed with non-FHP pieces, the FHP portion of handlings is not observable, in general.[16] In contrast, for mechanized and automated operations, TPH and TPF are measured directly via the piece counts collected by the sorting equipment. As a result, MODS can obtain exact piece counts for TPH and TPF in principle, though in practice data transmission and aggregation errors lead to some erroneous observations in the MODS data set. As a result of the FHP conversion process, FHP data are subject to measurement error even in automated and mechanized operations in which TPH and TPF are based on potentially error-free automatic piece counts.

As a measure of sorting output, FHP is incomplete and therefore inferior to the TPH and TPF measures. Consider a piece of mail that receives sorting at an

[16] The exceptions are operations, such as outgoing primary sorting, where essentially all of the pieces handled in the operation would be receiving the first sort, and hence would receive FHP counts. In others, such as the second pass of the two-pass DPS process on DBCS equipment, none of the handlings are counted as FHP since the only flow of mail into the operation is from the previous first-pass sort.

origin plant, an ADC (or AADC) that is a separate facility from the origin plant, and a destination plant that is also different from the ADC. This piece would (apart from measurement error) receive three FHP—one at each facility—as well as three or more TPH.[17] A piece addressed to a DPS zone processed by the destination plant would require additional sorting as compared to an otherwise identical piece addressed to a non-DPS zone. The DPS piece would, therefore, represent (other things equal) more output on the part of the destination plant than the non-DPS piece, since the latter requires additional sorting at the delivery office. The DPS piece receives additional sorts per the TPH measure, but both pieces receive the same FHP count. Thus, FHP generally fails to measure the additional sorting performed to finalize pieces to greater depths of sort. Likewise, the FHP measure would not recognize a difference in a destination plant's sorting of a 3-digit presort piece versus a 5-digit presort piece, as FHP does not capture the sort stage(s) avoided by the 5-digit piece; TPH reflects the difference. The shortcomings of FHP are particularly significant as the substitution of mailer or presort bureau work (or "output") for Postal Service work, via the avoidance of certain sort stages, is the basis for presort cost avoidances.

Pieces following the same path through the Postal Service sorting network receive the same counts in the MODS workload measures. The (expected) path of a piece through sorting operations is determined by the origin and destination of the piece, as well as physical characteristics that sort the piece into one of the flows depicted in Figures 1 and 2.[18] While the organization of the Postal Service

[17] The piece would also receive at least one TPF per handling recorded as TPH in an automated sorting operation.

[18] *Ex post*, the actual path may vary depending on whether the piece actually is successfully sorted, rejected, or missorted at each stage.

processing network is, naturally, subject to change over time, field managers process the mail they receive according to the existing operational plan. The nature of changes to the operating plan is that changes will have been studied long before any particular piece is processed according to a revised plan. In other words, the plan is *predetermined* from the standpoint of the sorting of any particular piece.

II.F. Relationship Between MODS Workloads and Workhours

The labor requirement for sorting operations comprises five broad types of activities:

- Runtime—operating the running machine: loading the machine, sweeping the output bins or stackers in the course of the run, clearing jams, monitoring the machine operation (for manual operations, the equivalent is the time spent actually sorting mail into the cases or other receptacles);
- "Quasi-allied labor"—handling of mail other than "direct" sorting activities, and related work, by employees assigned to the sorting operation—e.g., obtaining mail from staging areas, and obtaining and disposing of empty equipment;
- Setup and take-down—setting up the equipment in preparation of running a scheme; clearing processed mail from the machine at the end of the run;
- Waiting for mail and activities other than the above not involving the handling of mail;
- "Overhead" activities such as paid break time and clocking in or out.

The FY 2005 proportions for each activity category in the econometrically modeled cost pools, as measured by the In-Office Cost System, are provided in Table 2, below.

Table 2. Composition of activities in sorting cost pools, FY 2005

	Activity Category						
Cost Pool	Setup/ Take-down	Runtime	Container Handling	Other Handling	Brk/Clock	Waiting	Other
D/BCSINC	9%	61%	2%	6%	19%	1%	3%
D/BCSOUT	8%	62%	2%	6%	18%	1%	2%
OCR/	7%	62%	2%	7%	18%	1%	3%
AFSM100	8%	67%	2%	4%	17%	1%	2%
FSM/1000	6%	67%	1%	5%	17%	1%	2%
SPBS OTH	6%	62%	3%	3%	20%	2%	4%
SPBSPRIO	5%	62%	3%	5%	19%	1%	5%
MANF	4%	62%	5%	5%	19%	2%	4%
MANL	3%	64%	2%	6%	19%	2%	4%
MANP	5%	41%	12%	10%	20%	3%	8%
PRIORITY	5%	48%	10%	9%	19%	3%	7%
1CANCEL	4%	--	11%	54%	18%	4%	10%
Letter Sorting	6%	62%	2%	6%	19%	1%	3%
Flat Sorting	6%	66%	2%	4%	17%	2%	3%

Source: Analysis of FY 2005 IOCS Data.

The component activities have distinct relationships to processing volumes, which in turn potentially affect the degree of volume-variability.

II.F.1. Runtime

As shown in Table 2, above, runtime constitutes the majority of work hours within the letter and flat sorting cost pools, and is the major activity in all of the cost pools studied for this testimony. Runtime workhours are proportional to the number of pieces inducted into the operation for processing—TPF in MODS terminology (TPH for manual operations). For automated operations:

$$RuntimeWorkhours = (StaffingIndex) \cdot (1/MachineThroughput) \cdot TPF \quad (1A)$$

The staffing index is the number of workers assigned to the machine; the throughput is the rate at which the machine processes the mail. In manual operations:

$$RuntimeWorkhours = (1/SortingProductivity) \cdot TPH \quad (1B)$$

Equations (1A) and (1B) imply that holding the staffing index, throughput, and/or sorting productivity constant, runtime workhours would be 100 percent variable with TPH or TPF.

It is possible for the productivity, staffing index and/or throughput terms in equations (1A) and (1B) to vary positively or negatively with volume. For instance, increasing the staffing index can, to a limited extent, increase throughput towards a machine's technical limits at some cost to productivity. Conversely, in human-paced operations, employees may exert greater effort when faced with larger backlogs of pieces to clear. I would not, however, expect that many of these types of workload-based productivity variations are sustained (in either direction) over longer periods of time.

Prof. Roberts has suggested that the relationship between machine runtime and TPF:

$$MachineRuntime = (1/MachineThroughput) \cdot TPF \quad (1C)$$

implies that TPF is actually a measure of capital "input" rather than a sorting "output" (Roberts [2006] at 35-36). Prof. Roberts's conclusion is erroneous. Equation (1A) relates TPF to a portion of workhours or labor input. If Prof.

Roberts were correct that equation (1C) is sufficient to establish TPF as a measure of capital input, then it would follow from equation (1A) that TPF was also a measure of labor input. In effect, Prof. Roberts is claiming that labor input and capital input are identical.[19] This misinterprets the role of TPF. In the standard economic formulation of factor demands, *outputs* appear as explanatory factors for both labor and capital input.[20] So, considering TPF as a sorting output easily explains its appearance as an explanatory variable for both capital and labor input.

II.F.2. "Quasi-Allied Labor"

In addition to the work time spent sorting the mail, a portion of the time in sorting operations is spent on "quasi-allied labor" activities. I use the term to denote activities, particularly moving mail and equipment into and out of the operations, that are similar to LDC 17 allied labor operations but which are carried out by employees clocked into the sorting operation. Again, the volume "driver" is TPF (or TPH)—which counts the number of pieces taken to or from the sorting operation—though the amount of container handling also depends on the containerization profile of the mail.

As witness McCrery notes (USPS-T-42, Section III), many destinations will receive one container per processing cycle, largely independent of volume; more generally, the degree of variability of container handling depends on the extent to

[19] Prof. Roberts's logic also fails to explain the function of TPH in equation (1B) for manual operations, where no machine is utilized.

[20] It also would be more accurate to describe TPF's role in capital input as explaining capital *utilitzation* in sorting operations rather than capital stocks.

which changes in volumes cause changes in the number of container handlings on the margin. Based on my discussions with witness McCrery, container handlings and other quasi-allied labor activities would be expected to exhibit greater volume-variability than setup and take-down time, but significantly less than 100 percent variability. In Docket No. R2000-1, it had been noted that container handling costs should exhibit "stair step" patterns reflecting the process of filling (or emptying) containers, which has little effect on container handling costs, and (occasionally) reaching points at which increments or decrements of handlings occur. Determining the degree to which the Postal Service operates on the "treads" (where costs would show low volume-variability) versus the "risers" (with locally high variability) is a matter for the econometric estimation to determine.

Container handlings and related "quasi-allied labor" work constitute a relatively small fraction of work time for automated letter and flat operations; they contribute more prominently to cancellation operations, SPBS operations, and manual sorting, especially manual parcels and Priority Mail.

II.F.3. Setup and Take-Down Activities

Setup and take-down activities have little direct relationship to processing volumes. The essence of setup and take-down activities is that they must be performed once per scheme run, regardless of the quantity of pieces that will run (or have been run) through the scheme. The setup activities include printing container labels, positioning trays or other containers at the runouts, and loading the sort program. Takedown activities, which tend to be more time-consuming, include removing labels and sweeping all processed mail from each output bin or stacker. The latter, in particular, involves handling of mail in the IOCS sense, though the main driver of costs is the number of output separations to be swept, rather than the number of pieces needing to be withdrawn from the machine or the manual operation.

These were identified as activities likely to have low volume-variability by witness Kingsley in Docket No. R2000-1; witness Kingsley also offered a rough quantification of the fraction of time in setup and take-down activities (Docket No. R2001-1, USPS-T-39 at 30-32). Witness McCrery reiterates witness Kingsley's description in his current testimony (USPS-T-42, *op. cit.*). The FY 2005 IOCS data provide a systemwide picture of the relative magnitude of these activities. As shown in Table 2, they constitute 3 to 9 percent of the cost pools under study.

II.F.4. Waiting Time

Employees in sorting operations spend a small fraction of their time waiting for mail. A portion of waiting time is treated as non-volume-variable cost in the Commission's mail processing model. Waiting time is a relatively minor source of relatively low volume-variability costs in sorting operations.

II.F.5. "Overhead" activities

"Overhead" time—on-the-clock breaks and "personal needs" time, and time spent clocking into or out of an operation—traditionally was considered to be generated as a byproduct of "productive" work time, and thus were "attributable to the same degree as other than overhead mail processing costs." (See, e.g., Docket No. R97-1, USPS-LR-H-1 at 3-7.) As a result, while overhead activities comprise a relatively large fraction (17 to 20 percent) of the sorting operations, they traditionally were regarded as not affecting the degree of volume-variability. Note that to the extent the traditional theory is correct and productive work varies less than 100 percent with volume,[21] the Commission's mail processing methodology slightly overstates mail processing variabilities by assuming break and clocking overheads to be a 100 percent volume-variable component of mail processing costs.

[21] The Commission's model does, in fact, define some activities in mail processing cost pools as non-volume-variable.

III. Multiproduct Costing Issues for Mail Processing

III.A. The "Volume Variability/Distribution Key" Framework; Comparison to Prof. Roberts's Model

In this section, I describe the Postal Service's framework for developing estimates of subclass volume-variable costs. I will show that Prof. Roberts's (2006) model, as implemented, falls under the same basic framework: while Prof. Roberts uses a different characterization of processing volumes, use of the distribution key method is still necessary to relate volume-variable costs to subclasses under his model. In Section III.A.3, I compare TPF (or TPH) and FHP as measures of Prof. Roberts's sorting outputs, and show that the differences between the measures are narrower than Prof. Roberts suggests, though total handlings by definition do a better job than FHP at capturing actual variations in depth-of-sort. Differences between MODS sorting volumes and Prof. Roberts's outputs also reflect differences in sorting output that Prof. Roberts's definitions fail to capture and not flaws in the TPF and TPH definitions.

III.A.1. The Postal Service Multiproduct Costing Framework

Mail processing costs have been developed by both the Postal Service and the Commission as applications of what has been termed the "volume variability/distribution key" method for calculating volume-variable costs by subclass. See USPS-LR-L-1, Appendix H. That is, the volume-variable costs in cost pool *i* and subclass *j* are:

$$VVC_{i,j} = C_i \cdot \varepsilon_i \cdot d_{i,j} , \qquad (2)$$

where C_i is the costs in the pool, ε_i the elasticity of costs with respect to the "cost driver" in pool *i*, and $d_{i,j}$ is the distribution key share for subclass *j* in pool *i*. Equation (2) straightforwardly generalizes to the case of multiple cost drivers; please see Dr. Christensen's testimony from Docket No. R97-1, Tr. 34/18221-23.

In section II.F, I described how MODS piece handlings—TPF and TPH—relate to the various component activities in mail sorting operations such that it cannot safely be presumed that the elasticities of sorting operations' costs with respect to piece handlings are 1. It is also necessary to establish the relationship between volumes and piece handlings.

Equation (2) may be viewed as an approximation of the volume-variable costs from the "constructed marginal cost" method, which replaces the distribution key share with the elasticity of the cost driver with respect to volume, $\delta_{i,j}$:

$$VVC_{i,j} = C_i \cdot \varepsilon_{\iota} \cdot \delta_{i,j}\,, \qquad (3)$$

or, if the relationship between volumes and costs can be directly estimated:

$$VVC_{i,j} = C_i \cdot \eta_{i,j}\,. \qquad (3')$$

Equations (2) and (3) are identical when the relationship between the volumes and distribution keys is linear; otherwise, equation (2) provides an approximation to (3). Please see Appendix A for the approximation result. Equation (2) is valuable because reliable volume data generally do not exist at sufficient levels of time and geographic disaggregation to estimate (3') or even (3) directly. So the result (2) that permits the use of "cost drivers" as intermediaries between volumes and costs, as well as data sources such as IOCS that provide data on subclass shares of processed volumes but not the absolute volumes, is vital to generating "feasible" economic costs.

Summing equation (2) over cost pools and subclasses, total volume-variable costs are given by:

$$VVC = \sum_{i,j} VVC_{i,j} = \sum_{i,j} C_i \cdot \varepsilon_i \cdot d_{i,j} = \sum_i C_i \cdot \varepsilon_i \ , \qquad (4)$$

where the second equality holds because the distribution key shares sum to 1.

III.A.2. Relationship Between Volumes and Piece Handlings Revisited

In section II.E, I discussed the relationship between mail volumes and MODS piece handlings. The important feature of the relationship is that, given the Postal Service's operating plan, two otherwise identical pieces will follow the same (expected) path through the Postal Service's sorting network.

Consider, for instance, a non-presorted (or mixed AADC) automation-compatible letter addressed to a destination outside the service territory of a different plant than the origin facility. An idealized mailflow for such a piece[22] leads to the following sort handlings:

[22] I assume for the purposes of the example that the origin plant does not sort directly to the destination plant, that the AADC and destination plant are separate facilities, and that the destination is a 2-pass DPS zone. To simplify the exposition, I also ignore the flows for rejected pieces. Pieces with origin/destination combinations that yield a different processing path are analytically distinct categories from the perspective of both the Postal Service's and Prof. Roberts's models.

Example 1 (non-presorted, barcoded letter):

- Outgoing primary or secondary—sort from originating plant to AADC—1 TPH/TPF/FHP in D/BCS pool (outgoing)
- MMP—sort from AADC to destination plant—1 TPH/TPF/FHP in D/BCS pool (outgoing or incoming)[23]
- Incoming primary or SCF—sort from destination plant to 5-digit ZIP Code—1 TPH/TPF/FHP in D/BCS pool (incoming)
- Incoming secondary/tertiary—sort from 5-digit ZIP to delivery point sequence—2 TPH/TPF, no FHP, in D/BCS pool (incoming).

A second, otherwise identical, piece would require and normally receive exactly the same handlings, resulting in 10 D/BCS TPH/TPF and 6 D/BCS FHP, versus 5 and 3 for the first piece. If the first piece is First-Class Mail and the second piece is (otherwise identical) Standard Mail, the pieces will usually differ in when they are processed, but not how. It should be noted that this general picture is robust even to some restructuring of the processing network: the same set of handlings described above still will occur even if the identities of the origin plant, destination plant, and/or AADC are changed, as long as they remain different sites.

Of course, in reality, there is a small chance that the piece will be rejected at some processing stage and receive subsequent handlings in manual or different automated operations; for a very large number of pieces, some

[23] Prof. Roberts's model includes MMP operations in the "incoming" output measure. While this differs from the BY 2005 Postal Service methodology, it is a reasonable alternative classification for the MMP operations, particularly given the use of FHP as a sorting output measure.

handlings will appear in operations other than D/BCS as pieces are observed following “back-up” paths to the destination.

Meanwhile, an otherwise identical piece with the same destination but presorted to the AADC would avoid the initial outgoing primary or secondary sort at the origin plant, receiving (normally) 4 D/BCS TPH/TPF and 2 D/BCS FHP per piece:

Example 2 (AADC presort):

- MMP—sort from AADC to destination plant—1 TPH/TPF/FHP in D/BCS pool (outgoing or incoming)
- Incoming primary or SCF—sort from destination plant to 5-digit ZIP Code—1 TPH/TPF/FHP in D/BCS pool (incoming)
- Incoming secondary/tertiary— sort from 5-digit ZIP to delivery point sequence—2 TPH/TPF, no FHP, in D/BCS pool (incoming).

The avoidance of the outgoing primary (and/or secondary) handling is the main source of cost avoidance for an automation AADC presort piece.

Finer levels of presort can also avoid ADC/AADC processing as well. Increasing the presort level to 3-digit ZIP Code leads to the following sort handlings (again, assume the piece is otherwise physically identical):

Example 3 (3-digit presort):

- Incoming primary or SCF—sort from destination plant to 5-digit ZIP Code—1 TPH/TPF/FHP in D/BCS pool (incoming)
- Incoming secondary/tertiary—sort from 5-digit ZIP to delivery point sequence—2 TPH/TPF, no FHP, in D/BCS pool (incoming).

The same piece presorted to 5-digit ZIP Code enters the mail stream directly for secondary/tertiary processing, and receives:

Example 4 (5-digit presort):

- Incoming secondary/tertiary—sort from 5-digit ZIP to delivery point sequence—2 TPH/TPF, FHP in the first pass, in D/BCS pool (incoming).

This demonstrates a major defect of FHP as a measure of sorting "output"—the 5-digit presort piece avoids the incoming primary or SCF sort relative to the 3-digit piece, and thus the TPH and TPF for that processing stage, but it does not avoid an incoming FHP count. Rather, the incoming FHP represents less output (and picks up less cost) for the 5-digit piece, versus the 3-digit piece, as it needs less improvement to be finalized.

Similarly, FHP fails to register the incoming handling steps for local pieces. If the hypothetical non-presorted piece from the original example has a destination within the origin plant's service territory, it will usually be sorted directly to 5-digit ZIP Code:

Example 5 (local mail):

- Outgoing primary or secondary—sort directly to 5-digit ZIP Code—1 TPH/TPF/FHP in D/BCS pool (outgoing)
- Incoming secondary/tertiary—sort from 5-digit ZIP to delivery point sequence—2 TPH/TPF, no FHP, in D/BCS pool (incoming).

While the local piece receives incoming sorts, which the TPH and TPF measures pick up, it receives no incoming FHP, since FHP is only measured for the first sort within the facility. In this case, the outgoing FHP represents sorting output in the incoming operations in a way it does not for non-local pieces. The outgoing TPH and TPF represent only the output of the outgoing operations for all pieces.

The same type of exercise can be carried out for every other analytically distinct mail category. The result would be vectors of indicator variables indicating the handlings that would be incurred for a piece in each mail category in each cost pool given the operating plan. The handlings would appear as in Table 3, below.

Table 3. Stylized matrix relating volumes to handlings

Mail Category	BCS Out Primary or Secondary	BCS MMP	BCS In Primary or SCF	BCS In Secondary (1st Pass DPS)	BCS In Secondary (2nd Pass DPS)	OCR	Manual Letters […]
Ex. 1	1	1	1	1	1	0	0…
Ex. 2	0	1	1	1	1	0	0…
Ex. 3	0	0	1	1	1	0	0…
Ex. 4	0	0	0	1	1	0	0…
Ex. 5	1	0	0	1	1	0	0…
…	…	…	…	…	…	…	…

The result is that it is possible to write a relationship between volumes and handlings of the form:

$$H = A \cdot V, \qquad (5)$$

Where *H* is the vector of handlings by operation, *A* is a matrix of coefficients relating volumes to handlings, and *V* is the vector of volumes by mail category. The underlying assumption for equation (5) that yields the (linear) proportionality between handlings and volumes is simply ***that identical pieces will follow the identical (expected) paths through the sorting network under the operating plan***.

III.A.3. Comparison of the Postal Service's and Prof. Roberts's Models; Measuring Sorting "Outputs" in MODS

The central difference between the Postal Service model and Prof. Roberts's model is not that one assumes a proportional relationship between RPW volumes and handlings and the other doesn't, but rather in the details of the specification of the proportional relationship, in the forms of the handlings *H* and the handling-coefficient matrix *A* from equation (5). Both models condense the *A* matrix as shown in Table 3, above, for analytical tractability.

In the Postal Service's method, the handling matrix A is condensed to the sum of handlings by cost pool:

Table 4. Stylized matrix relating handlings to volumes (Postal Service model)

Mail Category	D/BCS Outgoing	D/BCS Incoming	OCR	Manual Letters
Ex. 1	2	3	0	0
Ex. 2	1	3	0	0
Ex. 3	0	3	0	0
Ex. 4	0	2	0	0
Ex. 5	1	2	0	0
…	…	…	…	…

In contrast, Prof. Roberts's model condenses handlings to outgoing ("initial sort") versus incoming ("final sort"), but does not distinguish the operation where the handling is incurred[24]:

[24] Prof. Roberts treats flat sorting operations similarly.

Table 5. Stylized matrix relating handlings to volumes (Prof. Roberts's model)

Mail Category	Initial Sort Letters—L(initial), outgoing	Final Sort Letters—L(final), incoming
Ex. 1	1	1
Ex. 2	1	1
Ex. 3	0	1
Ex. 4	0	1
Ex. 5	1	1
…	…	…

It follows that Prof. Roberts's outputs are also linearly related to volumes, and if VP_L is the total number of RPW letter pieces (of all classes and subclasses) requiring *any* sorting, then Prof. Roberts's output measures feature VP_L < L(Initial) + L(Final) < 2 VP_L, depending on the mix of volumes by processing category.[25]

In the Postal Service's model, TPF and TPH directly measure the handlings in Table 4. Prof. Roberts uses FHP disaggregated between incoming and outgoing operations to represent the handlings from Table 5. He further claims that FHP measures his output characterization better than other MODS measures (Roberts [2006] at 27). First, FHP—assuming away measurement error for the sake of discussion—corresponding to the examples in Table 5 would not exactly measure Prof. Roberts's outputs in principle, as shown in Table 6A:

[25] Prof. Roberts's 2006 paper claims L(initial) + L(final) = VP_L, which clearly is inconsistent with Prof. Roberts's definition of L(initial) and L(final) as, respectively, the pieces receiving the "initial" and "final" sorts.

Table 6A. Example of correspondence between FHP and Prof. Roberts's model "outputs"

Mail Category	Outgoing FHP ("initial sort")	Incoming FHP ("final sort")
Ex. 1	1	2 (differs from Table 5)
Ex. 2	0	2 (differs from Table 5)
Ex. 3	0	1
Ex. 4	0	1
Ex. 5	1	0 (differs from Table 5)
…	…	…

As described in the previous section, FHP does not capture the "final sort" stage for the local piece. In principle, FHP always captures the "initial sort" but not generally the "final sort." FHP also measures an additional "final sort" for the pieces from Examples 1 and 2, as compared to the Example 3 and 4 pieces. While the Example 1 and 2 pieces require more sorting improvement than the example 3 and 4 pieces, it is not necessarily the case that the MMP sort should constitute the same "output" as the collective sorting improvement in the remaining sort stages. Also, since only one FHP count is recorded per facility, there are wide variations from piece to piece in the amount of sorting—and sorting cost—represented by each FHP.

Suppose instead Prof. Roberts had chosen to measure his "outputs" with TPH (or TPF). The TPH corresponding to the examples above are in Table 6B:

Table 6B. Example of correspondence between TPH and Prof. Roberts's model "outputs"

Mail Category	Outgoing D/BCS TPH ("initial sort")	Incoming D/BCS TPH ("final sort")
Ex. 1	1	4
Ex. 2	0	4
Ex. 3	0	3
Ex. 4	0	2
Ex. 5	1	2
…	…	…

Note that TPH and FHP provide identical measures of "outgoing" output, abstracting from measurement error. Since automated TPH are recorded by machine counts, TPH can be preferable to FHP measured by weight conversion when they are otherwise measuring the same quantity. On the incoming side as well, it is not clear that FHP provides a better measure of Prof. Roberts's output than TPH. Prof. Roberts's output definition assumes that each piece involves the same sorting "output." Neither measure "agrees" with Prof. Roberts's output characterization, though since the less presorted pieces actually require more sorting, the conceptual problem is with Prof. Roberts's output definitions, not the MODS volumes. However, FHP fails to measure any incoming "output" for the Example 5 (local mail) piece. Therefore, TPH shows actual variations in output not present in Prof. Roberts's output definition and not always measured by FHP, and successfully meaures the incoming operations' output for local mail where FHP measures no output.

TPF also would more closely correspond to Prof. Roberts's outputs had he disaggregated the outputs by additional sorting stages. If Prof. Roberts had, for instance, disaggregated his letter output measures by the sorting stages within the “initial” and “final” sorting sequences, then his outputs would resemble the handlings in Table 3—and would be measured in MODS by TPF and TPH, not FHP. That is, in a full disaggregation (i.e., no subsequent handlings within a sort stage), there is in principle one sort per sorting stage. TPH and TPF by definition record one count per piece sorted in each stage. With the five letter processing stages from Table 3, the outputs are as given in Table 7:

Table 7. Possible Roberts-style letter outputs with five processing stages

Mail Category	Initial sort – Outgoing primary or secondary	MMP sort	Final sort – Incoming primary or SCF	Final sort – Incoming secondary (1^{st} pass)	Final sort – Incoming secondary (subsequent pass[es])
Ex. 1	1	1	1	1	1
Ex. 2	0	1	1	1	1
Ex. 3	0	0	1	1	1
Ex. 4	0	0	0	1	1
Ex. 5	1	0	0	1	1
…	…	…	…	…	…

The result, of course, is very similar to Table 3 minus the operation distinctions. In this case, FHP only measures the first secondary pass for the Example 4 piece (5-digit presort, with the first handling in the secondary first pass), and does not measure any secondary handlings for the other example pieces.

It should be noted that the examples above have been confined to the automation mailstream. That TPF and TPH better capture variations in sort depth within a mailstream than FHP does not imply, for instance, that it would be appropriate to aggregate automated TPF and manual TPH in a manner similar to Prof. Roberts’s FHP output measures. Different operations’ TPF and TPH represent widely varying amounts of cost and even sorting output. The multi-output models described in Section VII.D suggest how TPF and TPH might be appropriately used in a model that imposes minimal restrictions on output jointness. The results, it should be noted, generally support the use of operation-specific outputs as in the Postal Service models.

III.B. Function of the Variability Models in the Distribution Key Method

Recall that the volume-variable cost calculation in the "volume variability/distribution key" method involves three components:

$$VVC_{i,j} = C_i \cdot \varepsilon_i \cdot d_{i,j} \text{ ,} \qquad (2)$$

Both the Postal Service models and Prof Roberts's provide estimates of the second term, ε_i—the elasticity of the costs (i.e., labor input) with respect to output. As described above, the models differ in their characterizations of "outputs" but not in the fundamental framework.

III.C. Measuring the Volume-Handling Relationship; Accommodating Changes Over Time

For developing costs by subclass, both the Postal Service and Prof. Roberts's models require a method for characterizing an otherwise unmeasured relationship:

$$H = A \cdot V \text{ ,} \qquad (5)$$

Where in the Postal Service model, letter handlings H_L and flat handlings H_F are:

$$H_L = (TPF_{D/BCS-In}, TPF_{D/BCS-Out}, TPF_{OCR}, TPH_{Man.Letter}) \qquad (6)$$

$$H_L = (TPF_{AFSM-In}, TPF_{AFSM-Out}, TPF_{FSM1000}, TPH_{Man.Flat}) \text{ ,} \qquad (7)$$

the matrix *A* in equation (5) resembles Table 4, above. In Prof. Roberts's notation, his models use

$$H_L = (FHP_{Out,Letter}, FHP_{In,Letter}) \qquad (8)$$

$$H_F = (FHP_{Out,Flat}, FHP_{In,Flat}) \quad (9)$$

with the matrix *A* resembling Table 6, above.[26] Regardless of the specific formulation of Prof. Roberts's sorting "outputs," the essential features are that sorts by subclass are not directly observed, and that the number of measured sorts in each stage depends on mailpiece characteristics.

In the CRA, *A* is estimated (as shares of handlings by subclass, i.e., distribution keys) from In-Office Cost System (IOCS) data. The process makes use of the most widely-known function of IOCS: producing estimates of proportions of handlings of the subclasses of mail (see also USPS-T-46, Section II.B.1).[27]

It is important to note that the IOCS-based distribution key analysis is updated annually with the current year's IOCS sample data, as are the calculations of total labor costs by operation and (potentially) the variabilities. As a result, the observation that total handlings per piece (or per FHP) may change over time[28] does not imply that the distribution key-based cost estimates fail to reflect changes in handling patterns. Given the regular updating of the

[26] As noted in Section III.A, the details of Prof. Roberts's method may vary with the degree to which each sorting stage is represented in the outputs. Also, Prof. Roberts's exposition tends to obscure the indirect relationship between the sorting volumes he employs and RPW volumes by positing a single mail "volume" as a simplifying assumption, even though the actual cost calculations involve 17 subclasses or rate categories and several other services.

[27] The relationship between IOCS tallies and sorting handlings was presented as far back as Dr. Christensen's testimony in Docket No. R97-1 (Tr. 34/18221-23). The IOCS tallies estimate handling time: e.g. for automated operations, equation (1A) implies that the bulk of handling time is given by [staffing(op)/throughput(op)]*TPF(op, product), so the IOCS distribution key shares estimate TPF(op,product)/TPF(op).

[28] See, e.g., Roberts (2006) at 33.

distribution keys with current data to reflect current (base year) operating conditions, the linearization of the handling-volume relationship in the distribution key method does not itself bias the volume-variable cost estimates (see Appendix A).

Should Prof. Roberts's models as updated for Section VII.G, or any similar specification, be adopted by the Commission, a distribution key method will be needed to distribute the pools of volume-variable costs to subclasses. The general matter of distributing a pool of costs with two variability factors—i.e., Prof. Roberts's elasticities of labor in letter operations with respect to measures of pieces sorted in incoming and outgoing operations—is straightforward. As noted above, Dr. Christensen presented the generalization of the distribution key method for multiple elasticities and distribution keys in Docket No. R97-1. The volume-variable costs for subclass j could be calculated according to:

$$VVC_{op,j} = C_{op}\left(e_{op,outLetter}d_{outLetter,j} + e_{op,inLetter}d_{inLetter,j}\right) \text{ (letters)} \qquad (10)$$

$$VVC_{op,j} = C_{op}\left(e_{op,outFlat}d_{outFlat,j} + e_{op,inFlat}d_{inFlat,j}\right) \text{ (flats).}^{29} \qquad (11)$$

In effect, pools of volume-variable costs associated with each of the output elasticities would be distributed according to a matching subclass distribution key. To provide a complete method for calculating volume-variable by subclass, Prof. Roberts would need to define the relationship between his output measures and sets of IOCS tallies or other distribution key data he might choose to employ.

[29] In equations 10 and 11, "op" may represent cost pools or aggregates of cost pools subject to the applicable elasticities.

IV. Economic and Econometric Modeling Procedures

IV.A. Economic Specification of Labor Demands

I take the production process at the plants to be described by an implicit product transformation function:

$$g(H, L, K; H^*, L^*, K^*; X, X^*) \quad (12)$$

where *H*, *L*, *K*, and *X* are, respectively, vectors of sort handlings (i.e, the operations' "outputs" or "cost drivers"), variable (labor) inputs, quasi-fixed inputs, and other factors affecting the production process (e.g., site-specific factors) for the modeled cost pools. Asterisks denote the corresponding variables for cost pools outside the scope of my modeling work. That is, plants use a variety of capital inputs to "produce" mail handlings, including sorts. The "other factors" represented by the *X* variables may include fixed characteristics of the facility (or locality), processing network characteristics, and so on.

As my analysis is part of an application of the "volume-variability/distribution key" method for computing marginal cost-equivalent volume-variable costs, the vector of mail processing outputs (H, H^*) may be considered to be a translation of the vector of volumes (by product) *V* through the Postal Service's operating plan—that is, the operating plan describes relationships $H = A \cdot V$ and $H^* = A^* \cdot V$. (See Section III.C, above.) Note that Postal Service processing operations implement far fewer distinct mail streams than there are rate categories of mail.

I assume for the modeled operations that the production process is nonjoint such that it is possible to write a production function for cost pool i:

$$H_i = f_i(L_i, K_i, X_i), \qquad (13)$$

Where L_i is the labor input for cost pool (i), K_i represents capital control(s), and X_i is a collection of other explanatory variables. Please see also Docket No. R2000-1, USPS-T-15 at 42-43.

In specifying TPF (or TPH) for the outputs H_i, I am taking the output of a cost pool to be the aggregate sorting improvements performed within the cost pool—that is, the more sorting sites carry out in an operation, the more sorting output they have. The specification also implies that labor resources directed to sorting mail in one cost pool do not also improve mail in another cost pool, for instance an employee loading mail at a DBCS does not (indeed cannot) simultaneously sort mail at a manual case. (See Section II.D, above.)

Cost minimization by the Postal Service would yield labor demands of the general form

$$L_i = l_i(w_i, H_i, K_i, X_i), \qquad (14)$$

where w_i is an applicable (relative) wage. Equation (14) is identical, in concept, to Prof. Roberts's derived labor demands, though Prof. Roberts specifes handlings with a common H_i for all operations within a shape-based mailstream. I do not believe it is necessary, given engineering and other considerations, for the Postal Service to literally be a cost minimizer for the variables implied by cost minimization also to be appropriate explanatory variables in a non-minimizing case. Please see, e.g., Docket No. R2005-1, USPS-T-12 at 12-16; Docket No. R2000-1, USPS-T-15 at 32-33 and 44-53.

IV.B. Specification Changes from BY 2004

The major change I have made to the variability models for the BY 2005 CRA is separating incoming and outgoing operations within the AFSM 100 and D/BCS cost pools. The MPBCS and DBCS cost pools from BY 2004 are reorganized into D/BCS Incoming and D/BCS Outgoing pools for the purposes of estimating output elasticities with respect to the outgoing and incoming handlings. I recommend the use of the weighted average elasticity in Witness Van-Ty-Smith's volume-variable cost calculations (see USPS-T-11); witness Van-Ty-Smith also pools the outgoing and incoming BCS tallies in a single D/BCS distribution key. The AFSM 100 model employs a multi-output specification with both outgoing and incoming handlings on the right-hand side of the estimating equations. I recommend that witness Van-Ty-Smith use the sum of the incoming and outgoing elasticities in her calculations.

The change in procedures addresses two major concerns. BCS operations have been transitioning away from MPBCS equipment to DBCS for several years. Examining disaggregated MPBCS and DBCS data I provided Prof. Roberts for his modeling work, the MODS data appeared to contain a number of instances in which mismatches between MODS handlings and workhours resulted from the transition. In these cases, the total over the MPBCS and DBCS operations appeared to be correct. Thus, combining the BCS operations by equipment type eliminates some errors in the MODS data. Additionally, separating the effects of incoming and outgoing handlings helps prevent changes in the composition of handlings between incoming and outgoing operations from leading to mis-measurement of the elasticities.

I also discontinued estimation of the variability for the FSM 881 cost pool. My understanding is that the removal of FSM 881 equipment from service had been completed in FY 2004, and witness Van-Ty-Smith's analysis shows zero cost for the pool in BY 2005.

IV.C. Choice of Estimator

Continuing the procedures employed for the BY 2004 models, I use a mix of translog fixed effects/generalized least squares (FE/GLS) and log-linear fixed effects/instrumental variables (FE/IV) procedures to estimate the BY 2005 elasticities. I continue to employ FE/GLS estimation for automated and mechanized operations in which the TPF data are not subject to measurement error from weight conversion, and FE/IV (specifically, limited-information maximum likelihood) in manual operations to produce elasticity estimates for those operations that are robust to the presence of TPH measurement error. The details of the procedures and the modeling choices are discussed in detail in Docket No. R2005-1, USPS-T-12 at 22-41.

I investigated a variety of alternative specifications, including FE/IV models for automated operations, FE/GLS models for manual operations, models using Prof. Roberts's set of capital control variables, and models employing cross-operation outputs, and discuss the differences with the recommended results in Section VII.

IV.D. Estimating Equation Specifications

The mail processing volume-variability analysis uses four distinct estimating equations. The D/BCS Incoming, D/BCS Outgoing, FSM 1000, OCR, and SPBS operations employ a translog/fixed effects estimating equation identical to the one I used in R2005-1, which is shown below in equation (15):

$$
\begin{aligned}
\ln HRS_{int} = & \sum_{k=1}^{N} \beta_{1k} SITE_k \\
& +(\alpha_1 + \gamma_1 L + \gamma_2 L^2 + \gamma_3 L^3 + \gamma_4 L^4) \ln TPF_{int} \\
& +(\alpha_{11} + \gamma_{11} L + \gamma_{22} L^2 + \gamma_{33} L^3 + \gamma_{44} L^4)(\ln TPF_{int})^2 \\
& +\alpha_2 \ln CAP_{int} + \alpha_{22} (\ln CAP_{int})^2 + \alpha_3 \ln DEL_{nt} + \alpha_{22} (\ln DEL_{nt})^2 \\
& +\alpha_4 \ln WAGE_{int} + \alpha_{22} (\ln WAGE_{int})^2 + \alpha_5 TREND_t + \alpha_{55} TREND_t^{\,2} \\
& +\alpha_{12} \ln TPF_{int} \ln CAP_{int} + \alpha_{13} \ln TPF_{int} \ln DEL_{nt} + \alpha_{14} \ln TPF_{int} \ln WAGE_{int} \\
& +\alpha_{15} \ln TPF_{int} \cdot TREND_t \\
& +\alpha_{23} \ln CAP_{int} \ln DEL_{nt} + \alpha_{24} \ln CAP_{int} \ln WAGE_{int} + \alpha_{25} \ln CAP_{int} \cdot TREND_t \\
& +\alpha_{34} \ln DEL_{nt} \ln WAGE_{int} + \alpha_{35} \ln DEL_{nt} \cdot TREND_t \\
& +\alpha_{45} \ln WAGE_{int} \cdot TREND_t \\
& +\beta_2 QTR2_t + \beta_3 QTR3_t + \beta_4 QTR4_t \\
& +\varepsilon_{int} \qquad (15)
\end{aligned}
$$

The subscripts *i, n* and *t* refer to the cost pool, site, and time period, respectively; *L* denotes the lag operator.[30] The variables are:

TPF: Total Pieces Fed for cost pool *i*, site *n*, and time *t*,

CAP: Capital input index for cost pool *i*,[31] site *n*, and time *t*,

DEL: Possible deliveries (sum of city, rural, highway contract, and P. O. box) for site *n*, and time *t*,

WAGE: Relative wage for the LDC associated with cost pool *i* (see Table 1, above), versus the LDC 14 wage, for site *n*, and time *t*,

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[30] The lag operator is defined such that $L^s x_t = x_{t-s}$.

[31] The index is QIAHE for letter operations, QIMHE for flat and SPBS operations.

TREND: Time trend, set to 1 for Postal Quarter (PQ) 1, FY 1999, incremented linearly by PQ for time *t*,

$SITE_k$: Dummy variable, equals 1 if for observations of site *k*, zero otherwise; used to implement fixed effects model,[32] and

QTR*X*: Dummy variable, equals 1 if time *t* corresponds to PQ *X*, zero otherwise.[33]

The estimating equation for AFSM 100 pools incoming and outgoing AFSM 100 hours as the dependent variable, but splits the cost driver into incoming and outgoing piece handlings:

$$\begin{aligned}
\ln HRS_{int} = {} & \sum_{k=1}^{N} \beta_{1k} SITE_k \\
& + \sum_{r=I,O} \left\{ \begin{array}{l} (\alpha_1 + \gamma_1 L + \gamma_2 L^2 + \gamma_3 L^3 + \gamma_4 L^4) \ln TPF_{rint} \\ + (\alpha_{11} + \gamma_{11} L + \gamma_{22} L^2 + \gamma_{33} L^3 + \gamma_{44} L^4)(\ln TPF_{rint})^2 \end{array} \right\} \\
& + \alpha_2 \ln CAP_{int} + \alpha_{22} (\ln CAP_{int})^2 + \alpha_3 \ln DEL_{nt} + \alpha_{22} (\ln DEL_{nt})^2 \\
& + \alpha_4 \ln WAGE_{int} + \alpha_{22} (\ln WAGE_{int})^2 + \alpha_5 TREND_t + \alpha_{55} TREND_t^2 \\
& + \sum_{r=I,O} \left\{ \begin{array}{l} \alpha_{12} \ln TPF_{rint} \ln CAP_{int} + \alpha_{13} \ln TPF_{rint} \ln DEL_{nt} + \alpha_{14} \ln TPF_{rint} \ln WAGE_{int} \\ + \alpha_{15} \ln TPF_{rint} \cdot TREND_t \end{array} \right\} \\
& + \alpha_{23} \ln CAP_{int} \ln DEL_{nt} + \alpha_{24} \ln CAP_{int} \ln WAGE_{int} + \alpha_{25} \ln CAP_{int} \cdot TREND_t \\
& + \alpha_{34} \ln DEL_{nt} \ln WAGE_{int} + \alpha_{35} \ln DEL_{nt} \cdot TREND_t \\
& + \alpha_{45} \ln WAGE_{int} \cdot TREND_t \\
& + \beta_2 QTR2_t + \beta_3 QTR3_t + \beta_4 QTR4_t \\
& + \varepsilon_{int} \qquad (16)
\end{aligned}$$

As in previous implementations of the translog model, the regression error ε is allowed to exhibit first-order serial correlation. As was the case in BY 1998, BY 2000, and BY 2004, the generalized least squares procedure used to

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[32] Dummy variables for all sites are included in the regression, so the overall constant term is omitted to avoid multicollinearity.

[33] QTR1 is omitted to avoid multicollinearity.

implement this is a version of the “Baltagi-Li” autocorrelation adjustment (see Docket No. R97–1, USPS–T–14, at 50), modified to accommodate breaks in sites’ regression samples. The standard errors for the translog model are computed using a heteroskedasticity-consistent covariance matrix for the regression coefficients.

The specification for the cost pools using IV estimation—manual flats, manual letters, manual parcels, manual Priority Mail, and cancellation—is log-linear, like Prof. Roberts’s models. The log-linear model omits higher-order and interaction terms involving TPH, capital, deliveries, the relative wage, and the time trend. It adds year dummy variables to control for a more general pattern of time-related demand shifts than a linear time trend would allow. It also includes, for the letter and flat operations, a set of dummy variables to control for the plant’s mix of automation technology, a feature also acquired from Prof. Roberts’s models. The estimation procedure does not adjust for serially correlated errors. The estimated function is given by equation (17):

$$\begin{aligned} \ln HRS_{int} = {} & \sum\nolimits_{k=1}^{N} \beta_{1k} SITEk_n \\ & + \alpha_1 \ln TPH_{int} + \alpha_2 \ln CAP_{int} + \alpha_3 \ln DEL_{nt} \\ & + \alpha_4 \ln WAGE_{int} + \alpha_5 TREND_t \\ & + \beta_2 QTR2_t + \beta_3 QTR3_t + \beta_4 QTR4_t \\ & + \delta' YEAR + \gamma' TECH \\ & + \varepsilon_{int}. \end{aligned} \tag{17}$$

with the additional variables:

YEAR: a set of dummy variables indicating the fiscal years;

TECH: a set of dummy variables indicating the presence of automation operations, omitted in the manual parcel and Priority models;

δ, γ: parameter vectors associated with YEAR and TECH.

V. The Mail Processing Variability Data Set

V.A. Data Requirements for Study

The economic framework and econometric specifications described above indicate that MODS data alone are not sufficient for estimation of labor demand functions for mail processing operations. In addition to MODS data on workhours, or real labor input, and piece handlings, or mail processing volumes, the Postal Service model requires data to quantify characteristics of the sites' local service territories and the economic variables of wages and capital input. I briefly describe the MODS data in Section VI.B and the data sources other than MODS in Section VI.C, below. The data processing procedures are described further in USPS-LR-L-56, Section II.

V.B. MODS Data

The MODS data I employ are similar to the data that have been presented since Docket No. R97-1. I aggregate the MODS workhour and piece handling data from the three-digit operation code level to the mail processing cost pool groups employed for variability estimation purposes. As I describe in Section II.E, above, in the automated and mechanized sorting operations (D/BCS, OCR, FSM 1000, AFSM 100, and SPBS), Total Pieces Fed (TPF) is a more complete measure of the number of piece handlings than Total Pieces Handled (TPH), since the latter excludes rejected pieces from the total output. I collected both TPH and TPF data for the automated and mechanized sorting operations. I also employ MODS FHP data for use in the instrumental variables models presented in Sections VI and VII, below, and for extending Prof. Roberts's 2006 model with data from FY 2005.

V.C. Other Postal Service Data

In order to build a data set with sufficient information to estimate the mail processing labor demand models described above, I employed data from several Postal Service data systems in addition to MODS. The systems include the Address Information System (AIS), Address List Management System (ALMS), National Workhour Reporting System (NWRS), National Consolidated Trial Balance (NCTB), Facility Management System (FMS), Personal Property Asset Master (PPAM) or Property and Equipment Accounting System (PEAS), Installation Master File (IMF) or Finance Number Control Master (FNCM), Origin-Destination Information System-Revenue, Pieces, and Weight (ODIS-RPW), and Remote Barcode System (RBCS) Status Report,

Until FY 2003, the Postal Service reported most data by accounting period (AP) and postal quarter. Each AP contains four weeks; quarters 1 through 3 contain three APs, while quarter 4 contains four APs. Starting in FY 2004, the Postal service switched to monthly and government quarter accounting. Each government quarter contains 3 calendar months. In order to extend the time series dimension of the data, the FY 2004 and FY 2005 were recast from government quarters to postal quarters.[34] The conversion process for each data set is included in the descriptions below.

[34] Once sufficient data are available at the government quarter frequency, this process would be reversed, with data from the old postal calendar recast to the new government fiscal year frequencies.

V.C.1. Delivery Network Data—AIS, ALMS

AIS records the number of possible deliveries (i.e., delivery points) by delivery type—e.g., centralized, curbline, NDCBU—route, and Finance number. AIS data are collected by carriers, who record the number of deliveries at each delivery stop on the route. The detailed data are entered into the AIS system, and AIS software calculates the total deliveries for each route. AIS data are reported monthly. The month closest to the end of the quarter is used to represent the postal quarter.

ALMS contains information for each post office, station, and branch by Finance number. This information includes a contact name and telephone number, the address, CAG, facility type (e.g. station, branch, post office), and ZIP code. A station is a unit of a main post office located within the corporate limits of the city or town while a branch is outside the corporate limits. It also distinguishes contract facilities from non-contract facilities (contract facilities do not have Postal Service employees). Four variables are created from ALMS: number of large post offices, number of small post offices, number of stations and branches, and number of 5-digit ZIP Codes in each facility ID number. A large post office is defined as a Class 1 or Class 2 post office. A small post office is defined as a Class 3 or Class 4 post office. ALMS data have been reported by month since inception. The month closest to the end of the quarter is used to represent the quarter.

For all delivery network variables, the data are rolled up to 3-digit ZIP Code. The 3-digit ZIP Code data are then mapped to facility ID numbers using a destinating mail processing scheme. The destinating mail processing scheme is based on the Domestic Mail Manual (DMM) Labeling List L002, “3-Digit ZIP Code Prefix Matrix.” The facility names from Column B are mapped to Finance numbers. It is then straightforward to map Finance numbers to facility ID numbers. There is a separate map for each year. Not all 3-digit ZIP Codes get mapped to a facility ID number. In these cases, mail for the 3-digit ZIP Code is assumed to be processed locally or by a facility that does not report MODS. This is why several facility ID numbers have no delivery data mapped to them.

V.C.2. Wage Data—NWRS

I use NWRS to obtain wage rates by site as close to the operation level as possible. MODS provides data on workhours, but not compensation amounts, by three-digit operation number. NWRS provides data on workhours and compensation amounts in dollars by Labor Distribution Code (LDC). Each three-digit MODS operation number is mapped to an LDC. The implicit wage in NWRS is the ratio of compensation dollars to workhours. A collection of MODS operation numbers, comprising one or more mail processing cost pools, is therefore associated with each LDC (see USPS-LR-L-55, Section I, for details). Since many LDCs encompass operations from several distinct mail processing streams—e.g., LDC 14 consists of manual sorting operations in the letter, flat, parcel, and Priority Mail processing streams—it is not appropriate to use LDCs as the units of production for the labor demand analysis. However, most of the important differences in compensation at the cost pool level (due to skill levels, pay grades, etc.) are related to the type of technology (manual, mechanized, or automated) and therefore are present in the LDC-level data. Thus, the LDC wage is a reasonable estimate of the operation-specific wage rate.

NWRS compensation totals tie to the salary and benefits accounts in the NCTB. As with other Postal Service accounting systems, erroneous data in NWRS sometimes arise as a result of accounting adjustments. The adjustments are usually too small to materially affect the wage calculations, but occasional large accounting adjustments result in negative reported hours and/or dollars for certain observations. Unfortunately, it is not possible to isolate the accounting adjustments. As a result, I employed procedures to identify NWRS observations with negative values of hours and/or dollars and to treat those observations as missing.

NWRS is reported by month for FY 2004 and FY 2005. Data for these years are converted to APs by using the number of delivery days as a distribution key. Earlier data are reported by AP and aggregated to postal quarter.

V.C.3. Accounting Data—NCTB

NCTB is an accounting data system that records the Postal Service's revenues, expenses, assets, and liabilities. NCTB data are available by general ledger account, Finance number, and AP (or month for FY2004 and 2005). The data are provided as Year-To-Date totals through the current AP (or month), which may include prior period adjustments. While most adjustments are small relative to the current period entries, occasional large adjustments result in negative current expenses net of the adjustments. NCTB is the source for aggregate materials, building occupancy, equipment rental, and transportation expenses.

NCTB is reported by month for FY 2004 and FY 2005. Data for these years are converted to APs by using the number of delivery days as a distribution key. As with NWRS, earlier data are reported by AP and aggregated to postal quarter.

V.C.4. Capital Data—FMS, PPAM/PEAS

The Facility Master System (FMS) provides quarterly rented and owned square footage for each Postal Service facility. The beginning-of-the-year owned square footage is rolled up to facility ID number, which is then used to split out the quarterly national building occupancy expenses from NCTB. The FMS data include some duplicate records and "dropouts" (e.g., a record exists for a facility in FY2000 and FY2002, but not FY2001). To obtain accurate data from the system, I employ procedures to eliminate duplicate records and interpolate missing records. These procedures are described in USPS-LR–L–56.

The PPAM is a log of equipment that is currently in use. Each record on the tape is a piece of equipment. Retrofits to existing equipment are recorded as separate records. PPAM contains the Finance number, CAG, BA, Property Code Number (PCN), year of acquisition, and cost for each piece of equipment. PPAM classifies Postal Service equipment as Customer Service Equipment (CSE), Postal Support Equipment (PSE), and Mail Processing Equipment (MPE).

Using a classification from the Postal Service's Total Factor Productivity (TFP), MPE is subsequently separated into Automated Handling Equipment

(AHE) and Mechanized Handling Equipment (MHE). AHE consists of OCR and BCS machines, including RBCS. MHE represents the balance of the MPE category. Since each PPAM equipment category encompasses a variety of equipment types, there is no simple correspondence between the categories and specific mail processing cost pool. To obtain operation-specific capital measures, it is necessary to use more detailed contract information in conjunction with the PCN. This permits the construction of equipment series for DBCS, MPBCS, OCR, FSM 1000, and AFSM 100 equipment.

Using the year of acquisition, the value of each year's equipment is depreciated using a 1.5 declining balance rate of replacement. For CSE, PSE, AHE, and MHE the average lives are 14 years, 13 years, 18 years, and 18 years, respectively. The annual depreciation rates are then .107 for CSE, .115 for PSE, and .083 for AHE and MHE. These depreciated values are then deflated to 1972 dollars by using annual national deflators. The annual national deflators are derived from various public and private data sources, as well as Postal Service sources. The deflated values from 1968 to the current year are then added together to create a total value of the equipment type in 1972 dollars. The deflated values are used as shares to distribute quarterly NCTB expenses for each equipment type. The PPAM data have AP frequency. The PEAS system replaced PPAM in FY 2004 and is available monthly. The beginning-of-year values are used as a distribution key for the national values for all quarters in the following year. I also present alternative capital series based on quarterly updating of the PPAM/PEAS data to address concerns expressed in Prof. Roberts's 2006 paper. These data were not available in time for the production of the BY 2005 CRA, however, I briefly discuss them in Section VII.F, below. I also employ the alternative capital series in the update of Prof. Roberts's models with FY 2005 data; see Section VII.G.

V.C.5. Other Datasets— IMF/FNCM, ODIS-RPW, RBCS Status Report

The IMF lists the Postal Service's active Finance numbers. There are approximately 33,000 Finance numbers currently. The IMF includes details about each Finance number's postal address, ZIP Code, and BA code. The BA code identifies the function (e.g., mail processing, customer services) served by each Finance number. IMF data are instrumental in cross-walking data organized by Finance number to ZIP Codes, and thus for matching databases organized by ZIP Code with databases organized by Finance number. The IMF was reported at AP frequency prior to FY 2004, and was replaced by the monthly FNCM in FY 2004. For FNCM, I used the monthly file closest to the end of the quarter.

ODIS is a statistical sampling system designed to measure originating and destinating mail volumes by subclass and shape at a sub-national level.[35] The data are available by 3-digit ZIP Code but are not considered reliable at this level. ZIP Codes are aggregated to facility ID numbers based on the mail processing scheme described above. Three variables are created from ODIS: destinating letters (DLETTERS), destinating flats (DFLATS), and destinating parcels (DPARCELS). These variables are scaled to RPW volumes. ODIS and RPW are available by postal quarter before FY2004 and government quarter

[35] In FY 2004, ODIS was combined with the RPW sampling system to create the ODIS-RPW sampling system.

thereafter. Prior to FY 2004, the ODIS-RPW volumes for Q4 are scaled by a factor of 0.75 to reflect the additional AP in the quarter.

Remote Encoding Centers (RECs) have their own Finance numbers but process images for multiple facilities. The RBCS Status Report contains hours and images by REC site and mail processing facility. The hours from this report are used to distribute REC Finance number data to mail processing facility. This is necessary for the FMS, NCTB, NWRS, and PPAM/PEAS data sets. The RBCS Status Report was received weekly before FY 2004 and monthly thereafter. The monthly data are converted to APs using delivery days.

V.D. Data Screening Procedures

As I have done in the econometric analyses that I presented in Dockets No. R2000-1, R2001-1, and R2005-1, I applied threshold, productivity, and minimum observation screens to the data in order to select the final sample I used to estimate my models.[36] My approach has been to focus on the elimination of gross errors in the quarterly data, to avoid admitting observations that might serve as "leverage points" into the regression samples, and then to use appropriate econometric techniques, where necessary, to deal with remaining errors in the data. Summary statistics describing the effects of the sample selection rules on sample size for each of the cost pools I analyzed are presented in Table 9, in section VI.A, below.

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[36] See Docket No. R2000-1, USPS-T-15 at 107-115; and Docket No. R2001-1, USPS-T-14 at 41-42, 53-54 for descriptions of the mechanics and the purposes of these screens.

The screens have been criticized on various grounds. The Commission has contended that the screens are ineffective because they are applied to the MODS data after they had been aggregated into quarterly observations, rather than at a finer level of detail (Docket No. R2000-1, Op., Vol. 2, Appendix F at 39-40; Docket No. R2005-1, Op., Appendix I at 3). As a result, the Commission suggested, they inappropriately fail “to eliminate all suspect observations,” (Docket No. R2000-1, Op., Vol. 2, Appendix F at 40; Docket No. R2005-1, Op., Appendix I at 3). The Commission also claimed that because “the screens cause the deletion of large percentages of the sample,” they are “likely to cause unknown, but possibly large, selection biases” (Docket No. R2005-1, Op., Appendix I at 3).

As the Commission’s stated concerns make clear, there is an obvious tension between screening the data relatively lightly, thus potentially allowing anomalous observations into the regression samples, and deleting large fractions of the observations, with the possibility of inconsistency due to sample truncation. In Docket No. R2000-1, the Commission stated, “the screens must succeed in substantially eliminating errors in piece handlings without introducing a selection bias, and without systematically deleting valid but unusual observations from the sample” (PRC Op., Docket No. R2000-1, App. F at 38).

By making use of operational information regarding ranges of valid productivities by operation, the screens tread lightly by design on “unusual” but not demonstrably invalid observations. As the summary results of the screens in Table 9 show, the screens eliminate little data from the regression samples overall. The operations for which the screens eliminate relatively large fractions of the available data—manual parcels and manual Priority—comprise only 8.2 percent of the costs under study. Even with the effects of the screens, the regression samples include a considerable majority of the available observations, with 247 and 251 sites contributing observations for the manual parcels and manual Priority Mail cost pools, respectively.

From the standpoint of statistical theory, the screening approach I employ is justifiable because not all errors are equally important: small errors, in the sense of having small error variances, have relatively small effects on regression estimates. Indeed, UPS witness Neels's original problematizing of 'masking' errors in the aggregation of data in Docket No. R2000-1 (see Tr. 46E/22323) basically stands the true statistical problem on its head—the main concern is when the "signal" is hard to distinguish from the "noise," not the other way around. Still, I investigated the effects of more aggressive screening of errors in the time-disaggregated data; I present results from the application of stricter screens in Section VII.E. The results show that the quarterly screens are relatively effective at eliminating extreme outliers from the data sets, and therefore the effects of stricter screens are small.

VI. Summary of Econometric Results for the BY2005 CRA

VI.A. Summary Statistics and Main Regression Results

In this section, I present a summary of the results from the econometric procedures I used to obtain the elasticities incorporated in the Postal Service BY 2005 CRA. I produced the results with TSP version 4.5 econometric software, running on a Dell PowerEdge computer with 8 GB RAM, running the Red Hat Linux Advanced Server operating system. The econometric code is also compatible with current PC versions of TSP. The TSP programs, econometric input data, and full output files are provided in USPS-LR-L-56, Section I.

Table 8 presents—by cost pool—sample sizes and median values for workhours, piece handlings, the relative wage between the applicable automation and manual LDCs, and productivity.

Table 8. Selected summary statistics for regression samples

Cost Pool	Median Hours	Median TPF (000)	Median relative wage	Median productivity (TPF/hr)
BCS Outgoing (n=6913)	4,386	38,447	1.00	8,548
BCS Incoming (n=7182)	16,034	135,029	1.00	8,589
OCR (n=6285)	3,541	22,672	1.00	6,256
FSM/1000 (n=4564)	7,616	4,359	1.06	534
AFSM100 Total (n=2222)	16,097		1.06	
…AFSM Outgoing		8,911		2,102
…AFSM Incoming		21,668		2,078
Total SPBS (n=4696)	12,668	3,588	1.11	287
Manual Flats* (n=7182)	4,513	2,082	1.06	455
Manual Letters* (n=8453)	15,331	9,071	1.00	596
Manual Parcels* (n=4846)	1,432	390	1.03	348
Manual Priority* (n=5520)	3,169	831	1.02	306
Cancellations* (n=8169)	4,841	18,810	0.95	3,863

* Operations using TPH instead of TPF

Table 8 shows the large productivity differentials between automated and manual letter and flat operations—in automated operations, productivity exceeds that of manual by factors of more than 10 in letters.[37] and by 4.5 between AFSM 100 and manual flat operations. Automated operations also perform the vast majority of handlings. To handle even a relatively small fraction of the automated volume would entail enormous increases in labor devoted to manual sorting.

Table 9 shows the effects of the data screening procedures on the regression sample sizes by cost pool. The screens eliminate little of the data overall, particularly for automated operations and manual letters. Manual flats show a relatively large effect from the threshold screen. My understanding is that

[37] Compare D/BCS and OCR with manual letters.

some sites are seeking to reduce their manual flat processing to the extent of nearly eliminating their manual flat operations; those facilities may maintain very limited capacities to handle the few pieces that cannot be handled on the UFSM 1000. As has been seen previously (e.g., Docket No. R2005-1, USPS-T-12 at 45), the productivity screens have relatively large effects on the sample size for manual Priority Mail and particularly manual parcel operations. Still, even for manual parcels, the sample contains 74 percent of the observations before screening. As a practical matter, the eliminated observations represent relatively little of the costs in the operations analyzed here. Therefore, the prospect of large errors in volume-variable costs, in the unlikely situation that the dropped observations cannot be represented by the regression samples, is accordingly negligible.

Table 9. Summary of effect of sample selection rules on sample size

Cost Pool	Non-missing	Threshold	Productivity	Minimum Obs.
BCS Outgoing	8377	8352 (100%)	8233 (98%)	8229 (98%)
BCS Incoming	8571	8570 (100%)	8518 (99%)	8499 (99%)
OCR	7689	7673 (100%)	7546 (98%)	7517 (98%)
FSM/1000	5792	5776 (100%)	5656 (98%)	5564 (96%)
AFSM100	4007	3967 (99%)	3457 (86%)	3214 (80%)
SPBS	5612	5601 (100%)	5579 (99%)	5564 (99%)
Manual Flats	7583	7492 (99%)	7196 (95%)	7182 (95%)
Manual Letters	8570	8566 (100%)	8453 (99%)	8453 (99%)
Manual Parcels	6535	6310 (97%)	4891 (75%)	4846 (74%)
Manual Priority	6608	6326 (96%)	5567 (84%)	5520 (84%)
Cancellations	8351	8317 (100%)	8171 (98%)	8169 (98%)

Principal regression results by cost pool are shown in Tables 10-13. For the cost pools using translog estimating equations (Tables 10-12), the individual regression coefficients do not have economic interpretations; accordingly, I present the elasticities with respect to explanatory variables derived from the coefficients. The elasticities are evaluated at FY 2005 arithmetic mean values for the relevant variables.

Table 10. Principal results for automated letter sorting operations, translog-FE method

Cost Pool	BCS Outgoing	BCS Incoming	OCR
Output Elasticity or Volume-Variability Factor	1.06* (0.06)	0.82* (0.07)	0.78 (0.05)
Wage Elasticity	-0.25 (0.06)	-0.25 (0.04)	-0.32 (0.08)
Deliveries Elasticity	0.35 (0.17)	-0.00 (0.11)	0.02 (0.38)
Capital Elasticity	0.02 (0.05)	-0.08 (0.04)	0.03 (0.08)
Auto-correlation coefficient	0.70	0.72	0.71
Adjusted R^2	0.91	0.92	0.80
# observations	6598	6862	5991
# facilities	304	310	277

Heteroskedasticity-consistent standard errors in parentheses.

* Witness Van-Ty-Smith uses the average weighted by total cost in the BCS Outgoing and BCS Incoming operations, 88 percent.

Table 11. Principal results for automated flat and parcel sorting operations, translog-FE method (other than AFSM)

Cost Pool	FSM 1000	SPBS
Output Elasticity or Volume-Variability Factor	0.72 (0.03)	0.87 (0.05)
Wage Elasticity	-0.15 (0.06)	-0.51 (0.07)
Deliveries Elasticity	-0.09 (0.18)	-0.20 (0.19)
Capital Elasticity	-0.03 (0.03)	-0.02 (0.02)
Auto-correlation coefficient	0.73	0.73
Adjusted R^2	0.83	0.90
# observations	4322	4479
# facilities	237	208

Heteroskedasticity-consistent standard errors in parentheses.

Table 12. Principal results for automated flat and parcel sorting operations, translog-FE method (AFSM)

Cost Pool	AFSM 100
Output Elasticity or Volume-Variability Factor -- Total	0.99* (0.08)
-- Incoming	0.74 (0.07)
-- Outgoing	0.26 (0.04)
Wage Elasticity	-0.39 (0.05)
Deliveries Elasticity	0.23 (0.38)
Capital Elasticity	0.02 (0.03)
Auto-correlation coefficient	0.55
Adjusted R^2	0.96
# observations	2011
# facilities	194

Heteroskedasticity-consistent standard errors in parentheses.

* Witness Van-Ty-Smith uses the total elasticity. Differences between the total and the sum of the component incoming and outgoing elasticities are due to rounding.

Table 13. Principal results for manual sorting operations and cancellation, log-linear/IV method

Cost Pool	Manual Flats	Manual Letters	Cancellation	Manual Parcels	Manual Priority
Output Elasticity or Volume-Variability Factor	0.94 (0.07)	0.89 (0.09)	0.50 (0.07)	0.80 (0.18)	0.75 (0.09)
Wage Elasticity	0.00 (0.03)	0.26 (0.03)	-0.21 (0.10)	-0.46 (0.24)	-0.73 (0.20)
Deliveries Elasticity	0.37 (0.10)	0.07 (0.05)	0.22 (0.07)	0.39 (0.23)	-0.03 (0.14)
Capital Elasticity	0.02 (0.01)	-0.01 (0.01)	-0.10 (0.02)	-0.13 (0.05)	0.15 (0.04)
Auto-correlation coefficient	n.a.	n.a.	n.a.	n.a.	n.a.
Adjusted R^2	0.94	0.97	0.94	0.83	0.91
# observations	7180	8451	8169	4846	5520
# facilities	292	313	304	247	251

Standard errors in parentheses.

VI.B. Discussion of Results

VI.B.1. Where Employed, the Fixed Effects and Translog Specifications Are Appropriate.

The recommendation of results from fixed effects/GLS and fixed effects/IV models is consistent with specification tests that decisively reject the simpler "pooled" model (with a common intercept for all sites) in favor of the fixed effects specification. As with the results of similar tests in Docket No. R97-1, Docket No. R2000-1, Docket No. R2001-1, and Docket No. R2005-1, the tests of the fixed effects specification versus the pooled model strongly favor fixed effects. Tables 14 and 15, below, present the test statistics and p-values.

Table 14. *F* Statistics for tests of fixed effects vs. pooled GLS specifications, translog-FE method

Cost Pool	*F* Statistic	Degrees Of Freedom	*P*-value	Reject Pooled GLS?
BCS Outgoing	5.28	(303, 6263)	< .00005	Y
BCS Incoming	6.72	(309, 6521)	< .00005	Y
OCR	3.62	(276, 5683)	< .00005	Y
FSM/1000	5.20	(236, 4054)	< .00005	Y
AFSM100	3.78	(193, 1772)	< .00005	Y
Total SPBS	7.75	(207, 4240)	< .00005	Y

Table 15. Chi-square statistics for tests of fixed effects vs. pooled IV specifications, IV method

Cost Pool	X^2 Statistic	Degrees Of Freedom	*P*-value	Reject Pooled IV?
Manual Flats	5431.2	291	< .000005	Y
Manual Letters	9836.0	312	< .000005	Y
Cancellation	15625.0	303	< .000005	Y
Manual Parcels	5747.8	247	< .000005	Y
Manual Priority	3109.0	251	< .000005	Y

Specification issues also have arisen with respect to the choice of the translog functional form over simpler, log-linear specifications. Please see Docket No. R2001-1, USPS-T-14 at 27 for additional discussion. More recently, Prof. Roberts expressed some preference during his 2006 seminar for the log-linear specification for being somewhat simpler to interpret—that is, the parameters have direct economic interpretations, and it is not necessary to consider higher-order effects from the explanatory variables. In large part, the interpretation issue is overcome by—as has been the longstanding practice when presenting results from the translog and other “flexible” functional forms for use in the CRA—reporting the economic statistics of interest rather than the raw coefficient estimates. Whether the higher-order terms in the translog are relevant is a matter for specification testing.

I tested the translog specification against the simpler log-linear specification for the models where I recommend the translog estimating equation. The log-linear functional form is obtained from the translog by restricting the coefficients on second-order and interaction terms to zero. I used a Wald test statistic for a set of zero restrictions on linear regression coefficients. In every case, the more restrictive log-linear specification is rejected in favor of the translog. The test results are presented in Table 16, below.

Table 16. Wald Statistics for tests of translog vs. log-linear specifications

Cost Pool	X^2 Statistic	Degrees Of Freedom	*P*-value	Reject Log-linear?
BCS Outgoing	34.3	19	0.017	Y
BCS Incoming	34.7	19	0.015	Y
OCR	77.3	19	< .000005	Y
FSM/1000	127.8	19	< .000005	Y
AFSM100	194.0	19	< .000005	Y
Total SPBS	70.2	19	< .000005	Y

VI.B.2. Comparison to Postal Service BY 2004 Variabilities

In Docket No. R2005-1, the combination of the relatively long elapsed time between base years and econometric methodology changes for manual operations led to relatively large variability changes for a number of operations, as well as in the composite variability that the Postal Service CRA uses for pools not covered by econometric variabilities. Compared to BY 2004, the effects of the data and estimation updates are relatively small, with most changes at the cost pool level well within one estimated standard error of the estimates; see Table 17, below. The exception is SPBS, which is still within an approximate 95 percent confidence interval of the FY 2004 estimate.[38] The elasticity estimates using the Postal Service IV implementation are also relatively stable given the standard errors of the estimates. The composite increases by two percentage points, which reflects the relatively small increases in the large D/BCS and Manual Letters cost pools, as well as the larger elasticity increase for the smaller SPBS cost pools.

[38] The standard error for the SPBS estimate in FY 2004 was 0.06, leading to an approximate confidence interval upper bound of 0.89. The actual sampling error of the difference between the FY 2004 and FY 2005 estimates cannot be easily calculated, however, since the estimators are not statistically independent by construction.

Table 17. BY 2005 recommended variabilities versus BY 2004 variabilities (USPS version)

Cost pool	BY 2004	BY 2005
D/BCS*	0.86	0.88
OCR/	0.78	0.78
FSM/	1.01	N/A
FSM/1000	0.73	0.72
AFSM 100	1.03	0.99
SPBS	0.77	0.87
Manual flats	0.90	0.94
Manual letters	0.87	0.89
Manual parcels	0.78	0.80
Manual Priority	0.76	0.75
Cancellation	0.46	0.50
Composite	0.83	0.85

For BY 2004 factors, see Docket No. R2005-1, USPS-T-12 at 3.

* BY 2004: Weighted average of MPBCS and DBCS. BY 2005: Weighted average of D/BCS Outgoing and D/BCS Incoming.

VI.B.3. Comparison to IOCS Activity Data

The IOCS data on the proportions of work time spent in various activities provide some indication that the amount of time spent in activities that would be expected to exhibit low variability can account for much of the difference between the econometric variabilitites and the 100 percent variability assumption. As the data in Table 2 show, the proportion of setup and take-down time is large relative to the waiting time that has been classified as non-volume-variable in the Commission method since Docket No. R97-1.

While container handling time in sorting operations is reasonably expected to exhibit greater variability with respect to volume than the setup and take-down time, it would not be expected to be 100 percent variable, as witness McCrery describes (USPS-T-42 at 39). Container handling represents a significant proportion of time in some operations, particularly the cost pools with relatively low econometric variabilities, such as cancellation operations, manual parcels, and manual Priority show considerably higher proportions of container handling time than letter and flat sorting operations.[39] Those operations also exhibit relatively high fractions of not-handling time not associated with direct sorting or processing activities.

IOCS data do not depict variability as such, but rather show the relative sizes of activities. As such, they will not account for all factors that might affect a proper analysis of variability. Still, activities that might be expected to show relatively low variabilities are large enough to explain much of the "fixed" cost measured by the econometric models. The average variabilities for letter and flat sorting operations—88 percent and 92 percent, respectively—yield fixed cost percentages of 12 and 8 percent, consistent with the magnitudes of the waiting, setup/take-down, and container handling activities. See Table 18. If the Commission were to continue using IOCS data to determine fixed costs in mail

[39] LDC 17 "allied labor" operations also have high fractions of container handlings relative to total handling time.

processing activities, it should at a minimum include the setup and take-down activities as “fixed’ cost categories.

Table 18. Size of selected “fixed” activities by cost pool, FY 2005 IOCS

	Fraction of time including overhead		Fraction of time excluding overhead			
Cost Pool	Setup/Take-Down & Waiting	Setup + Container	Setup/Take-Down & Waiting	Setup + Container	Econometric Variability	Econometric Non-Volume Variable Costs
D/BCSINC	10%	12%	12%	15%	82%	18%
D/BCSOUT	9%	11%	11%	13%	106%	n/a***
OCR/	8%	10%	10%	12%	78%	22%
AFSM100	9%	11%	11%	13%	99%	1%
FSM/1000	7%	9%	9%	10%	72%	28%
SPBS OTH	8%	11%	10%	13%	87%	13%
SPBSPRIO	7%	10%	8%	12%	87%	13%
MANF	6%	11%	8%	14%	94%	6%
MANL	4%	7%	5%	8%	89%	11%
MANP	8%	20%	10%	25%	80%	20%
PRIORITY	8%	17%	9%	21%	75%	25%
1CANCEL	7%	18%	9%	22%	50%	50%
Letter Sorting*	7%	10%	9%	12%	88%	12%
Flat Sorting**	8%	10%	10%	13%	92%	8%

Sources: Table 1, Table 2.

* D/BCSINC, D/BCSOUT, OCR, Manual Letters

** AFSM100, FSM/1000, Manual Flats

*** Econometric variability exceeds 100 percent.

VI.B.4. Capital and Wage Elasticities

The estimated capital elasticities, similar to the BY 2004 and BY 2000 results, are small, often statistically insignificant, and mixed in arithmetic sign. The small magnitudes of the capital elasticities are consistent with the observation that the main way in which capital affects labor input is by providing capacity in higher productivity (automated) operations, rather than by making specific (existing) mail processing operations more productive.

Prof. Roberts employs a set of operation-specific capital control variables in his models. I estimated log-linear models using Prof. Roberts's capital variables and compared the results with otherwise similar models using the Postal Service capital indexes. The substitution has little effect on the variability estimates; see Section VII.C.

Economic theory predicts that labor demand should vary inversely with the wage rate. The elasticities of workhours with respect to the relative wage variable behave largely as predicted. The wage elasticities have the correct arithmetic sign in most operations.[40] The wage elasticity for manual flats rounds to zero as reported; in contrast, the BY 2004 manual flats wage elasticity estimate was small and statistically insignificant but had the wrong sign. The elasticities are uniformly less than unity in absolute value.

[40] The relative wage variables are defined such that the correct sign is positive for manual letters and manual flats. For those operations, the wage for the "own" LDC is in the denominator of the relative wage rather than the numerator as for other operations.

VI.B.5. Deliveries and network effects

The elasticities of workhours with respect to possible deliveries ("deliveries elasticities") derived from the recommended models suggest that network effects remain difficult to accurately quantify (see also Docket No. R2005-1, USPS-T-12 at 57). The Docket No. R2001-1 analysis indicated that the probable cause was near-multicollinearity between possible deliveries and the site-specific effects (Docket No. R2001-1. USPS-T-14 at 69-70); the result that the inclusion of the site dummy variables dramatically inflated the standard errors of the deliveries elasticities is classically symptomatic of the problem. The implied high correlation between the possible deliveries and the fixed effects reinforces the argument that the fixed effects represent the effect of non-volume factors such as fixed network characteristics.

VI.B.6. Variability of Remote Encoding Operations

The LDC 15 cost pool includes remote encoding activities for both letter and flat-shape pieces, as AFSM 100 equipment lifts the images of pieces that cannot be sorted using its barcode sorting and/or OCR capabilities. Letter remote encoding has been treated as 100 percent volume-variable based on remote encoding centers' ability to staff their encoding operations according to workloads, and also based upon an econometric analysis of REC workhours and image processing volumes presented in Docket No. R97-1. My understanding is that the operational factors that lead to high variabilities for letter encoding are generally present for flat encoding as well, so I recommend that witness Van-Ty-Smith continue to use a 100 percent variability factor for the entire LDC 15 cost pool. However, due to changes to REC operations since their inception, REC variability may merit new quantitative analysis in a future proceeding.

VI.B.7. Treatment of Operations Without Econometric Variabilities

I recommend that witness Van-Ty-Smith apply the 85 percent cost weighted average of the econometric variabilities to most mail processing cost pools not covered by the econometric analysis.[41] This method was also used in the BY 2004 Postal Service CRA. See also Docket No. R2005-1, USPS-T-12 at 39-41. In my opinion, using the average econometric variability yields a more reasonable estimate of mail processing volume-variable cost than the alternative of a hybrid of econometric sorting operation variabilities and the 100 percent variability assumption elsewhere.

Applying the composite variability is justifiable on several grounds. First, the activities (e.g., set-up and take-down time at final scheme changes) identified by witness McCrery and his predecessors as having relatively fixed costs with respect to marginal volume changes are present in operations not covered by the econometric models. The composition of IOCS handling and not-handling tallies in other operations indicates that the low-variability activities are likely to be present to the same or greater extent as in the econometric cost pools. This consideration alone suggests that the 100 percent variability assumption overstate the true variability for most operations. Additionally, a number of BMC and post office operations have direct analogues within the set of cost pools

[41] The exceptions are the MODS LDC 18 Registry cost pool, and the analogous Registry cost pool in the post office/station/branch group.

covered by the econometric variabilities, as Dr. Bradley observed in Docket No. R97-1. Accordingly, econometric estimates for similar operations covered by the econometric analysis may provide better estimates by proxy than the 100 percent assumption. This was briefly discussed by Postal Service witness Moden in Docket No. R97-1 (Docket No. R97-1, USPS-T-4 at 22). Finally, for allied labor and general support operations, it is possible to view cost causation as following a “piggyback” model, in which it the costs in support operations are viewed as driven by—and thus volume-variable to the same degree as—the “direct” operations.

VI.B.8. Comparison with Commission methodology

The Commission’s Rule 53 requires proposed cost methodology changes to discuss differences between the proposed methodology and the methodology most recently accepted by the Commission. For mail processing variability, the Commission has maintained the use of the 100 percent variability assumption, excluding from volume-variable costs only costs associated with specified IOCS activity codes assumed to represent “fixed” costs. In contrast, the variabilities I recommend for use in the Postal Service’s BY 2005 CRA are derived from an econometric labor demand analysis consistent with both economic cost theory and appropriate econometric practice. For some operations, the difference between the Commission’s assumptions and the econometric variabilities is insignificant both practically and statistically (e.g., AFSM 100). In a few other cases, the difference is statistically insignificant but large as a practical matter. In those cases, the statistical consistency property of the econometric point estimates makes them preferable to the Commission's assumption. Elsewhere, variability estimation yields both practically and statistically significant departures from the Commission's assumptions. The weighted average of the econometric variabilities is 13 percentage points lower than the IOCS-based average under Commission assumptions. See Appendix D, Table D-1, below, for a comparison. Witness Van-Ty-Smith provides additional comparisons including the effect of employing the sorting operation average for cost pools without econometric variabilities (see USPS-T-11, Table 5).

VII. Alternative Methods for Variability Estimation

VII.A. Instrumental Variables Alternatives

I estimated alternative models to show the effects of choosing FE/GLS estimation over FE/IV for the automated operation models, and FE/IV over FE/GLS for the manual operation models.

For manual operations, the effect of IV is generally consistent with the measurement error attenuation explanation of low variabilities from non-IV manual models. The IV point estimates are uniformly less than 100 percent and differ from 100 percent by at least one estimated standard error for all IV estimates except manual flats. The IV estimates also uniformly exceed the corresponding FE/GLS estimates by at least one estimated standard error. The IV composite is significantly larger than the FE/GLS, 80 percent versus 45 percent. While the IV standard errors are relatively high, the approximate 95 percent confidence intervals exclude 100 percent for the manual Priority and Cancellation cost pools. The IV estimation appears to be having the intended effect, and the results are consistent with the Postal Service's understanding of the structure of the operations. See Table 19.

Table 19. Comparison of recommended variabilities with FE/GLS estimates for manual and cancellation operations

Cost Pool	Recommended Variabilities	FE/GLS Variabilities
Manual Flats	0.94 (0.07)	0.77 (0.03)
Manual Letters	0.89 (0.09)	0.38 (0.03)
Manual Parcels	0.80 (0.18)	0.47 (0.05)
Manual Priority Mail	0.75 (0.09)	0.43 (0.04)
Cancellation	0.50 (0.07)	0.41 (0.08)
Composite	0.80	0.45

Standard errors in parentheses.

For automated operations, I also estimated the models using the IV specification from equation 17, above. As with the BY 2004 estimates (see Docket No. R2005-1, USPS-T-12 at 58), there is no systematic direction of difference between the IV and translog models: some IV estimates are higher—for instance, D/BCS Outgoing—though not significantly so. Others are markedly lower, such as OCR and FSM 1000. Because the IV estimates exhibit mostly higher standard errors than the translog/GLS estimates, there is, at a minimum, some overlap between the confidence intervals for the IV and GLS estimates in each case. The differences are largely offsetting, as the composite variability for the automated operations using IV, 89 percent, is insignificantly different from the 88 percent resulting from the recommended models. There is no evidence of material measurement error attenuation, no surprise considering the more reliable machine-based methods used to record sorts in these operations and the screens for observations showing gross errors. See Table 20.

Table 20. Comparison of recommended variabilities with FE/IV estimates for automated operations

Cost Pool	Recommended Variabilities	FE/IV Variabilities
BCS Outgoing	1.06 (0.94,1.18)	1.19 (0.81,1.57)
BCS Incoming	0.82 (0.68,0.96)	0.82 (0.68,0.96)
OCR	0.78 (0.68,0.88)	0.53 (0..37,0.69)
FSM/1000	0.72 (0.66,0.78)	0.44 (0.2,0.68)
AFSM100 Total	0.99 (0.83,1.15)	1.03 (24.43*)
-- Incoming	0.74 (0.07*)	0.85 (3.73*)
-- Outgoing	0.26 (0.04*)	0.18 (20.72*)
SPBS	0.87 (0.77,0.97)	1.03 (0.81,1.25)
Composite	0.88	0.89

Approx. 95 percent confidence intervals in parentheses, except (*) denotes standard errors.

It is undesirable to adopt a relatively inefficient estimation procedure such as IV on the basis of results which differ from OLS or GLS due, in substantial part, to the much larger sampling variation typical of the IV estimates. Moreover, the increased range of the IV estimates cannot be operationally justified: variabilities markedly exceeding 100 percent and, for automated distribution operations, variabilities as low as the IV models produce in some cases are also difficult to square with operational understanding of the cost pools. I conclude that the IV estimation procedure does not improve the quality of the variability estimates for automated sorting operations, and therefore recommend the more efficient and more operationally plausible FE/GLS results.

VII.B. Alternative Formulations of AFSM and D/BCS Models

In addition to the recommended models for the D/BCS and AFSM 100 operations, I considered alternative single-driver and multiple-driver models using the incoming and outgoing piece handlings. In addition to the specifications employed for D/BCS and AFSM 100 in the BY 2005 recommended models, I investigated separate incoming and outgoing models with both incoming and outgoing sorts serving as outputs. The multi-output models allow for cross-effects between the incoming and outgoing operations. I also estimated "would-have-been" results for the recommended models using the observations available for BY 2004. The results are summarized in Table 21, below.

The AFSM results fall within a narrow range, all relatively close to 100 percent. The results suggest very little cross-effect from outgoing AFSM sorting volumes on incoming AFSM hours. The multiple output model for outgoing AFSM shows an anomalously large elasticity with respect to the incoming AFSM sorting volume, though. Since there is no backflow of mail from incoming AFSM to outgoing AFSM (see section II.C.2, Figure 2), the "result" appears to be a spurious consequence of moderate correlation[42] between the incoming and outgoing outputs. In the end, the results are statistically quite similar, though the

[42] The correlation coefficient between log incoming and log outgoing TPF is 0.63.

recommended results with slightly lower variability than the single-output models are easier to reconcile with other operational considerations.

The D/BCS results show somewhat greater dispersion. The models allowing cross-effects yield substantially lower variabilities than the recommended models. As with AFSM, the effect from outgoing D/BCS TPF to incoming D/BCS hours—i.e., in the general direction of the mailflow from Figure 1—is small (negative but small and insignificant). The reverse effect, which is negative and statistically significant, is anomalous. This, again, appears to be a spurious result of cross-correlation of the volumes.[43] The own-operation elasticities—1.01 and 0.75 for outgoing and incoming D/BCS, respectively—are quite close to those from the recommended single-output models. In the absence of an operational justification for the cross-effects, I prefer the single-output models for D/BCS.

Additional econometric results from the alternative models are provided in Appendix C, Tables C-3 to C-7.

[43] For D/BCS, the correlation between log incoming TPF and log outgoing TPF is stronger than with AFSM, at 0.82.

Table 21. Comparison of elasticities from alternative D/BCS and AFSM models

Cost Pool	Separate Outgoing and Incoming, Single Output	Combined Outgoing and Incoming, Multiple Outputs	Separate Outgoing and Incoming, Multiple Outputs	Recommended Method, Using BY 2004 Observations
D/BCS	0.88* (0.05)	0.72 (0.08)	0.74 (0.07)	0.85 (0.05)
AFSM 100	1.03 (0.05)	0.99* (0.08)	1.02 (0.06)	0.95 (0.09)

*Recommended estimate. Standard errors in parentheses.

VII.C. TPF-Based Models with Roberts Capital Controls

Prof. Roberts contends that the Postal Service's models are misspecified as a result of employing capital input indexes that aggregate capital from several operations, instead of equipment-specific capital variables employed in his models (Roberts [2006] at 24). However, Prof. Roberts does not demonstrate whether his alternative specification significantly affects the relevant results, the labor demand elasticities. To investigate the issue, I compared a log-linear specification of the Postal Service models using Prof. Roberts's capital variables with alternative models employing the Postal Service capital input indexes. A summary of results is presented in Table 22, below.

Table 22. Comparison of log-linear TPF/TPH models with Roberts and USPS capital variables

Cost Pool	BY2005 Variability	Log-Linear, Roberts Capital	Log-Linear, USPS Capital
BCS Outgoing	1.06 (0.06)	0.83 (0.01)	0.83 (0.01)
BCS Incoming	0.82 (0.07)	0.67 (0.02)	0.68 (0.02)
OCR	0.78 (0.05)	0.75 (0.01)	0.74 (0.01)
FSM/1000	0.72 (0.03)	0.84 (0.01)	0.83 (0.01)
AFSM100 Total	0.99 (0.08)	0.85 (0.02)	0.85 (0.02)
-- Incoming	0.74 (0.07)	0.78 (0.02)	0.77 (0.02)
-- Outgoing	0.26 (0.04)	0.07 (0.01)	0.08 (0.01)
Manual Flats	0.94 (0.07)	0.90 (0.07)	0.91 (0.07)
Manual Letters	0.89 (0.09)	0.89 (0.07)	0.92 (0.07)
Composite	0.89	0.80	0.81

Standard errors in parentheses.

The log-linear elasticities show very little sensitivity overall to the capital specification.[44] The capital specification does not matter much as a practical issue. In part, this reflects the role of capital (stock) as providing capacity for the operations, rather than making pre-existing operations more (or less) productive

[44] While the log-linear elasticities are lower overall, that is due primarily to differences between the log-linear models and the less restrictive translog specifications used in the Postal Service CRA for D/BCS and AFSM. See also Section VI.B.1.

on the margin. Prof. Roberts's capital specification also hinders direct comparison of effects in that it cannot easily be determined whether the statistically significant capital effects he shows have qualitative economic significance. The significance does not extend to affecting the robustness of the labor demand elasticities.

VII.D. Other Multiple-Output Models and Cross-Operation Interactions

An alternative approach to specifying joint outputs for variability estimation is to specify a vector of outputs for the component operations within a shape-based mailstream. A similar method was advanced as an alternative model by UPS witness Neels in Docket No. R2000-1 (see Docket No. R2000-1, Tr. 27/1829-31; Tr. 46-E/22171-73). This method allows interactions between the outputs of one operation and the resource usage in another, and has the useful property when used as a specification for cost pool-level models that operation-specific outputs are a special case where the cross-operation effects are small and/or statistically insignificant.

I estimated models for the automated letter and flat-shape operations (D/BCS, OCR, AFSM 100, and other FSM) using three outputs. For letters, I used D/BCS, OCR, and manual letter sorts; for flats, I used AFSM, other FSM, and manual flat sorts.[45] Of the eight cross-operation output elasticities reported in Tables 23 and 24, seven are small and statistically insignificant. The small manual cross-elasticities indicate it is very unlikely that correcting for

[45] Because the results would be more likely to be biased by measurement error in manual TPH volumes, I did not estimate models for manual operations.

measurement error in the manual sorting volumes would materially affect the results, given the observed degrees of measurement error attenuation in the manual cost pool models. The data therefore support the analysis from section II.F, above, that within-operation sorting volumes should be the primary if not the exclusive volume-related factors determining sorting operations' workhours.

Table 23. Translog shape-level model results -- letters

Cost Pool	Recommended Variability	OCR	D/BCS	Manual Letters	Sum Of Elasticities	Own Elasticity As Percent Of Sum
OCR	0.78 (0.05)	0.74 (0.05)	-0.03 (0.13)	-0.04 (0.04)	0.66 (0.14)	111%
D/BCS	0.88 (0.05)	0.04 (0.03)	0.80 0.07	0.01 (0.02)	0.84 (0.08)	95%

Table 24. Translog shape-level model results -- flats

Cost Pool	Recommended Variability	AFSM 100	Other FSM*	Manual Flats	Sum of Elasticities	Own Elasticity as Percent Of Sum
AFSM 100	0.99 (0.08)	1.22 (0.08)	0.03 (0.03)	0.03 (0.02)	1.28 (0.09)	95%
Other FSM*	n.a.	-0.03 (0.12)	0.66 (0.05)	-0.10 (0.03)	0.54 (0.14)	123%

(*) Combined FSM 881 and FSM 1000.

Note: Cost pool entries in left-hand column refer to dependent variables in specific models; cost pool entries in topmost row refer to elasticities with respect to specific independent variables in each model. Heteroskedasticity-consistent standard errors in parentheses. Row details may not sum to totals due to rounding.

VII.E. Alternative Screens for MODS Data Anomalies

In light of the criticism of screening for MODS data anomalies at the level of the quarterly aggregates, mentioned in Section V.D, above, I re-estimated the Postal Service variability models using data samples that had been screened at two higher levels of frequency than the quarterly level: weekly and the AP level. In both cases, the hours variable in each MODS operation and the relevant piece handling variable (TPF in the case of the automated and mechanized operations, TPH in the case of the manual operations) were examined before the observations were aggregated to quarterly frequency, and each weekly or AP observation was marked as either a "good" or "bad" observation.

In addition to implementing higher frequency analogues of the existing productivity screen, the higher-frequency screens incorporate a check for single-period data dropouts. The dropouts are observations with zero TPF (or TPH) and hours, but nonzero TPF or TPH and hours in the preceding and following periods.[46] The dropout observations, in contrast to unbroken sequences of zero observations located at the beginning or end of a series, would be unlikely to represent "true" zero observations.

This procedure yielded a set of eight flags for each of the operation groups: TPHGOOD_AP_*x*, TPHBAD_AP_*x*, TPFGOOD_AP_*x,* and TPFBAD_AP_*x* for the AP-level screen; TPHGOOD_WK*x*, TPHBAD_WK_*x*, TPFGOOD_WK_*x,* and TPFBAD_WK_*x* for the weekly screen, where AP or WK

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[46] The first and last observations in a time series were checked using just the following and preceding periods, respectively.

indicates the frequency at which the screen was performed, and *x* is the operation group. Using the additional flags, I eliminated observations with one or more “bad” higher-frequency components.

Table 25 shows the means and standard errors of MODS productivities by operation. These statistics are not robust to outliers, and so provide some indication of the effectiveness of the screens at removing anomalous observations. It is clear from the table that the screens on the quarterly data remove the most grossly erroneous observations, and the stricter screens have relatively modest incremental effects on the distribution. Much of the productivity variation reflects actual systematic differences among facilities, which screening would not (and should not) remove.

Table 26 shows that applying stricter screens has relatively little effect on most variabilities. Stricter screening does not serve to systematically increase or decrease the variabilities. The exception is that the IV models for manual parcels and manual Priority show increases in the point estimates but also rapidly increasing standard errors. Excluding manual Priority, the stricter screens have no significant effect on the overall variability level.

Table 25. Effects of screens on MODS productivity distributions

Cost Pool	Pre-Screen	Quarterly Screen	AP-Level Screen	Weekly Screen
BCS Outgoing	10178 (61476)	8892 (2753)	8727 (2502)	8504 (2276)
BCS Incoming	9432 (18075)	8758 (2015)	8696 (1870)	8642 (1774)
OCR	13385 (501527)	6475 (2144)	6424 (1875)	6308 (1723)
FSM/1000	714 (1291)	604 (268)	600 (257)	588 (227)
AFSM100	1945 (1257)	1933 (277)		
-- Outgoing	2747 (15077)	2065 (410)	2091 (417)	2060 (346)
-- Incoming	2140 (1409)	2056 (310)	2069 (310)	2045 (271)
SPBS	293 (103)	295 (88)	294 (84)	290 (78)
Manual Flats	509 (1177)	466 (176)	462 (165)	452 (148)
Manual Letters	647 (272)	633 (225)	625 (214)	607 (193)
Manual Parcels	4303 (44310)	312 (187)	289 (163)	261 (136)
Manual Priority	1778 (28656)	301 (147)	287 (130)	274 (114)
Cancellations	4599 (11307)	4226 (1805)	4164 (1688)	4070 (1528)

Top entry in each cell is sample mean productivity (TPF/hr or TPH/hr); bottom entry in parentheses is associated sample standard deviation.

Table 26. Comparison of recommended variabilities with alternatives (AP-level and weekly screens)

Cost Pool	Recommended Variabilities	AP-Level Screens	Weekly Screens
BCS Outgoing	1.06 (0.06)	1.08 (0.05)	1.09 (0.05)
BCS Incoming	0.82 (0.07)	0.82 (0.06)	0.81 (0.07)
OCR	0.78 (0.05)	0.73 (0.05)	0.68 (0.05)
FSM/1000	0.72 (0.03)	0.73 (0.03)	0.70 (0.03)
AFSM100 Total	0.99 (0.08)	0.90 (0.08)	0.90 (0.08)
-- Incoming	0.74 (0.07)	0.69 (0.06)	0.67 (0.07)
-- Outgoing	0.26 (0.04)	0.21 (0.04)	0.23 (0.06)
Total SPBS	0.87 (0.05)	0.86 (0.05)	0.84 (0.05)
Manual Flats	0.94 (0.07)	0.98 (0.08)	0.89 (0.10)
Manual Letters	0.89 (0.09)	0.91 (0.15)	0.87 (0.14)
Manual Parcels	0.80 (0.18)	0.84 (0.23)	0.97 (0.31)
Manual Priority	0.75 (0.09)	1.23 (0.30)	2.28 (1.80)
Cancellation	0.50 (0.07)	0.53 (0.08)	0.59 (0.08)
Composite	0.85	0.88	0.93
Composite excl. Manual Priority	0.86	0.86	0.84

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

VII.F. Alternative Capital Series

Prof. Roberts had expressed concern over observations where there were mismatches between the equipment-specific capital variables he employs and the associated MODS data (Roberts [2006] at 63). This is, in part, a byproduct of the frequency of updating the capital inventory data, which had been based on annual data from PPAM and PEAS. I investigated alternative capital variables using quarterly updates of the PPAM/PEAS data to eliminate mismatches due to the updating frequency; see also Section V.C.4, above. Capital series based on the annual updating method and alternative series based on quarterly updating are compared in Table 27, below.

There are relatively few mismatches for letter operations, and correspondingly relatively little difference between the original and alternative capital series. Flats are a different matter, particularly due to AFSM 100 deployment during the sample period. The increased frequency of PPAM data acquisition reduces capital/hours "mismatches" by 42 percent for AFSM 100 and 35 percent for other FSM types. The observations not affected by the data timing improvement appear mostly to occur during equipment startup periods, which Prof. Roberts excludes in his sample selection criteria (Roberts 2006 at 44). While there appears to be some lag between the installation of equipment and its appearance in PPAM/PEAS inventories, this appears to have little effect for periods of normal operations. I used the alternative capital series in the FY 2005 update of Prof. Roberts's (2006) models.

Table 27. Comparison of original and alternate capital variables

	Obs. with Hrs. > 0 and Capital = 0			
Operation	Original	Alternative	Reduction	% of Obs. With Hrs.>0
D/BCS	44	36	-18%	<1%
OCR	194	149	-23%	2%
AFSM 100	919	535	-42%	13%
Other FSM	372	242	-35%	4%

VII.G. Updating Prof. Roberts's (2006) Models With FY 2005 Data

In order to facilitate comparisons between the Postal Service variability models for BY 2005 and Prof. Roberts's revised (2006) framework, I provide additional data employed in Prof. Roberts's analysis, as well as Stata programs that update Prof. Roberts's models with the addition of FY 2005 data, in Section IV of USPS-LR-L-56. I also re-estimated Prof. Roberts's models with data through 2004 derived from the LR-L-56 data sets, and using alternative capital series based on the use of more frequently updated PPAM and PEAS equipment data (see section VII.F, above).

I calculated weighted average variabilities by shape using Prof. Roberts's method, which uses data from the entire sample period to construct workhour weights, as well as using weights derived from the final year in the sample. The latter approach is similar to evaluating the elasticities from the translog Postal Service models using Base Year data. By including previous years' data in the weights, Prof. Roberts overweights declining operations and underweights growing operations. This is particularly apparent in flat sorting operations, where FSM 881 operations represent 23 percent of flat sorting hours in Prof. Roberts's full 1999-2004 sample, but only 1 percent in FY 2004 and none in FY 2005. Based on statements in his March 2006 seminars, Prof. Roberts appears to view adjusting the weights as reasonable means of recombining his results consistent with an evolving processing mix; I agree and add that it would be appropriate for him to incorporate current weights in his analysis.

Prof. Roberts had obtained highly anomalous results for BCS operations for his 2006 paper—variabilities of 0.32 and 1.21, respectively, for MPBCS and DBCS operations. Neither result squares well with operational reality. Employing an incoming/outgoing D/BCS structure similar to the Postal Service's yields more reasonable results—0.85 for incoming D/BCS and 0.57 for outgoing D/BCS for FY 2005 using the alternative capital series.[47]

Using the more reliable D/BCS operation groups and current weights lowers letter variabilities and raises flat variabilities, relative to the results from Prof. Roberts's (2006) paper. The former owes mainly to the difference between the anomalously high DBCS elasticity estimated by Prof. Roberts and the more reliable result for incoming D/BCS. The flat shift reflects the reduced weight on FSM 881 and the increased weight on the higher AFSM 100 elasticity. Overall, Prof. Roberts's models yield results that are more similar to the Postal Service elasticities. The results are summarized in Table 28; additional results are provided in Appendix E and in USPS-LR-L-56.

[47] A negative and large but statistically insignificant cross-elasticity of outgoing D/BCS workhours with respect to incoming FHP affects the total elasticity for outgoing D/BCS; the elasticity with respect to outgoing letter FHP is 0.74. The outgoing letter elasticity is relatively stable. Since the outgoing D/BCS costs are much smaller than incoming D/BCS, this has a limited effect on the overall letter variability.

The FY 2005 update of Prof. Robert's models, incorporating the D/BCS and capital improvements, yields results that differ little from the Postal Service's models for letters, and that differ less for flats than Prof. Robert's 2006 paper suggests—87 percent (Roberts) versus 88 percent (Postal Service) for the letter cost pools; 78 percent (Roberts) versus 92 percent (Postal Service) for the flat sorting cost pools. The results are reasonably stable from FY 2004 to FY 2005.

The reason for the relatively small differences in results is that while Prof. Roberts misspecifies sorting outputs by using FHP aggregates instead of operation-specific total piece handlings, FHP does not badly mismeasure sorting output in most cases—and the IV estimation procedure helps correct the resulting measurement error. The major differences occur in cost pools where the aggregated FHP variables employed by Prof. Roberts have a weak connection to the sorting activities in the operations, notably manual flats and outgoing D/BCS. It follows from both approaches using statistically consistent methods to estimate the same economic quantities that the results should substantially coincide.

Table 28. Summary of shape-level elasticities from FY 2005 update of Roberts (2006)

Shape	FY05 update of Roberts model, alt. capital, FY05 weights	FY04 "would-have-been" (FY05 update model, FY04 weights)	FY04 "would-have-been" (Orig. capital, full sample weights)	USPS FY04 "replication" of Roberts (2006), using LR-L-56 data*	Roberts (2006)*
Letters	0.87 (0.07)	0.93 (0.07)	0.94 (0.07)	1.07 (0.08)	0.99 (0.08)
Flats	0.78 (0.08)	0.82 (0.09)	0.71 (0.08)	0.71 (0.08)	0.70 (0.08)
Both	0.85 (0.05)	0.90 (0.05)	0.86 (0.05)	0.95 (0.06)	0.89 (0.06)

Standard errors in parentheses.

(*) Uses FY 2004 DBCS and MPBCS cost pool groups.

Appendixes

Appendix A. Mathematical Results Pertaining to the "Volume-Variability/Distribution Key" Method

The volume-variable cost of subclass *j* in cost pool *i* is defined as the product of the marginal cost of subclass *j* in cost pool *i* and the RPW volume of subclass *j*:

$$VVC_{i,j} \equiv MC_{i,j} V_j \, , \tag{A1}$$

where

$$MC_{i,j} = \partial C_i \big/ \partial V_j \, . \tag{A2}$$

Because of the limited availability of time series data on volumes, directly estimating subclass marginal costs from subclass volumes is not feasible.[48] However, with some elementary calculus, the problem can be decomposed into feasible components. Since data on the intermediate outputs ("cost drivers") are available, the usual decomposition of marginal cost is given by equation (A3):

$$\partial C_i \big/ \partial V_j = \partial C_i \big/ \partial D_i \cdot \partial D_i \big/ \partial V_j \, , \tag{A3}$$

which shows that the marginal cost can be rewritten as the product of the marginal cost of the intermediate output and the marginal contribution of RPW volume to the intermediate output. Equation (A3) can be rewritten in terms of elasticities as follows:

$$\partial C_i \big/ \partial V_j = (C_i \big/ D_i \cdot \varepsilon_i) \cdot (D_i \big/ V_j \cdot \delta_{ij}) = C_i \varepsilon_i \delta_{ij} / V_j \, , \tag{A4}$$

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[48] The implicit cost function generally would have many more parameters than there are observations given the number of CRA subclasses. Of course, all the usual difficulties of reliably estimating multivariate regressions from pure time series data would also be present.

where $\varepsilon_i = \partial \ln C_i / \partial \ln D_i$ is the elasticity of cost with respect to the cost driver in cost pool *i* (i.e., the variability for cost pool *i*), and δ_{ij} is the elasticity of the cost driver with respect to RPW volume. Substituting equation (A4) into (A1) gives:

$$\Rightarrow VVC_{i,j} = C_i \varepsilon_i \delta_{ij} . \qquad \text{(A5)}$$

Equation (A5) is the "constructed marginal cost" formula from Appendix H of USPS-LR-L1.

Implementing equation (A5) to measure volume-variable costs is generally not feasible either, as the RPW volume time series are inadequate to estimate the function relating RPW volumes to the cost driver and thus δ_{ij}. Accordingly, the Postal Service approximates the elasticities δ_{ij} with "distribution key shares" $d_{ij} = D_{i,j} / D_i$, representing the proportions of the cost driver by subclass. The substitution of the distribution key for the elasticity δ_{ij} leads to the "distribution key method" for computing volume-variable cost, which approximates marginal cost:

$$VVC_{i,j} = C_i \varepsilon_i d_{ij} \cong MC_{i,j} \cdot V_j . \qquad \text{(A6)}$$

The distribution key formula can be shown to be equivalent to the constructed marginal cost formula when the function relating the RPW volumes to the cost driver, $D_i = g_i(V_1, ...V_N)$, is linear in volumes, in which case both equalities in (A6) would be exact.[49] This is the essence of the so-called "proportionality assumption." The "assumption," however, is more appropriately termed a first-order approximation, as one can always write:

[49] To see this, note that the higher order terms in equation (A7) would be identically zero with $g_i(V_1, ...V_N)$ linear, so the approximations in equations (A8) and (A9) would hold exactly.

$$g_i(V_1,...,V_N) = \sum_{j=1}^{N} \alpha_{i,j} V_j + O(V^2) \quad (A7)$$

[50]

or

$$g_i(V_1,...,V_N) \cong \sum_{j=1}^{N} \alpha_{i,j} V_j \quad (A8)$$

to a first approximation. The interpretation of the parameters a_j is units of the cost driver (TPF) per RPW piece. The approximate elasticity from equation (A8) is:

$$\delta_{ij} = \partial \ln g_i(V_1,...,V_N) / \partial V_j \cong \alpha_{ij} V_j \Big/ \sum_{j=1}^{N} \alpha_{ij} V_j = D_{i,j} / D_i . \quad (A9)$$

Equation (A9) establishes that the distribution key method produces unit volume-variable costs that constitute a first approximation to marginal costs. Note that FHP need not be invoked in the derivation.

To introduce Dr. Neels's FHP adjustment term, the elasticity of TPF with respect to FHP (say, $\phi_i = \partial \ln D_i / \partial \ln F_i$), it is necessary to further decompose the term $\partial D_i / \partial V_j$ from equation (A3), which leads to:

$$\partial C_i \big/ \partial V_j = \partial C_i \big/ \partial D_i \cdot \partial D_i \big/ \partial F_i \cdot \partial F_i \big/ \partial V_j \ , \quad (A3')$$

or in elasticity terms:

$$\partial C_i \big/ \partial V_j = (C_i \big/ D_i \cdot \varepsilon_i) \cdot (D_i \big/ F_i \cdot \phi_i) \cdot (F_i \big/ V_j \cdot \eta_{ij}) = C_i \varepsilon_i \phi_i \eta_{ij} / V_j \quad (A4')$$

$$\Rightarrow VVC_{ij} = C_i \varepsilon_i \phi_i \eta_{ij} \ , \quad (A5')$$

where the additional term η_{ij} is the elasticity of FHP with respect to RPW volume.

I noted in Docket No. R2000-1 that Dr. Neels's "reverse regression" analysis of the relationship between TPH and FHP sheds no light on η_{ij} (Docket No. R2000-1, Tr. 46-E/22162). However, the results derived above imply that the

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[50] The term $O(V^2)$ denotes terms involving squares and higher-order terms in $V = V_1, \ldots, V_N$. In the Taylor series approximation, the parameters a_j are chosen so that at the actual volumes $V^* = V_1^*, \ldots, V_N^*$, $O(V^2)\big|_{V=V^*} = 0$.

additional term neglected by Dr. Neels must, to a first approximation, cancel out his FHP adjustment. This result may be shown by combining equations (A5) and (A5'), which gives:

$$\delta_{ij} = \phi_i \cdot \eta_{ij} \,. \tag{A10}$$

The approximation result from equation (A9) implies

$$d_{ij} \cong \phi_i \cdot \eta_{ij} \tag{A11}$$

or

$$\eta_{ij} \cong d_{ij} / \phi_i \,. \tag{A12}$$

Finally, substituting (A12) into (A5'), we obtain:

$$VVC_{ij} \cong C_i \varepsilon_i \phi_i d_{ij} / \phi_i = C_i \varepsilon_{i_i} d_{ij} \,, \tag{A13}$$

the rightmost term of which is the same as equation (A6), establishing the result that properly applying FHP elasticities in the calculation of volume-variable costs would have (to a first approximation) no effect on the measured costs.

Appendix B. Additional Econometric Results from Alternative MODS Screens

Table B-1. Selected summary statistics for regression samples (weekly screen)

Cost Pool	Median Hours	Median TPF (000)	Median relative wage ($/hr)	Median productivity (TPF/hr), before screening
BCS Outgoing (n=5555)	6715	56211	1.00	8596
BCS Incoming (n=6351)	17417	147227	1.00	8517
OCR (n=4888)	4194	27017	1.00	6341
FSM/1000 (n=3896)	7793	4460	1.06	558
AFSM100 Outgoing (n=1385)	19507	13217	1.07	2747
AFSM100 Incoming (n=1385)	19507	24270	1.07	2140
SPBS (n=4031)	13506	3779	1.11	282
Manual Flats* (n=6089)	5097	2336	1.06	458
Manual Letters* (n=7832)	16920	9742	1.00	599
Manual Parcels* (n=3445)	1608	396	1.03	348
Manual Priority* (n=4177)	3791	961	1.02	306
Cancellations* (n=7555)	5177	19760	0.95	3880

* Operations using TPH

Table B-2. Principal results for automated letter sorting operations, translog-FE method (weekly screen)*

Cost Pool	BCS Outgoing	BCS Incoming	OCR
Output Elasticity or Volume-Variability Factor	1.09 (0.05)	0.81 (0.07)	0.68 (0.05)
Wage Elasticity	-0.26 (0.06)	-0.25 (0.04)	-0.12 (0.06)
Deliveries Elasticity	0.26 (0.17)	-0.09 (0.10)	0.32 (0.23)
Capital Elasticity	0.01 (0.05)	-0.03 (0.03)	0.11 (0.06)
Auto-correlation coefficient	0.71	0.74	0.71
Adjusted R^2	0.93	0.93	0.86
# observations	5201	5984	4560
# facilities	287	307	261

* Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table B-3. Principal results for automated flat and parcel sorting operations, translog-FE method, non-AFSM (weekly screen)

Cost Pool	FSM 1000	SPBS
Output Elasticity or Volume-Variability Factor	0.70 (0.03)	0.84 (0.05)
Wage Elasticity	-0.18 (0.05)	-0.43 (0.07)
Deliveries Elasticity	-0.02 (0.19)	-0.20 (0.22)
Capital Elasticity	-0.02 (0.03)	0.01 (0.02)
Auto-correlation coefficient	0.73	0.74
Adjusted R^2	0.83	0.89
# observations	3631	3772
# facilities	224	206

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table B-4. Principal results for automated flat and parcel sorting operations, translog-FE method, AFSM (weekly screen)

Cost Pool	AFSM 100
Output Elasticity or Volume-Variability Factor -- Total	0.90 (0.08)
-- Incoming	0.67 (0.07)
-- Outgoing	0.23 (0.06)
Wage Elasticity	-0.46 (0.06)
Deliveries Elasticity	0.29 (0.45)
Capital Elasticity	0.09 (0.03)
Auto-correlation coefficient	0.50
Adjusted R^2	0.97
# observations	1231
# facilities	141

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table B-5. Principal results for manual sorting operations and cancellation, log-linear/IV method (weekly screen)

Cost Pool	Manual Flats	Manual Letters	Cancellation	Manual Parcels	Manual Priority
Output Elasticity or Volume-Variability Factor	0.89 (0.10)	0.87 (0.14)	0.59 (0.08)	0.97 (0.31)	2.28 (1.80)
Wage Elasticity	0.01 (0.03)	0.26 (0.03)	-0.18 (0.10)	-0.19 (0.35)	1.62 (2.82)
Deliveries Elasticity	0.23 (0.08)	0.05 (0.05)	0.18 (0.07)	0.70 (0.26)	0.08 (0.39)
Capital Elasticity	0.01 (0.01)	0.00 (0.01)	-0.09 (0.02)	-0.03 (0.07)	0.22 (0.15)
Auto-correlation coefficient	n.a.	n.a.	n.a.	n.a.	n.a.
Adjusted R^2	0.96	0.97	0.95	0.87	0.68
# observations	6089	7832	7555	3445	4177
# facilities	281	311	302	215	293

Standard errors in parentheses.

Table B-6. Selected summary statistics for regression samples (AP-level screen)

Cost Pool	Median Hours	Median TPF (000)	Median relative wage ($/hr)	Median productivity (TPF/hr), before screening
BCS Outgoing (n=6612)	4735	40842	1.00	8596
BCS Incoming (n=7048)	16236	136899	1.00	8517
OCR (n=5738)	3720	24214	1.01	6341
FSM/1000 (n=4446)	7693	4387	1.06	558
AFSM100 Outgoing (n=2109)	16366	9332	1.06	2129
AFSM100 Incoming (n=2109)	16366	22159	1.06	2061
SPBS (n=4576)	12841	3636	1.12	282
Manual Flats* (n=6896)	4650	2159	1.06	453
Manual Letters* (n=8326)	15626	9203	1.00	599
Manual Parcels* (n=4362)	1495	387	1.03	348
Manual Priority* (n=4986)	3397	874	1.02	306
Cancellations (n=8046)	4937	18964	0.95	3880

* Operations using TPH

Table B-7. Principal results for automated letter sorting operations, translog-FE method (AP-level screen)

Cost Pool	BCS Outgoing	BCS Incoming	OCR
Output Elasticity or Volume-Variability Factor	1.08 (0.05)	0.82 (0.06)	0.73 (0.05)
Wage Elasticity	-0.23 (0.06)	-0.24 (0.04)	-0.18 (0.07)
Deliveries Elasticity	0.28 (0.15)	0.15 (0.11)	0.38 (0.22)
Capital Elasticity	0.00 (0.05)	-0.05 (0.03)	0.16 (0.06)
Auto-correlation coefficient	0.71	0.74	0.71
Adjusted R^2	0.97	0.93	0.85
# observations	6281	6725	5417
# facilities	302	309	273

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table B-8. Principal results for automated flat and parcel sorting operations, translog-FE method, non-AFSM (AP-level screen)

Cost Pool	FSM/1000	SPBS
Output Elasticity or Volume-Variability Factor	0.73 (0.03)	0.86 (0.05)
Wage Elasticity	-0.13 (0.05)	-0.46 (0.07)
Deliveries Elasticity	-0.10 (0.19)	-0.02 (0.16)
Capital Elasticity	-0.02 (0.03)	0.00 (0.02)
Auto-correlation coefficient	0.73	0.74
Adjusted R^2	0.82	0.89
# observations	4205	4352
# facilities	235	208

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table B-9. Principal results for automated flat and parcel sorting operations, translog-FE method, AFSM (AP-level screen)

Cost Pool	AFSM 100
Output Elasticity or Volume-Variability Factor -- Total	0.90 (0.08)
-- Incoming	0.69 (0.06)
-- Outgoing	0.21 (0.04)
Wage Elasticity	-0.42 (0.05)
Deliveries Elasticity	0.22 (0.39)
Capital Elasticity	0.06 (0.02)
Auto-correlation coefficient	0.56
Adjusted R^2	0.96
# observations	1910
# facilities	187

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table B-10. Principal results for manual sorting operations and cancellation, log-linear/IV method (AP-level screen)

Cost Pool	Manual Flats	Manual Letters	Cancellation	Manual Parcels	Manual Priority
Output Elasticity or Volume-Variability Factor	0.98 (0.08)	0.91 (0.15)	0.53 (0.08)	0.84 (0.23)	1.23 (0.30)
Wage Elasticity	0.01 (0.03)	0.24 (0.03)	-0.21 (0.10)	-0.28 (0.30)	0.08 (0.51)
Deliveries Elasticity	0.31 (0.09)	0.06 (0.05)	0.19 (0.07)	0.56 (0.27)	0.06 (0.21)
Capital Elasticity	0.02 (0.01)	-0.01 (0.02)	-0.10 (0.02)	-0.12 (0.05)	0.20 (0.06)
Auto-correlation coefficient	n.a.	n.a.	n.a.	n.a.	n.a.
Adjusted R^2	0.95	0.97	0.94	0.85	0.86
# observations	6896	8326	8046	4362	4986
# facilities	289	312	304	234	234

Standard errors in parentheses.

Appendix C. Additional Econometric Results from Alternative Estimation Approaches

Table C-1. Principal results for manual sorting operations and cancellation, translog-FE method

Cost Pool	Manual Flats	Manual Letters	Cancellation	Manual Parcels	Manual Priority
Output Elasticity or Volume-Variability Factor	0.77 (0.03)	0.38 (0.03)	0.41 (0.08)	0.47 (0.05)	0.43 (0.04)
Wage Elasticity	0.21 (0.07)	0.50 (0.05)	0.12 (0.19)	-1.30 (0.28)	-1.86 (0.24)
Deliveries Elasticity	-0.10 (0.16)	-0.04 (0.07)	0.10 (0.40)	0.66 (0.41)	1.34 (0.54)
Capital Elasticity	0.01 (0.03)	0.15 (0.04)	0.02 (0.04)	-0.10 (0.08)	-0.04 (0.09)
Auto-correlation coefficient	0.70	0.73	0.75	0.68	0.64
Adjusted R^2	0.83	0.92	0.76	0.68	0.84
# observations	5268	6758	6502	3100	3712
# facilities	278	309	303	206	217

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table C-2. Principal results for automated sorting operations, FE/IV method

Cost Pool	D/BCS Outgoing	D/BCS Incoming	OCR	AFSM 100	FSM 1000	SPBS
Output Elasticity or Volume-Variability Factor	1.19 (0.19)	0.82 (0.07)	0.53 (0.08)	1.03 (24.43)	0.44 (0.12)	1.03 (0.11)
Outgoing	N/A	N/A	N/A	0.18 (20.72)	N/A	N/A
Incoming	N/A	N/A	N/A	0.85 (3.73)	N/A	N/A
Wage Elasticity	-0.28 (0.04)	-0.35 (0.02)	-0.34 (0.04)	-0.27 (10.65)	-0.01 (0.04)	-0.36 (0.04)
Deliveries Elasticity	0.04 (0.09)	0.10 (0.04)	0.13 (0.09)	0.19 (71.73)	-0.26 (0.09)	-0.54 (0.07)
Capital Elasticity	-0.05 (0.01)	-0.05 (0.01)	0.01 (0.02)	-0.08 (13.83)	0.06 (0.02)	0.00 (0.01)
Adjusted R^2	0.97	0.98	0.94	0.97	0.91	0.97
# obs.	8215	8503	7533	3449	5626	5556
# facilities	304	313	281	221	249	209

Standard errors in parentheses.

Table C-3. Principal results for multi-driver D/BCS model, translog-FE method

	D/BCS (incoming and outgoing)
Output Elasticity or Volume-Variability Factor -- Total	0.72 (0.08)
-- Incoming	0.48 (0.07)
-- Outgoing	0.24 (0.03)
Wage Elasticity	-0.26 (0.03)
Deliveries Elasticity	-0.02 (0.09)
Capital Elasticity	-0.02 (0.04)
Auto-correlation coefficient	0.71
Adjusted R^2	0.95
# observations	6531
# facilities	304

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table C-4. Principal results for single-driver AFSM 100 models, translog-FE method

Cost Pool	AFSM100 Outgoing	AFSM100 Incoming
Output Elasticity or Volume-Variability Factor	1.10 (0.06)	1.00 (0.07)
Wage Elasticity	-0.34 (0.07)	-0.37 (0.05)
Deliveries Elasticity	0.08 (0.58)	0.11 (0.40)
Capital Elasticity	0.07 (0.04)	-0.01 (0.03)
Auto-correlation coefficient	0.54	0.58
Adjusted R^2	0.95	0.93
# observations	2163	2680
# facilities	196	224

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table C-5. Results for BCS operations, translog-FE method (sample restricted to FY1999-FY2004)

Cost Pool	BCS Outgoing	BCS Incoming
Output Elasticity or Volume-Variability Factor	1.06* (0.06)	0.78* (0.07)
Wage Elasticity	-0.25 (0.06)	-0.24 (0.05)
Deliveries Elasticity	0.35 (0.17)	-0.01 (0.11)
Capital Elasticity	0.02 (0.05)	-0.10 (0.05)
Auto-correlation coefficient	0.70	0.69
Adjusted R^2	0.91	0.93
# observations	6598	5658
# facilities	304	309

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table C-6. Results for AFSM 100 operation, translog-FE method (sample restricted to FY1999-FY2004)

Cost Pool	AFSM 100
Output Elasticity or Volume-Variability Factor -- Total	0.95* (0.09)
-- Incoming	0.72 (0.08)
-- Outgoing	0.23 (0.05)
Wage Elasticity	-0.49 (0.06)
Deliveries Elasticity	0.16 (0.51)
Capital Elasticity	0.04 (0.04)
Auto-correlation coefficient	0.49
Adjusted R^2	0.96
# observations	1337
# facilities	175

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Table C-7. Principal results for incoming and outgoing D/BCS and AFSM models with multiple outputs

Cost Pool	D/BCS Incoming	D/BCS Outgoing	AFSM 100 Incoming	AFSM 100 Outgoing
Output Elasticity or Volume-Variability Factor -- Total	0.71 (0.09)	0.81 (0.12)	0.90 (0.08)	1.32 (0.10)
-- Incoming	0.75 (0.07)	-0.20 (0.09)	0.90 (0.07)	0.29 (0.05)
-- Outgoing	-0.05 (0.04)	1.01 (0.05)	0.00 (0.05)	1.03 (0.10)
Wage Elasticity	-0.24 (0.04)	-0.23 (0.06)	-0.41 (0.05)	-0.32 (0.07)
Deliveries Elasticity	0.01 (0.12)	0.31 (0.16)	0.18 (0.44)	0.01 (0.59)
Capital Elasticity	-0.02 (0.05)	0.03 (0.06)	0.00 (0.03)	0.06 (0.04)
Auto-correlation coefficient	0.73	0.71	0.53	0.51
Adjusted R^2	0.93	0.91	0.94	0.96
# observations	6531	6531	2,011	2011
# facilities	304	304	194	194

Translog-FE elasticities evaluated using arithmetic mean method; heteroskedasticity-consistent standard errors in parentheses.

Appendix D. Comparison of Postal Service Method to Commission Methodology, Pursuant to Rule 53

Table D-1. Comparison of Postal Service BY 2005 variabilities to Commission methodology

Cost pool	BY 2005, USPS Method	Commission Method
D/BCS	0.88	0.98
OCR/	0.78	0.98
FSM/1000	0.72	0.99
AFSM 100	0.99	0.98
SPBS	0.87	0.97
Manual flats	0.94	0.97
Manual letters	0.89	0.97
Manual parcels	0.80	0.95
Manual Priority	0.75	0.96
Cancellation	0.50	0.98

Appendix E. Additional Econometric Results from Roberts (2006) Replication and Update

Table E-1. Comparison of Roberts (2006) results with USPS replication, Letters

	USPS "replication" with FY 2005 data set					Roberts 2006			
Cost pool	Incoming FHP	Outgoing FHP	Total	R^2		Incoming FHP	Outgoing FHP	Total	R^2
Total letter sorting	0.86 (0.06)	0.07 (0.01)	0.93 (0.05)	0.94		0.77 (0.06)	0.07 (0.01)	0.84	0.94
Manual letters	0.96 (0.09)	0.04 (0.02)	1.00 (0.09)	0.85		0.87 (0.09)	0.04 (0.02)	0.91	0.85
D/BCS incoming	0.82 (0.11)	0.09 (0.02)	0.91 (0.10)	0.91		n/a	n/a		
D/BCS outgoing	-0.09 (0.19)	0.76 (0.04)	0.67 (0.18)	0.80		n/a	n/a		
OCR/	0.80 (0.22)	0.20 (0.05)	1.00 (0.22)	0.76		0.70 (0.22)	0.21 (0.05)	0.91	0.76
MPBCS	0.16 (0.51)	0.23 (0.08)	0.39 (0.49)	0.40		0.08 (0.51)	0.24 (0.08)	0.32	0.39
DBCS	1.19 (0.13)	0.11 (0.03)	1.30 (0.12)	0.88		1.10 (0.13)	0.11 (0.03)	1.21	0.88

Standard errors in parentheses

Table E-2. Comparison of Roberts (2006) results with USPS replication, Flats

	USPS "replication" with FY 2005 data set					Roberts 2006			
Cost pool	Incoming FHP	Outgoing FHP	Total	R^2		Incoming FHP	Outgoing FHP	Total	R^2
Total flat sorting	0.66 (0.03)	0.14 (0.02)	0.79 (0.03)	0.91		0.63 (0.03)	0.15 (0.02)	0.78	0.91
Manual flats	0.55 (0.14)	0.06 (0.07)	0.62 (0.14)	0.23		0.53 (0.14)	0.08 (0.07)	0.60	0.23
FSM/881	0.77 (0.08)	-0.04 (0.07)	0.73 (0.09)	0.80		0.72 (0.08)	-0.02 (0.07)	0.71	0.80
FSM/1000	0.65 (0.21)	-0.09 (0.08)	0.57 (0.21)	0.39		0.65 (0.21)	-0.09 (0.09)	0.56	0.39
AFSM 100	0.79 (0.08)	0.21 (0.03)	1.00 (0.09)	0.88		0.79 (0.08)	0.22 (0.03)	1.01	0.88

Standard errors in parentheses

Table E-3. Composite variabilities from "replication" of Roberts (2006) model using FY 2005 data set

Composite variability, evaluated with FY1999-2004 weights	USPS "replication"	Roberts 2006
Letters (old MPBCS and DBCS cost pools)	1.07 (0.08)	0.99 (0.08)
Letters (new D/BCS incoming and outgoing cost pools)	0.94 (0.07)	n/a
Flats	0.71 (0.08)	0.70 (0.08)
Total (old MPBCS and DBCS cost pools)	0.95 (0.06)	0.89 (0.06)
Total (new MPBCS and DBCS cost pools)	0.86 (0.05)	n/a
Composite variability, evaluated with FY2004 weights		
Letters (new D/BCS incoming and outgoing cost pools)	0.93 (0.07)	n/a
Flats	0.77 (0.08)	n/a
Total	0.88 (0.05)	n/a

Standard errors in parentheses

Table E-4. Results from update of Roberts (2006) model with FY 2005 data, Letters

			FY05 update of Roberts model, alternative capital					FY04 "would-have-been" (FY05 update model, FY04 weights)			
Cost pool	BY2005, USPS method		Incoming FHP	Outgoing FHP	Total	R^2		Incoming FHP	Outgoing FHP	Total	R^2
Total letter sorting	0.88*		0.85 (0.06)	0.08 (0.01)	0.93 (0.05)	0.94		0.86 (0.06)	0.06 (0.01)	0.93 (0.05)	0.94
Manual letters	0.89		0.91 (0.09)	0.05 (0.02)	0.96 (0.09)	0.85		0.97 (0.09)	0.04 (0.02)	1.01 (0.09)	0.85
D/BCS incoming	0.88		0.75 (0.10)	0.10 (0.02)	0.85 (0.10)	0.92		0.78 (0.11)	0.09 (0.02)	0.87 (0.10)	0.91
D/BCS outgoing	0.88		-0.17 (0.18)	0.74 (0.03)	0.57 (0.17)	0.81		0.11 (0.19)	0.74 (0.04)	0.86 (0.18)	0.81
OCR/	0.78		0.68 (0.22)	0.22 (0.04)	0.90 (0.21)	0.77		0.76 (0.22)	0.20 (0.05)	0.96 (0.21)	0.77

Standard errors in parentheses

Table E-5. Results from update of Roberts (2006) model with FY 2005 data, Flats

		FY05 update of Roberts model, alternative capital				FY04 "would-have-been" (FY05 update model, FY 1999-2004 sample)			
Cost pool	BY2005, USPS method	Incoming FHP	Outgoing FHP	Total	R^2	Incoming FHP	Outgoing FHP	Total	R^2
Total flat sorting	0.92*	0.74 (0.03)	0.11 (0.01)	0.85 (0.03)	0.91	0.64 (0.03)	0.13 (0.02)	0.78 (0.03)	0.91
Manual flats	0.94	0.63 (0.14)	0.11 (0.05)	0.74 (0.13)	0.19	0.46 (0.14)	0.03 (0.07)	0.49 (0.14)	0.08
FSM/881	n/a	n/a	n/a			0.77 (0.08)	-0.06 (0.07)	0.71 (0.09)	0.79
FSM/1000	0.72	0.72 (0.21)	0.01 (0.07)	0.73 (0.20)	0.43	0.89 (0.21)	-0.03 (0.08)	0.86 (0.21)	0.45
AFSM 100	0.99	0.71 (0.07)	0.13 (0.02)	0.84 (0.06)	0.89	0.85 (0.09)	0.21 (0.03)	1.06 (0.1)	0.89

Standard errors in parentheses

Table E-6. Composite variabilities from update of Roberts (2006) model with FY 2005 data

Composite Variability	USPS BY 2005	Roberts Model, FY 2005 Update, FY 2005 weights	Roberts Model, FY 2004 "would-have-been," FY 2004 weights
Letters	0.88*	0.87 (0.07)	0.93 (0.07)
Flats	0.92*	0.78 (0.08)	0.82 (0.09)
Total	0.89*	0.85 (0.05)	0.90 (0.05)

Standard errors in parentheses

* Average of cost pool results weighted by total pool costs.