UPS-T-1

RECEIVED

MAY 22 5 29 PM '00

POSTAL RATE COMMISSION
OFFICE OF THE SECRETARY

BEFORE THE
POSTAL RATE COMMISSION

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

DIRECT TESTIMONY
OF
KEVIN NEELS
ON BEHALF OF
UNITED PARCEL SERVICE
ON MAIL PROCESSING COSTS

TABLE OF CONTENTS

BIOGRAPHY

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

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

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

My curriculum vitae is attached as Appendix A.

PURPOSE OF MY TESTIMONY

I have been asked to comment on the study of mail processing labor hour variability introduced by Witness Bozzo in this case on behalf of the United States Postal Service. Because Dr. Bozzo's study is supported by and relies upon the testimony of Postal Service Witness Degen, I also review and analyze Mr. Degen's statements regarding the variability of mail processing labor hours.

In the first section of my testimony, I review the choices that the Postal Service faces as it attempts to deal with increases in mail volume, and I analyze the implications of those choices for the study of mail processing labor cost variability. This discussion provides background for my critique, which follows in the second section of my testimony, of the mail processing cost study presented by Dr. Bozzo.

After reviewing Dr. Bozzo's analysis, I review the operational and theoretical evidence for the presence or absence of economies of scale in mail processing. This section focuses on the testimony of Mr. Degen and on his argument that there are economies of scale in mail processing. I carefully analyze Mr. Degen's arguments, and I point out some serious flaws in them.

I then present alternative calculations of the volume variability of mail processing labor costs that correct for some of the flaws in Dr. Bozzo's study. I find that correcting these flaws leads to estimates of mail processing cost variability that equal or exceed 100 percent.

The final section of my testimony presents recommendations about how mail processing labor costs should be treated in this proceeding. I also offer some suggestions about what an empirically and conceptually sound analysis of mail processing labor cost variability should look like.

HOW DOES THE POSTAL SERVICE RESPOND TO CHANGES IN VOLUME?

As Dr. Bozzo has noted, there was considerable controversy in Docket No. R97-1 about the length of time over which the response of mail processing labor costs to changes in volume should be measured. In that proceeding, I criticized Professor Bradley's study for taking an excessively short run view of the response of costs to changes in volume. Other witnesses agreed with this criticism.[1]

In response, Dr. Bozzo has modified Dr. Bradley's econometric specifications to permit adjustments to changes in volume to take place over a longer period of time. Although I believe this change is necessary, I am still troubled by the extremely narrow, short run view taken in the new analysis of how the Postal Service accommodates changes in mail volume.

Dr. Bozzo has noted that in R97-1, all parties accepted the proposition that the economic concept of the "long run" involved a period of time sufficient to allow a firm to adjust fully to changes in volume and factor prices.[2] Thus, the distinction between short

1. See, e.g., the testimony of OCA Witness Smith in Docket No. R97-1, Tr. 28/15835-36.

2. USPS-T-15, p. 17.

run and long run responses to changes in volume has to do essentially with the completeness of the Postal Service's response to a change in mail volume. Obviously, the more time one allows, the more complete that response will be.

Although this distinction between the short run and the long run has to do with the period of time over which a response takes place, one can also analyze this question in functional terms. A change in volume can affect many different aspects of postal operations and trigger decisions in many different areas. The difference between a short run response to an increase in volume and a long run response has to do with which aspects of postal operations are held constant, and which are allowed to vary.

In order to place Dr. Bozzo's results in perspective, it is helpful to review the various ways in which the Postal Service actually responds to increases in the volume of mail to be processed. The record in this proceeding provides considerable evidence regarding the nature of that response and of the economic decisions and tradeoffs that it entails.

(1) Staffing Level Changes

Dr. Bozzo's study focuses on the response of staffing levels to changes in volume. As he notes, decisions regarding mail processing staffing levels occur over two distinct time frames.[3] The first is measured in hours, and involves redeployment of the *existing staff among the different mail processing activities present in the plant.* In this context, plant supervisors respond to stochastic, or unpredictable and random, variations in the volume and mix of mail to be sorted. To some extent, adjustments can

3. USPS-T-15 at 18.

be made to accommodate growth in volume, although over a very short time frame the available options may be limited.[4]

The second adjustment described by Dr. Bozzo involves changing the size or composition of the staff. There are substantial transaction costs associated either with the hiring of new staff, or with the downsizing, transfer, or redeployment of existing staff. For this reason, these latter decisions, Dr. Bozzo says, can take up to a year to implement.[5]

(2) Automation and Mechanization

Another broad area of decisionmaking that is heavily affected by growth in mail processing volume involves capital expenditures on mail processing equipment. As Postal Service Witness Kingsley makes clear, decisions regarding the installation or upgrading of mail processing equipment are often driven by the need to accommodate growth in volume.[6] Actions taken to increase mail processing capacity can take a number of different forms. For example, existing equipment can be upgraded to enhance its capacity; new machines can be installed; and different types of MODS activities can be added to mail processing plants. As the record in this proceeding amply indicates, all of these changes have taken place since the filing of the last general postal rate case.

---

4. To accommodate a sudden increase in volume a supervisor can ask workers to defer time off, authorize extra overtime, monitor workers more closely to minimize unproductive downtime, or alter work practices in an effort to increase productivity.

5. USPS-T-15, p. 18.

6. See, e.g., USPS-T-10, pp. 12-15, 31-32.

The testimony of Ms. Kingsley describes numerous instances in which existing equipment has been upgraded. Just a few quotations are sufficient to provide a good sense of the nature of the Postal Service's activities in this area:

- "This past year all of the FSM 881s were retrofitted with OCRs that can read the addresses on flats."[7]
- "A total of 875 MLOCRs are deployed. No additional deployments are planned, but several enhancements since Docket R97-1 have been added, including a Grayscale Camera, a co-directory lookup, and a co-processor. The Grayscale Camera facilitates better image capture (256 shades of gray instead of just black and white) while the co-directory and co-processor augment the address matching process through redundancy. These enhancements have improved the overall encode rate of the MLOCR and reduced the amount of mail that obtains a barcode through Remote Bar Coding."[8]
- "The addition of the Mail Cartridge System (MCS) to the DBCSs is currently planned to commence near the end of FY 2001 into FY2002. The MCS will eliminate sweeping and second pass ledge loading for DPS processing."[9]
- "The SBPS Feed System has been a recent addition to the SPBS. These feed systems consolidate all the induction lines into a centralized network capable of transferring mail from all types of mail containers and transporting the contents on mechanized conveyors to the induction/keying consoles."[10]

Augmentation of an existing mail processing operation through the installation of additional equipment or the upgrade of existing machinery is also a frequent occurrence. Table 1 shows the average number of machines per site for a number of

---

7. USPS-T-10, p. 10.

8. USPS-T-10, p. 4.

9. USPS-T-10, p. 9.

10. USPS-T-10, p. 20.

important mechanized MODS activities for the period from 1993 through 1998. It shows substantial increases in a number of different areas.

Table 1

Multi-Machine Installations and Changes in Sorting Technology Over Time
Average Number of Machines per Site

MODS Group	Equipment Description	PCN	1993	1994	1995	1996	1997	1998
Metered Cancellations	Culling Machine	400000	1.436	1.381	1.398	1.418	1.487	1.454
Metered Cancellations	Cancelling/Facing Machine	401020	5.588	5.945	4.487	4.529	4.581	5.976
LSM	Letter Sorting Machine, Multi Pos	910000	7.012	7.727	7.698	7.484	5.284	3.603
FSM	Flat Sorter Machine	920000	5.631	8.614	9.546	9.621	9.693	11.329
SPBS	Parcel Sorting Machine	930000	3.714	2.640	1.463	1.576	1.638	1.932
SPBS	Small Parcel/Bundle Sorter System	930040	4.016	4.081	3.922	4.078	5.000	5.576
BCS	Bar Code Reader	950000	15.780	19.339	18.490	17.847	9.716	9.648
BCS	Small Bar Code Sorter (SBCS)	950010	7.323	7.411	7.400	7.885	9.878	17.029
BCS	Delivery Bar Code Sorters (DBCS)	950020	6.743	14.964	20.015	24.773	25.261	26.621
OCR	Reader, Optical Character	960000	2.950	3.440	3.574	3.352	4.000	4.638
OCR	Reader, Optical Character (OCR/CS)	960010	5.715	6.462	7.031	8.048	9.797	18.613

Notes and Sources:

1. Data from MPE93.txt - MPE98.txt, provided in USPS-LR-I-244.
2. Site-specific equipment counts are average over sites that have some equipment.
3. Appendix B presents average number of machines per site for all PCN codes.

Yet another way in which the Postal Service accommodates increases in mail volume is by establishing automated or mechanized processing activities in plants where these activities had previously not been present. These actions are manifested in changes in the mix of MODS activities present at a site. According to Dr. Bozzo's data, activity mix at a plant is highly dynamic. Table 2 summarizes changes over time in the mix of activities present in the processing plants in Dr. Bozzo's sample. An activity is regarded as "present" during a time period if positive values are reported for pieces handled.

Table 2

Changes Over Time in the
Percent of Sites Reporting Each Activity Mix in the Fourth Quarter of Each Year

Letter Sorting

Activity Present?									
OCR	**LSM**	**BCS**	**Manual Letters**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
yes	yes	yes	yes	85.98	87.23	87.23	81.31	39.25	9.35
yes	yes	yes	no					0.31	
yes	yes	no	yes	0.93					
yes	no	yes	yes	4.05	4.98	6.54	12.15	53.58	75.39
yes	no	yes	no						0.62
yes	no	no	yes	0.62	0.62	0.31	0.31		
no	yes	yes	yes	1.25	1.56	1.56	1.25	0.93	3.43
no	yes	no	yes	0.93	0.93	0.31			
no	no	yes	yes	2.49	1.87	2.18	2.80	3.74	8.72
no	no	yes	no				0.31	0.31	0.31
no	no	no	yes	0.93	0.62	0.62	0.62	0.62	0.62
no	no	no	no	2.80	2.18	1.25	1.25	1.25	1.56

Flat Sorting

Activity Present?							
FSM	**Manual Flats**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
yes	yes	75.08	75.70	75.70	74.77	74.77	76.95
yes	no				0.31	0.62	1.56
no	yes	22.12	22.12	23.05	23.68	23.05	19.94
no	no	2.80	2.18	1.25	1.25	1.56	1.56

Parcel Sorting

Activity Present?							
SPBS	**Manual Parcels**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
yes	yes	17.76	23.36	24.30	23.68	32.09	26.48
yes	no	4.05	6.85	7.48	11.21	9.03	13.08
no	yes	68.22	62.31	62.93	60.12	52.96	54.83
no	no	9.97	7.48	5.30	4.98	5.92	5.61

Priority Mail Sorting

Activity Present?	1993	1994	1995	1996	1997	1998
yes	75.39	78.50	80.37	80.06	81.31	75.08
no	24.61	21.50	19.63	19.94	18.69	24.92

Notes and Sources:

1. Data from reg9398.xls, provided in USPS-LR-I-107.
2. At most 16 combinations of activities are possible. Over the period of investigation, no more than 13 combinations are observed, and no more than 12 occur in any fourth quarter.

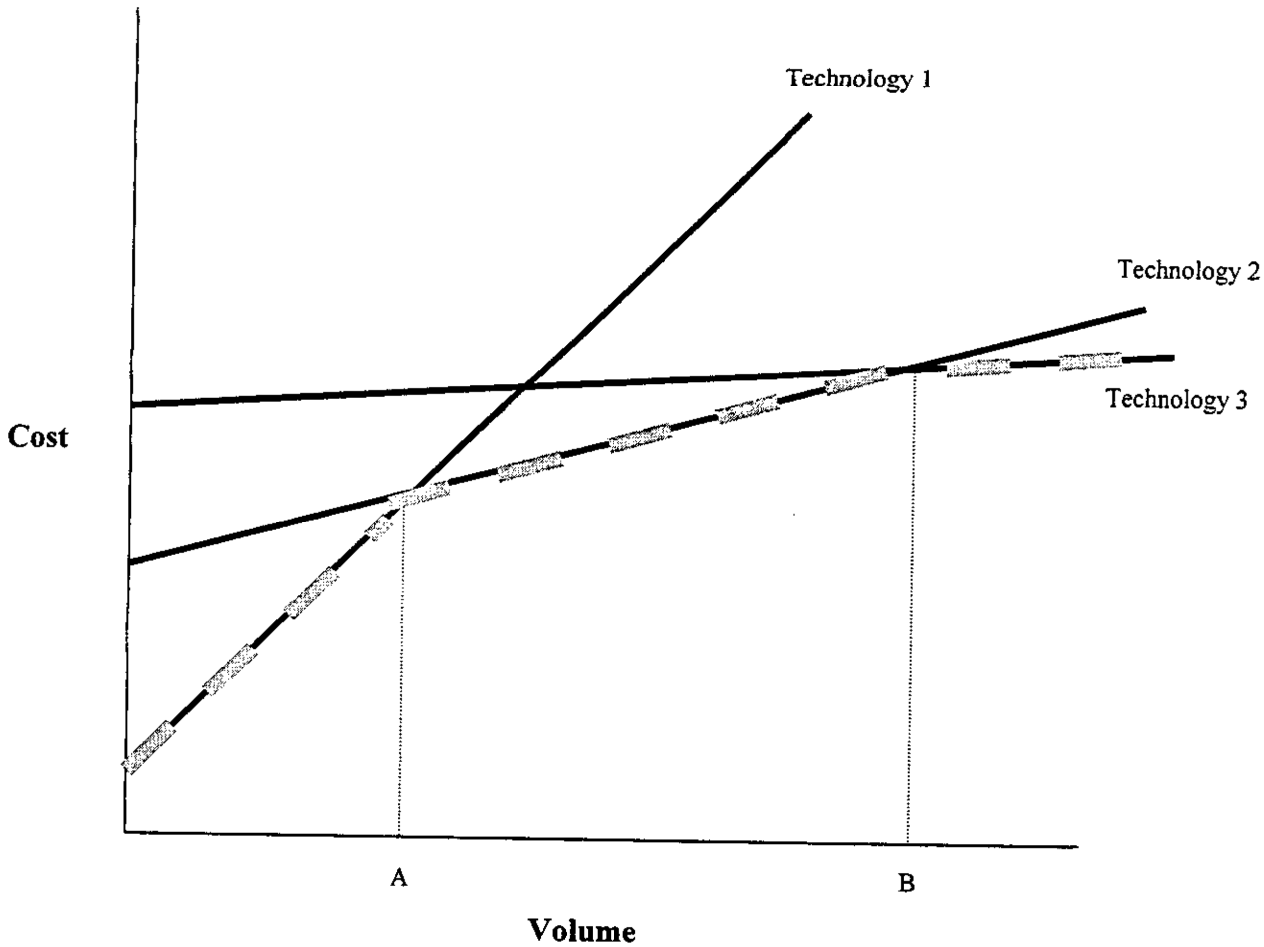
Four MODS activities are involved in the processing of letters: OCR, LSM, BCS, and Manual. These four activities yield 16 possible combinations of activities, of which only twelve are actually observed at the end of a year. The most noteworthy trend in letter processing is the gradual shutdown of letter processing machines. By the end of the period shown, these are quite rare. Apart from this change, trends are difficult to discern. A number of implausible combinations occur sporadically and at low frequencies. For example, instances appear in which a site reports activity for an optical character reader without a bar code sorter being present. Such combinations probably reflect data errors consisting of either failure to report numbers for activities present and in operation, or reporting numbers under the wrong codes. I will discuss the subject of data errors in more detail below.

Flats are processed either manually or with the help of sorting machinery. Over the period we see increasing reliance on mechanized processing, and a gradual decline in the proportion of sites relying entirely on manual processing. The small number of sites showing only mechanized processing may once again represent data errors.

The picture we see in connection with parcels mirrors that seen in connection with flats, but with a more marked trend over time. The number of sites relying solely on manual processing declines substantially over the period, and, obviously, there is a corresponding increase in the number of sites with mechanized processing.

A cost minimizing provider of mail processing services can be expected to alter systematically its procedures for processing mail in response to changes in mail volumes. The economic rationale behind such changes is shown graphically in Figure 1.

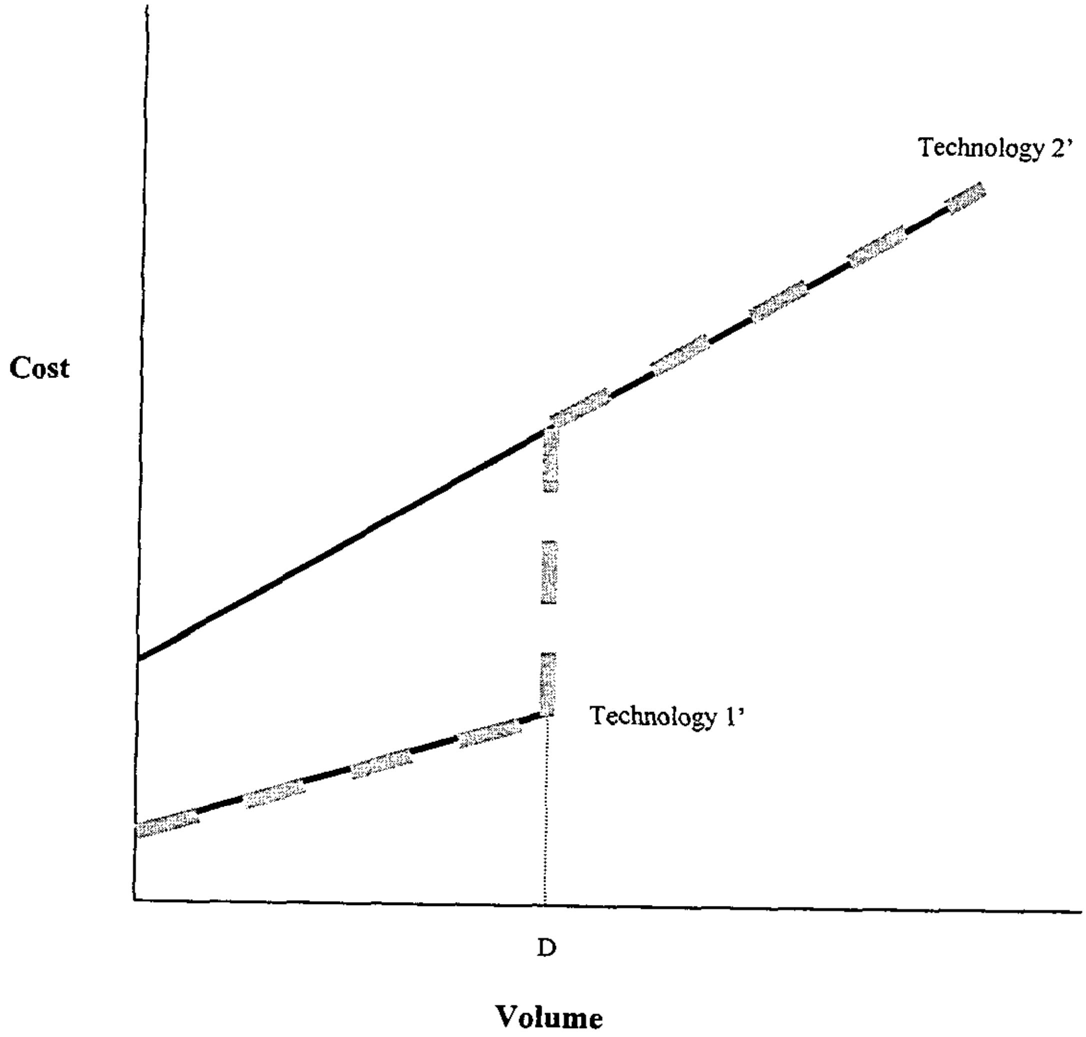
Figure 1: Technology Switching I



This figure depicts the costs of three different idealized mail processing technologies. In this example, a processing technology is characterized by a fixed setup cost that is independent of the volume of mail processed, and a variable component that reflects a constant per piece processing cost. Technology 1 has low setup costs, but high variable costs. Technology 3 is the reverse, with high fixed costs and lower variable costs. Technology 2 occupies an intermediate position. For mail volumes between 0 and A, technology 1 has a lower total cost than either of the other two technologies. For volumes falling in the range from A to B, technology 2 is the cost minimizing choice. For volumes above B, technology 3 is optimal. The final relationship between costs and volumes that results from these technology choices is shown by the dotted line.

The example shown in Figure 1 depicts a situation in which costs rise less than proportionately with volume, but this result is by no means guaranteed. Figure 2 depicts a different situation in which technology 1' has low costs, but can accommodate only volumes less than or equal to D . To accommodate volumes above D, one must switch to a different and higher cost technology that is labeled 2' in the figure. Such a situation could easily arise as the result of a reliance by technology 1' on a scarce factor of production. In this example, the final relationship between costs and volumes is shown by the dotted line, which depicts a situation in which there are diseconomies of scale.

Figure 2: Technology Switching II



In fact, the available data show a systematic relationship between the mix of activities present at a plant and the volume of mail that it processes. I have conducted a series of simple econometric analyses of this relationship for flats and for parcels. The results of these analyses are shown in Table 3.

Table 3

Automation in Response to Volume Growth

Dependent Variable = 1 if Facility has FSM Technology

	Logit	Conditional Logit Fixed Effects
ln(TPH)	5.842	7.407
	(0.241)	(1.601)
Pseudo R2	0.627	
Sample	4843	168

Dependent Variable = 1 if Facility has SPBS Technology

	Logit	Conditional Logit Fixed Effects
ln(TPH)	3.240	3.347
	(0.112)	(0.330)
Pseudo R2	0.800	
Sample	3912	691

Notes and Sources:
1. Data from reg9398.xls, provided in USPS-LR-I-107.
2. Models estimated using Maximum Likelihood. Standard errors shown in parentheses.
3. The logit model is estimated on the full analysis sample and the probability of having a technology is a function of ln(TPH) and a constant.
4. The conditional logit uses only those panels in which technology switching occurs (i.e. panels where the dependent variable is neither all zeros or all ones).

The top panel of Table 3 shows results obtained by estimating binary logit models in which the dependent variable indicates whether or not flat sorting machinery is present at the site in the time period in question, and the independent variable is the natural log of the number of piece handlings in flats-related MODS pools. The first column shows the results obtained by fitting a simple binary logit model. The second column shows the results obtained in a conditional logit model that includes site-specific fixed effects terms. The inclusion of fixed effects terms essentially sweeps cross-sectional comparisons out of the data, and relates the installation of flat sorting machinery at a site to trends in that site's flats volume. Both models show a highly significant relationship between volume and the decision to mechanize.

The bottom panel of Table 3 shows comparable results for parcel sorting. Here too, we find in both models a highly significant relationship between volume and the decision to install SPBS equipment.

The findings shown in Table 3 result from the expenditure of a great deal of econometric firepower to answer what is really a fairly simple and obvious question. It should come as no surprise to anyone involved in this proceeding that mechanization decisions are closely related to mail volume, and that mechanization is one of the important ways in which the Postal Service accommodates growth in mail volume.

(3) Construction, Expansion, or Modification of Mail Processing Plants

In his direct testimony, Mr. Degen dismisses a comment I offered during R97-1 in response to a question by Chairman Gleiman regarding the possibility that one of the ways in which the Postal Service might respond to growth in volume would be by building new processing plants.[11] Mr. Degen argues that this would not be a "rational response," because "the additional workload caused by an additional piece is

11. USPS-T-16, p. 17.

necessarily dispersed throughout the network."[12] The testimony offered by other Postal Service witnesses appears to contradict Mr. Degen's assertion.

Ms. Kingsley provides a detailed description of the Postal Service's approach to space planning in which she identifies the acquisition of new space as a measure of last resort:

> The ideal configuration for distribution is centralized distribution within an existing plant, utilizing existing plant space to the fullest. When existing plant space is inadequate, the second option is to decentralize some processing operations into existing postal space outside of the plant. The third option is to change mail flows to reduce workload and thus space required for the workload. New processing space is obtained only as a last resort.[13]

Ms. Kingsley goes on to describe in more detail the ways in which the Postal Service alters or decentralizes its operations in an effort to maintain operations within its existing network of facilities. She concludes this discussion by flatly stating: "When these options still do not produce enough space, new space must be obtained."[14]

Dr. Bozzo has testified that his analysis includes five new facilities that came on line during the 6 year period covered by his data, plus another eight existing facilities that were added to the MODS system, suggesting a change in the scale of those facilities. He states his understanding that "additions of facilities to MODS are most commonly related to expansions of the facilities to include automated sorting

12. USPS-T-16, p. 17.

13. USPS-T-10, p. 33.

14. USPS-T-10, p. 33.

equipment."[15] Thus, according to Dr. Bozzo, either five or thirteen new facilities were added to the system, depending upon how one defines "new."

Even Mr. Degen describes the construction of new processing plants by the Postal Service to accommodate changes in volume:

> This is not to say that the Postal Service network is static. It has evolved over time as the nation has grown and its population distribution has changed, and as mail processing technology has progressed. It continues to evolve, albeit slowly. For example, between FY1993 and FY1996 (the R94-1 and R97-1 Base Years) the Postal Service added two new 3-digit zip codes, in addition to the 912 in use previously. During this same period it added five new mail processing plants – averaging just over one plant a year – each built to handle a portion of an existing plant's service territory. During this same period it also replaced 20 existing plants with new ones, and expanded or rehabilitated another three.[16]

Mr. Degen is correct in emphasizing the interconnectedness of the Postal Service's network, and the constraints that places on the ability of the Postal Service to build and integrate new plants. However, the record demonstrates clearly that the Postal Service has been successful in overcoming those constraints. Mr. Degen's assertion that the construction of new plants plays no part in the response of the Postal Service to an increase in mail volume is simply wrong.

CRITICISMS OF DR. BOZZO'S ANALYSIS

(1) Overview

Dr. Bozzo presents the results of a statistical analysis aimed at measuring the extent to which mail processing labor costs vary with volume. Historically, the Commission has held that mail processing labor costs are 100 percent volume variable.

---

15. Response of Bozzo to UPS/USPS-T15-18, Tr. 15/6389.

16. USPS-T-16, pp. 14-15.

In other words, the treatment of these costs has reflected the Commission's view that they vary in direct proportion to changes in the volume of mail being processed. In R97-1, the Postal Service introduced a new econometric study purporting to show that the volume variability of mail processing costs was well below 100 percent. This study was heavily criticized and was ultimately rejected by the Commission in that case. Dr. Bozzo's updated version of Professor Bradley's R97-1 study again finds that the volume variability of mail processing labor costs is well below 100 percent for many cost pools, although Dr. Bozzo's variabilities are generally higher than those found by Professor Bradley.

Dr. Bozzo begins his analysis by discussing the Commission's and intervenors' criticisms of the R97-1 study. He discusses the concerns expressed in R97-1 about the appropriate "length of run" for such a study, and about selection bias due to Dr. Bradley's use of ad hoc sample selection criteria. Dr. Bozzo's numerous changes to Dr. Bradley's model specifications, data "scrubbing" procedures, and data sources reflect Dr. Bozzo's efforts to respond to criticisms of the original study. Nonetheless, Dr. Bozzo has in large part accepted Dr. Bradley's original conceptual and empirical framework.

Following Dr. Bradley's R97-1 approach, Dr. Bozzo specifies separate translog regression equations for each of a number of MODS cost pools. Once again, he takes labor hours rather than costs as the dependent variable for his equations, and "piece handlings" rather than mail volume as his cost driver.[17] He retains the time trend and

17. Dr. Bozzo has selected a cost driver that is slightly different from that used by Dr. Bradley. For a number of the activities he examines, he uses Total Pieces Fed ("TPF") in place of the Total Piece Handlings ("TPH") measure used by Dr. Bradley. The latter measure counts the number of mail pieces successfully

manual ratio variables included in Dr. Bradley's original specification. To these he adds a number of new regressors: a facility-level measure of installed capital; a measure of the number of delivery points served by the facility; and a measure of the wages paid to mail processing employees. Dr. Bozzo's study is also much narrower in scope than Dr. Bradley's R97-1 investigation. In contrast to the previous study, Dr. Bozzo's testimony presents variability results only for ten direct MODS activities. No results are presented for MODS allied activities, or for BMC mail processing activities.

Dr. Bozzo finds volume variabilities to be significantly lower than 100%, suggesting that mail sortation exhibits increasing returns to scale. His elasticity estimates are lowest for the manual operations, Manual Parcels, Manual Flats, and Priority. They are highest for the automated/mechanized operations, Optical Character Reader ("OCR"), Letter Sorting Machine ("LSM"), Bar Code Sorter ("BCS"), Flat Sorting Machines ("FSM"), and Small Package and Bundle Sorter ("SPBS"). Curiously, Dr. Bozzo's variabilities indicate that manual operations exhibit greater economies of scale than automated operations.

Unfortunately, Dr. Bozzo dismisses many serious concerns raised with respect to Dr. Bradley's R97-1 study. Despite Dr. Bozzo's vigorous defense of the quality of the MODS data, the evidence presented in his testimony again provides ample reason for continuing concern about the errors that infect the data and the effects of those errors on variability estimates. Moreover, Dr. Bozzo continues to rely on piece handlings as a

---

sorted, while the former includes the total number of pieces fed into the machine. Thus, the two measures differ by the number of pieces rejected by the machine.

cost driver, despite the concerns raised in R97-1 regarding the ability of this measure to serve as a proxy for volume. As I demonstrate below, these concerns are well founded.

In addition, Dr. Bozzo continues to analyze each activity in isolation, largely ignoring the fact that they are housed in the same facilities, operated in many instances by the same personnel, and in many cases serve as actual or potential substitutes for one another. One of the arguments advanced by Dr. Bozzo in support of his decision to base his analysis on each MODS cost pool in isolation is that "the cost pools can be defined such that they represent distinct (intermediate) production processes with separate, identifiable, and relatively homogenous inputs (e.g., labor services) and outputs (processed pieces, or TPF)."[18] He asserts, in effect, that each of the activities he has defined can be studied in complete isolation, ignoring entirely its interactions with other activities carried out within the same mail processing plant. He offers no evidence in support of this assertion. In fact, it is inconsistent with the descriptions of mail processing operations provided by the Postal Service's operational witnesses.

Mr. Degen and Ms. Kingsley both testify that staffing levels in opening units are driven by the need to get mail into downstream operations in order to carry out necessary processing within the available time window.[19] This example demonstrates one particular way in which different MODS activities interact and influence one another. It is not difficult to find other such examples.

Many facilities possess parallel processing operations for particular mail streams. Letters, flats, and parcels can all be sorted manually, or with the aid of automated

18. USPS-T-15, p. 43.

19. USPS-T-16, p. 47; USPS-T-10, pp. 28-32.

equipment. It seems highly unlikely that the operations of these parallel processing activities would not be affected by the way in which mail is allocated between them. Mr. Degen describes the highly dynamic way in which these allocation decisions are made.[20] Mail can be sorted manually because that is the only type of sortation carried out within the plant, because the physical characteristics of the mail do not lend themselves to mechanized processing, because the automated equipment is being used to full capacity, or because a batch of mail has arrived too late in the shift to accommodate the setup times needed for mechanized processing. It is reasonable to expect substantial differences in the operation of the manual sorting activity depending upon which of these reasons motivates its use.

Many of the mail streams within a plant undergo sequential processing steps. The layout, staffing, and organization of these steps must be determined in such a way as to provide for the smooth and efficient flow of mail through the entire system. Uncertainties in when and how much mail arrives at the plant will create at times temporary inventories of unprocessed mail. Does it make sense to process mail immediately, or to hold it until enough accumulates to permit efficient batch processing? This decision depends upon the total volume of mail to be processed, and the capacities and processing rates of all of the stages in the processing stream.

It is also reasonable to expect interactions between activities simply because of the fact that they are housed in the same plant and rely upon a shared workforce. In a crowded facility, a high volume of mail in one activity could create congestion that affects the operation of otherwise unrelated activities. A drop in volume for one mail

20. USPS-T-16, pp. 18-19.

stream could create a temporary labor surplus in the plant that could alter the mix of automated and manual processing for a different mail stream.

For all of these reasons, I would expect the different sorting activities within a plant to interact in numerous ways that Dr. Bozzo's study simply ignores.

Finally, although Dr. Bozzo has attempted to interpret his cost equations as labor demand functions, the microeconomic foundations for his analysis remain incomplete and confused. Dr. Bozzo's analysis treats as "control variables" many aspects of mail processing that in fact are under the control of the Postal Service and that can be expected to change in response to a shift in volume. In many cases this treatment is implicit. In some cases it is stated explicitly, and then generally defended with an assertion that the changes in question occur over too long of a time to be relevant. Rarely does he provide evidence to support such assertions. Often the available evidence contradicts them.

A few examples suffice to make the point:

- His analysis includes as an explanatory variable an index of the amount of capital at a facility. His variability estimates are thus calculated holding capital investment constant, whereas the amount of capital investment in a particular plant is influenced by the volume of mail handled by that plant.
- His analysis is carried out conditional on a MODS activity being present at a facility. The decision to install a new activity at a facility occurs outside of his analytical framework, even though that decision is often influenced by the amount of volume which the plant handles.
- In a similar way, his analysis is carried out conditional on the facility itself being present. Thus, construction of new facilities occurs outside of and is ignored by his analysis.

For all of these reasons, I remain as skeptical of Dr. Bozzo's results as I was of Dr. Bradley's R97-1 results. However, while my earlier criticisms of Dr. Bradley's work were largely conceptual and methodological, I am now able to present empirical results documenting the validity of my concerns and the infirmities in Dr. Bozzo's approach.

(2) Dr. Bozzo Has Not Allayed Concerns About MODS Data Quality.

Dr. Bozzo admits that there exist large errors in the MODS data, particularly with those relating to operations. However, he dismisses the concerns expressed in R97-1 over data quality by arguing first that the noise in the MODS data are acceptable relative to other survey data, and second that, in any case, the effects of measurement errors are attenuated by the inclusion of site-specific fixed effects in the estimation. I address each of these points in turn.

Dr. Bozzo argues that overall data quality is acceptable by citing a survey of the statistics literature that describes data with errors of one to ten percent as "routine data," and data with a few percent errors as "average quality" data.[21] He explains that "[e]xcluding the manual parcels and manual Priority Mail operations, . . . [his threshold and productivity scrubs] identify between 0.6 percent and 7.1 percent of the raw MODS observations as erroneous."[22] However, as he implies, a significantly higher proportion of observations on manual operations are identified as erroneous by his threshold and productivity scrubs. In particular, as Table 4 shows, 13 percent of the manual flats observations, 22 percent of the manual parcels observations, and 15 percent of the Priority Mail observations in Dr. Bozzo's "non-missing" samples are erroneous. Moreover, these numbers actually understate the degree of error because they do not count as erroneous those observations with erroneously recorded zero piece

21. USPS-T-15, p. 106.

22. USPS-T-15, p. 106.

handlings.[23] Inspection of Dr. Bozzo's data suggests that the problem of falsely recorded zeros is widespread for a number of the MODS activities he examines.

Table 4
MODS Data Quality

MODS Group	Non-Missing	Threshold	Threshold and Productivity	% of Observations Exhibiting Gross Data Errors
BCS	6885	6883	6780	1.53%
OCR	6644	6639	6495	2.24%
FSM	5442	5442	5424	0.33%
LSM	5156	5150	5127	0.56%
Manual Flats	6914	6914	6033	12.74%
Manual Letters	6914	6914	6667	3.57%
Manual Parcels	5835	5625	4545	22.11%
Priority	5717	5644	4864	14.92%
SBPS	2244	2239	2213	1.38%
Metered Cancellations	6746	6718	6579	2.48%

Notes and Sources:

1. Data from USPS-T-15, p. 107.
2. Because Dr. Bozzo records both true missing values and bad data as zeros, these data underestimate the percent of gross errors.

(a) Data Problems in the Manual Parcels Series

A careful look at the manual parcels series for piece handlings suggests the presence of serious data errors. In particular, this series appears to exhibit frequent gaps in reporting. I define a "gap" in reporting as a pattern in the data series in which a period with zero piece handlings for a particular site is both preceded by and followed by positive entries. Consider for example Site # 6, which shows positive piece handlings for Manual Parcels from the first quarter of 1993 to the first quarter of 1994, zero piece handlings from the second quarter of 1994 to the second quarter of 1995,

23. In Dr. Bozzo's dataset, a zero can in fact signify either a true zero -- a situation in which labor hours or piece handlings were equal to zero -- or a missing value. Missing values correspond to situations in which the activity in question was present and in operation but, for some unknown reason, the data were not entered into the system.

and then positive piece handlings again. Taken at face value, these data would have the unrealistic implication that Site #6 did not process any mail through Manual Parcels for one calendar year.

In response to interrogatory UPS/USPS-T-15-13, Dr. Bozzo stated that MODS data for Manual Parcels are manually logged. Tr. 15/6387. The logging process is labor intensive, and as a result, it appears that data are often simply not entered into the system. For Site #6 in particular, Dr. Bozzo indicates that the gaps in the data series correspond to periods where data for the SPBS and Manual Parcels MODS activities were commingled and reported together as data for the SPBS MODS group. This suggests that both the SPBS and the Manual Parcels data series are individually noisy, and that the distinction between the two pools cannot be relied upon. Combining them into a single Parcels category is a way of dealing with the reporting error problem.

As shown in Table 5, a systematic search for gaps in the manual parcels series revealed a total of 46 gaps, with an average gap length of five quarters, suggesting a total of 230 observations with gross data error. In this same series, Dr. Bozzo's threshold and productivity scrubs detect the presence of another 1,290 observations with data errors. Moreover, given the nature of the manual data entry problems cited by Dr. Bozzo, it is possible that these series may contain other errors that are undetectable by the simple editing screens he uses.

Table 5

Intermittent Gaps in TPH

MODS Group	Number of Gaps	Average Gap Length
BCS	2	8
OCR	6	2
FSM	6	5
LSM	15	2
Manual Flats	4	2
Manual Letters	5	2
Manual Parcels	46	5
Priority	96	3
SPBS	6	6

Notes and Sources:

1. Data are from reg9398.xls, provided in USPS-LR-I-107.
2. A gap in the TPH series is defined as a series of non-positive values both preceded and followed by positive values.

(b) Data Problems in the Priority Mail Series

A careful look at the Priority Mail series for piece handlings also suggests the presence of serious data errors. In response to UPS/USPS-T-15-13, Dr. Bozzo stated that MODS data for Priority Mail, like Manual Parcels, are manually logged.[24] For Site #6, he explains that a gap in the Priority Mail data series reflects "a period prior to the filling of a related in-plant support position."[25]

A systematic search for gaps in this series revealed 96 gaps (see Table 5, above), with an average gap length of three quarters, suggesting a total of 288 observations with data errors. In addition, Dr. Bozzo's threshold and productivity scrubs detect the presence of another 853 observations with data error. Furthermore, as with

24. Tr. 15/6387.

25. Tr. 15/6387-88.

Manual Parcels, these data series are likely to have other errors that are undetectable by simple screens.

(c) Implications for Econometric Results

Measurement error in an explanatory variable of a linear regression model renders the estimator inconsistent and frequently biases coefficient estimates towards zero. Dr. Bozzo himself explains that the likely reason his variabilities for SPBS, Manual Parcels, and Priority Mail are considerably higher than those reported by Dr. Bradley in R97-1 is that the newer results reflect the use of tighter selection criteria to eliminate unusable observations. It is clear, however, that errors remain in Dr. Bozzo's data, despite his use of tighter selection criteria. This fact suggests that the relatively low volume variabilities he reports for the manual operations may be attributable to this remaining measurement error rather than to true economies of scale.

(d) Dr. Bozzo's Fixed Effects Estimator Does Not Solve the Data Quality Problems.

Although Dr. Bozzo concedes that the manual piece handling data series (at least for parcels) continue to be subject to measurement error even after his scrubs, he argues that the nature of the measurement error is such that it is not of concern. In particular, he asserts that the measurement error is likely to vary systematically across sites,[26] and he claims that therefore the inclusion of site-specific effects in the panel fixed effects model attenuates this errors-in-variables problem. Dr. Bozzo says, ". . . models such as fixed effects . . . are completely effective at controlling for omitted factors associated with sites and/or time periods, when panel data are available."[27]

26. USPS-T-15, p. 85.

27. USPS-T-15, p. 104.

While Dr. Bozzo's reasoning may be true for site-specific errors that are fixed over time, there is good reason to believe that, in fact, the site-specific errors change over time.

To understand why site-specific errors in data entry may change over time, consider again the case of parcel sorting. One type of error found in the data is the inadvertent commingling of Manual Parcel piece handlings and the SPBS piece handlings data. This type of error is possible only if the facility operates an SPBS sorting machine. In fact, 26 percent of sites acquired SPBS technology at some point after the start of the analysis sample. Certainly, for these sites any site-specific error that commingles data for SPBS and Manual Parcels begins only after the adoption of the mechanized technology. More generally, it is plausible to expect that at a given facility the burden of manually logging data increases over time with mail volume.

The piece counts for many manual activities are derived by weighing mail and applying national conversion factors to convert these weights into item counts. As Dr. Bozzo notes, local variations in weight per piece would cause this estimation process to yield erroneous results.[28] He notes that weight per piece will vary from site to site, but he ignores the fact that it may also vary over time. A trend over time in weight per piece will impart a false trend in the estimates of piece handlings. That false trend is capable of distorting Dr. Bozzo's volume variability estimates.

When site-specific measurement error changes over time, fixed effects estimation cannot solve the errors-in-variables problem. In such cases, measurement error destroys the favorable statistical properties of all of the estimators considered by Dr. Bozzo. In particular, the fixed effects, the random effects, and the pooled estimators

28. USPS-T-15, p. 86.

will all be inconsistent. Moreover, the pattern of change in Manual Parcels and SPBS from Dr. Bradley's study in R97-1 to Dr. Bozzo's study as well as my own calculations suggest that the estimated variabilities are likely to be biased downward.

(3) Dr. Bozzo Erroneously Continues to Rely on Piece Handlings as a Proxy for True Volume.

Postal ratemaking procedures require estimates of the elasticities of various costs with respect to subclass-specific volumes of mail delivered. Because the number of subclasses is very large, direct estimation of these cost elasticities is often not feasible. As a result, most Postal Service costing studies rely on the cost driver/ distribution key approach in which the required elasticities are estimated in a two-step process. The first step in this process involves estimating the elasticity of the costs in question with respect to a "cost-driver." In the second step, the shares of the cost driver accounted for by each subclass are combined with the estimated elasticity to arrive at the required subclass-specific cost elasticity.

There are a number of assumptions implicit in the cost driver/distribution key approach. The first is that the cost driver captures the essential cost-causing characteristics of the various subclasses. For example, in the case of purchased highway transportation, the cost driver is the number of cubic foot miles of mail carried. The greater the number of cubic foot miles carried, the greater are purchased highway transportation costs. To measure the contribution of a particular subclass to purchased highway transportation costs, all one need know is the number of cubic foot miles associated with that subclass.

The second key assumption is that the cost driver changes in direct proportion to the volume of mail carried. This assumption is referred to by Dr. Bozzo as the "proportionality" assumption.[29] Pursuing further the example cited above, this assumption requires that if the volume of a particular subclass of mail were to double, the number of cubic foot miles associated with it must also double.

In R97-1, I criticized Dr. Bradley for his reliance on "piece-handlings" as a cost driver in his study of mail processing labor costs. At that time, I noted that what is required for ratemaking purposes is the elasticity of mail processing costs with respect to ***volume***, and that piece handlings is a measure that is conceptually distinct from volume. Volume is measured by the number of pieces of mail tendered for delivery, or, alternatively, by the number of pieces of mail delivered (these two should hopefully be equal). A piece handling, however, is generated each time a piece of mail at a specific site is processed in a particular sorting activity. Thus, in the vast majority of cases, a single piece of mail will generate many piece handlings as it makes its way from its origin to its destination. The proportionality assumption requires that, on average within a subclass, each additional piece of mail generates the same number of additional piece-handlings. In R97-1, I pointed out that Dr. Bradley had presented no empirical evidence regarding the validity of this crucial assumption.

Dr. Bozzo's study is equally silent on the subject. In his written testimony, Dr. Bozzo discusses and dismisses my R97-1 criticism on this point. In the course of this discussion he offers a number of arguments, none of which is fully convincing.

---

29. USPS-T-15, p. 53.

The first of these arguments is essentially a "it's not my problem" argument. He correctly notes that even if it were the case that piece handlings and volume were not proportional, this would not necessarily mean that the elasticity of labor hours with respect to piece handlings had been measured incorrectly.[30] Although true, this observation is disingenuous. What is required for ratemaking is an estimate not of a piece handling variability, but rather of a volume variability.

The second of these arguments is that the proportionality assumption simplifies the calculation of the required subclass-specific volume variabilities. This argument is equally true and equally disingenuous. It would be even simpler for the Postal Service to dispense with the whole cost driver/distribution key approach and retain the traditional finding that mail processing labor costs are 100 percent volume variable. The Postal Service, however, apparently believes this finding to be untrue, and has presented Dr. Bozzo's much more complicated study because it believes its results to be closer to the truth. This decision demonstrates an obvious principle: simplicity alone is not enough to justify a critical assumption; in addition, the assumption must be true.

The third argument offered in support of the proportionality assumption rests upon the multi-year nature of national deployments of new equipment and adoption of major operational changes.[31] It may be inaccurate to characterize Dr. Bozzo's statements in this context as an argument, since his reasoning is not fully set forth. He seems to suggest that because major deployments of new equipment take time, their effects on the relationship between volume and piece handlings should be disregarded.

30. USPS-T-15, p. 52.

31. USPS-T-15, p. 55.

If this is his argument, I find it unconvincing. I would expect the installation of major new pieces of equipment at a particular plant to have potentially substantial effects on mail processing operations at that site. Many of the deployments to which he refers involve dozens or hundreds of such sites.[32] Over the span of a few years such deployments could have drastic effects. Ultimately, the question of whether or not these effects should be disregarded is one that should be answered empirically.

I have conducted an empirical investigation of the relationship between the *volume of mail processed at a plant and the number of piece handlings at that plant.* My results show that an increase in volume causes a disproportionate increase in piece handlings. Those results validate the criticisms I made in R97-1. Thus, my criticisms in R97-1 apply equally to Dr. Bozzo's current study.

There are at least two obstacles to estimating the elasticity of cost with respect to volume at the facility level. The first is that true volume can only be measured at the system level, not at the facility level. There is, however, a volume-like measure available at the facility level: first handling pieces ("FHP"). First handling pieces counts the unique number of mail pieces entering the facility. Thus, FHP is a conceptually attractive measure of volume at the facility level. The second problem, however, is that FHP is known to be a very noisy measure of volume. FHP is not a physical count of the number of mail pieces entering a facility; rather, it is a weight-imputed count. Facilities use national weight conversion factors to convert weights to pieces, by shape. Because of the known pitfalls of using poor quality data as control variables, there is general agreement that FHP ought not be used as the measure of volume.

32. ANM/USPS-T10-34, Tr. 5/1584.

I investigated the relationship between FHP and piece handlings ("TPH/F") using the data provided by Dr. Bozzo in USPS-LR-I-186. These data, like the data on TPH/F, are presented by site and by quarter, for each of the MODS groups. I merge the FHP data with the original data provided by Dr. Bozzo in his workpapers and modify the sample selection criteria to include checks on FHP. In particular, I include an observation in the analysis sample if, along with Dr. Bozzo's other sample selection criteria, FHP is greater than zero and there are still a minimum of eight usable observations for the site to which the observation belongs.

To avoid the pitfalls of errors-in-variables bias, I estimate the elasticity of TPH/F with respect to FHP using the reverse regression of FHP on TPH/F and other variables, running separate regressions for each of eight MODS groups of interest and also for each of two shape categories. The reverse regression isolates the mismeasured variable FHP as the dependent variable. It is a well known result that measurement error in the dependent variable is absorbed in the error term and can be ignored.[33] The elasticity of interest, then, is computed as the reciprocal of the estimated marginal effect of ln(THP/F) on ln(FHP).

(a) MODS Pool-Level Analysis

In keeping with Dr. Bozzo's MODS-level analysis, I first estimate a MODS-level, log-log specification of the reverse regression, which includes as regressors the level and square of TPH/F, possible deliveries (DPT) as a measure of local network effects,

33. See William H. Greene, Econometric Analysis (2d ed. 1993), p. 281.

and a set of eighteen time dummies, one for each quarter excluding the second quarter of 1994. For each MODS group, the full estimating equation is:

$$\ln(FHP_{it}) = \alpha_i + \beta_1 \ln(THP / F_{it}) + \beta_2 \ln(TPH / F_{it})^2 + \beta_3 \ln(DPT_{it}) + \beta_4 TimeDummies_{it} + u_{it}$$

where the subscripts *i* and *t* index the site and time period, respectively. To investigate the importance of DPT and the time dummies, I also estimate a restricted model. The restricted estimating equation is:

$$\ln(FHP_{it}) = \alpha_i + \beta_1 \ln(THP / F_{it}) + \beta_2 \ln(TPH / F_{it})^2 + u_{it}.$$

Following Dr. Bozzo's approach, I estimate the parameters of both equations using panel fixed effects estimation with the modified Baltagi and Li's generalized least squares procedure, to allow the regression disturbances to exhibit first-order serial correlation.

Table 6 presents the estimated elasticities of TPH with respect to FHP, instead of the individual regression coefficients, for both specifications. The full set of regression coefficients is presented in Appendix C. Because of the problem of commingling of data between the manual parcels and SPBS pools, I combine them into a single composite parcels pool. F-tests uniformly find in favor of the full specification, indicating that local network characteristics and time specific effects are important determinants of the relationship between FHP and TPH. Moreover, the estimated marginal effects resoundingly reject the proportionality assumption. In every case, the estimated elasticity of TPH with respect to FHP is greater than one, and often by a very large margin.

Table 6

Estimates of the Elasticity of TPH with respect to FHP
Imputed from the Reverse Regression of FPH on TPH - MODS Level Analysis

MODS Group	Specification	AR1-Fixed Effects	Ho: Proportionality	F-Statistic	Pvalue
OCR	Full	1.597	reject	20.304	0.000
		(0.043)			
	Partial	1.386	reject		
		(0.030)			
LSM	Full	1.069	reject	6.446	0.000
		(0.030)			
	Partial	0.956	reject		
		(0.018)			
BCS	Full	2.091	reject	25.748	0.000
		(0.058)			
	Partial	1.560	reject		
		(0.027)			
Manual Letters	Full	1.229	reject	14.606	0.000
		(0.012)			
	Partial	1.174	reject		
		(0.010)			
FSM	Full	1.544	reject	56.969	0.000
		(0.027)			
	Partial	1.138	reject		
		(0.012)			
Manual Flats	Full	1.010	reject	9.000	0.000
		(0.008)			
	Partial	0.969	reject		
		(0.006)			
Parcels	Full	1.795	reject	7.692	0.000
		(0.099)			
	Partial	1.786	reject		
		(0.088)			
Priority	Full	1.013	reject	1.697	0.030
		(0.003)			
	Partial	1.010	reject		
		(0.002)			

Notes and Sources:

1. Data from fhp9398.xls and reg9398.xls, provided in USPS-LR-I-186 and USPS-LR-I-107, respectively.
2. Standard errors shown in parentheses.
3. Estimated effects are significantly different from zero and one at or below the 1% significance level.
4. Partial specification regresses ln(FHP) on ln(TPH) and the square of ln(TPH).
5. Full specification regresses ln(FHP) on ln(TPH), the square of ln(TPH), ln(DPT), and a set of 18 time dummies (one for each quarter, excluding the first one).
6. F-Tests (statistics and pvalues shown in table) uniformly favor the full specification.
7. Appendix C shows the full set of estimation results.

(b) Shapes-Level Analysis

Because FHP is calculated from mail weight using national weight conversion factors by shape, it may well be that the data are meaningful only at the shapes level, not at the MODS level. Thus, I estimate a shapes-level log-log specification of the reverse regression described above for letters and flats. The shapes-level analysis requires aggregation of the OCR, LSM, BCS, and Manual Letters MODS groups into Letters and the aggregation of FSM and Manual Flats into Flats.

Table 7 presents the estimated elasticities of TPH with respect to FHP, instead of the individual regression coefficients, for both specifications. The full set of regression coefficients are presented in Appendix D. As with the MODS-level analysis, F-tests uniformly find in favor of the full specification, indicating that local network characteristics and time-specific effects are important determinants of the relationship between FHP and TPH. Furthermore, the estimated marginal effects resoundingly reject the proportionality assumption. Aside from Priority, the point estimates indicate that total piece handlings increase considerably faster than first piece handlings. Elasticities of TPH with respect to FHP range from just over one for Priority to a high of 2.06 for letters.

Table 7

Estimates of the Elasticity of TPH with respect to FHP
Imputed from the Reverse Regression of FPH on TPH - Shapes Level Analysis

Shape	Specification	AR1-Fixed Effects	Ho: Proportionality	F-Statistic	Pvalue
Letters	**Full**	2.062	reject	14.148	0.000
		(0.061)			
	Partial	1.689	reject		
		(0.034)			
Flats	**Full**	1.318	reject	46.449	0.000
		(0.015)			
	Partial	1.078	reject		
		(0.009)			
Parcels	**Full**	1.795	reject	7.691	0.000
		(0.099)			
	Partial	1.786	reject		
		(0.088)			
Priority	**Full**	1.013	reject	1.697	0.030
		(0.003)			
	Partial	1.010	reject		
		(0.002)			

Notes and Sources:

1. Data from fhp9398.xls and reg9398.xls, provided in USPS-LR-I-186 and USPS-LR-I-107, respectively.
2. Standard error shown in parentheses.
3. Estimated effects are significantly different from zero and one at or below the 1% significance level.
4. Partial specification regresses ln(FHP) on ln(TPH) and the square of ln(TPH).
5. Full specification regresses ln(FHP) on ln(TPH), the square of ln(TPH), ln(DPT), and a set of 18 time dummies (one for each quarter, excluding the first one).
6. F-Tests (statistics and pvalues shown in table) uniformly favor the full specification.
7. Appendix D shows the full set of estimation results for Letters, Flats, and Parcels. Appendix C shows the full set of estimation results for Priority.

(4) Dr. Bozzo's Results Have Unreasonable Implications for the Efficiency of Manual Operations.

Dr. Bozzo's variabilities for manual operations are uniformly smaller than his variabilities for automated or mechanized operations, implying that manual operations exhibit economies of scale while mechanized or automated operations do not. This relationship implies that as volumes grow in both activities, costs grow less rapidly in manual activities, and thus that manual processing eventually becomes less expensive on a per piece basis than mechanized and automated activities. Such a result would be counter-intuitive. The Postal Service has pursued automation as a cost saving strategy. Since the move to mechanized or automated operations entails significant capital expenditures, it makes sense only if these capital costs are offset by lower per piece processing costs.

The anomaly caused by the presence of economies of scale in manual processing could be more apparent than real. It is possible that the per piece cost of processing a piece manually is substantially higher than the corresponding cost of mechanized processing, and that the per piece cost of manual processing declines slowly with growth in volume. One might, in such a case, never actually encounter a situation in which manual processing is actually the less costly option.

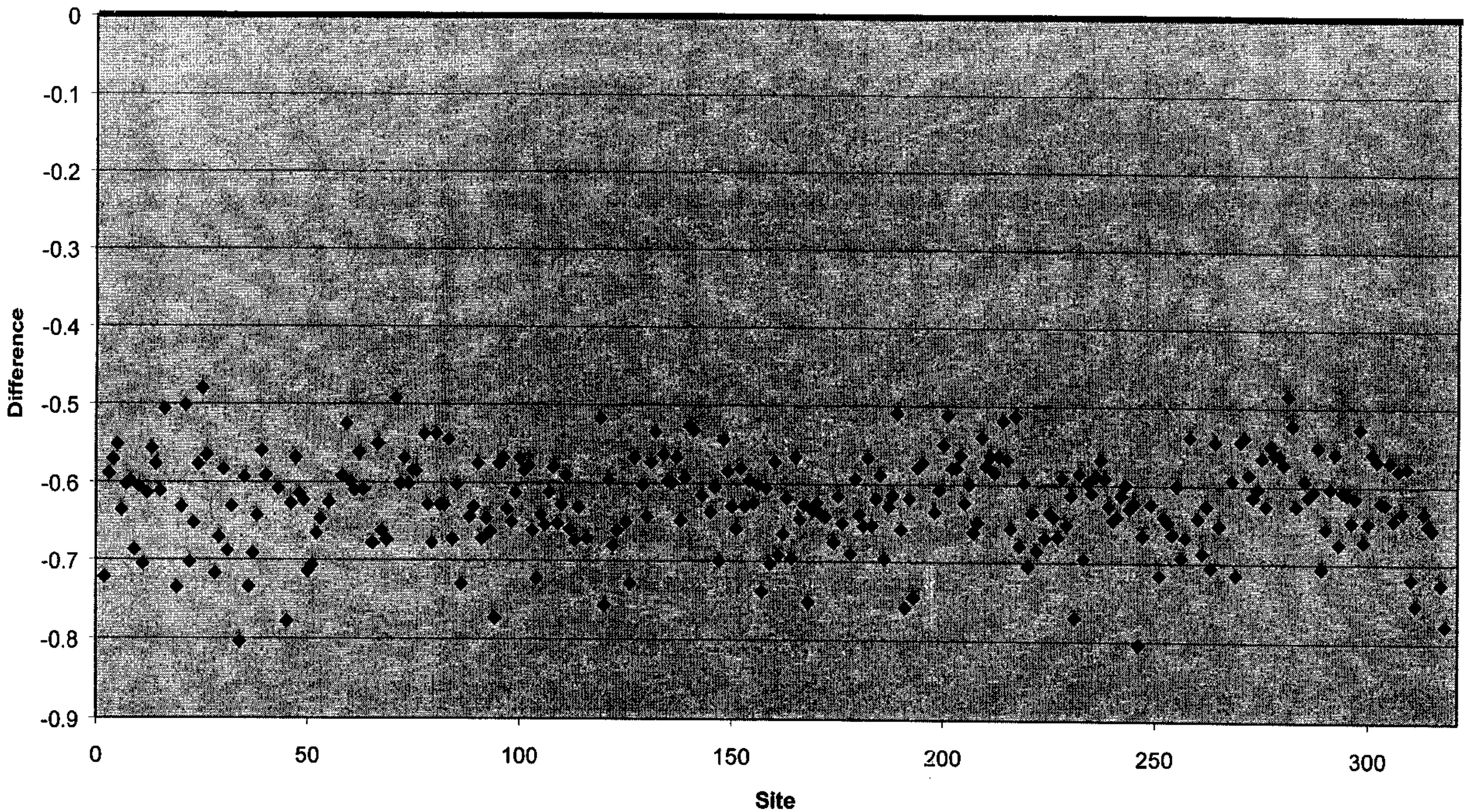
One can test the reasonableness of Dr. Bozzo's results by checking to determine whether manual processing ever actually is the lower cost option for any of the facilities in his sample. A result indicating that manual processing is less expensive on a marginal cost basis than mechanized or automated processing would raise serious questions about the validity of Dr. Bozzo's findings. I have conducted such a test, and find that there are numerous instances in which manual processing is apparently the more economical option.

The necessary calculation of marginal cost is straightforward. The elasticity (ε) of labor costs (C) with respect to piece handlings (V) is equal to $\frac{dC}{dV}\frac{V}{C}$, where $\frac{dC}{dV}$ is the marginal cost (MC) of an increase in V. Marginal cost in a particular sorting operation *i* is given by $\hat{MC}_i = \hat{\varepsilon}_i \frac{\overline{C_i}}{\overline{V_i}}$, where *i* indexes the sorting operation, and $\overline{C_i}$ and $\overline{V}_i$ are average piece handlings and volume, respectively.

Using facility-specific 1998 piece handlings and volume data and Dr. Bozzo's estimated coefficients from his labor demand model, I calculate the marginal cost in 1998 for sorting operation *i* at facility *j* as: $\hat{MC}_{98,i,j} = \hat{\varepsilon}_{98,i,j} \frac{\overline{C_{98,i,j}}}{\overline{V_{98,i,j}}}$, where $\overline{C}_{98,i,j}$ and $\overline{V}_{98,i,j}$ are site-specific average piece handlings and volume, respectively.

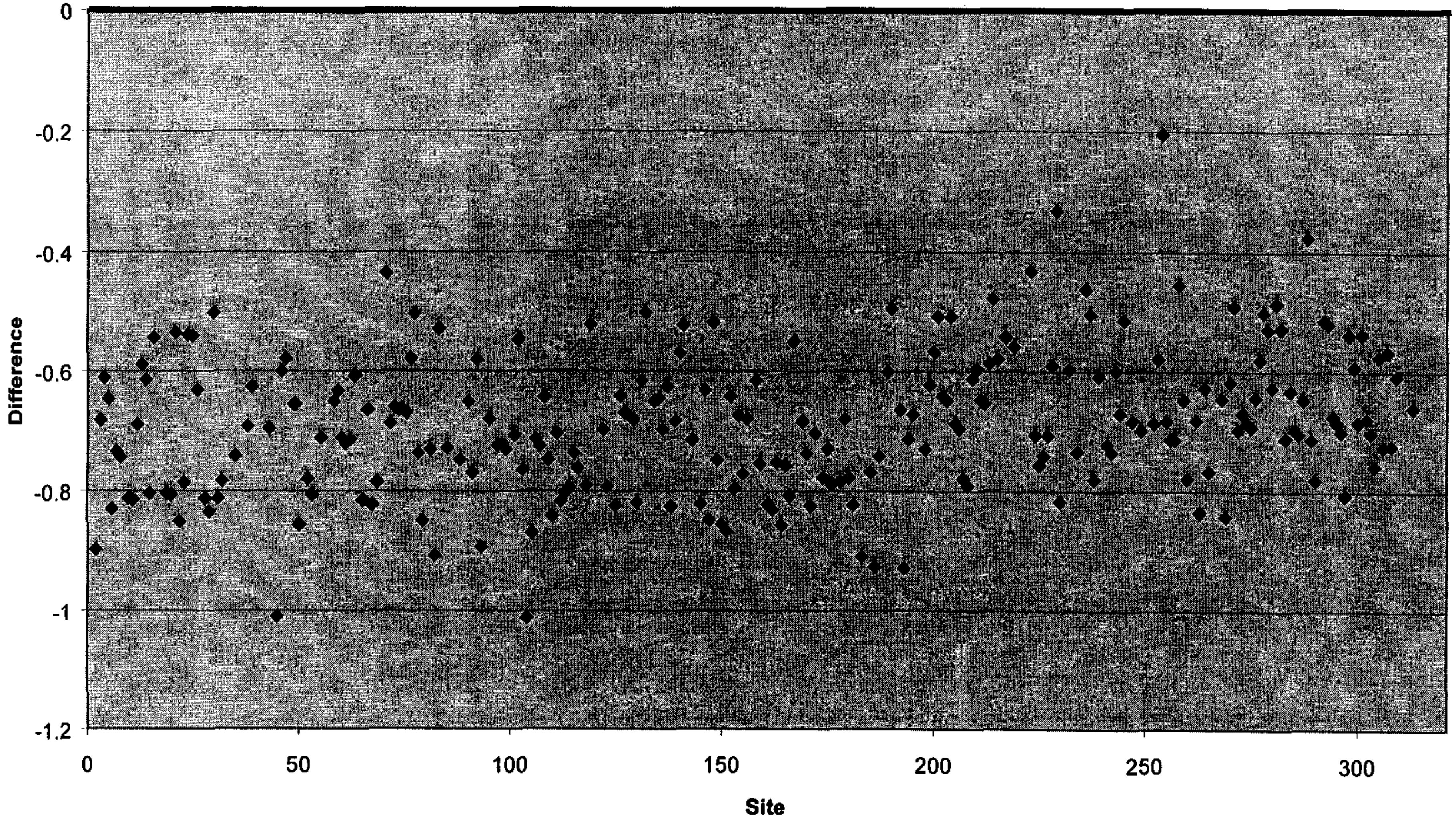
To investigate the reasonableness of the pattern of implicit marginal costs across MODS groups, I compare the facility-level marginal cost of manual sorting relative to the marginal cost of automated/mechanized sorting by mail shape. In particular, I compare the marginal cost of BCS to Manual Letters, the marginal cost of OCR to Manual Letters, the marginal cost of SPBS to Manual Parcels, and the marginal cost of FSM to Manual Flats. These comparisons reveal the expected pattern for letters. In particular, I find that for each of the 282 facilities for which we have 1998 estimated elasticities, the marginal cost of processing a letter in BCS is well below the marginal cost of manual processing. Similarly, I find that for each of the 246 facilities in the comparison, the marginal cost of processing a letter in OCR is well below the marginal cost of manual processing. See Figures 3 and 4.

Figure 3
Comparison of the Implied Marginal Costs of BCS and Manual Letters



Notes: The figure plots the difference between the ratio of manual to automated elasticities and the ratio of automated to manual average costs. For facilities below the zero line, the marginal cost of automated processing is lower than the marginal cost of manual processing. The figure contains data on 282 sites, none of which are above the zero line.

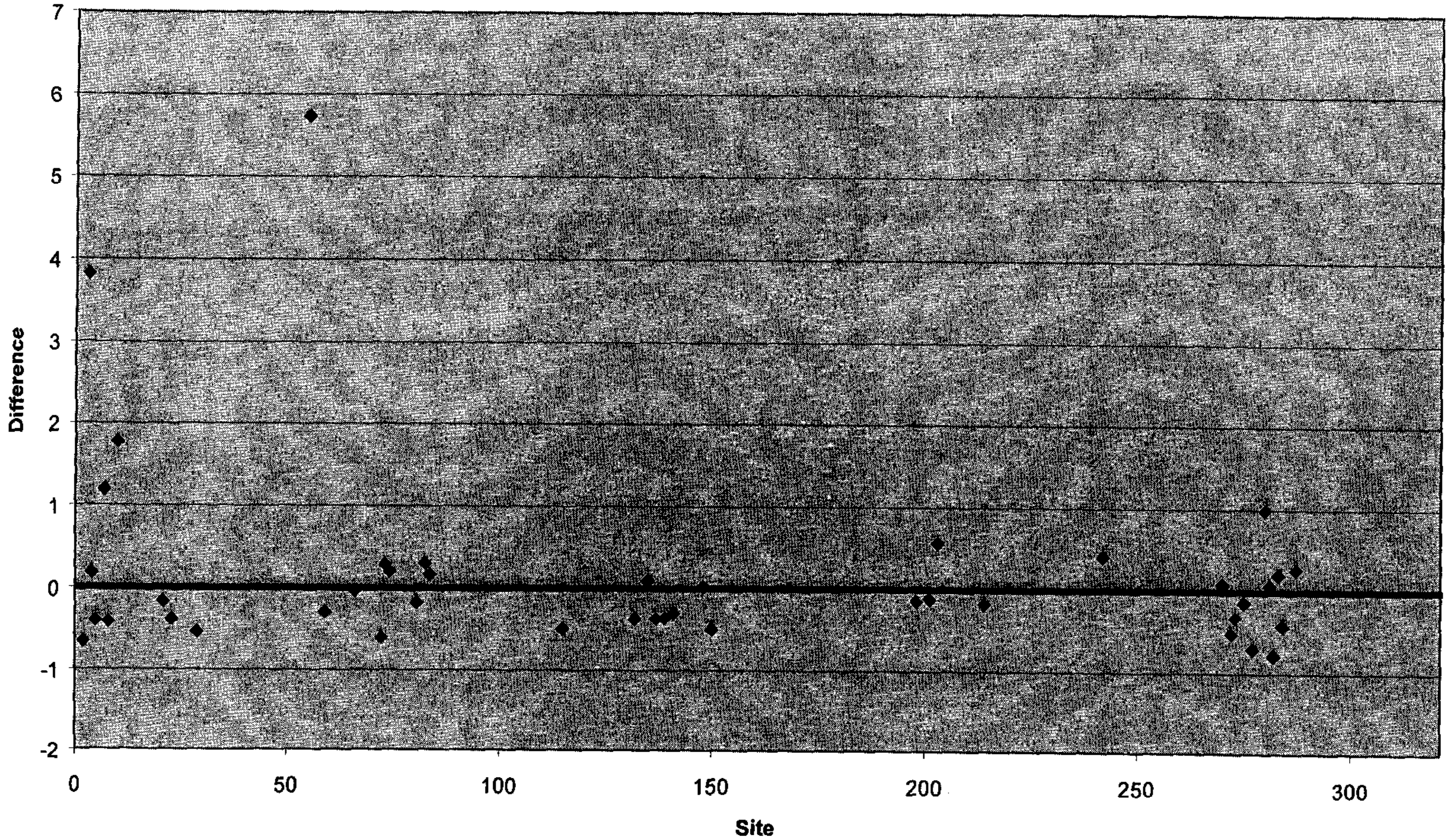
Figure 4
Comparison of the Implied Marginal Costs of OCR and Manual Letters



Notes: The figure plots the difference between the ratio of manual to automated elasticities and the ratio of automated to manual average costs. For facilities below the zero line, the marginal cost of automated processing is lower than the marginal cost of manual processing. The figure contains data on 246 sites, none of which are above the zero line.

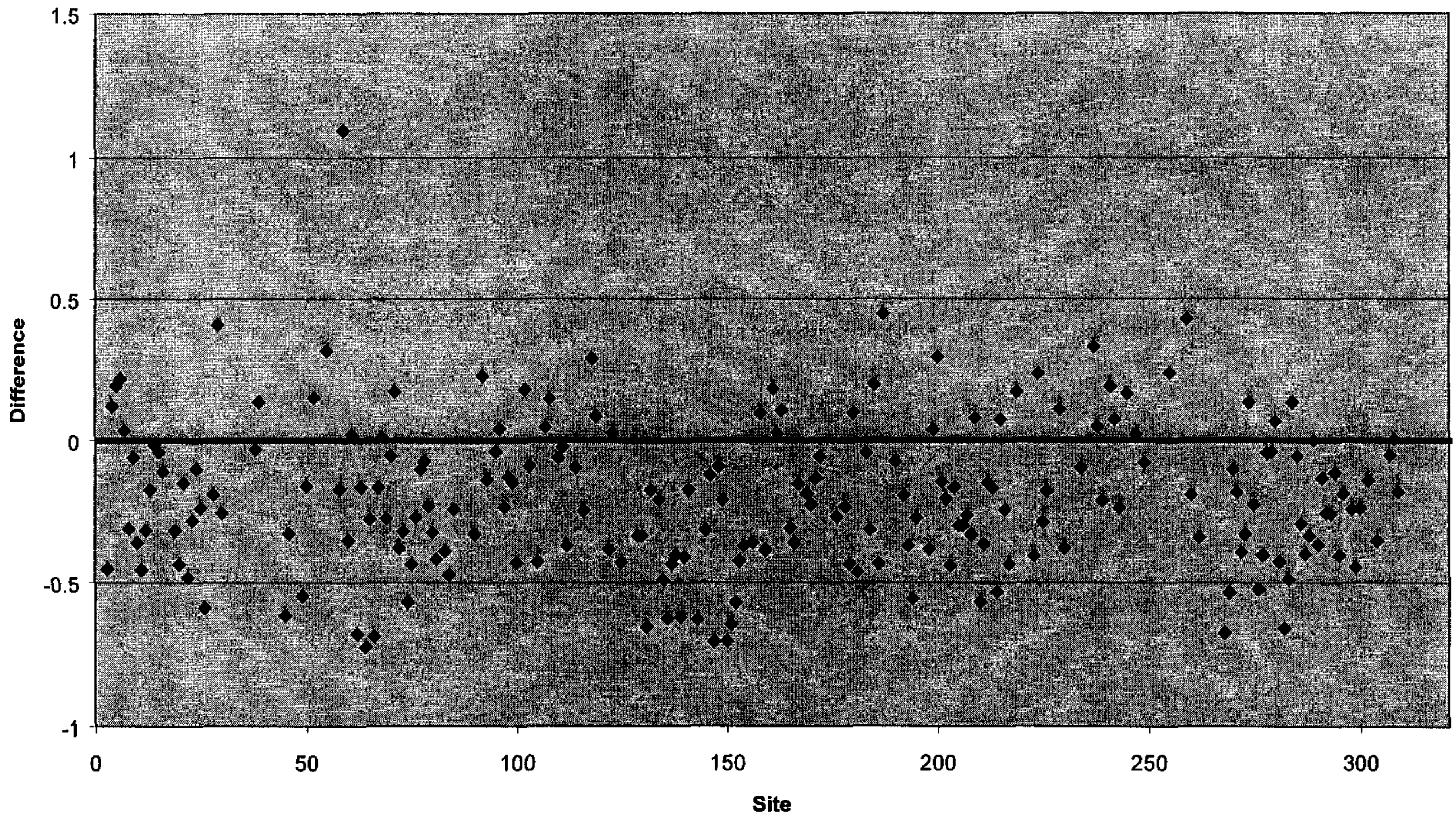
The comparisons for parcels and flats, however, reveal peculiar patterns. I find that for 42 percent of the facilities in the comparison, the marginal cost of manually processing a parcel is lower than the marginal cost of the mechanized SPBS technology. Consistent with previous conclusions, this investigation casts serious doubt on the reliability of the estimated elasticities for Manual Parcels and SPBS. I find that for 22 percent of the facilities in the comparison, the marginal cost of manually processing a flat is lower than the marginal cost of the mechanized FSM technology. This finding casts doubt on the reliability of the estimated elasticities of Manual Flats and FSM. Figures 5 and 6. I suspect that the large number of cases shown in these tables in which manual processing is apparently less expensive than mechanized or automated processing reflects downward bias in the estimated volume variabilities for manual operations.

Figure 5
Comparison of the Implied Marginal Costs of SPBS and Manual Parcels



Notes: The figure plots the difference between the ratio of manual to automated elasticities and the ratio of automated to manual average costs. For facilities below the zero line, the marginal cost of automated processing is lower than the marginal cost of manual processing. The figure contains data on 43 sites, 42 percent of which are above the zero line.

Figure 6
Comparison of the Implied Marginal Costs of FSM and Manual Flats



Notes: The figure plots the difference between the ratio of manual to automated elasticities and the ratio of automated to manual average costs. For facilities below the zero line, the marginal cost of automated processing is lower than the marginal cost of manual processing. The figure contains data on 213 sites, 22 percent of which are above the zero line.

MR. DEGEN'S CONCLUSIONS REGARDING VOLUME VARIABILITY OFTEN REST UPON FLAWED ARGUMENTS OR UNVERIFIED ASSUMPTIONS.

In this proceeding, Postal Service Witness Degen presents his "operational analysis" of mail processing on the basis of which he argues that volume variabilities "are generally less than 100 percent."[34] In this part of my testimony, I review his arguments and assess their validity. I consider carefully in the light of the available evidence the potential for volume specific diseconomies associated with the operation of a single mail sorting operation, for plant-specific diseconomies associated with the operation of an entire facility, and for system-wide diseconomies associated with the Postal Service's operation of multiple facilities.

Based on this analysis, I conclude that Mr. Degen's testimony should be approached with some caution and considerable skepticism. The operational arguments he offers for the presence of economies of scale are weaker than they first appear. In his effort to support Dr. Bozzo's study and argue for volume variabilities below 100 percent, Mr. Degen makes a number of important but implicit assumptions regarding the effects of increases in mail flow on mail processing operations. Often these assumptions are made without supporting evidence, and at times they are contradicted by available information. Frequently, the situation turns out to be considerably more complex than he makes it out to be. In this section, I explain in turn each of his principle arguments for the existence of economies of scale. I conclude that

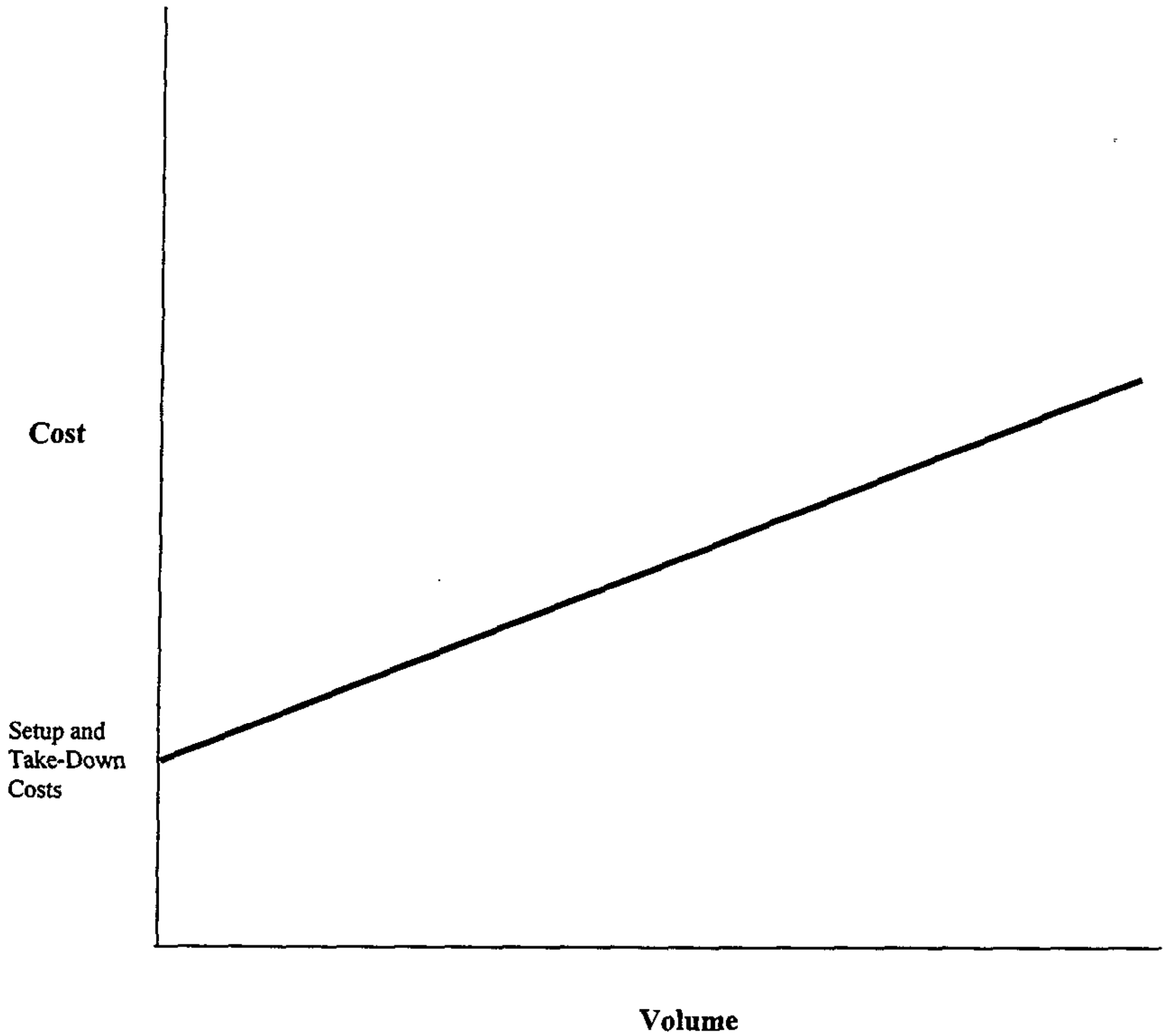
34. USPS-T-16, p. 51.

mail processing operations may very well experience *dis*economies of scale, manifested as volume variabilities in excess of 100 percent.

(1) Existence of Setup and Takedown Times

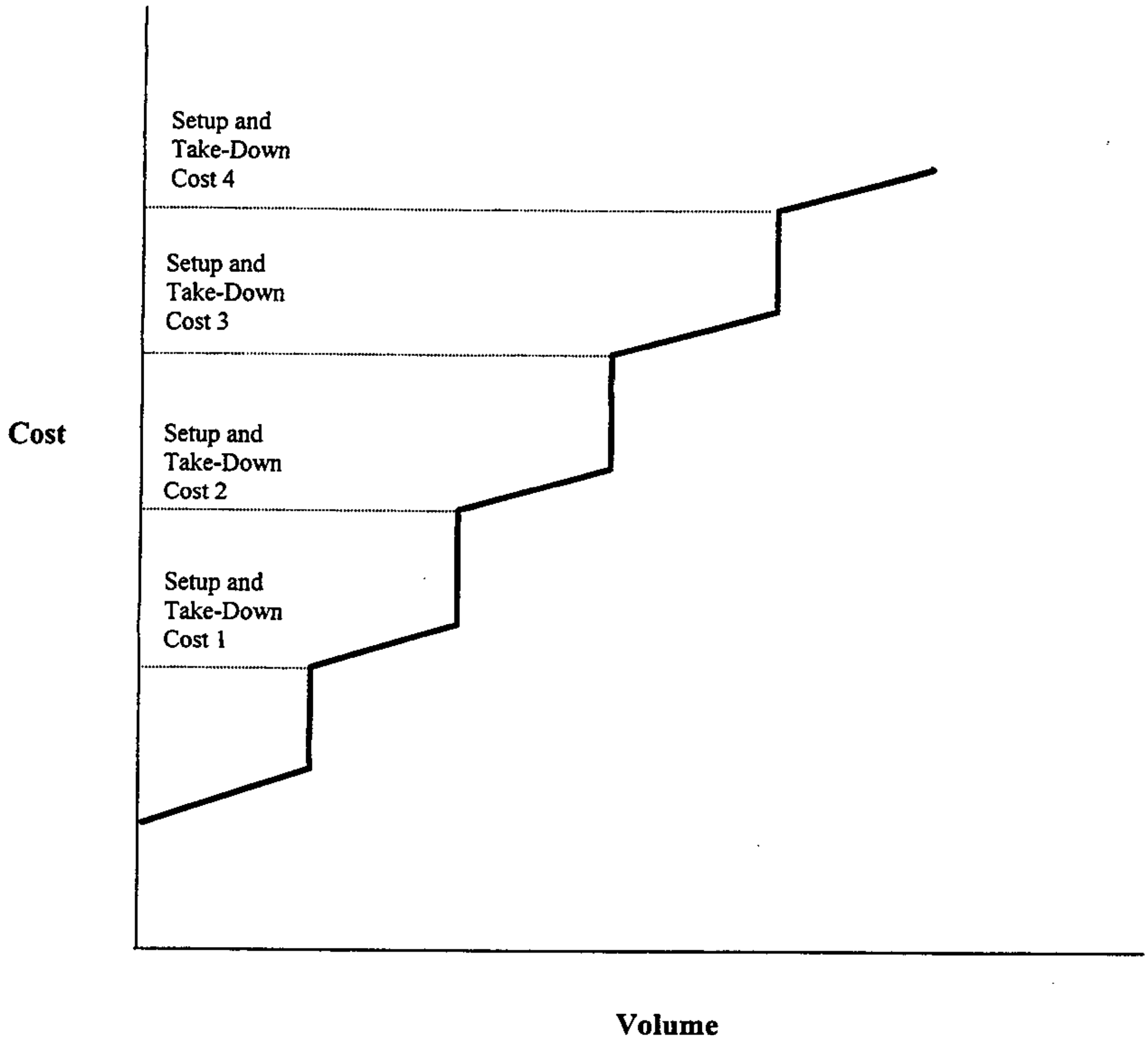
Mr. Degen argues that setup and takedown times for an operation represent a fixed cost that does not vary with the volume of mail processed. Over at least some range of volumes, Mr. Degen is almost certainly correct. For small increases in volume, these costs will remain fixed and with growth they will be amortized over ever larger volumes, giving the result that such operations will exhibit economies of scale. Figure 7 depicts the relationship between volume and cost in just such a situation.

Figure 7
Setup and Take-Down Times Over a Limited Range of Volumes



However, what Mr. Degen fails to recognize is that large enough increases in volume may require replication of a mail processing operation, with a corresponding replication of setup and takedown times. This point is illustrated most clearly when there are setup and takedown times associated with the operation of a piece of mail sorting equipment. At some point, growth in volume could necessitate the installation of a second machine, at which point the setup and takedown times could be expected to double. Replication of setup and takedown times in response to continuing growth in volume could create a situation in which costs increase in a stepwise fashion in direct proportion to volume. Such a situation is depicted in Figure 8.

Figure 8
Replication and Stepwise Increase of Setup and Take Down Times in Response to Volume Growth



In this situation, the economies of scale associated with the existence of setup and takedown times are limited to a narrow range of volume changes. At the end of this range, when it becomes necessary to step up to the next capacity level, the process encounters substantial *dis*economies of scale. For a large change in volume that spans a number of steps, costs should increase in direct proportion to the change in volume.

This point is by no means a theoretical one. One of the MODS pools which, according to Mr. Degen, had setup costs involved the operation of Flat Sorting Machines. Table 1 on page 9 above shows the average number of machines per site for the facilities in Dr. Bozzo's dataset. That table selects some of the more significant pieces of equipment from the much longer list shown in Appendix B. To pick one example, the average number of flat sorting machines per facility starts at 5.6 in 1993, and grows over the period covered by Dr. Bozzo's data to 11.3. In this case, therefore, we are much closer to the situation depicted in Figure 8 than that shown in Figure 7.

(2) Implicit Assumption that Incremental Volume Growth Occurs in the Shoulders of the Peak

Mr. Degen explains that gateway operations such as culling and canceling require peak-load staffing early in the day and late in the day to ensure that mail can flow quickly to the outgoing sorting operations; he also explains that at other times of the day, because of the uncertain arrival times of mail batches, these gateway operations can hold idle capacity to process mail.[35] He goes on to say, "Increases in

35. USPS-T-16, p. 37.

total collection volume . . . will not increase cancellation hours proportionately . . . -- some of the waiting time will simply be converted to processing."[36]

What Degen ignores is the possibility that growth in volume could occur during the peak periods that govern staffing levels in these operations, rather than in addition to the shoulders of the peak when extra capacity is available. There is no evidence to suggest that in fact, incremental volume growth would occur only in the shoulders of the peak. If all volumes grow proportionately -- including the peak period volume that sets staffing levels -- one would expect staffing levels to grow proportionately in response. Existence of these waiting times in gateway operations would give rise to economies of scale only in limited situations in which volume growth occurred in a very specific and highly favorable manner.

(3) The Need in Gateway Operations to "Get Mail Into Processing"

Mr. Degen describes a perceived urgency in upstream gateway operations to move mail quickly to downstream mail sortation operations.[37] This sense of urgency suggests that the combination of finite downstream throughput rates and finite processing windows necessitate early upstream staffing to guarantee that every possible minute of downstream processing time is fully utilized. Otherwise, there would be no reason for concern about the possible buildup of unprocessed mail in gateway operations. The need to make full use of downstream processing capacity implies that gateway staffing levels are in fact volume driven. In this case the volume in question, however, is the volume to be processed in downstream operations, and the issue is the

36. USPS-T-16, p. 37.

37. USPS-T-16, p. 37.

ability of those operations to handle that volume within the available processing window. This example illustrates not only the volume variability of gateway staffing levels, but also the interdependency of the different activities housed within a mail processing facility.

(4) Worker Pacing in Manual Operations

Mr. Degen claims that machine paced operations should exhibit higher variabilities than worker paced operations. He explains that in worker paced operations, "[i]ncreased mail volumes create pressure to sort faster in order to meet dispatch requirements."[38] While it is likely that workers under pressure will work harder, Mr. Degen oversimplifies the relationship between mail volume and the amount of pressure to which workers in manual operations are subject.

Both Mr. Degen and Ms. Kingsley identify a number of different situations in which the Postal Service resorts to manual processing. Manual processing may be the only type of sortation available at a facility for that mail stream. The Postal Service also resorts to manual sorting for pieces of mail with physical characteristics that do not lend themselves to mechanized processing.[39] In flats processing, some plants resort to manual processing when the available sorting equipment is being used to full capacity.[40] Particular batches of mail may also be sorted manually if they arrive too late in the

38. USPS-T-16, p. 41.
39. USPS-T-10, p. 13.
40. USPS-T-16, pp. 43-44.

processing window to accommodate the setup and takedown times associated with mechanized processing.[41]

The time pressure associated with these various situations are likely to vary dramatically. For example, late arriving mail could well put workers under enormous pressure, even if the volumes are relatively low. More generally, the amount of pressure workers operate under will reflect the relationship between the volume of mail to be processed, and the number of labor hours scheduled. This relationship is heavily influenced by supervisory personnel.

Mr. Degen's arguments regarding worker pacing suggest that he is taking an extremely short run view of volume variability. It is clearly the case, as many witnesses have testified, that mail volume varies randomly, and that supervisors set staffing levels to handle an expected workload. In such situations one can well imagine that there will be light days and heavy days, and that productivities in worker-paced operations might vary in response to these changes in workload. However, a sustained increase in workload is likely to lead to changes in staffing levels. It is up to supervisors to determine what those staffing levels will be, and I have seen no evidence to suggest that they would demand higher and higher productivities as mail volumes grow.

ALTERNATIVE CALCULATIONS OF VOLUME VARIABILITIES

(1) Overview

As I have explained, Dr. Bozzo's analysis is vulnerable to a number of potentially serious biases. Dr. Bozzo's analysis ignores serious issues of data quality for manual

41. USPS-T-16, p. 20.

operations. It also maintains the artificial assumption of proportionality of piece handlings with true volume. Perhaps most important, it ignores structural changes, at both the facility and the system levels, that undoubtedly alter the underlying efficiency of mail processing. Dr. Bozzo's failure to address these concerns renders his variability estimates unreliable.

In this section, I present alternative calculations that directly address each of the biases described. Concerns over data quality and over the proportionality assumption can be examined within Dr. Bozzo's MODS-level analysis. Indeed, my first two sets of calculations intentionally adopt and modify the MODS level setup in order to illustrate the effects of data errors and violations of the proportionality assumption, respectively, on Dr. Bozzo's estimated variabilities. Specifically, I explore the effects of aggregating up to the shapes level for letters, flats, and parcels, and adjust both MODS level and shapes level TPH variabilities for the elasticities of TPH with respect to volume. However, it is not possible using facility, MODS-level analysis to account for structural changes. Concerns about such structural changes in underlying technology and organizational design of the postal system can only be examined outside of Dr. Bozzo's setup -- which by its very nature ignores facility-wide and system-wide changes. Consequently, my third set of calculations presents new elasticity estimates using aggregate system-level volume and mail processing cost segment data.

All three sets of analyses demonstrate the sensitivity of Dr. Bozzo's estimates to a more serious treatment of the concerns raised by the Commission in R97-1. Moreover, all three find volume variabilities that are much closer to one hundred percent, and often in excess of that level.

(2) Aggregation by Shape Produces Higher Volume Variabilities for Parcels and Flats

As noted above, a careful look at the TPH series for Manual Parcels and SPBS reveals that data for the two are sometimes commingled. Because a significant fraction of the gross errors in Manual Parcels may be explained by the commingling of SPBS and Manual Parcel reporting, I combine these two MODS groups into a single Parcels group. TPH for the combined group equals the sum of the TPH for Manual Parcels and SPBS. Combining the two MODS groups in this way eliminates reporting discrepancies between them.

There are arguments quite apart from the commingling of reporting for aggregating MODS pools up to the shapes level. As I have discussed, manual and automated processing activities represent parallel and interdependent methods for handling the same mail stream. For this reason, it may be appropriate to view the set of activities for a specific shape as an integrated whole and to measure the volume variability of that integrated process. Hence, I also estimate shape and volume variability for letters and flats.

Details of my procedures for aggregating to the shapes level are contained in my workpapers. In general, this involves simply summing the hours and piece handlings used in the individual MODS level regressions. It was necessary, however, to distinguish between true zeros and missing values. In general, I treated a string of consecutive zeros at either the start or the end of the series for a site as true zeros, and zeros embedded in the middle of the series as missing values. A missing value for a component MODS pool would result in deletion of the entire observation from the shape level sample. In constructing the new shapes level wage variables, I noticed that an unusually large number of LDC 13 wages were missing from the data, resulting in a considerable reduction in sample size. To minimize the effect of wages on sample selection, I used predicted postal wages when actual postal wages were missing.[42]

The final analysis samples consists of 4,807 observations for letters, 4,774 observations for flats, and 3,651 observations for parcels.

I estimate Dr. Bozzo's labor demand model using panel fixed effects estimation with the modified Baltagi and Li's generalized least squares procedure, to allow the regression disturbances to exhibit first-order serial correlation. Following Dr. Bozzo, I then evaluate volume variability at the sample mean. As Table 8 shows, the estimate of Parcels variability produced in this way is 0.750, with a standard error of 0.034. By contrast, Dr. Bozzo estimates a SPBS variability of 0.641 and a Manual Parcels variability of 0.522. The estimated variability for Parcels is about 29% higher than the average of the SPBS and Manual Parcel individual variabilities. This pattern is likely explained by the elimination of gross errors in data reporting across the two parcel sorting operations.

Table 8 also shows comparable results for the other two principal shapes: flats and letters. In the case of flats, I find results like those described above for parcels. Dr. Bozzo's analysis produces volume variabilities of 0.817 and 0.772 for FSM and manual flat sorting, respectively. Combining these two into a single composite flats group yields

42. Predicted wages are constructed from a set of ancillary regressions of actual wages on a complete set of facility and time dummies. The full regression outputs are included in Appendix E.

an estimate of volume variability of 0.857 -- higher than either of Dr. Bozzo's MODS pool estimates.

The picture with letters is somewhat different. Aggregation by shape produces a composite volume variability of 0.663, lower than any of the estimates for Dr. Bozzo's letter-based activities. As I have shown, however, in the case of letters there is an exceptionally high elasticity of piece handlings with respect to volume. Below I show that this high elasticity offsets the low elasticity of labor hours with respect to letter piece handlings, and produces a final estimate of volume variability for letters that is in excess of 100 percent.

Table 8

Estimated Volume Variabilities - Shapes Level

Shape	Variability	Std. Error	Sample Size	Adj R2	Rho
Letters	0.663	0.023	4807	0.997	0.650
Flats	0.857	0.022	4774	0.996	0.615
Parcels	0.750	0.034	3651	0.959	0.589

Notes and Sources:

1. Data from reg9398.xls, provided in USPS-LR-I-107.
2. The Letters shape includes OCR, LSM, BCS, and Manual letter sorting. Bozzo's variabilities for these MODS groups are 0.751, 0.955, 0.895, and 0.735, respectively.
3. The Flats shape includes FSM and Manual flats sorting. Bozzo's variabilities for these MODS groups are 0.817 and 0.772, respectively.
4. The Parcels shape includes SPBS and Manual parcels sorting. Bozzo's variabilities for these MODS groups are 0.641 and 0.522, respectively.
5. Appendix F presents the full set of labor demand estimates for the shapes-level regressions.

(3) Correcting Dr. Bozzo's Variabilities for TPH/FHP Elasticities

Both the MODS-level and the shapes-level analyses presented above show that THP/F grows disproportionately faster than FHP. These results imply that the elasticities of labor costs with respect to TPH/F systematically underestimate the true volume variability. In particular, when TPH/F grows 50 percent faster than FHP, a 10 percent increase in FHP results in a 15 percent increase in TPH. Consequently, to know how a one percent increase in FHP affects costs, it becomes necessary to adjust the THP elasticity by a factor of 1.50.

Formally, the Postal Service's distribution key method requires an estimate of the elasticity of labor costs with respect to volume. This elasticity can be decomposed as:

$$\frac{d\ln C}{d\ln FHP} = \frac{d\ln C}{d\ln TPH} x \frac{d\ln TPH}{d\ln FHP}$$

Dr. Bozzo's analysis provides an estimate of the first component. Under the proportionality assumption, which requires that the second component exactly equal one, Dr. Bozzo's elasticity is equal to the true volume variability. However, my estimates demonstrate that the second component is in fact significantly greater than one, indicating a need to adjust Dr. Bozzo's variabilities.

Tables 9 and 10 present adjusted volume variabilities using both the MODS-level and the shapes level estimates of the elasticity of TPH with respect to FHP, respectively. Most of these corrected volume variabilities are well in excess of one, indicating the presence of diseconomies of scale. The sole exception is the Priority MODS pools, which, as I note above, is subject to an exceptional degree of reporting error.

Table 9

MODS-Level Estimates of the Elasticity of Labor Costs with Respect to First Handled Pieces

MODS Group	Bozzo's Variability of Costs w.r.t. TPH	MODS Level Variability of TPH w.r.t. FHP	Shapes Level Variability of TPH w.r.t. FHP	Volume Variability With MODS Level Correction	Volume Variability With Shapes Level Correction
OCR	0.751	1.597	2.062	1.199	1.549
LSM	0.954	1.069	2.062	1.020	1.967
BCS	0.895	2.091	2.062	1.871	1.845
Manual Letters	0.735	1.229	2.062	0.903	1.516
FSM	0.817	1.544	1.318	1.261	1.077
Manual Flats	0.772	1.010	1.318	0.780	1.017
Parcels[3]	0.750	1.795	1.795	1.346	1.346
Priority	0.522	1.010	1.013	0.527	0.529

Notes and Sources:

1. Volume variability is defined as :

$$\frac{\partial \ln C}{\partial \ln FHP} = \frac{\partial \ln C}{\partial \ln TPH} x \frac{\partial \ln TPH}{\partial \ln FHP}$$

2. Bozzo's variabilities taken from USPS-T-15, pp. 119-120.
3. For Parcels, the elasticity of costs with respect to (w.r.t.) TPH was estimated by combining the SPBS and Manual Parcels MODS groups, as described in the text of my report and presented in Exhibit 9. The full set of coefficients used to construct this variability is presented in Appendix 5.
4. The MODS-level variability of TPH w.r.t. FHP is taken from Exhibit 10.
5. The Shapes-level variability of TPH w.r.t. FHP is taken from Exhibit 11. Letter variability of TPH w.r.t. FHP applied to MODS groups OCR, LSM, BCS, and Manual Letters. Similarly, Flats variabilities applied to Manual Flats and FSM.

Table 10

Shapes - Level Estimates of the Elasticity of Labor Costs With Respect to First Handled Pieces

Shape	Variability of Costs w.r.t. TPH	Variability of TPH w.r.t. FHP	Volume Variability
Letters	0.663	2.062	1.367
Flats	0.857	1.318	1.130
Parcels	0.750	1.795	1.346
Priority	0.522	1.013	0.529

Notes and Sources:

1. Volume variability is defined as :

$$\frac{\partial \ln C}{\partial \ln FHP} = \frac{\partial \ln C}{\partial \ln TPH} x \frac{\partial \ln TPH}{\partial \ln FHP}$$

2. Shapes-level variabilities of costs w.r.t. TPH taken from Exhibit 9.
3. Shapes-level variabilities of TPH w.r.t. FHP is taken from Exhibit 11.

(4) Time Series Analysis of System-wide Mail Processing Costs

None of the alternative estimates of volume variability presented above reflects the full response of the Postal Service to changes in mail volume. Indeed, analyses based upon Dr. Bozzo's analytical framework cannot do so. To overcome this limitation and capture the effects of structural changes in the underlying technology and organizational design of the postal system, I analyze the effects of mail volume on work hours using aggregate, system-level time series data on volumes and mail processing costs. These aggregate data, by their very nature, automatically reflect net changes in productivity and efficiency from system-wide structural changes. They also circumvent concerns over both measurement error with piece handlings data at the facility level and the use of piece handlings as a proxy for true volume. Thus, the aggregate analysis is a conceptually superior alternative to the MODS-level analysis presented by Dr. Bozzo.

The analysis uses annual mail volume by class from 1981 to 1998. The classes include First Class Mail, Priority Mail, Express Mail, Periodicals, Standard (A), and Standard (B). The analysis also incorporates annual data on work sharing by class and on mail processing costs. I adjust for the effects of inflation using the GDP deflator. The volume and work sharing data are taken from LR-I-117. The mail processing costs data for cost segments 3.1 (Mail Processing Clerks and Handlers), 2.1 (Mail Processing Supervisors), and 11.2 (Mail Processing Operating Equipment Maintenance) are taken from the Postal Service's response to Interrogatory UPS/USPS-T11-7-17, Tr. 21/9351-52. My selection of an inflation index is guided by analysis of data on postal wages obtained from the U.S. Office of Personnel and Management's *1984-1994 Postal Service Employees and Payroll Report*. The GDP deflator is from the Bureau of Commerce, and data on four other wage series I considered are taken from the Bureau of Labor Statistics. Finally, the analysis uses base year data from the In-Office Cost System ("IOCS") and work hours data from Dr. Bozzo's MODS data.

Due to sample size limitations, estimating effects of changes in volume on aggregate mail processing work hours requires consideration of three important data issues. The first issue arises in the adjustment of mail processing costs for the effects of inflation. In principle, this adjustment could be carried out using data on average postal wages. However, direct information on postal wages is available only for the years 1986-1995 and 1997. In the interest of preserving sample size, I investigated the relationship, during the more limited period for which postal wage data are available, between postal wages and more readily available inflation indices, including other wages series, the Consumer Price Index, and the GDP deflator. I find that the GDP deflator tracks postal wages most closely.[43] Inflation adjusted costs, then, are computed as

$$\frac{Cost_t}{GDPDeflator_t}.$$

The second issue arises from the fact that different classes of mail place different burdens on the mail processing system, and hence have different per piece costs. If sample size were not an issue, one could simply estimate separate coefficients for the individual effects on mail processing costs of volumes by class. However, this would require a six-fold increase in the number of parameters to be estimated -- too heavy a burden for the relatively small sample to bear. Consequently, it becomes necessary to find a way to weight the classes in a single composite measure of volume.

I aggregate volumes based upon the labor intensity of the different classes. The weighting scheme is derived from a combination of base year IOCS data and 1998 MODS data on labor hours. The IOCS data provide a breakdown of base year labor hours at the MODS pool level by class. This distribution, referred to as the transition matrix from MODS groups to subclasses, is shown in Appendix G. From Dr. Bozzo's dataset I obtain quarterly 1998 data on labor hours by MODS pool. Using the transition matrix, I first disaggregate base year MODS pool labor hours into classes, and then sum across MODS pools to derive overall labor hours by class. These figures are shown in Appendix H. Using these base year labor hours and base year volumes, I

43. The GDP deflator was chosen by comparing R2 across six different regression models which relate the log of postal wages to a constant and the log of one of the other wage or price series. The R2 from the regression with GDP deflator is 0.871. The other R2 are 0.418, 0.819, 0.792, 0.857, and 0.884 for each of the four wage series and the CPI, respectively. In addition, of all of these regressions, the GDP deflator regression had the coefficient estimate closest to one.

then construct my composite volume measure as follows: $V_t = \sum_j w_j V_{jt}$, where j indexes subclass and $w_j = \frac{HRS_{j,98}}{V_{j,98}}$. This weighting scheme implicitly gives relatively more weight to the more labor-intensive classes.

The aggregate mail processing cost equation, then, is given by:

$$\ln(\frac{Cost_t}{GDPDeflator_t}) = \alpha_0 + \alpha_1 \sum_j w_j V_{jt} + e_t$$

where t indexes time, j indexes the class, and e_t is the stochastic error term.

The final issue to be accounted for involves the work sharing in certain classes that reduces the effective volume of mail requiring processing. The volume data contain information on work sharing volumes. Again, if sample size were no issue, we would simply allow work share volumes to separately enter the cost equations. I incorporate the work share information into the mail processing cost equation as follows:

$$\ln(\frac{Cost_t}{GDPDeflator_t}) = \alpha \ + \alpha_1 \ln(\sum_j w_j (V_{jt} - \lambda V^*_{jt}) + e_t$$

where t indexes time, j indexes class, V_{jt} is the work share volume for class j in period t, and $w_j = \frac{L_{j,98}}{V_{j,98} - \lambda V^*_{j,98}}$. The parameter λ is the degree to which work sharing effectively reduces volume.

The parameter α_1 is the volume variability parameter. Estimation methodology depends upon the treatment of the work share parameter. To illustrate the role of this parameter, consider setting $\lambda = 0.80$. This would mean that work shared volume requires only a fifth of the mail processing effort that is required by non-work shared volume. If λ is treated as a fixed parameter, the model can be estimated using ordinary least squares. Otherwise, all these parameters can be estimated using nonlinear least squares.

Table 11 presents the ordinary least squares estimates for three values of λ, 0.60, 0.70, and 0.80, and for three different definitions of mail processing labor costs. The leftmost column in the table focuses on mail processing clerk and mailhandler costs (cost segment 3.1), and adopts the narrowest definition of costs. The middle column adds labor costs associated with mail processing equipment maintenance (cost segment 11.2). The rightmost column broadens the cost definition further by adding the labor costs associated with supervision of mail processing (cost segment 2.1). The results strongly indicate that volume variabilities are greater than or equal to one. Estimates of volume variability range from a low of 98 percent to a high of 123 percent, indicating the presence of substantial *dis*economies of scale. In a number of instances, the difference from 100 percent is statistically significant.

Table 11

Aggregate Time Series Analysis, 1981-1998
Dependent Variable: ln(Costs/GDP Deflator)

Parameter	MP Clerks and Handlers	MP Clerks, Handlers, and Operating Equipment Maintenance	MP Clerks, Handlers, Supervisors, and Operating Equipment Maintenance
	Work Share Parameter = 0.8		
Constant	-9.796	-11.412	-11.461
	(1.468)	(1.424)	(1.305)
Volume Variability	1.135	1.224	1.230
	(0.078)	(0.076)	(0.070)
Adj R2	0.925	0.939	0.949
	Work Share Parameter = 0.7		
Parameter	**MP Clerks and Handlers**	**MP Clerks, Handlers, and Operating Equipment Maintenance**	**MP Clerks, Handlers, Supervisors, and Operating Equipment Maintenance**
Constant	-8.147	-9.650	-9.696
	(1.365)	(1.310)	(1.192)
Volume Variability	1.048	1.131	1.137
	(0.073)	(0.070)	(0.064)
Adj R2	0.924	0.939	0.950
	Work Share Parameter = 0.6		
Parameter	**MP Clerks and Handlers**	**MP Clerks, Handlers, and Operating Equipment Maintenance**	**MP Clerks, Handlers, Supervisors, and Operating Equipment Maintenance**
Constant	-6.836	-8.247	-8.290
	(1.288)	(1.227)	(1.112)
Volume Variability	0.979	1.057	1.063
	(0.069)	(0.065)	(0.059)
Adj R2	0.923	0.939	0.950

Notes and Sources:

1. Volume data from USPS-LR-I-117; accrued cost data from Postal Service response to UPS/USPS-T11-7-17, Tr. 21/9351-52; weights used to aggregate volumes constructed from the 1998 IOCS data provided in UPS-Sellick-W2, and reg9398.xls provided in USPS-LR-I-107; other data from 2000 U.S. *Statistical Abstract* and the Bureau of Labor Statistics.
2. Parameters and standard errors estimated using Ordinary Least Squares.

One pattern shown in Table 11 that is worth noting is the effect of the estimated volume variability of adding to the dependent variable the labor costs associated with the maintenance of mail processing equipment. In all cases, variability increases when these costs are added, implying that they have a higher volume variability than mail processing clerk and mailhandler costs. These results reemphasize the importance of considering capital costs in evaluating the response of mail processing costs to increases in volume. They also call into question Dr. Bozzo's argument that the capital intensity of mail processing is unaffected by growth in mail volume.

Clearly, the estimate of volume variability generated by this aggregate analysis depends upon what one uses for the workshared cost saving percentage. To provide a factual basis for this measure, I reestimated the model presented above, using nonlinear least squares and specifying the workshared cost saving percentage as a parameter. Table 12 presents results based upon the same definitions of cost depicted in Table 11. Estimated values for the workshared savings percentage range from .63 to .86, depending upon the cost definition used.

One point worth mentioning in connection with the results shown in Table 12 is that the estimated work share discount is higher for the narrower definition of costs -- based just on mailhandlers and clerks -- that for the broader definitions that include supervisory and equipment maintenance personnel. The result makes sense, since it is the handler's work that is being shared. Point estimates for volume variability are in all cases in excess of 100 percent, although in this more general model they are not statistically distinguishable from 100 percent.

Table 12

Nonlinear Aggregate Time Series Analysis, 1981-1998
Dependent Variable: ln(Costs/GDP Deflator)

Parameter	MP Clerks and Handlers	MP Clerks, Handlers, and Operating Equipment Maintenance	MP Clerks, Handlers, Supervisors, and Operating Equipment Maintenance
Constant	-10.892	-9.782	-8.711
	(5.736)	(5.733)	(5.293)
Volume Variability	1.193	1.138	1.085
	(0.303)	(0.303)	(0.279)
Work Share	0.855	0.708	0.632
	(0.256)	(0.350)	(0.383)
Adj R2	0.920	0.935	0.946

Notes and Sources:

1. Volume data from USPS-LR-I-117; accrued cost data from Postal Service Institutional response to UPS/USPS-T11-7-17, Tr. 21/9351-52; weights used to aggregate volumes constructed from the 1998 IOCS data provided in UPS-Sellick-WP2, and reg9398.xls provided in USPS-LR-I-107; other data from 2000 U.S. *Statistical Abstract* and the Bureau of Labor Statistics.
2. Parameters and standard errors estimated using Nonlinear Least Squares.

These results are derived from a model which, although highly simplified, responds fully to the concerns I have raised regarding both Dr. Bradley's R97-1 analysis and Dr. Bozzo's current analysis. This aggregate model is based upon an appropriate measure of mail volume. It encompasses the full range of actions taken by the Postal Service in response to changes in volume, and allows for the presence either of economies of scare or of diseconomies of scale at the activity, plant, and system levels. It presents results sharply at variance with those of Dr. Bozzo, and supports the Commission's historically-held view that mail processing labor costs are 100 percent volume variable. It suggests that at the system level there are, if anything, diseconomies of scale.

WHAT SHOULD A STUDY OF MAIL PROCESSING COST VARIABILITY LOOK LIKE?

On two occasions now I have been highly critical of the studies of mail processing cost variability introduced by witnesses testifying on behalf of the Postal Service. Although I believe firmly that these criticisms are warranted, I recognize the Commission's need for reliable information on this important subject. Accordingly, I end my testimony with some comments about how an appropriately designed study of mail processing cost variability should be structured.

(1) Only Plant or System Level Analysis Can Fully Capture the Interactions Between Activities.

As I have argued throughout my testimony and demonstrated through both empirical analyses and citations to the testimony of Postal Service operational witnesses, there are important interactions between the activities present in a mail processing plant. In most cases, for a given mail stream manual and automated processing activities operate in parallel and interact in complex ways. In many instances, the same mail passes sequentially through multiple MODS activities. This is especially true if one considers not just the direct activities that are the subjects of Dr. Bozzo's analysis, but also the allied activities. Staff can be reassigned from one activity to another. Congestion at a facility can influence the processing of all of the different mail streams.

For all of these reasons, I believe that it is inappropriate to attempt to estimate mail processing cost variabilities through analyses conducted at the MODS pool level. In principle, given detailed enough models, one ought to be able to arrive at the correct result. As a practical matter, however, I doubt that such richly specified models will be achievable in the foreseeable future. It is clear from Dr. Bozzo's testimony that he conducted an extensive review of Postal Service databases in an effort to locate information suitable for use in his analysis. This huge effort resulted in the inclusion of a few additional variables in his analysis, but did not fundamentally alter his analysis or conclusions. I do not believe that, with the information that is realistically available, it is or will be possible to capture in a MODS pool analysis the effects of the rich set of interactions that occur within a mail processing plant.

An appropriate study of mail processing cost variability should focus on system-level analyses, or at minimum on plant-level analyses. If analysis is conducted at the plant level, it should account explicitly for the effects of changes in the network that alter the number, configuration or operating characteristics of plants.

(2) Capital Costs Play an Integral Role in the Postal Service's Response to Volume Growth.

It is absolutely clear that mechanization and automation are integral elements of the response of the Postal Service to growth in mail volume. As automation programs progress, the focus of these programs necessarily must switch from the substitution of capital for labor to providing enough capital and enough processing capacity to accommodate growth in volume. These fundamental facts imply that no analysis of mail processing cost variability can be complete without a full and adequate treatment of capital costs.

A full treatment of capital costs in this context would have to account for all aspects of the Postal Service's automation programs. These include the capital expenditures associated with the expansion of automated processing, changes in the mix of activities that result from the installation and upgrading of mail processing equipment, and the ongoing costs associated with the upkeep of that equipment.

(3) Growth in Delivery Points Must Be Considered a Part of the Growth In Volume.

A number of Postal Service witnesses have drawn distinctions between growth in volume and growth in "delivery points," or addresses to which mail might be delivered. The former, they argue, represents a "true" increase in volume whose effects should be reflected in rates. The latter, they assert, merely represents a change in network structure, and has no implications for ratemaking. This argument reappears in various forms in the testimony of a number of different witnesses.

Ms. Kingsley, for example, draws this distinction in her discussion of changes in staffing levels: "Delivery volume growth can be due to more pieces per delivery, or more delivery points. If it is a pure volume increase without any changes in mail composition or delivery area it is relatively easy to handle."[44]

In Dr. Bozzo's testimony, the distinction is drawn once again. His econometric models include as explanatory variables both the number of piece handlings and the number of delivery points within each plant's service territory. He strongly rejects the idea that volume and delivery points have anything to do with one another: "Volume and network characteristics interact in complicated ways, but volume does not cause network characteristics. Recipients (addresses) must exist before there is any need to generate a mail piece."[45]

There is ample evidence in the record both in the testimony of operational witnesses and in the results of econometric analyses to suggest that volume growth resulting from an increase in mail volume per delivery point will have an effect on processing costs that is different from that of volume growth arising from an increase in the number of delivery points. That such differences should exist is not surprising. Similar cost structures can be found in other industries. They indicate that there are costs associated with connecting a new point to the network that do not vary directly with the volume generated by that point. A situation in which it costs less to expand volume within a fixed network than to expand the size of the network has been described as one characterized by "economies of density."

Postal Service witnesses have argued that increases in cost associated with growth in the number of addresses have no relevance to ratemaking. They argue, in

---

44. USPS-T-10, p. 30.

45. USPS-T-15, pp. 47-48.

effect, that the only costs that need to be considered are the costs associated with increases in pieces per delivery point. This argument might have merit in a situation in which mailers paid a two-part tariff consisting of a fixed charge for connecting to the network, and a variable charge associated with the number and mix of pieces mailed. But postal rates do not work that way, and that fact raises questions about how the costs associated with growth in the number of delivery points should be recovered.

Conceptually, one can divide growth in the volume of mail handled by the Postal Service into two components, one having to do with growth in the number of delivery points and the other having to do with increases in the number of mail pieces per delivery point. The former component may represent a significant fraction of the volume growth experienced by the Postal Service. Population is growing, new businesses are being formed, the economy is expanding, and the number of addresses is increasing. As Ms. Kingsley, Mr. Degen, and Dr. Bozzo have testified, this component of volume growth affects the organization and the costs of mail processing operations.[46] It is costly to accommodate.

Increases in the *density* of deliveries, in contrast, will be much easier and less costly to accommodate. The volume growth experienced by the Postal Service will consist of a mixture of this high cost and low cost growth in volume. For this reason, Mr. Degen's marginal mail piece will be associated with changes both in network size and in network density.[47] To ignore the clear association between the size of the

46. USPS-T-10, pp. 30-35.

47. USPS-T-16, pp. 15-17.

network and the volume of mail delivered, as Postal Service witnesses have urged, would be to ignore significant elements of cost associated with volume growth.

(4) Analyses of Mail Processing Costs Require an Appropriate Cost Driver.

We have yet to identify an appropriate driver for an empirical analyses of mail processing costs. Piece handlings, the measure that has featured prominently in Postal Service testimony in two rate cases now, has a questionable and variable relationship to the true volume of mail being processed at a plant. First handling pieces, although appropriate from a conceptual standpoint, is subject to serious measurement problems. No other attractive candidates have surfaced.

I do not believe that progress will be made in this area until an appropriate cost driver can be identified. Although I do not yet know what that cost driver might be, I do know some of the properties it must have. First, it must be something that can be measured with some precision and reliability. Second, if it is to be able to support plant-level analyses, it should measure in some meaningful way the volume of mail coming into the plant. These two requirements to some extent conflict with one another. Piece handlings can be measured with precision, at least for mechanized operations. However, they are internal process measures, and not measures of the amount of mail flowing in from the outside world. Third and most obviously, the cost driver has to relate in a meaningful way to the ability of the mail stream to generate cost. The weight of the incoming mail stream, which apparently meets the first and second criteria, fails on this third.

I do not know yet what the right answer is in this context, but I am confident that little progress will be made until a good answer is found.

Appendix A

Kevin Neels — Vice President

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

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

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

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

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

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

Among the projects Dr. Neels has successfully concluded are:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

- Working under a federally funded research grant, he served as a key staff member of a Rand Corporation study of the equity implications of substituting user charges for tax funding of public services.

- For the developer of a new orphan drug, he conducted a cost-benefit analysis, a review of political and legislative trends and a hedonic analysis of existing orphan drug prices to support development of a defensible pricing strategy.

- For a medical device company, he prepared a payor education brochure describing the results of a cost-effectiveness study of a new therapy, which allows payors to calculate the savings they could realize by granting coverage of the therapy.

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

PROFESSIONAL AFFILIATIONS

American Economic Association

American Law and Economics Association

National Association of Business Economists

National Health Lawyers Association

International Health Economics Association

Drug Information Association

KEVIN NEELS

PUBLICATIONS AND TESTIMONY

Articles

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

"Insurance Issues and New Treatments." *Journal of the American Dental Association*, 125 (January 1994): 45S-53S

"Medical Cost Savings from Pentoxifylline Therapy in Chronic Occlusive Arterial Disease." *Pharmacoeconomics* 4, No. 2, (February 1994): 130-140.

"Analyzing Rent Control: The Case of Los Angeles." With M. P. Murray, C. P. Rydell, C. L. Barnett, and C. E. Hillestad. *Economic Inquiry* 29, No. 4 (October 1991): 601–625.

"Forecasting Intermodal Competition in a Multimodal Environment." With Joseph Mather. *Transportation Research Record* 1139 (1987).

"Modeling Mode Choice in New Jersey." With Joseph Mather. *Transportation Research Record* 1139 (1987).

"Direct Effects of Undermaintenance and Deterioration." With C. Peter Rydell. In *The Rent Control Debate*. Ed. Paul L. Niebanck. Chapel Hill, NC: University of North Carolina Press, 1985.

"Energy and the Existing Stock of Housing." With M. P. Murray. In *Energy Costs, Urban Development, and Housing*. Ed. Anthony Downs and Katherine L. Bradbury. Washington, D.C.: The Brookings Institution, 1984.

"Reducing Energy Consumption in Housing: An Assessment of Alternatives." *International Regional Science Review* 7, 1 (May 1982).

"Production Functions for Housing Services." *Papers of the Regional Science Association* 48 (1981).

Testimony

Before the U.S. District Court, Northern District of Ohio, Eastern Division, Testimony in the matter of Avery Dennison Corporation vs. Four Pillars Enterprise Co., Ltd., P.Y. Young, Huen-Chan (Sally) Yang and Tenhuong (Victor) Lee, Case No. 1:97 CV. 2282, September 1999.

Before the American Arbitration Association, Testimony in the matter of Westerbeke Corporation vs. Daihatsu Motor Co., Ltd., Arbitration No. 13 T 153 01057 97, August 1999.

Before the Commonwealth of Massachusetts, Superior Court Department of the Trail Court, Worcester Division, Testimony in the matter of Performance Polymers, Inc. vs. Mohawk Plastics, Inc. and Dimeling Schreiber & Park, Civil Action No. 98-0230A (Mass./Worcester), July 1999.

Before the American Arbitration Association, Testimony in the matter of GCC Technologies Inc. vs. Toshiba TEC Corporation, American Arbitration Number 50 T1815897, March 1999.

Before the U.S. District Court, District of Maryland, Testimony in the matter of Borman Motor Company Limited Liability Co., et al. vs. American Honda Motor Company Inc., et al. Civil Action MDL-1069, August 1998.

Before the U.S. Postal Rate Commission, Postal Rate and Fee Changes, Docket R97-1. Expert Report and Live Testimony, February 1998.

Before the U.S. District Court, District of Kansas, Testimony in the matter of Timothy Mellon vs. The Cessna Aircraft Company. Civil Action 96-1454-JTM, Expert Report, November 1997.

Before the U.S. District Court, Southern District of New York, Testimony in the matter of Virgin Atlantic Airways Limited vs. British Airways PLC. Civil Action No. 93-7270 (MGC). Affidavit, August 1997.

Before the U.S. District Court, Western District of Pennsylvania, Testimony in the matter of Lazy Oil Co., John B. Andreassi and Thomas A. Miller Oil Co. vs. WITCO Corporation; Quaker State Corporation; Quaker State Oil Refining Corp.; Pennzoil Company; and Pennzoil Products Company. Civil Action No. 94-110E, Class Action. Expert Report, March 1996; live testimony April 28, 1997.

Before the U.S. District Court, Eastern District of Pennsylvania, Testimony in the matter of Stephen M. Clifton and Stephen M. Clifton Ultra Sonoco vs. Sun Refining & Marketing Company. Civil No. 95-CV-7694. Expert Report, February 1997.

Before the U.S. District Court, Northern District of Georgia, Testimony in the matter of ValuJet Airlines, Inc., vs. Trans World Airlines, Inc., and Delta Air Lines, Inc. Civil Action No. 1:95-cv-2896-GET. Expert Report, June 1996.

Before the State of Michigan, Testimony in the matter of Wayne State University, Lumigen, Inc. and A. Paul Schaap vs. Irena Bronstein and Tropix. Circuit Court Case No. 88-804-627CK, Court of Claims Case No. 88-11871CM. December 13, 1994.

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

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

Multi-Machine Installations and Changes in Technology Over Time

Equipment Description	PCN	1993	1994	1995	1996	1997	1998
Dockboard/Dockramp, Portable	230000	7.822	7.521	7.619	7.859	3.707	4.316
Platform Elevator/Lift, Portable	230010	9.240	9.406	9.537	9.540	8.572	8.565
Wheel Raiser	230020	1.000	1.333	1.000	1.000	1.000	1.000
Culling Machine	400000	1.436	1.381	1.398	1.418	1.487	1.454
Dual Pass Rough Cull System (DPRCS)	400010	1.304	1.333	1.333	1.333	1.313	1.286
Cancelling Machine, M-36	401000	5.840	5.478	5.850	5.450	5.000	3.600
Cancelling Machine, Mark II	401010	6.679	6.627	6.186	5.912	5.699	5.222
Cancelling/Facing Machine	401020	5.588	5.945	4.487	4.529	4.581	5.976
Cancelling Machine	401030	3.393	3.371	3.303	3.166	3.000	2.954
Canceller Flat	401040	1.821	1.807	1.816	1.824	1.585	1.600
Modification, Mark II Control	401094	1.000	1.000	1.000	1.000	1.000	1.000
Diverter Edger Feeder Attachment	402000	2.754	2.724	2.579	2.545	3.000	2.875
Edger Feeder	402010	6.416	6.313	5.785	5.556	5.220	4.696
Edger Stacker	402020	1.606	1.588	1.606	1.516	1.536	1.500
Inclined Feeder Assembly	402030	7.207	7.022	6.816	6.605	5.385	4.243
Stacker Unit	402040	1.680	1.640	1.717	1.673	2.071	2.036
Vibrator Hopper Assembly	402050	4.000	4.000	1.833	1.571	1.429	1.429
Conveyor	420000	17.303	18.260	19.153	20.058	16.242	16.285
Conveyor, Extendible	420010	3.034	3.066	2.906	2.939	2.522	2.483
Conveyor, Tractor	420030	2.333	2.333	1.833	1.857	1.857	1.875
Dumper, Hamper	420050	5.057	5.336	5.975	6.379	6.565	6.809
Rack, Tray Storage	421000	7.077	6.814	6.340	6.451	3.129	3.133
Strapping Machine, Non-Metallic	422000	9.259	9.467	9.397	9.498	8.238	8.003
Strapping System	422010	4.010	5.004	5.263	5.611	5.498	5.456
Tying Machine	422020	4.962	4.778	5.480	5.357	6.333	5.885
Tractor, Attachments & Accessories	423000	3.034	2.967	4.353	4.179	2.029	2.054
Tractor, Industrial & Farm Type	423010	1.133	1.121	1.121	1.088	1.056	1.077
Tractor, Tow/Tug/Warehouse	423020	9.945	10.255	11.005	11.475	11.435	11.896
Tractor, W/Auto Guidance System	423030	2.444	2.444	2.444	2.750	2.417	2.200
Truck, Fork Lift	423040	5.828	5.943	6.045	6.318	7.174	8.344
Truck, Hand Lift/Pallet	423050	4.436	4.617	5.196	5.576	6.159	6.844
Truck, Lift Specialized System	423060	1.877	1.729	1.773	1.974	2.095	2.247
Carrier, Cargo & Materials	440000	3.267	4.529	4.294	4.235	3.556	3.286
Carrier, Personnel	440010	3.906	3.853	4.200	4.278	3.781	3.667
Scooter	440020	1.364	1.364	1.222	1.222	2.000	2.600
Label Printing System	441000	2.667	4.107	4.277	4.281	3.847	3.656
Printer, Address Label	441010	4.162	4.415	4.566	4.383	2.375	2.133
Dispenser, Label	441020	3.304	3.120	2.354	2.195	1.415	1.338
Feeder, Label Printer	441030	1.333	1.333	1.600	1.600	1.600	1.600
Dispenser, Tape	442000	1.000	1.000	1.000	1.000	1.000	1.000
Rewrap Or Patch-Up Equipment	442010	1.944	1.923	1.905	1.907	1.825	1.693
Scale, Floor Or Platform	443000	4.613	4.730	4.763	4.795	3.276	3.375
Scale, Remote Console/Indicator	443010	2.196	2.185	2.339	2.242	2.192	2.111
Envelope Stuffer / Sealer System	444000	1.125	1.100	1.100	1.100	1.111	1.125
Bulk Conveyor	900000	2.407	2.492	2.366	2.419	2.397	2.449
Fixed Mech Memory Cont Sys	900010	2.286	2.125	3.444	3.444	2.111	2.111
Loose Mail Conveyor System	900020	1.848	1.857	2.022	1.891	1.776	1.784
Mail Preparation System	900030	1.521	1.566	1.615	1.759	2.145	1.982
Monorail Sorting System	900035	3.158	3.050	3.158	3.333	3.294	1.857
Multibelt Sorting System	900040	1.000	1.000	1.000	1.000	1.000	1.000
Multi-Slide	900050	1.396	1.396	1.435	1.476	1.487	1.500
Pallet Unloader	900060	2.263	2.426	2.571	2.723	2.681	2.862
PP Distribution Ring	900070	1.273	1.273	1.273	1.300	1.222	1.286
Tray Transport System	900080	2.468	2.632	2.604	2.725	2.539	2.653
Letter Sorting Machine, Multi Pos	910000	7.012	7.727	7.698	7.484	5.284	3.603
Letter Sorting Machine, Single Pos	910010	2.900	4.275	4.556	4.581	2.938	5.207
LSM Tray Conveyor System	910020	1.611	1.526	1.524	1.524	1.444	1.533

Equipment Description	PCN	1993	1994	1995	1996	1997	1998
LSM - Zip Mail Translator	910030	2.325	2.325	2.260	1.986	1.783	2.481
LSM - Electronic Sort Processor	910034	1.935	1.987	2.000	1.881	1.764	1.640
LSM - Expanded Zip Retrofit	910091	2.273	3.217	3.364	1.738	1.469	1.366
LSM - EZR Maintenance Terminal	910092	1.175	1.175	1.190	1.190	1.167	1.000
LSM Misc Modification Cost	910093	2.417	2.417	2.455	2.455	1.400	1.444
LSM - Vacuum System	910094	1.815	1.841	1.855	1.717	1.478	1.371
Flat Sorter Machine	920000	5.631	8.614	9.546	9.621	9.693	11.329
Flat Sorter Bin Unit	920010	1.667	1.667	1.667	1.667	N/A	N/A
Flat Sorter Cull Unit	920020	1.400	1.208	1.167	1.167	1.000	N/A
Flat Sorter Extractor Unit	920030	2.333	2.333	2.333	2.333	2.500	2.500
Flat Sorter Feed Unit	920040	1.867	1.867	1.793	1.821	1.727	1.619
Parcel Sorting Machine	930000	3.714	2.640	1.463	1.576	1.638	1.932
Small Parcel/Bundle Sorter System	930040	4.016	4.081	3.922	4.078	5.000	5.576
Small Parcel/Roll Sorter System	930050	1.200	1.167	1.222	1.364	1.333	1.313
Sack Sorting Machine	940000	2.500	2.771	2.378	2.467	2.568	2.674
Sack Sort Mach Modification	940099	1.600	1.600	1.250	1.250	1.250	1.250
Bar Code Reader	950000	15.780	19.339	18.490	17.847	9.716	9.648
Small Bar Code Sorter (SBCS)	950010	7.323	7.411	7.400	7.885	9.878	17.029
Delivery Bar Code Sorters (DBCS)	950020	6.743	14.964	20.015	24.773	25.261	26.621
Reader, Optical Character	960000	2.950	3.440	3.574	3.352	4.000	4.638
Reader, Optical Character (OCR/CS)	960010	5.715	6.462	7.031	8.048	9.797	18.613
Remote Bar Coding Image Process Sys	960020	1.000	1.087	1.103	1.123	1.845	2.665
BMC Container Loader/Unloader	970000	3.714	3.714	2.667	8.800	4.464	2.676
Loader/Unloader Modifcation	970009	1.000	1.000	1.000	1.000	1.000	N/A
BMC Inbound-Outbound Tow Conveyor	970010	4.000	4.000	3.000	3.000	3.000	3.000
BMC Parcel Sorting Induction Unit	970020	3.667	3.667	1.000	1.000	1.000	1.000
BMC Parcel Sorting Machine	970022	4.000	24.000	1.000	1.000	1.000	1.333
BMC Parcel Sorting Mach Mod Cost	970029	4.000	4.000	N/A	N/A	N/A	N/A
BMC Process Control System	970030	2.500	2.714	2.000	1.714	1.500	2.875
BMC Sack Shakeout Machine	970040	3.000	3.000	N/A	N/A	N/A	N/A
BMC Sack Sorter And Loader	970050	10.750	10.750	1.500	1.500	1.750	2.000
BMC Towveyor - Internal Tow Conv	970060	2.333	2.667	1.000	1.000	1.000	1.000
BMC Towveyor - Wearbar Lubricator	970062	1.000	1.000	N/A	N/A	N/A	N/A
Install Cost, Non-Fixed Mechanization	999998	2.181	2.181	2.174	2.202	2.180	2.045
Installation Cost Fixed Mechanization	999999	1.149	1.149	1.071	1.075	1.190	1.507

Source: Data from MPE93.txt-MPE98.txt in USPS-LR-I-244.

MODS Group OCR

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	0.725	1.292
	(0.053)	(0.016)
TPH2	-0.005	-0.027
	(0.003)	(0.001)
DPT	0.266	
	(0.022)	
T7	-0.065	
	(0.022)	
T8	-0.123	
	(0.032)	
T9	-0.100	
	(0.038)	
T10	-0.085	
	(0.041)	
T11	-0.134	
	(0.042)	
T12	-0.181	
	(0.044)	
T13	-0.163	
	(0.044)	
T14	-0.154	
	(0.045)	
T15	-0.190	
	(0.045)	
T16	-0.244	
	(0.045)	
T17	-0.234	
	(0.045)	
T18	-0.201	
	(0.045)	
T19	-0.276	
	(0.044)	
T20	-0.320	
	(0.045)	
T21	-0.295	
	(0.045)	
T22	-0.246	
	(0.045)	
T23	-0.281	
	(0.046)	
T24	-0.341	
	(0.046)	
Adj. R2	0.972	0.970

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

MODS Group LSM

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	0.625	0.706
	(0.072)	(0.027)
TPH2	0.015	0.016
	(0.004)	(0.002)
DPT	0.074	
	(0.029)	
T7	-0.097	
	(0.092)	
T8	-0.152	
	(0.145)	
T9	-0.130	
	(0.178)	
T10	-0.054	
	(0.199)	
T11	-0.135	
	(0.212)	
T12	-0.180	
	(0.221)	
T13	-0.128	
	(0.226)	
T14	-0.053	
	(0.229)	
T15	-0.116	
	(0.231)	
T16	-0.181	
	(0.233)	
T17	-0.263	
	(0.234)	
T18	-0.228	
	(0.235)	
T19	-0.370	
	(0.237)	
T20	-0.624	
	(0.239)	
T21	-0.596	
	(0.243)	
T22	-0.612	
	(0.243)	
T23	-0.886	
	(0.246)	
T24	-0.976	
	(0.254)	
Adj. R2	0.898	0.895

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

MODS Group BCS

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	0.787	1.196
	(0.056)	(0.010)
TPH2	-0.013	-0.023
	(0.002)	(0.001)
DPT	0.267	
	(0.027)	
T7	0.022	
	(0.016)	
T8	0.018	
	(0.022)	
T9	0.055	
	(0.026)	
T10	0.058	
	(0.028)	
T11	0.066	
	(0.029)	
T12	0.049	
	(0.03)	
T13	0.100	
	(0.03)	
T14	0.086	
	(0.031)	
T15	0.103	
	(0.031)	
T16	0.132	
	(0.031)	
T17	0.208	
	(0.031)	
T18	0.201	
	(0.031)	
T19	0.204	
	(0.032)	
T20	0.192	
	(0.031)	
T21	0.258	
	(0.032)	
T22	0.260	
	(0.032)	
T23	0.295	
	(0.032)	
T24	0.238	
	(0.032)	
Adj. R2	0.984	0.982

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

MODS Group FSM

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	1.213	1.086
	(0.05)	(0.009)
TPH2	-0.029	-0.011
	(0.003)	(0.001)
DPT	0.041	
	(0.019)	
T7	0.070	
	(0.014)	
T8	0.024	
	(0.019)	
T9	0.094	
	(0.021)	
T10	0.048	
	(0.022)	
T11	0.089	
	(0.023)	
T12	0.020	
	(0.023)	
T13	0.104	
	(0.023)	
T14	0.050	
	(0.023)	
T15	0.082	
	(0.023)	
T16	0.020	
	(0.023)	
T17	0.129	
	(0.023)	
T18	0.064	
	(0.023)	
T19	0.115	
	(0.023)	
T20	0.084	
	(0.023)	
T21	0.179	
	(0.023)	
T22	0.127	
	(0.023)	
T23	0.183	
	(0.023)	
T24	0.136	
	(0.023)	
Adj. R2	0.991	0.987

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

MODS Group Manual Flats

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	1.255	0.919
	(0.037)	(0.007)
TPH2	-0.015	0.006
	(0.002)	(0.001)
DPT	-0.106	
	(0.013)	
T7	-0.001	
	(0.008)	
T8	-0.007	
	(0.014)	
T9	0.011	
	(0.018)	
T10	0.006	
	(0.022)	
T11	0.004	
	(0.025)	
T12	0.008	
	(0.028)	
T13	0.012	
	(0.031)	
T14	0.009	
	(0.033)	
T15	0.010	
	(0.035)	
T16	0.009	
	(0.036)	
T17	0.016	
	(0.038)	
T18	0.001	
	(0.039)	
T19	-0.005	
	(0.04)	
T20	-0.018	
	(0.041)	
T21	-0.005	
	(0.042)	
T22	-0.033	
	(0.043)	
T23	-0.055	
	(0.043)	
T24	-0.084	
	(0.044)	
Adj. R2	0.986	0.986

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

MODS Group Manual Letters

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	1.038	1.037
	(0.038)	(0.007)
TPH2	-0.011	-0.009
	(0.002)	(0.001)
DPT	0.011	
	(0.015)	
T7	-0.024	
	(0.011)	
T8	-0.053	
	(0.017)	
T9	-0.020	
	(0.022)	
T10	-0.046	
	(0.025)	
T11	-0.064	
	(0.028)	
T12	-0.079	
	(0.03)	
T13	-0.036	
	(0.031)	
T14	-0.061	
	(0.032)	
T15	-0.068	
	(0.033)	
T16	-0.079	
	(0.033)	
T17	-0.025	
	(0.034)	
T18	-0.033	
	(0.034)	
T19	-0.040	
	(0.034)	
T20	-0.050	
	(0.034)	
T21	-0.026	
	(0.034)	
T22	-0.049	
	(0.035)	
T23	-0.067	
	(0.035)	
T24	-0.090	
	(0.035)	
Adj. R2	0.990	0.989

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

MODS Group Priority

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	1.032	1.013
	(0.01)	(0.005)
TPH2	-0.003	-0.002
	(0.001)	(0.000)
DPT	-0.003	
	(0.003)	
T7	0.010	
	(0.007)	
T8	0.010	
	(0.008)	
T9	0.014	
	(0.009)	
T10	0.018	
	(0.009)	
T11	0.010	
	(0.009)	
T12	0.013	
	(0.009)	
T13	0.020	
	(0.009)	
T14	0.019	
	(0.009)	
T15	0.024	
	(0.009)	
T16	0.010	
	(0.009)	
T17	0.016	
	(0.009)	
T18	0.021	
	(0.009)	
T19	0.013	
	(0.009)	
T20	0.016	
	(0.009)	
T21	0.017	
	(0.009)	
T22	0.021	
	(0.009)	
T23	0.018	
	(0.009)	
T24	0.015	
	(0.009)	
Adj. R2	0.998	0.998

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

Shape Group Letters
Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	1.140	1.307
	(0.077)	(0.013)
TPH2	-0.026	-0.029
	(0.003)	(0.001)
DPT	0.122	
	(0.038)	
T7	-0.037	
	(0.013)	
T8	-0.068	
	(0.014)	
T9	-0.023	
	(0.014)	
T10	-0.007	
	(0.014)	
T11	-0.052	
	(0.014)	
T12	-0.039	
	(0.014)	
T13	-0.022	
	(0.014)	
T14	-0.014	
	(0.014)	
T15	-0.033	
	(0.014)	
T16	-0.043	
	(0.014)	
T17	0.010	
	(0.014)	
T18	0.017	
	(0.015)	
T19	-0.013	
	(0.014)	
T20	-0.045	
	(0.014)	
T21	0.000	
	(0.014)	
T22	0.013	
	(0.015)	
T23	0.021	
	(0.015)	
T24	-0.046	
	(0.014)	
Adj. R2	0.987	0.987

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

Shape Group Flats

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	0.897	1.036
	(0.036)	(0.007)
TPH2	-0.007	-0.027
	(0.002)	(0.001)
DPT	0.117	
	(0.015)	
T7	0.035	
	(0.014)	
T8	-0.005	
	(0.007)	
T9	0.045	
	(0.011)	
T10	0.011	
	(0.011)	
T11	0.035	
	(0.011)	
T12	-0.013	
	(0.011)	
T13	0.046	
	(0.011)	
T14	0.006	
	(0.011)	
T15	0.026	
	(0.011)	
T16	-0.014	
	(0.011)	
T17	0.064	
	(0.011)	
T18	0.014	
	(0.011)	
T19	0.043	
	(0.011)	
T20	0.019	
	(0.011)	
T21	0.091	
	(0.011)	
T22	0.048	
	(0.011)	
T23	0.081	
	(0.011)	
T24	0.044	
	(0.011)	
Adj. R2	0.996	0.994

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

Shape Group Parcels

Dependent Variable: FHP

Variable	Full Specification	Partial Specification
TPH	1.062	1.221
	(0.101)	(0.028)
TPH2	-0.032	-0.042
	(0.008)	(0.003)
DPT	0.039	
	(0.027)	
T7	-0.055	
	(0.039)	
T8	-0.168	
	(0.058)	
T9	-0.169	
	(0.071)	
T10	-0.107	
	(0.081)	
T11	-0.150	
	(0.088)	
T12	-0.179	
	(0.093)	
T13	-0.153	
	(0.096)	
T14	-0.083	
	(0.099)	
T15	-0.166	
	(0.101)	
T16	-0.216	
	(0.103)	
T17	-0.184	
	(0.105)	
T18	-0.189	
	(0.107)	
T19	-0.314	
	(0.108)	
T20	-0.202	
	(0.109)	
T21	-0.296	
	(0.110)	
T22	-0.316	
	(0.110)	
T23	-0.429	
	(0.111)	
T24	-0.564	
	(0.112)	
Adj. R2	0.798	0.792

Notes and Sources:

1. Data from reg9398.xls and fhp9398.xls, in USPS-LR-I-107 and USPS-LR-I-186, respectively.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation within panels. Standard errors shown in parentheses.

Wage Regression Results: Letters

Missing wage values filled with predicted wages from this regression.
Sample size increased from 6834 to 7296.
R2 = 0.750

Site	Bhat	Se	Site	Bhat	Se	Site	Bhat	Se
1	3.177	0.566	46	3.186	0.566	89	3.226	0.566
2	3.245	0.566	47	3.204	0.566	90	3.184	0.566
3	3.166	0.566	48	3.181	0.566	91	3.141	0.566
4	3.176	0.566	49	3.156	0.566	92	3.160	0.566
5	3.151	0.566	50	3.142	0.566	93	3.171	0.566
6	3.175	0.566	51	3.088	0.566	94	3.161	0.955
7	3.182	0.566	52	3.148	0.566	95	3.170	0.566
8	3.133	0.566	53	3.122	0.566	96	3.093	0.566
9	3.209	0.566	55	3.144	0.566	97	3.172	0.566
10	3.112	0.566	57	3.049	0.857	98	3.099	0.566
11	3.256	0.566	58	3.203	0.566	99	3.096	0.566
12	3.213	0.566	59	3.208	0.566	100	3.168	0.566
13	3.167	0.566	60	3.144	0.566	101	3.129	0.648
14	3.280	0.566	61	3.202	0.566	102	3.118	0.566
15	3.167	0.566	62	3.218	0.566	103	3.106	0.566
16	3.210	0.566	63	3.153	0.566	104	3.204	0.602
19	3.247	0.566	64	3.211	0.566	105	3.127	0.566
20	3.197	0.566	65	3.198	0.566	106	3.093	1.023
21	3.176	0.566	66	3.143	0.566	107	3.103	0.566
22	3.155	0.578	67	3.176	0.566	108	3.151	0.566
23	3.180	0.566	68	3.172	0.566	109	3.221	0.706
24	3.208	0.566	69	3.147	0.566	110	3.157	0.566
25	3.230	0.566	70	3.153	0.566	111	3.172	0.566
26	3.145	0.566	71	3.190	0.566	112	3.148	0.566
28	3.164	0.566	72	3.136	0.566	113	3.134	0.578
29	3.161	0.566	73	3.157	0.566	114	3.165	0.566
30	3.163	0.566	74	3.217	0.566	115	3.133	0.566
31	3.131	0.566	75	3.130	0.566	116	3.098	0.566
32	3.208	0.578	76	3.220	0.566	117	3.228	0.860
33	3.211	0.648	77	3.129	0.566	118	3.177	0.566
34	3.271	0.648	78	3.244	0.578	119	3.115	0.566
35	3.146	0.566	79	3.158	0.566	121	3.082	2.670
36	3.228	0.756	80	3.227	0.566	122	3.131	0.566
38	3.133	0.566	81	3.150	0.566	123	3.144	0.566
39	3.123	0.566	82	3.080	0.566	124	3.220	2.679
40	3.284	0.685	83	3.206	0.566	125	3.191	0.566
42	3.208	0.566	84	3.181	0.566	127	3.135	0.648
43	3.003	0.566	85	3.138	0.566	128	3.135	0.566
44	3.216	0.706	86	3.247	0.616	129	3.144	0.566
45	3.148	0.566	88	3.130	0.902	130	3.160	0.566

Site	Bhat	Se	Site	Bhat	Se	Site	Bhat	Se
131	3.159	0.566	179	3.105	0.566	229	3.148	0.566
132	3.197	0.566	180	3.119	0.566	230	3.155	0.566
133	3.202	0.566	181	3.159	0.566	233	3.240	0.822
134	3.146	0.566	182	3.127	0.566	234	3.141	0.566
135	3.183	0.566	183	3.025	0.566	235	3.220	1.897
136	3.152	0.566	184	3.118	0.566	236	3.047	0.955
137	3.164	0.566	185	3.058	0.578	237	3.204	0.566
138	3.218	0.566	186	3.049	0.566	238	3.081	0.566
139	3.132	0.566	187	3.156	0.566	239	3.168	0.566
140	3.121	0.566	188	3.106	0.566	240	3.125	0.857
141	3.141	0.566	189	3.036	0.578	241	3.173	0.566
142	3.240	0.566	190	3.154	0.566	242	3.116	0.566
143	3.109	0.566	191	3.095	0.616	243	3.162	0.566
144	3.209	0.566	192	3.096	0.592	244	3.079	0.706
145	3.110	0.566	193	3.251	0.566	245	3.157	0.566
146	3.216	0.566	194	3.112	0.566	246	3.198	1.898
147	3.127	0.566	195	3.160	0.566	247	3.189	0.566
148	3.144	0.566	196	3.014	0.633	249	3.136	0.566
149	3.177	0.566	198	3.178	0.566	250	3.171	0.566
150	3.124	0.566	199	3.152	0.566	251	3.114	0.685
151	3.097	0.566	200	3.080	0.566	252	3.126	0.685
152	2.982	0.566	201	3.112	0.566	253	3.200	0.566
153	3.133	0.566	202	3.112	0.566	254	3.173	0.566
154	3.175	0.566	203	3.137	0.566	255	3.179	0.566
155	3.220	0.566	204	3.155	0.566	256	3.054	0.602
156	3.129	0.566	205	3.181	0.566	257	3.169	0.602
157	3.125	0.590	206	3.154	0.566	258	3.132	0.566
158	3.134	0.566	207	3.137	0.566	259	3.193	0.566
159	3.143	0.566	208	3.203	0.566	260	3.125	0.566
160	3.105	0.579	209	3.165	0.566	261	3.154	0.616
161	3.047	0.566	210	3.168	0.566	262	3.176	0.566
162	3.132	0.566	211	3.151	0.566	263	3.132	2.679
163	3.139	0.566	212	3.233	0.566	264	3.171	0.566
164	3.091	0.566	213	3.161	0.566	265	3.133	0.959
165	3.195	0.566	214	3.195	0.566	268	3.137	0.566
166	3.095	0.566	215	3.224	0.566	269	3.227	0.566
167	3.186	0.566	216	3.185	0.566	270	3.161	0.566
168	3.104	0.566	217	3.157	0.566	271	3.139	0.566
169	3.081	0.566	219	3.184	0.566	272	3.120	0.566
170	3.130	0.566	220	3.187	0.631	273	3.149	0.566
171	3.152	0.566	221	3.161	2.679	274	3.078	0.566
172	3.134	0.566	222	3.200	0.566	275	3.147	0.566
173	3.125	0.590	223	3.145	0.566	276	3.193	0.566
174	3.162	0.566	224	3.218	0.566	277	3.158	0.566
175	3.088	0.566	225	3.121	0.566	278	3.133	0.566
176	3.178	0.566	226	3.160	0.566	279	3.069	0.566
177	3.112	0.590	227	3.143	0.631	280	3.214	0.566
178	3.204	0.566	228	3.187	1.547	281	3.158	0.566

Site	Bhat	Se
282	3.129	0.566
283	3.216	0.566
284	3.189	0.566
285	3.257	0.566
286	3.131	0.566
287	3.111	0.566
288	3.202	0.566
289	3.233	0.566
290	3.091	0.566
291	3.080	0.566
292	3.099	0.566
293	3.211	0.566
294	3.127	0.566
295	3.109	0.566
296	3.108	0.566
297	3.294	0.566
298	3.139	0.566
299	3.184	0.566
300	3.124	0.566
301	3.102	1.206
302	3.127	0.566
303	3.134	0.602
304	3.117	0.566
305	3.159	0.566
306	3.155	0.602
307	3.179	0.566
308	3.144	0.566
309	3.124	0.566
310	3.155	0.566
311	3.206	0.578
312	3.185	0.566
313	3.128	0.590
314	3.159	0.566
315	3.214	0.566
316	3.136	0.566
317	3.198	0.566
318	3.144	0.616
319	3.204	0.566
320	3.067	0.566
321	3.125	0.579

Period	Bhat	Se
2	0.002	0.222
3	0.023	0.222
4	0.029	0.222
5	0.010	0.222
6	0.011	0.222
7	0.036	0.222
8	0.045	0.222
9	0.023	0.222
10	0.006	0.222
11	0.024	0.223
12	0.044	0.223
13	0.033	0.223
14	0.035	0.223
15	0.058	0.223
16	0.079	0.223
17	0.068	0.224
18	0.049	0.224
19	0.077	0.225
20	0.096	0.225
21	0.079	0.227
22	0.069	0.226
23	0.105	0.226
24	0.119	0.227

Notes and Source:

1. Data from reg9398.xls in USPS-LR-I-107.
2. Parameters estimated using Ordinary Least Squares.

Wage Regression Results: Flats

Missing wage values filled with predicted wages from this regression.
Sample size increased from 6858 to 7296.
R2 = 0.715

Site	Bhat	Se
1	3.248	0.630
2	3.255	0.630
3	3.204	0.630
4	3.223	0.630
5	3.202	0.630
6	3.180	0.630
7	3.202	0.630
8	3.183	0.630
9	3.202	0.630
10	3.151	0.630
11	3.276	0.630
12	3.272	0.630
13	3.219	0.630
14	3.303	0.630
15	3.204	0.630
16	3.268	0.630
19	3.277	0.630
20	3.207	0.630
21	3.217	0.630
22	3.179	0.642
23	3.204	0.630
24	3.248	0.630
25	3.320	0.630
26	3.187	0.630
28	3.199	0.630
29	3.175	0.630
30	3.199	0.630
31	3.141	0.630
32	3.240	0.642
33	3.259	0.720
34	3.294	0.720
35	3.167	0.630
36	3.251	0.841
38	3.108	0.630
39	3.162	0.630
40	3.319	0.762
42	3.219	0.630
43	3.109	0.630
44	3.214	0.785
45	3.160	0.630
46	3.173	0.630
47	3.227	0.630
48	3.189	0.630
49	3.231	0.630
50	3.153	0.630
51	3.145	0.630
52	3.144	0.630
53	3.122	0.630
55	3.164	0.630
57	3.070	0.954
58	3.234	0.630
59	3.213	0.630
60	3.197	0.630
61	3.204	0.630
62	3.237	0.630
63	3.136	0.630
64	3.222	0.630
65	3.231	0.630
66	3.172	0.630
67	3.172	0.630
68	3.196	0.630
69	3.192	0.630
70	3.227	0.630
71	3.222	0.630
72	3.148	0.630
73	3.195	0.630
74	3.267	0.630
75	3.164	0.630
76	3.246	0.630
77	3.139	0.630
78	3.275	0.642
79	3.195	0.630
80	3.242	0.630
81	3.176	0.630
82	3.099	0.630
83	3.216	0.630
84	3.183	0.630
85	3.161	0.630
86	3.262	0.686
88	3.188	1.004
89	3.304	0.630
90	3.201	0.630
91	3.161	0.630
92	3.180	0.630
93	3.192	0.630
94	3.165	1.063
95	3.189	0.630
96	3.147	0.630
97	3.178	0.630
98	3.151	0.630
99	3.096	0.630
100	3.186	0.630
101	3.143	0.720
102	3.151	0.630
103	3.136	0.630
104	3.251	0.670
105	3.125	0.630
106	3.109	1.138
107	3.116	0.630
108	3.172	0.630
109	3.256	0.785
110	3.171	0.630
111	3.216	0.630
112	3.151	0.630
113	3.156	0.642
114	3.208	0.630
115	3.140	0.630
116	3.112	0.630
117	3.240	0.642
118	3.168	0.630
119	3.159	0.630
121	3.111	2.971
122	3.165	0.630
123	3.226	0.630
124	3.255	2.981
125	3.227	0.630
127	3.149	0.720
128	3.137	0.630
129	3.197	0.630
130	3.178	0.630
131	3.200	0.630
132	3.241	0.630
133	3.252	0.630

Site	Bhat	Se	Site	Bhat	Se	Site	Bhat	Se
134	3.176	0.630	182	3.239	0.630	234	3.164	0.630
135	3.220	0.630	183	3.081	0.630	235	3.237	2.111
136	3.168	0.630	184	3.147	0.630	236	3.080	1.063
137	3.185	0.630	185	3.137	0.630	237	3.230	0.630
138	3.257	0.630	186	3.043	0.630	238	3.092	0.630
139	3.177	0.630	187	3.176	0.630	239	3.184	0.630
140	3.145	0.630	188	3.145	0.630	240	3.152	0.954
141	3.220	0.630	189	3.083	0.642	241	3.190	0.630
142	3.265	0.630	190	3.188	0.630	242	3.121	0.630
143	3.161	0.630	191	3.091	0.686	243	3.159	0.630
144	3.206	0.630	192	3.135	0.658	244	3.125	0.785
145	3.111	0.630	193	3.275	0.630	245	3.183	0.630
146	3.286	0.630	194	3.164	0.630	246	3.232	2.112
147	3.116	0.630	195	3.174	0.630	247	3.227	0.630
148	3.166	0.630	196	3.063	0.705	249	3.149	0.630
149	3.222	0.630	198	3.217	0.630	250	3.187	0.630
150	3.174	0.630	199	3.155	0.630	251	3.145	0.762
151	3.083	0.630	200	3.108	0.630	252	3.146	0.762
152	3.052	0.630	201	3.155	0.630	253	3.212	0.630
153	3.144	0.630	202	3.127	0.630	254	3.182	0.630
154	3.196	0.630	203	3.185	0.630	255	3.180	0.630
155	3.278	0.630	204	3.202	0.630	256	3.080	0.670
156	3.183	0.630	205	3.195	0.630	257	3.198	0.670
157	3.134	0.656	206	3.190	0.630	258	3.148	0.630
158	3.147	0.630	207	3.165	0.630	259	3.189	0.630
159	3.171	0.630	208	3.202	0.630	260	3.158	0.630
160	3.120	0.630	209	3.195	0.630	261	3.169	0.686
161	3.089	0.630	210	3.188	0.630	262	3.199	0.630
162	3.207	0.630	211	3.162	0.630	263	3.143	2.981
163	3.183	0.630	212	3.265	0.630	264	3.178	0.630
164	3.146	0.630	213	3.175	0.630	265	3.153	1.067
165	3.244	0.630	214	3.213	0.630	268	3.189	0.630
166	3.139	0.630	215	3.237	0.630	269	3.243	0.630
167	3.204	0.630	216	3.186	0.630	270	3.241	0.630
168	3.132	0.630	217	3.223	0.630	271	3.198	0.630
169	3.113	0.630	219	3.216	0.630	272	3.188	0.630
170	3.147	0.630	220	3.204	0.702	273	3.180	0.630
171	3.162	0.630	221	3.195	2.981	274	3.127	0.630
172	3.120	0.630	222	3.222	0.630	275	3.195	0.630
173	3.134	0.656	223	3.177	0.630	276	3.203	0.630
174	3.174	0.630	224	3.231	0.630	277	3.226	0.630
175	3.117	0.630	225	3.144	0.630	278	3.190	0.630
176	3.214	0.630	226	3.203	0.630	279	3.098	0.630
177	3.146	0.642	227	3.181	0.702	280	3.252	0.630
178	3.220	0.630	228	3.207	1.721	281	3.201	0.630
179	3.095	0.630	229	3.175	0.630	282	3.201	0.630
180	3.136	0.630	230	3.164	0.630	283	3.248	0.630
181	3.174	0.630	233	3.267	0.702	284	3.235	0.630

Site	Bhat	Se
285	3.271	0.630
286	3.155	0.630
287	3.135	0.630
288	3.240	0.630
289	3.247	0.630
290	3.145	0.630
291	3.133	0.630
292	3.119	0.630
293	3.229	0.630
294	3.189	0.630
295	3.133	0.630
296	3.114	0.630
297	3.343	0.630
298	3.155	0.630
299	3.216	0.630
300	3.133	0.630
301	3.152	1.342
302	3.156	0.630
303	3.189	0.670
304	3.136	0.630
305	3.189	0.630
306	3.165	0.670
307	3.224	0.630
308	3.145	0.630
309	3.151	0.630
310	3.186	0.630
311	3.234	0.642
312	3.228	0.630
313	3.141	0.656
314	3.195	0.630
315	3.232	0.630
316	3.172	0.630
317	3.213	0.630
318	3.166	0.686
319	3.237	0.630
320	3.130	0.630
321	3.189	0.644

Period	Bhat	Se
2	-0.003	0.246
3	0.021	0.245
4	0.027	0.246
5	0.001	0.246
6	-0.003	0.246
7	0.028	0.246
8	0.040	0.246
9	0.016	0.246
10	-0.006	0.246
11	0.018	0.247
12	0.038	0.247
13	0.026	0.247
14	0.024	0.247
15	0.054	0.247
16	0.077	0.248
17	0.064	0.248
18	0.038	0.249
19	0.075	0.249
20	0.092	0.250
21	0.068	0.252
22	0.046	0.251
23	0.093	0.251
24	0.104	0.252

Notes and Source:

1. Data from reg9398.xls in USPS-LR-I-107.
2. Parameters estimated using Ordinary Least Squares.

Wage Regression Results: Parcels

Missing wage values filled with predicted wages from this regression.
Sample size increased from 3895 to 7056.
R2 = 0.725

Site	Bhat	Se	Site	Bhat	Se	Site	Bhat	Se
1	3.173	0.618	49	3.081	0.618	91	3.050	0.929
2	3.186	0.618	50	3.086	1.034	92	3.068	0.889
3	3.109	0.618	51	2.971	2.872	93	3.066	1.029
4	3.130	0.642	52	2.977	2.872	94	3.160	0.742
5	3.079	0.618	53	3.066	0.618	95	3.071	0.618
6	3.085	0.618	54	3.214	2.871	96	3.052	0.817
7	3.145	0.618	55	3.101	0.618	97	3.090	1.181
8	3.079	0.618	57	3.017	2.025	98	3.026	0.743
9	3.109	0.618	58	3.106	0.618	99	3.010	0.742
10	3.048	0.726	59	3.131	0.618	100	3.116	0.686
11	3.219	0.618	60	3.083	0.690	102	3.036	0.789
12	3.144	1.182	61	3.158	0.618	103	3.095	0.930
13	3.124	0.794	62	3.144	0.618	104	3.185	1.034
14	3.267	0.618	63	3.013	0.642	105	2.987	0.817
15	3.096	0.618	64	3.094	0.618	106	3.101	0.765
16	3.201	0.789	65	3.132	0.618	107	3.024	0.618
19	3.263	0.925	66	3.062	0.618	108	3.059	0.618
20	3.114	0.618	67	3.082	0.618	109	3.244	1.658
21	3.151	0.618	68	3.089	0.618	110	3.080	0.790
22	3.068	0.671	69	3.073	0.618	111	3.143	1.034
23	3.126	0.618	70	3.193	0.642	112	3.166	0.972
24	3.189	0.618	71	3.076	0.618	113	3.114	0.742
25	3.180	0.618	72	3.036	0.618	114	3.109	1.298
26	3.084	0.618	73	3.082	0.618	115	2.986	0.707
27	2.832	1.034	74	3.216	0.642	116	2.924	2.025
28	3.140	0.765	75	3.025	0.687	117	3.173	1.097
29	3.106	0.726	76	3.134	0.618	118	3.065	0.769
30	3.124	0.659	77	3.022	0.853	119	3.066	0.618
31	2.993	1.298	78	3.087	0.630	120	3.124	2.025
32	3.143	2.872	79	3.089	0.618	121	3.142	2.036
33	3.210	2.873	80	3.110	0.618	122	3.097	0.742
35	3.151	1.658	81	3.047	0.670	123	3.170	2.855
36	3.213	1.667	82	2.983	0.646	124	3.243	0.848
38	3.049	0.618	83	3.067	0.618	125	3.176	0.848
39	3.047	0.643	84	3.189	1.096	127	3.079	1.658
42	3.171	0.630	85	3.051	0.849	128	3.061	0.646
43	2.982	0.930	86	3.207	1.447	129	3.101	0.618
44	3.100	1.439	87	3.207	0.742	130	3.007	1.028
45	3.086	0.618	88	3.150	2.035	131	3.149	0.618
46	3.091	0.671	89	3.158	2.855	132	3.184	0.618
48	3.011	0.659	90	3.122	1.097	133	3.138	0.618

Appendix E

Site	Bhat	Se
134	3.076	0.618
135	3.131	0.618
136	3.080	0.618
137	3.036	0.618
138	3.140	0.618
139	3.086	0.618
140	3.083	0.618
141	3.167	0.618
142	3.178	0.618
143	3.087	0.618
144	3.139	0.618
145	2.991	0.618
146	3.206	0.618
147	2.963	1.102
148	3.081	0.674
149	3.114	1.034
150	3.088	0.618
151	3.067	1.188
152	2.880	1.188
153	2.953	0.630
154	3.015	0.618
155	3.146	0.618
156	3.120	0.671
157	3.081	1.097
159	3.123	2.025
160	3.154	1.447
161	2.966	1.181
162	3.150	2.037
163	3.111	2.871
164	3.051	0.703
166	3.078	2.025
167	3.133	1.029
168	3.066	1.658
169	2.940	1.658
170	2.951	2.872
171	3.150	2.037
172	3.060	0.618
173	3.079	0.889
174	3.147	1.447
175	3.068	1.181
176	3.131	2.873
177	2.953	2.025
178	3.119	1.029
179	2.943	1.439
180	3.016	2.872
181	3.230	2.871
182	3.204	0.978
183	2.852	2.855
184	3.044	1.667
185	3.036	1.291
186	2.822	1.188
188	3.110	1.448
189	2.907	1.666
190	3.095	1.658
192	3.118	2.036
193	3.206	0.618
194	2.963	0.630
195	3.084	0.618
196	2.972	0.690
198	3.100	0.618
199	3.077	0.618
200	2.974	0.930
201	3.091	0.618
202	3.055	0.618
203	3.073	0.618
204	3.150	0.618
205	3.079	0.972
206	3.074	0.618
207	2.974	0.618
208	3.095	1.291
209	3.066	0.656
210	3.052	0.630
211	3.110	1.182
212	3.188	0.817
213	3.097	0.618
214	3.157	0.618
215	3.190	0.618
216	3.176	0.972
217	3.164	0.618
219	3.109	0.884
220	3.143	2.871
221	3.031	1.181
222	3.142	2.037
223	3.111	0.925
224	3.146	2.872
225	3.108	2.025
226	3.147	1.188
227	3.039	2.871
228	3.188	2.025
229	3.011	1.666
230	3.080	1.182
232	3.117	1.658
233	3.190	1.658
234	3.103	2.872
235	3.218	1.291
236	3.025	0.848
237	3.137	1.029
238	3.054	0.972
239	3.081	2.871
240	3.115	2.872
241	3.020	2.855
242	3.021	0.618
243	3.098	1.440
244	3.047	2.025
245	3.100	0.972
247	3.114	1.658
248	3.103	2.872
249	3.029	1.298
250	3.110	0.618
251	3.131	2.025
252	3.099	2.036
253	3.088	1.181
254	3.097	0.790
255	3.072	1.029
256	2.978	2.855
257	3.117	1.097
258	3.097	1.097
259	3.086	2.025
260	3.087	0.690
261	3.123	1.182
262	3.110	2.872
263	3.078	1.439
264	3.089	0.849
265	3.151	1.440
268	3.120	0.618
269	3.159	0.618
270	3.170	0.618
271	3.122	0.618
272	3.087	0.618
273	3.084	0.618
274	2.972	0.618
275	3.070	0.630
276	3.137	0.618
277	3.146	0.618
278	3.112	0.978
279	3.034	1.182
280	3.131	0.618
281	3.049	0.618
282	3.090	0.618
283	3.153	0.671
284	3.160	0.618
285	3.132	1.291
286	3.087	2.855
287	3.116	0.707

Appendix E

Site	Bhat	Se
288	3.205	2.037
289	3.173	0.790
290	3.063	2.037
291	3.097	1.188
292	3.068	0.765
293	3.150	0.977
294	3.108	1.029
295	3.045	1.658
296	2.988	1.034
297	3.280	1.181
298	3.064	1.188
300	3.075	1.188
301	3.095	2.855
302	3.074	1.291
304	3.084	0.972
307	3.088	1.034
308	2.989	1.668
309	3.086	1.298
310	3.146	2.855
311	3.108	2.025
313	3.032	1.667
314	3.157	2.855
315	3.160	2.873
316	3.104	1.447
317	3.135	1.658
320	3.129	1.447
321	3.211	2.855

Period	Bhat	Se
2	-0.019	0.296
3	0.028	0.308
4	0.024	0.307
5	0.004	0.310
6	-0.016	0.314
7	0.036	0.313
8	0.045	0.311
9	0.026	0.313
10	-0.020	0.313
11	0.027	0.317
12	0.044	0.317
13	0.040	0.319
14	0.022	0.318
15	0.067	0.318
16	0.091	0.318
17	0.088	0.314
18	0.042	0.310
19	0.105	0.309
20	0.121	0.308
21	0.105	0.304
22	0.076	0.301
23	0.139	0.302
24	0.148	0.301

Notes and Source:

1. Data from reg9398.xls in USPS-LR-I-107.
2. Parameters estimated using Ordinary Least Squares.

Labor Demand Estimates for Letters

Variable	Coefficient	Standard Error
TPH	2.001	0.340
TPH2	-0.168	0.009
MAN	-0.066	0.245
MAN2	0.035	0.007
TTREND	-0.114	0.020
TTREND2	0.000	0.000
DPT	-0.258	0.456
DPT2	0.056	0.022
QICAP	-0.163	0.253
QICAP2	0.004	0.006
WAGE	0.769	1.170
WAGE2	0.002	0.226
LNT_M	-0.045	0.012
LNT_TR	0.001	0.001
LNT_D	0.097	0.020
LNT_CAP	0.157	0.013
LNT_W	-0.291	0.097
LNM_TR	0.000	0.001
LNM_D	-0.002	0.016
LNM_C	0.032	0.010
LNM_W	0.158	0.072
TR_D	0.010	0.001
TR_C	-0.005	0.001
TR_W	0.008	0.006
LND_C	-0.164	0.018
LND_W	0.048	0.110
LNC_W	0.118	0.073
QTR2	0.052	0.003
QTR3	-0.004	0.003
QTR4	-0.029	0.003
TPHLAG1	-0.192	0.091
TPHLAG2	0.068	0.088
TPHLAG3	-0.207	0.085
TPHLAG4	-0.399	0.071
TPHL12	0.009	0.004
TPHL22	0.000	0.004
TPHL32	0.012	0.004
TPHL42	0.019	0.003
Adj R2	0.997	
Estimated Rho	0.650	
Sample Size	4807	
Volume Variability	0.663	0.023

Notes and Sources:

1. Data from reg9398.xls in USPS-LR-I-107.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation.

Labor Demand Estimates for Flats

Variable	Coefficient	Standard Error
TPH	2.254	0.314
TPH2	-0.095	0.010
MAN	-0.349	0.184
MAN2	0.010	0.004
TTREND	-0.012	0.018
TTREND2	0.001	0.000
DPT	0.487	0.383
DPT2	0.006	0.019
QICAP	-0.272	0.236
QICAP2	0.017	0.006
WAGE	-0.740	1.128
WAGE2	0.120	0.203
LNT_M	0.047	0.010
LNT_TR	0.001	0.001
LNT_D	0.026	0.017
LNT_CAP	0.011	0.012
LNT_W	-0.105	0.083
LNM_TR	0.001	0.001
LNM_D	0.008	0.014
LNM_C	-0.005	0.010
LNM_W	-0.049	0.048
TR_D	0.004	0.001
TR_C	-0.002	0.001
TR_W	-0.010	0.005
LND_C	-0.044	0.018
LND_W	-0.041	0.085
LNC_W	0.101	0.066
QTR2	-0.012	0.004
QTR3	-0.018	0.003
QTR4	-0.037	0.004
TPHLAG1	0.182	0.101
TPHLAG2	-0.717	0.107
TPHLAG3	-0.157	0.097
TPHLAG4	-0.621	0.077
TPHL12	-0.006	0.005
TPHL22	0.043	0.006
TPHL32	0.011	0.005
TPHL42	0.036	0.004
Adj R2	0.996	
Estimated Rho	0.615	
Sample Size	4774	
Volume Variability	0.857	0.022

Notes and Sources:

1. Data from reg9398.xls in USPS-LR-I-107.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation.

Labor Demand Estimates for Parcels

Variable	Coefficient	Standard Error
TPH	0.052	0.338
TPH2	0.024	0.006
TTREND	-0.100	0.060
TTREND2	0.001	0.000
DPT	-0.657	1.093
DPT2	0.013	0.060
QICAP	2.483	0.751
QICAP2	0.015	0.026
WAGE	-5.313	3.396
WAGE2	0.952	0.570
LNT_TR	-0.002	0.001
LNT_D	-0.023	0.024
LNT_CAP	0.004	0.021
LNT_W	0.141	0.085
TR_D	0.005	0.004
TR_C	0.000	0.003
TR_W	0.006	0.017
LND_C	-0.064	0.062
LND_W	0.484	0.228
LNC_W	-0.618	0.187
QTR2	0.000	0.010
QTR3	-0.045	0.010
QTR4	-0.045	0.009
TPHLAG1	-0.073	0.066
TPHLAG2	-0.008	0.065
TPHLAG3	0.022	0.063
TPHLAG4	0.134	0.060
TPHL12	0.012	0.005
TPHL22	0.004	0.005
TPHL32	-0.001	0.005
TPHL42	-0.010	0.005
Adj R2	0.959	
Estimated Rho	0.589	
Sample Size	3651	
Volume Variability	0.750	0.034

Notes and Sources:

1. Data from reg9398.xls in USPS-LR-I-107.
2. Parameters estimated using FGLS, panel fixed effects estimation, allowing for AR(1) serial correlation.

IOCS Observations: Transition Matrix - from MODS to Classes

	BCS	OCR	FSM	LSM	SPBS	Manual Flats	Manual Letters	Manual Parcels	Priority
First Class	0.7765	0.8435	0.5079	0.9129	0.2227	0.4200	0.7872	0.1996	0.0455
Priority	0.0005	0.0011	0.0186	0.0028	0.2377	0.0243	0.0040	0.2816	0.9082
Express	0.0000	0.0000	0.0001	0.0000	0.0014	0.0005	0.0009	0.0067	0.0079
Mailgram	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
Periodicals	0.0011	0.0005	0.0895	0.0000	0.1023	0.1950	0.0096	0.0377	0.0043
Standard A	0.2195	0.1522	0.3698	0.0761	0.3834	0.3436	0.1877	0.1818	0.0065
Standard B	0.0000	0.0000	0.0078	0.0000	0.0353	0.0107	0.0010	0.2705	0.0072
USPS	0.0024	0.0027	0.0057	0.0083	0.0113	0.0055	0.0089	0.0177	0.0202
Free Mail	0.0001	0.0000	0.0006	0.0000	0.0059	0.0003	0.0006	0.0044	0.0000

Source: 1998 IOCS data in UPS-Sellick-WP2.

MODS Labor Hours Used to Aggregate Mail Volumes Constructed Using IOCS Transition Matrix and 1998 MODS Workhours

First Class	107,089,718
Priority	10,921,907
Express	146,857
Periodicals	7,891,001
Standard A	42,002,705
Standard B	1,493,194

Source: 1998 IOCS Data in UPS-Sellick-WP2 and reg9398.xls in USPS-LR-I-107.