The Effects of Worksharing, Other Product Innovations and the 9/11-Anthrax Attack on U. S. Postal Volumes and Revenues

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Abstract

An econometric model of the demand for U. S. mail service by subclasses and major discount categories is used to estimate the impact of worksharing, other product innovations and the 9/11-Anthrax attack on postal volumes and revenues. The model employs adaptive processes to describe the effects over time of these events on volumes per household and revenues per piece. The estimates confirm the prediction of economic theory that aggregate volume should increase when new service offerings allow postal customers to use the mail more efficiently. The fitted model shows that the product innovations made by the U. S. Postal Service (USPS) beginning in 1976, primarily in the form of discounts for worksharing, were responsible for generating about 37 percent of the total volume of mail and special service transactions by the end of 2003. The volume increases, in turn, have caused an increase in total revenue of about 26 percent despite the lowering of average rates for most subclasses due to the discounts. These percentages will eventually grow to 46 and 27 percent, respectively. With regard to the 9/11-Anthrax attack, the estimates reveal that the Service suffered an initial volume loss of approximately 4 percent and a revenue loss of about 5 percent. Twenty-year projections made with and without the effects of the attack indicate that the Service's real gross revenue loss will eventually surpass $16 billion in constant (2000) dollars and the loss in revenue net of attributable cost will be around $5.7 billion.

1. Introduction

An econometric model of the demand for U. S. mail services by subclass and major discount category has been fit for this paper and is applied to estimate the impacts that worksharing, other product innovations and events, such as the 9/11-Anthrax attack, have had (and will have) on mail volumes and postal revenues.[1]

Since 1975 the U. S. Postal Service (USPS) has made many product innovations creating new categories of services, either directly, as with Express mail and the Priority mail envelope, or indirectly, by unbundling existing services as was done for large mailers with discounts for presorting, prebarcoding and drop shipping. In all of these instances economic theory tells us that postal volumes should have increased *ceteris paribus* after the changes. This occurs because mailers are able to use the new mix of services more efficiently than the old, especially after they have had the time to develop necessary worksharing technologies, and because delivery has always remained a bundled component of all of the offerings. In effect USPS has liberalized potential competitors' access to postal markets but has strictly limited the liberalization to upstream service components involving collection, mail processing and transportation while retaining its monopoly on delivery.

Although mail volumes should have increased, it is not necessarily true that postal revenues would have increased proportionately. Postal revenues may have increased less than

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[1] An early version of the econometric model used in this paper is described in Cohen *et al* (2001).

proportionately, or even decreased, because some existing mail would typically shift categories to obtain a lower discounted rate. This effect usually lowers the revenues per piece received by the Service when mailers are given the opportunity to workshare.

Adaptive processes are used to model the impact of innovations and other events on volume per household and revenue per piece. Innovations are assumed to initiate the processes by creating new, usually higher, equilibrium levels for volumes and new, usually lower, levels for revenues per piece. Actual volumes and revenues per piece then adapt over time at rates that are proportionate to the remaining displacement from the new equilibria.[2] The effects of the 9/11-Anthrax attack are also modeled as adaptive processes in which volumes and revenues per piece grow back to their equilibrium levels after an initial, usually downward, displacement.

The adaptive processes are represented in the equations by variables that follow an exponential time-path from the old equilibrium to the new. Both the size of the displacements caused by innovations and other events, and the rates of adaptation that determine the exponential paths are estimated econometrically. The econometrics is outlined in Appendix A.

The entire econometric model consists of two mostly-matching sets of equations describing quarterly postal volumes per household and revenues per piece in constant dollars. Altogether there are 36 equations for volumes (or volume ratios for discount categories) and 31 equations for revenues per piece at a level of detail generally corresponding to that found in the Service's annual Revenue, Pieces and Weight (RPW) reports (USPS, 1971 to 2004). Readers wishing to examine the estimated equations of the model can find them assembled in 16 tables holding 3 to 4 equations each in Appendix B.[3]

The basic methodology for deriving the historical impact of product innovations is back-casting with the fitted model. Projections of volumes per household and revenues per piece were generated over the sample period beginning at the date of the first innovations for each subclass. The (quarterly) projections were made both with and without the exponential path variables representing the demand effects of the innovations. Direct comparisons of the generated time series disclose how the product innovations have altered volumes per household and revenues per piece over the time periods spanned by the projections.

To estimate the effects of the 9/11-Anthrax attack the model was used to make a combination forecast and back-cast over a twenty-year period beginning with 2001 Q3. These projections were made with and without the adaptive processes describing the effects of the attack.

The fitted model shows that the product innovations made by the U. S. Postal Service (USPS) beginning in 1975 were responsible for generating about 37 percent of the total volume of mail and special service transactions by the end of 2003. The volume increases, in turn, have caused an increase in total revenue of about 26 percent despite the lowering of average rates for most subclasses due to discounts. These percentages will eventually grow to 46 and 27 percent, respectively, when the adaptive processes have run their course. Therefore, upstream liberalizations of access to U. S. postal markets and other product innovations have greatly stimulated the aggregate growth of both U. S. postal volumes and revenues since 1975.

With respect to the 9/11-Anthrax attack, the estimates reveal that the Service suffered an initial volume loss of approximately 4 percent and a revenue loss of about 5 percent. Twenty-year projections made with and without the effects of the attack indicate that the Service's real gross revenue loss will eventually surpass $16 billion in constant (2000) dollars and the loss in revenue net of attributable cost will be around $5.7 billion.

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[2] Strictly speaking, this proportionality applies to the dependent variables of the econometric model which are natural logarithms and logits.

[3] Appendix B is available as a detached .pdf file on the PRC web site at *www.prc.gov*. The site also holds a copy of the Lotus 1-2-3 worksheet used to compile the data, derive the estimates, and construct the various tables and figures.

2. Worksharing and Other Product Innovations

The modern USPS inherited from the federal department it replaced in 1971 a system of postal product offerings consisting entirely of composite services. A composite service combines two or more basic services in given proportions in a single bundle at a single price. Prior to 1971 all mail was collected, transported, processed and delivered exclusively by the Service at undiscounted rates.

This cradle-to-grave marketing doctrine changed in 1976 when USPS began to offer discounts to First-Class mailers for presorting cards and letters. This was soon followed by discounts for other subclasses of mail and for other kinds of worksharing. By 1990 the Service was offering discounts for several levels of presorting, prebarcoding and drop shipping on many categories of First-Class, Priority mail, Periodicals (Second-Class), Standard (Third-Class) mail and Parcel Services. For large mailers, the discounts first offered during this period effectively expanded the Service's original short list of composite services into a much larger menu of simpler composites consisting of bundles of different basic services with delivery always included as part of the mix.

In 1975 USPS also introduced two new services, Express mail and Mailgrams. Later, the Service added more new products such as the two-pound envelope for Priority mail, and made innovations in its pricing formulas such as un-zoned rates up to five pounds for Priority mail.

Offering a larger less bundled selection of services has the same effect on postal demand as offering an a la carte menu to customers in a restaurant. Since delivery is always included in the mix, a more diverse menu of postal services increases the overall volume of mail delivered. This occurs because the expanded list of services usually makes it possible for mailers to choose for themselves a more efficient mix of the basic collection, processing, transportation and delivery services that are included in different proportions in the composites. Overall volume will increase when postal customers are offered a discount for worksharing because the difference between the discount and the lower cost of presorting or drop shipping to mailers who take the discount has the same effect on their demand as a reduction in the price of the original composite. When mailers are offered a new product some of the demand for the new service constitutes new pieces that would not have been mailed in other forms under the old offerings.

The immediate impact of unbundling is limited to mailers with a worksharing cost advantage conferred by the available technology. Similarly, new services and other product innovations have an immediate impact largely on the demands of mailers who have anticipated their introduction. But the immediate effects are not the only, and may not be the most important, stimulus to postal demand resulting from the Service's innovations in its product offerings. The unbundling of basic mail services and the introduction of new services also have the delayed effect of promoting the development of better commercial technologies for generating and processing mail. Mailing is actually a sequence of connected processes beginning with the generation of the mail, which is always performed by the mailer, and ending with delivery, which has always been performed by USPS. Between generation and delivery, the intermediate collection, transportation, and processing activities were performed by USPS until about 1981 using a limited range of simple manual technologies. With the introduction of worksharing, mailers had the opportunity to perform some of these activities for themselves. However, the gain to undertaking a worksharing activity depends upon the mailer having a cost advantage over the offered discount, or being able perform the activity with superior results. Thus worksharing discounts gave mailers an incentive to develop specialized technologies that were cheaper or more effective than those used by USPS for the workshared activities.

As specialized technologies were developed, mail volumes grew as more mailers discovered a cost advantage to performing the activities themselves and taking the discount. USPS has also encouraged the development of more efficient technologies by adapting its own technology and regulations to smooth its interface with large mailers. The discounts for most kinds of

worksharing also tended to increase in relation to the rate for undiscounted mail during the period prior to the general reclassification proceeding of 1995. So the economic incentive to develop better technologies for most kinds of worksharing was maintained or increased by the rate structure for many years following the introduction of the discounts.

3. The 9/11-Anthrax Attack

The 9/11 attack on the World Trade Center directly affected the mail in a number of ways. The attack closed lower Manhattan Island, including a major mail center serving the financial district. Air service was suspended throughout the country for several days and was resumed only gradually at sensitive locations, including Washington's Reagan National airport. All of this produced a sensible degradation in expedited mail service throughout the country and especially in the Northeast. However, the impact of the 9/11 attack on the demand for postal services would probably not have been severe or long lasting were it not for the Anthrax mailings which followed.

Shortly after the 9/11 attack several letters laced with anthrax were sent though the U. S. mail. By early October a number of cases of contact anthrax and inhalation anthrax (the more deadly form of the disease) had appeared and been traced to mail rooms and postal facilities. Ironically, none of the victims were the intended recipients of the letters. All of the victims had been infected indirectly. The original letters had leaked anthrax spores as they made their way through the Service's collection, processing and distribution facilities, contaminating the facilities, the equipment, postal employees and all of the other mail passing through. The letters continued to leak spores at mail rooms and offices at their destinations despite the fact that only one of the letters appears to have actually been opened.

The Service was tardy in its response believing initially that few spores would have leaked from the sealed envelopes and that exposure to small quantities of spores would not be particularly dangerous. As it became apparent that these assumptions were wrong, USPS responded more vigorously. Exposed employees were tested for the disease and put on antibiotics as a preventative. Virtually all of the facilities on the paths of the contaminated letters were closed and tested for the presence of spores, and, when spores were found, they were subjected to a thorough and often lengthy decontamination. Wherever possible, the mail that had passed through the contaminated facilities was quarantined, irradiated and delivered only after long delays. Not all of the contaminated mail was intercepted before delivery, so the Service found it necessary to candidly advise the public of the appropriate precautions for handling possibly contaminated mail and detecting symptoms of anthrax.

Reports of postal volumes during the weeks following the 9/11-Anthrax attack showed that postal customers had reacted measurably to the sudden realization that mail delivery was not as prompt, reliable or safe as had been previously believed.[4] In effect, mailers responded as might be expected to a degradation in service quality by reducing the levels of demand for most postal services.

Given time and no repetition of the events of 9/11 or the anthrax mailings, postal customers may be expected to return to their pre-attack conception of the quality of postal services. When this occurs postal demands should recover to the levels that would have occurred without the attack. Perhaps the best known example of this recovery process before 9/11 was the recovery of Tylenol. In 1982 Tylenol sales evaporated following seven fatal poisonings from tampered capsules. Johnson and Johnson, the makers of Tylenol, retrieved all of the unsafe product that they could lay their hands on, redesigned their packaging to make it tamper-proof, heavily

[4] Postal data systems continuously sample mail volumes. These reports are used to estimate volumes for postal accounting periods that are four weeks long. The reports for the accounting periods immediately before and after the 9/11-Anthrax attack showed a distinct drop in the volumes of most categories of mail.

promoted the relative safety of their new product, and returned to successfully reclaim their normal share of the non-prescription market for pain killers.

4. A Model of Adaptive Processes

Adaptive processes occur whenever postal customers must adapt over time to new market conditions. In the case of worksharing, for example, customers must learn how to exploit the opportunities offered by new partially unbundled composite services. In the case of the 9/11-Anthrax attack, mailers had to relearn the U. S. mail's characteristics of speed, reliability and safety after an event that temporarily degraded all three. Put simply, adaptive processes are often just learning curves, or, in the case of the 9/11-Anthrax attack, a relearning curve.

The demand for new service offerings takes time to develop for a reason that is fundamental to the study of marketing. The demand develops as postal customers learn of the new product and then adapt their personal habits and business practices to use it. It is this process that marketing tries to speed up, since, unassisted, it would proceed only slowly as customers learned mostly from the example of others. However, heavy marketing campaigns for new products have never been a hallmark of USPS. Consequently, the adaptive response of postal customers to new services and to other product innovations may be fairly slow.

Adaptive processes also may take time to develop because adaptation can be costly. In order to do worksharing, it is usually necessary for postal customers to make investments in capital equipment, training and/or computer software. The speed of adoption of new practices is then constrained by customer investment rates.

Even a casual examination of the time series for most major subclasses of mail is sufficient to show that adaptive processes have been important determinants of postal volume since 1975. For example, the volume per household of First-Class letters was declining from 1971 to 1976, leveled off between 1976 and 1982, grew rapidly but at a declining rate from 1982 to 1996, was level again until 2000, and has since declined. This growth pattern corresponds to the growth path one would expect from the introduction of successively less effective innovations beginning with the discounts for basic 3/5-digit presorting in 1976 and ending with the automation discounts accompanying the mail reclassification of 1996. It also tracks closely a simultaneous migration of First-Class letters away from single-piece and into the discounted rate categories.

First-Class letters, cards and Standard mail all exhibit growth paths with periods of rapidly changing demand per household that are much too large to be explained as the response to the usual economic suspects such as long term trends, population growth, relative rate changes and changes in the gross domestic product (GDP). As with First-Class letters, the episodes of rapid growth typically follow in the wake of major innovations in service offerings. Furthermore, the changes usually are accompanied by redistributions toward new discounted rate categories.Parcel Service volume per household after 1985 also exhibits a pattern that is almost impossible to explain except as a slowly developing response by large mailers to new worksharing discounts.

Adaptive processes are represented in the equations of the econometric model by variables whose values follow exponential paths. The assumption that underlies this treatment is that the effect of an adaptive process is proportional to a function $D(t; t_0)$ that is zero for $t \le t_0$ and ranges from zero to one along a time path that obeys a linear differential equation for $t \ge t_0$. The time t_0 corresponds to the date that the adaptive process begins. The linear differential equation that sets the time path of $D(t;t_0)$ after t_0 is $\frac{dD(t;t_0)}{dt} = r[1 - D(t;t_0)]$. The equation makes the rate of change in the level of $D(t;t_0)$ proportional to the difference remaining between $D(t;t_0)$ and it's limiting value of one. The coefficient r is the rate of adaptation for the process. If time is

measured in years then r is roughly equal to the fraction of the difference, $1-D(t;t_0)$, that the adaptive process attempts to make up each year. The solution to the linear differential equation is $D(t;t_0)=1-e^{-r(t-t_0)}$ for $t \geq t_0$. Therefore, the effect of the adaptive process is represented as a path beginning at the time t_0 and growing exponentially over time at the rate r from an initial value of zero towards a limiting value of one.

$D(t;t_0)$ is a continuous function of time, however, the econometric model is necessarily specified for variables measured over finite intervals. Therefore, the variables that are used as regressors in the equations of the econometric model are averages of $D(t;t_0)$ over calendar quarters. For a quarter beginning at time t_1 and ending at t_2 the average value of the variable, $\overline{D}$, is found by evaluating the integral $\overline{D}=\int_{t_1}^{t_2}\frac{D(t;t_0)}{(t_2-t_1)}dt$. The form of the integral depends upon whether the start of the adaptive process occurs after the end of the quarter, during the quarter, or before the quarter begins. The three cases are:

1. $\overline{D}=0$, if $t_1 < t_2 \leq t_0$,
2. $\overline{D}=\frac{(t_2-t_0)}{(t_2-t_1)}+\frac{\left(e^{-r(t_2-t_0)}-1\right)}{r(t_2-t_1)}$, if $t_1 < t_0 < t_2$, and
3. $\overline{D}=1+\frac{\left(e^{-r(t_2-t_0)}-e^{-r(t_1-t_0)}\right)}{r(t_2-t_1)}$, if $t_0 \leq t_1 < t_2$.

For product innovations, an exponential path variable, $\overline{D}$, is inserted directly in a linear equation $Y=\alpha+..+\beta\overline{D}+....$ The equation may then be fit by standard econometric methods for a given rate of adaptation r. The coefficient β becomes the asymptotic limit to the change in the dependent variable Y for the adaptive process. It is the change in the equilibrium level of Y that triggers the process at the time t_0. It is also the addition to Y that occurs as $\overline{D}$ approaches its limiting value of one.

For the 9/11-Anthrax attack $\overline{D}$ is subtracted from an ordinary dummy variable to obtain a variable $\overline{R}$ that is inserted in the linear equation $Y=\alpha+..+\beta\overline{R}+..etc.$ $\overline{R}$ is called a reverse exponential path variable because the adaptive process returns the dependent variable Y to its original level after an initial disequilibrating change at time t_0. This equation can also be fit by standard econometric methods for a given r. As before, there are three cases for the dummy variable:

1. $\overline{R}=0$, if $t_1 < t_2 <= t_0$,
2. $\overline{R}=\frac{\left(1-e^{-r(t_2-t_0)}\right)}{r(t_2-t_1)}$, if $t_1 < t_0 < t_2$, and
3. $\overline{R}=\frac{\left(e^{-r(t_1-t_0)}-e^{-r(t_2-t_0)}\right)}{r(t_2-t_1)}$, if $t_0 <= t_1 < t_2$.

The coefficient β is the amount of the initial change in Y that sets the adaptive process in motion at t_0. It is also the amount that Y recovers as demand returns to normal.

An econometric model incorporating the exponential path variables $\overline{D}$ and $\overline{R}$ to describe the impact of product innovations, the effects of the 9/11-Anthrax attack and other events

changing postal market conditions comprises a technical advance beyond the common econometric practice of representing the impact of such events with ordinary dummy variables. In fact, when an ordinary dummy is used to approximate an adaptive process, the resulting coefficient tends to underestimate the impact of the event. This occurs because the coefficient for the ordinary dummy measures an average effect on Y that is present when the dummy variable is set to one and is absent otherwise. The average effect of an innovation will include smaller effects during many early quarters when postal customers have only partially adapted to the new or improved service. With an event such as the 9/11-Anthrax attack, the coefficient for the ordinary dummy will include in the average the impact for later quarters after the initial impact has somewhat attenuated. In both cases the result is an underestimate.

Each exponential path variable used in the econometric model is completely defined by just two parameters – the initial time t_0 and the rate of adaptation r. The initial dates for postal product innovations and events such as the entry of postal competitors were taken from postal sources.[5] The date for the 9/11-Anthrax attack was chosen as September 11, 2001 even though the anthrax mailings were unknown until several weeks later. All of the initial times for the exponential paths were treated as fixed and given in the econometrics. The same rate of adaptation is used for all the exponential path variables found in the equations pertaining to a single class or, in some cases, a large subclass. For example, the model includes eight different equations to explain the collective demand behavior of mailers of First Class Letters. Each of the equations includes between one and six exponential path variables for innovations and one reverse exponential path variable for the 9/11-Anthrax attack. A single annual rate of adaptation is used to define all of these variables.

Figure 1 exhibits the way postal volumes are altered over time by adaptive processes. The curves in the figure follow the reverse exponential paths used in the model to represent the effects of the 9/11-Anthrax attack on several categories of mail. The paths are shown as percentages of volume per household without the attack, i.e., the horizontal line at 100 percent represents the path of demand without the attack. For most, but not all, subclasses of mail and services the immediate effect of the attack was to depress volumes per household. However, the percentage changes differed considerably from one subclass to another. They are approximated by the percentages shown in Figure 1 for the fourth quarter of 2001. These immediate effects are determined by the coefficients of the exponential path variables in the fitted equations of the model.[6]

The paths also differ with respect to the speed of recovery. The estimated rate of adaptation for parcel services is only 13.91 percent per year. Therefore, the exponential path for Parcel Post returns to the pre-attack equilibrium so gradually that the effects are still significant many years later. At the other extreme is Periodicals with a rate of adaptation of 60.94 percent. The effects of the attack on this class have largely disappeared by the fourth quarter of 2003, the quarter of the last observation in the time series used to fit the model.

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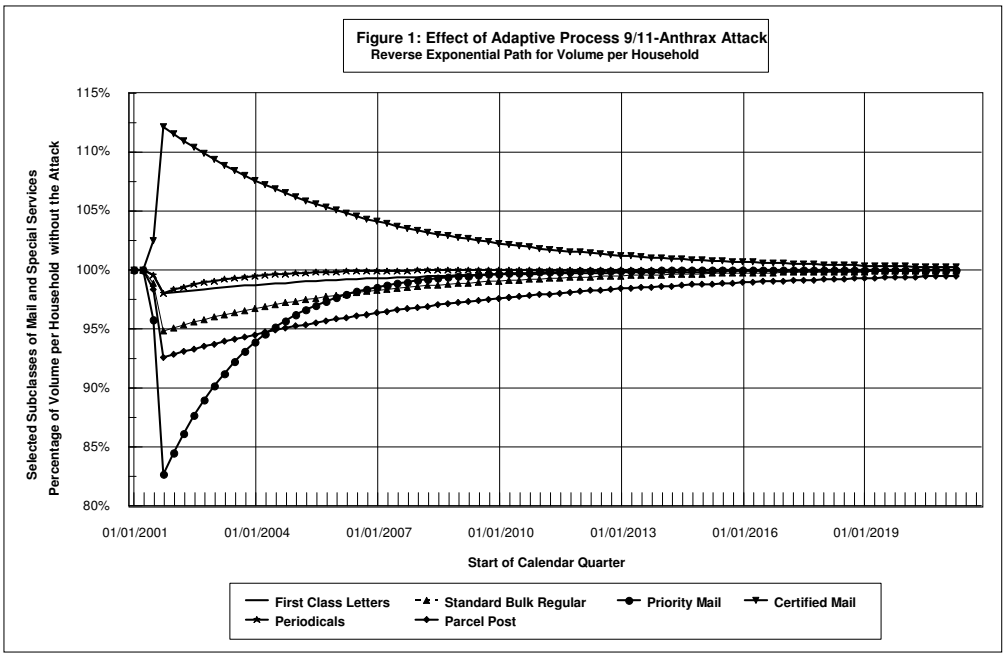
[5] The most important of these sources is the Domestic Mail Rate History filed by USPS with the PRC for every general rate proceeding. Most of the initial dates used to define exponential path variables for the introduction of worksharing discounts, new postal services and other product innovations were taken from the Service's R2001-1 filing (USPS 2001). In several instances dates have been obtained from the testimony of Service witnesses Thress (2001) and Musgrave (2001), or from USPS Library References (USPS, 2001).

[6] The immediate effects of the 9/11-Anthrax attack are slightly larger in magnitude than the percentage changes shown in Figure 1 because the fourth quarter value is an average effect taken over the period from 10-01-01 to 12-31-01. Since the attack occurred on 09-11-01, volumes per household in the fourth quarter have already attenuated slightly from the date of the attack.



There are both theoretical and practical reasons for adopting a one-size-fits-all assumption for the rate of adaptation for equations grouped together by a class or large subclass. First, an exponential path variable for the same innovation or event often appears in several of the equations for a class or subclass. The representations for each innovation or event ought to mirror each other in these equations. Second, the rates of adaptation for different innovations and events should roughly be the same if they describe similar behavior by a single group of mailers. When an adaptive process is a learning curve, the rate of adaptation is the underlying rate at which mailers acquire and act on new information and should not differ too much with respect to what is being learned. When adaptive processes are constrained by capital formation, the rates of adaptation should also be similar.

The practical reason for using a single rate of adaptation for a single class/subclass everywhere in the model is that the maximum likelihood method of estimating these rates is not particularly robust. Formally, the model can be generalized fairly easily by introducing unique rates of adaptation for each of the adaptive processes affecting demand. However, relaxing the single-rate assumption in this way, while complicating the econometrics, would be unlikely to lead to a better understanding of mailer behavior.

5. An Outline of the Complete Model

The model comprises a complete system of fitted equations describing U. S. postal volumes and revenues for domestic mail and special services at a level of detail that is approximately the same as that found in the Service's annual RPW reports (USPS, 1971 to 2004). International mail volumes and revenues are treated as aggregates.

There are two sets of equations with mostly matching explanatory variables. The first set describes volumes per household by subclass and major discount category. The second set describes revenue per piece for the same subclasses and categories. The first set of equations, but not the second, have a rough counterpart in the demand model that the Service must submit to the PRC at the start of an omnibus rate proceeding.[7]

[7] The PRC's current rules (PRC 2004, 52) require the submission of "an econometric demand study relating postal volumes to their economic and non-economic determinants…" The most recent filed

Projections of postal volumes alone may be made with the first set, but projections of postal revenues require both sets of equations. The second set of equations is needed because postal revenues per piece may be expected to respond to all of the same influences as postal volumes per household. The volumes and revenues given in the RPW reports are actually vast aggregates of somewhat heterogeneous pieces of mail and transactions. Since 1971 postal tariffs for mail and special services have undergone many structural changes and have become quite complex, especially for large mailers. As a result mailers now respond to changing rates and other market conditions not only by changing the volume of mail sent but also by changing the characteristics of the pieces or by choosing different combinations of worksharing. When mailers do this it affects the average revenue per piece.

USPS, in its filings, and the PRC, in its recommended decisions, employ behavioral equations to forecast volumes but not to project revenues per piece. Instead, both make calculations based on the simple assumption that the relative proportions of mail with different characteristics found in an annual survey of mail and services will not change.[8] Revenues are estimated by applying new rates to forecasts of volumes with an unchanged distribution of characteristics. In effect, revenues per piece are assumed to be unit-elastic with respect to a fixed-weight average of the rates.

There is little about this assumption that seems attractive as a description of economic behavior. Faced with a complex tariff based not only on pieces but frequently also on their weights, dimensions, content, size of mailing, entry point, destination, workshared characteristics, etc., mailers will re-optimize their selection of services and discounts whenever rates and other market conditions change. These re-optimizations can be expected to alter the characteristics of the mail in ways that predictably relate revenues per piece to postal rates and to the other determinants of postal demand. Therefore, a complete model of the demand for postal services should include behavioral equations for revenues per piece rather than depend upon the simplistic assumption that the relative proportions of the mail with different characteristics remain fixed.

The overall design of the volume equations in the model partly reflects a need to preserve degrees of freedom for the econometrics. A problem arises because the Service has occasionally revised its RPW reports to disaggregate mail streams into sub-streams in order to report workshared mail in greater detail. This has occurred several times with all four subclasses of First-Class and Standard mail, most recently in 1996. A model that simply adopted the categories currently in use in the definitions of its dependent variables would limit the econometrics to using time series that began in 1996 even though there are quarterly RPW reports of volumes and revenues using more aggregated category definitions that reach continuously back to 1971.

A solution to the problem is to fit an equation for aggregate subclass volume using the entire sample, and then to fit equations for subsequent subdivisions of the aggregate using the shorter time series that start later after USPS had begun reporting the components. The equations for First-Class letters illustrate how this is done. First, an equation for volume per household is fit to the entire sample for total First-Class letters. The next equation explains the division of First-Class letters into single-piece and worksharing segments. This equation is a logit that is fit to the sample beginning in 1976 after the Service began reporting single-piece and workshared mail

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version of this model, submitted for the R2001-1 general rate proceeding, is described at considerable length in the testimony, workpapers, responses to interrogatories and library references of Service witnesses Thress (2001) and Musgrave (2001).

[8] The results of these surveys are called "billing determinants". They are estimates of the weights, numbers of pieces by shape, or whatever, to which each element of the postal tariff applies. The billing determinants for a recent base year are filed by the Service for every general rate proceeding , for example, see USPS (2001).

separately.[9] Another logit explains the division of workshared letters into its carrier-route presorted and non-carrier-route presorted components. The time series for the fit of this equation begins in 1981. The subdivision of non-carrier-route presorted mail into automation and non-automation components is explained by a final logit. This last equation is the only one in the set whose fit must be made using a short time series beginning in 1996.

6. Determinants of the Demand for Mail and Postal Services

Except for the exponential path variables, the model relies on standard economic determinants of demand and on conventional forms for the variables representing their effects. The dependent variable for each equation is the natural logarithm of either volume per household, the volume ratio for two rate categories (a logit), or, revenue per piece in constant dollars. All of the explanatory variables, except for dummies, trends and exponential path variables, appear in the equations as natural logarithms. This includes the variables relating the dependent variables to levels of economic activity, indexes of U.S postal rates, prices of competitive services, and other measures of market conditions. The equations are linear in the transformed variables with additive disturbances.

The determinants of postal demand and the ways they are represented in the equations are as follows.

Demographics – Mail is the sum of messages and packages exchanged over the postal network by individuals, households, businesses, nonprofit organizations and government agencies. Volumes should be roughly proportional to the number of participants. However, the number of postal customers is not known and must be represented indirectly by a demographic measure. The overwhelming bulk of postal transactions involve a household at either the sending or the receiving end. Therefore, the equations use RPW volumes converted to calendar quarters and divided by the number of domestic households from the Census (2003). Income and other activity variables found in the equations as regressors are expressed as flows per quarter per household. The equation for Classroom mail also includes the school age (5 to 21 years of age) population per household as an explanatory variable.

Long Term Trends – Gradually encroaching indirect competition forms the background economic environment for most non-competitive subclasses. "Gradually encroaching indirect competition" is a term that describes the effect of the telegraph, telephone, newspapers, radio, television, messenger services, time-shared computers, faxes, e-mails, the Internet and cell phones. In fact the term applies to any alternative method for communicating messages between the same points served by the postal network. In the case of competitive services, the effects that predominate in the long run are the entry and growth of successful direct competitors such as United Parcel Service and Federal Express. All but four of the equations include a linear trend beginning with the quarter corresponding to the first observation in the time series to which they are fit. The four exceptions are four logit equations that must be fit to time series beginning only in 1996.

Seasonality – The volumes per household and revenues per piece for most categories of mail exhibit seasonal patterns that are clearly evident when volumes are plotted against time. The reason for the seasonality is that some of the mail is closely linked to social customs and business practices that are also seasonal (e.g., Christmas mail). All of the equations therefore include an intercept and dummy variables for the second, third and fourth quarters of the calendar year. These would suffice if social customs and business practices did not change over time. To

[9] Suppose that a variable has two components, e.g., $Y = Y_1 + Y_2$. The logit is defined as the natural logarithm of the ratio of the components $\lambda = \ln(Y_1 / Y_2)$. The logit divides Y into its components as follows: $Y_1 = Ye^{\lambda}/(1+e^{\lambda})$ and $Y_2 = Y/(1+e^{\lambda})$.

account for changes in the seasonal patterns, the equations also include seasonal trends obtained by interacting the seasonal dummies with the linear trend.

Reclassifications, Redefinitions and Eligibility Changes – One time shifts in the volumes and revenues in the Service's RPW reports are occasionally caused simply by revisions in the ways that these variables are defined, measured and reported. On other occasions changes in the Service's eligibility rules have caused sudden migrations of mail from one category to another that are largely involuntary. Changes of these kinds can be represented by simple dummy variables because the changes are instantaneously and do not occur as the result of an adaptive process. Suitably defined simple dummy variables have been included in selected equations for the redistribution of government mail that occurred in 1988, for the MC95-1 reclassification that took effect in 1996, for the separate accounting of return receipts in 1996, and for a heterogeneous collection of subclass-specific changes in eligibility, sampling methods and RPW reporting.

Market Conditions – Postal markets have been transformed from time to time by the entry and exit of competitors such as Federal Express, by the business decisions of major customers such as Sears' discontinuation of catalog mailings, by the misfortunes of competitors such as strikes by United Parcel Service's delivery men, and by pricing anomalies such as the ones that have sometimes made First-Class cards cheaper than comparable Standard cards. When a change in market conditions can be related to a specific dateable cause, the effect is represented in the equations by an exponential path variable or by a simple dummy variable, depending upon whether the circumstances require adaptive behavior by mailers or not. In some other cases, for example, to represent the effect of the maximum weight for a First-Class letter on Priority mail, a tracking variable has been inserted in the equations.

Economic Activity – USPS surveys of the composition of the mail stream have always shown that the mail is primarily business-driven. The volumes in most categories are derived demands that arise from the broad range of other production, distribution and marketing activities taking place in the economy. This argues that the demand for postal services is related to economic activity in a way that is best represented by broad aggregate measures of income and product. The measure of general economic activity that is used in all-but-one of the equations is the constant dollar Gross Domestic Product (GDP) per household. The series that is used is the chained GDP in year 2000 dollars (U. S. Dep't. of Commerce 2004).

Special Services – Special service transactions are complementary services to First-Class letters, Priority mail or Parcels. These complementary relationships are represented in the model by the inclusion of First-Class letters, Priority mail and Parcel Post pieces per household in the equations for their complementary special services.[10]

Worksharing and Other Product Innovations –The effects of these innovations are represented in the equations by exponential path variables as described earlier. Typically, several such variables appear in an equation, one for each major product innovation that has occurred since the start of the time series used to fit the equation. Variables are not included for innovations that predate the time series.

9/11-Anthrax Attack – A reverse exponential path variable for the effect of the 9/11-Anthrax attack is included in every equation. All of these paths are assumed to begin on 9/11/2001 and to converge over time to zero, i.e., it is assumed that the effects of the 9/11-Anthrax attack are disappearing without leaving any permanent changes in volumes per household or revenues per piece. It is also assumed that the rates of adaptation for the reverse exponential path variables of the attack are the same as the rates for the exponential paths representing the effects of product innovations.

[10] The equations for Special Services were fit last using the predicted values for First-Class volume per household etc. This procedure avoids an errors-in-variables bias that would arise from using the series for First-Class letters etc. as regressors without the errors removed.

Postal Rates and the Rates of Substitutes – The demand functions for monopoly services like First-Class letters can be expected to be fairly price-inelastic because of the absence of direct competition and because postage is rarely large in proportion to a person or business's total outlay. Services with direct competition like Priority mail should tend to have more price-elastic demands since mailers have the option of switching to a similar service offered by a postal competitor when USPS raises its rates. The rates enter the demand equations in the deflated form of fixed-weight indexes divided by the implicit deflator for the GDP. The fixed weights for the indexes are derived from postal billing determinants for either GFY 1997 or GFY 2000[11]. Billing determinants were not available for International mail, Mailgrams or Special Delivery. For these subclasses rates were represented by revenue per piece divided by the GDP deflator. No rates appear in the equations for Penalty mail or Free-for-the-Blind mail. All of the rates found in the equations are unlagged. If the expectations of postal customers are rational, there should be no lags in the responses of demand to changes in any of the rates. A lagged response may occur only when postal customers are surprised by the change. Relative postal rates mirror the general level of prices in the economy between rate proceedings; changes that emanate from rate proceedings are preceded by many months of public consideration by the PRC. So, postal customers have little trouble anticipating changes in the relative rates that they will pay several quarters into the future. This fact makes mechanical lagged responses to rate changes incompatible with modern theories of rational economic behavior.

Auto Regressive Disturbances – The sources of errors in quarterly observations of volumes per household and revenues per piece are diverse and may include causes that persist for more than a quarter or tend to recur seasonally for several years. The model copes with these possibilities by treating the disturbances as auto regressive. Specifically, the current disturbance for each equation is assumed to be a linear function of the disturbances for each of the preceding four quarters plus a serially uncorrelated error. This is known as an AR-4 process.

Estimation procedures for the AR-4 process and for the rates of adaptation used to derive the exponential path variables are described in Appendix A.

7. First-Class Letters

The equations for First-Class letters are generally characteristic of the equations that have been fit for all subclasses and rate categories. This similarity exists because the individual equations were derived by adapting a single common prototype equation with as few alterations as possible. Table 1 shows how the prototype was adapted to obtain the four estimated equations that describe volume per household for the various RPW categories of First-Class letters. All of the equations in Table 1 are fit to the same basic set of regressors, so the equations are structurally similar except for the dependent variable. The same regressors are included in every equation where they might reasonably be expected to have influenced the demand behavior, whether the resultant coefficients are statistically significant or not.

The revenue-per-piece equations for First-Class letters are shown in Table 2. The regressors for these equations exactly match the regressors found in the corresponding volume-per-household equations. The reason for this mirroring is that the matched equations are just different manifestations of the same economic behavior. Volume per household and revenue per piece for a mail category are determined simultaneously by postal customers when they confront a complex postal tariff. As postal customers respond to changes in the regressors by changing

[11] Most of the fixed-weight indexes used to fit the model were derived by modifying and consolidating USPS worksheets submitted to the PRC for the R2001-1 rate proceeding. In several instances the worksheets provided a choice of 1997 or 2000 billing determinants for computing the indexes. The 1997 billing determinants were usually selected. The fixed-weight indexes were calculated as averages for the calendar quarters.

volumes they simultaneously reoptimize weight, piece shape, discounts taken, and every other billing determinant - all of which affects revenue per piece.

Shown at the bottom of Tables 1 and 2 are the rate of adaptation for all of the First-Class letters equations, confidence intervals for 90, 95 and 99 percent significance tests, and the coefficients of the AR-4 process for each equation.

The estimates also include t-values computed from the final variance-covariance matrices for three combinations of the coefficients. The first combination is the sum of the coefficient of the linear trend plus 0.0151 times the coefficient of GDP per household. GDP per household has increased at an average annual rate of 1.51 percent since 1971, so this sum describes the long-term trend of the dependent variable for each of the equations.

Table 1. First-Class Letters Volume

Calendar Quarter Volumes per Household and Volume Ratios

Regressor	Effective Date	Ln 1st Cls Ltrs/ Household		Logit Single-Piece/ Work Shared		Logit Car-Rte Presort/ Non-Car.-Rte		Logit Automated NCR/ Non-Automated	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		4.170	12.214	3.325	3.064	-9.719	-1.282	6.844	0.701
2nd Quarter Seasonal Dummy Variable		-0.017	-1.754	0.047	2.769	0.110	1.570	0.046	2.042
3rd Quarter Seasonal Dummy Variable		-0.075	-9.538	0.017	0.954	0.076	1.036	0.053	1.777
4th Quarter Seasonal Dummy Variable		0.096	10.010	0.174	10.711	-0.010	-0.152	0.055	2.339
Linear Trend		-0.019	-5.305	-0.014	-0.656	-0.297	-3.878		
2nd Quarter Dummy Times Trend		-0.001	-2.857	-0.004	-3.644	-0.008	-1.529		
3rd Quarter Dummy Times Trend		0.000	1.004	-0.002	-1.856	-0.006	-1.021		
4th Quarter Dummy Times Trend		-0.003	-6.645	-0.008	-8.237	0.001	0.283		
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	-0.033	-3.349	0.055	1.990	0.140	1.287		
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	-0.002	-0.209	0.062	2.183	-1.093	-4.425	0.695	2.468
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.242	2.869	0.091	0.331	1.183	0.618	-1.003	-0.466
3/5-digit Presort Introduction (Exponential Path from the Effective Date)	07/06/1976	0.171	4.447	-3.419	-12.032				
Carrier-Route Presort Introduction (Exponential Path from the Effective Date)	03/21/1981	0.199	7.272	0.273	3.021	7.695	8.688		
Zip+4 Discount (Exponential Path from the Effective Date)	10/09/1983	0.171	4.236	0.176	1.478	-2.275	-3.942		
5-digit Prebarcode Discount (Exponential Path from the Effective Date)	04/03/1988	0.034	1.215	0.016	0.205	1.299	3.956		
3-digit Prebarcode Discount (Exponential Path from the Effective Date)	02/03/1991	0.094	2.827	-0.313	-2.906	1.184	3.050		
MC95-1 Automation Discounts (Exponential Path from the Effective Date)	07/01/1996	0.039	1.130	-0.220	-1.813	0.492	1.076	1.551	2.857
911 Attack/Anthrax Letters (Reverse Exponential Path from 9/11)	09/11/2001	-0.021	-1.921	-0.035	-1.017	0.237	1.782	0.047	0.605
First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.165	-2.679						
First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.037	0.642						
Single-Piece First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.667	-1.063				
Workshared First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.467	0.717	3.871	1.139	6.054	0.560
Carrier-Route First Class letters Rate (Ln of Fixed-Weight Index/GDP Deflator)						-3.291	-1.030		
Automated Non Car-Rte First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)								-4.579	-0.431
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		-0.016	-3.843	-0.013	-0.607	-0.279	-3.989	-0.015	-0.466
Sum of Coefficients for all Innovations (3/5-digit Presort to MC95-1 Automation)		0.708	5.805	-3.487	-5.645	8.395	5.126	1.551	2.857
Sum of Coefficients for all Postal Rates (1st Cls Letters to Auto Non Car-Rte Letters)		-0.129	-4.397	-0.200	-1.581	0.580	0.963	1.475	2.448
Regression Diagnostics		Adj. R^2	0.988	Adj. R^2	0.998	Adj. R^2	0.956	Adj. R^2	0.970
		Std. Error	0.013	Std. Error	0.037	Std. Error	0.117	Std. Error	0.052
		d.f.	106	d.f.	86	d.f.	68	d.f.	19
Estimated Annual Rate of Adaptation	19.86%	AR-1	0.003	AR-1	0.081	AR-1	0.203	AR-1	0.763
99 Percent Confidence Interval	+/- 11.70%	AR-2	0.104	AR-2	-0.043	AR-2	-0.022	AR-2	-0.480
95 Percent Confidence Interval	+/- 9.34%	AR-3	-0.036	AR-3	0.023	AR-3	-0.069	AR-3	0.184
90 Percent Confidence Interval	+/- 8.17%	AR-4	0.215	AR-4	-0.277	AR-4	-0.057	AR-4	-0.206

Table 2. First-Class Letters Revenue per Piece

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln 1st Cls Ltrs Real Rev/Pc		Ln Single-Piece Real Rev/Pc		Ln Car-Rte Real Rev/Pc		Ln Automated Real Rev/Pc	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-0.500	-2.135	0.281	0.922	0.607	0.745	-0.645	-1.181
2nd Quarter Seasonal Dummy Variable		0.007	1.958	0.004	0.972	0.021	2.196	0.007	2.906
3rd Quarter Seasonal Dummy Variable		0.009	2.701	0.002	0.460	-0.001	-0.105	-0.003	-1.442
4th Quarter Seasonal Dummy Variable		-0.013	-3.733	-0.016	-4.407	-0.020	-2.089	0.001	0.445
Linear Trend		0.004	2.020	-0.003	-0.474	0.007	0.783		
2nd Quarter Dummy Times Trend		0.000	1.053	0.001	3.485	-0.001	-1.054		
3rd Quarter Dummy Times Trend		-0.000	-1.314	0.000	1.753	0.000	0.304		
4th Quarter Dummy Times Trend		0.001	3.688	0.001	4.206	0.002	2.140		
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	0.004	0.572	-0.013	-1.879	-0.021	-1.703		
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	0.007	1.032	0.008	1.089	-0.044	-1.529	0.042	1.251
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.100	1.729	-0.121	-1.591	-0.149	-0.724	0.074	0.594
3/5-digit Presort Introduction (Exponential Path from the Effective Date)	07/06/1976	0.031	1.338	-0.009	-0.132	0.033	0.418		
Carrier-Route Presort Introduction (Exponential Path from the Effective Date)	03/21/1981	-0.060	-3.505	0.073	2.885	-0.005	-0.093		
Zip+4 Discount (Exponential Path from the Effective Date)	10/09/1983	-0.023	-0.870	0.000	0.016	-0.103	-2.939		
5-digit Prebarcode Discount (Exponential Path from the Effective Date)	04/03/1988	-0.017	-0.951	0.018	0.791	0.043	1.021		
3-digit Prebarcode Discount (Exponential Path from the Effective Date)	02/03/1991	-0.041	-1.942	0.075	2.651	-0.014	-0.304		
MC95-1 Automation Discounts (Exponential Path from the Effective Date)	07/01/1996	-0.058	-2.787	0.068	2.068	-0.017	-1.081	-0.003	-0.083
911 Attack/Anthrax Letters (Reverse Exponential Path from 9/11)	09/11/2001	-0.016	-2.232	-0.007	-0.848	0.655	1.719	0.009	2.482
First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)		1.035	24.764						
First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.054	-1.407						
Single-Piece First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)				1.190	9.370				
Workshared First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.280	-2.105	0.367	0.888	-0.526	-0.706
Carrier-Route First Class letters Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.655	1.719		
Automated Non Car-Rte First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)								1.277	1.764
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.006	2.410	-0.004	-0.840	0.005	0.591	0.001	0.594
Sum of Coefficients for all Innovations (3/5-digit Presort to MC95-1 Automation)		-0.167	-2.347	0.225	1.450	-0.064	-0.360	-0.003	-0.083
Sum of Coefficients for all Postal Rates (1st Cls Letters to Auto Non Car-Rte Letters)		0.981 t-value for Ho: B=1	-0.908	0.910 t-value for Ho: B=1	-3.043	1.022 t-value for Ho: B=1	0.287	0.751 t-value for Ho: B=1	-7.007
Regression Diagnostics		Adj. R^2	0.984	Adj. R^2	0.990	Adj. R^2	0.912	Adj. R^2	0.951
		Std. Error	0.008	Std. Error	0.008	Std. Error	0.017	Std. Error	0.005
		d.f.	106	d.f.	86	d.f.	68	d.f.	19
Estimated Annual Rate of Adaptation	19.86%	AR-1	0.144	AR-1	0.180	AR-1	0.031	AR-1	-0.396
99 Percent Confidence Interval	+/- 11.70%	AR-2	0.156	AR-2	0.118	AR-2	-0.079	AR-2	-0.070
95 Percent Confidence Interval	+/- 9.34%	AR-3	0.042	AR-3	0.032	AR-3	-0.177	AR-3	0.294
90 Percent Confidence Interval	+/- 8.17%	AR-4	-0.094	AR-4	-0.147	AR-4	-0.229	AR-4	0.022

The second sum is the sum of the coefficients for the exponential path variables associated with postal innovations. This sum is an estimate of the asymptotic limit of the combined effect of the adaptive processes represented by the exponential path variables included in each equation. The t-value for the sum may be used to test the statistical significance of the combined effects of the innovations on volume per household, worksharing volume ratios and revenue per piece.

The third sum is the sum of the coefficients for all of the postal rates in the equation. In the volumes equations this sum shows the combined effect on volume-per-household of changing postal rates in the same proportion. The t-values for the volumes equations are computed in the usual way for tests of the null hypothesis that the sum of the rate elasticities is equal to zero (Ho: $\beta = 0$). The t-statistics for the revenue per piece equations are computed for tests of the null hypothesis that the sum of the elasticities is equal to one (Ho: $\beta = 1$).

An examination of the coefficients in Tables 1 and 2 for the various innovations that have affected First-Class letters reveals a pattern that is also characteristic of other subclasses. The Service's innovations have tended to be successively less effective. The original introduction of 3/5-digit presort discounts in 1976 initiated an adaptive process that grew toward a 17.1 percent increase in volume per household. Discounts for carrier-route presorting in 1981 caused an increase of 19.9 percent and discounts for Zip+4 addressing added 17.1 percent in 1983. More recently, discounts for 5-digit prebarcoding raised equilibrium volumes per household by 3.4 percent in 1988; discounts for 3-digit prebarcoding raised volumes 9.4 percent in 1991; automation discounts raised volumes 3.9 percent in 1996.

8. Overall Results

The estimates of the 67 fitted equations in Appendix B tell us generally that the econometric model successfully explains the data to which it has been fit. This is apparent from the high adjusted R-squares, the high proportion of statistically significant estimates among the coefficients, and the fact that the coefficients almost always have estimated values that conform to expectations. So the estimates demonstrate that a fairly conventional model of the demand behavior of postal customers can be made to succeed statistically.

Next in importance, the estimates reveal that revenues per piece respond to the same behavioral determinants as volumes per household. Many of the variables in the revenue equations have estimated coefficients that differ from zero at high levels of confidence. It turns out that revenues per piece have all of the same general behavioral characteristics as volumes. They have seasonal patterns and trends; they are affected by reclassifications, market conditions and the level of economic activity; they have adapted over time to worksharing and other innovations; they were changed by the 9/11-Anthrax attack and are recovering; and, finally, they are almost always less than unit-elastic with respect to postal rates.

The non-zero coefficients for the AR-4 processes show why it is difficult to accurately forecast postal volumes and revenues using an econometric model. The autoregressive process is usually an important part of the mechanism that explains the time series in each equation. But this part of the mechanism must be partially omitted when making forecasts more than one quarter beyond the end of the sample period; and must be completely omitted when making forecasts more than four quarters out. These omissions leave forecasts with errors that are typically larger in magnitude than the high adjusted R-squares of the fitted equations would indicate.

Table 3 was derived from the estimates to show how volumes and revenues tend to change over the long run when they are affected only by the linear trends and the long run growth in GDP per household of about 1.51 percent per year.[12] The t-values in Table 3 indicate that the estimates of the long term rates of change in volume per household, revenue per piece and revenue per household are mostly significant, many at very high levels.

The long run rates of change in volume per household for all First-Class letters and cards, Periodicals, Parcel Post and Bound Printed Matter are negative. Most of these negative long-term trends can be explained as the effect of gradually encroaching indirect competition. In the case of Parcel Post the competition from United Parcel Service is direct and its effect has not been particularly gradual. Altogether, the subclasses with negative long term rates of growth account for slightly more than half the mail and a considerably larger proportion of USPS' revenue.

[12] The rates of change for volume per household and revenue per piece in Table 3 are equal to the equation coefficient for linear trend plus the coefficient for GDP per household times its annual growth rate (see Appendix A). The percentage for revenue per household is the sum of the percentages for volume per household and revenue per piece. The two coefficient estimates are assumed to be uncorrelated.

The long-term trends for revenues per piece are mostly upward as mailers gradually change the characteristics of the mail to increase the weight and size of the average piece, send the average parcel over a greater distance, perform less worksharing on the average bulk piece, and opt in other ways to select a more expensive average mix of basic services. The long-term trends in volume per household and revenue per piece combine to produce the long-term rates of change in revenue per household shown in the right-hand columns of Table 3.

Table 3. Long Run Trends and Income Growth

		Volume per Household		Revenue per Piece		Revenue per Household	
	d.f.	Rate of Chg.	t-value	Rate of Chg.	t-value	Rate of Chg.	t-value
First-Class Letters	106	-1.58%	-3.84	0.57%	2.41	-1.01%	-2.12
First-Class Cards	105	-1.88%	-2.95	0.98%	4.90	-0.91%	-1.35
Periodicals	106	-1.87%	-3.87	-0.61%	-0.81	-2.48%	-2.77
Standard Regular	106	0.55%	2.12	0.60%	1.72	1.15%	2.65
Standard Nonprofit	106	3.42%	7.02	2.14%	8.00	5.57%	10.01
Parcel Post	105	-14.00%	-15.75	2.04%	3.06	-11.96%	-10.77
Bound Printed Matter	109	-2.56%	-1.94	0.07%	0.13	-2.50%	-1.77
Priority Mail	108	2.05%	5.27	-0.14%	-1.52	1.92%	4.80
Certified Mail	111	2.58%	3.68	2.20%	3.20	4.78%	4.87
International Mail	115	0.25%	1.21			0.25%	1.21

The long-term trends in Table 3 are mostly gradual and are not apparent in time plots of the data for most subclasses of mail and services. They are obscured by the effects of the large-scale introduction of worksharing discounts and other innovations beginning in 1976. Table 4 shows that the cumulative effects of the innovations on volume per household and revenue per piece for the affected subclasses were enormous. The columns labeled "Sum of Effects" in Table 4 are the sums of the estimated coefficients expressed as percentages for the exponential path variables for the innovations affecting the subclass. Most of the sums are significantly different from zero as seen from their high t-values. These sums constitute the total displacements of equilibrium volumes per household and revenues per piece driving adaptive processes in the equations of the demand model. Even with slow rates of adaptation, these displacements are so large that the changes in volumes and revenues they caused dwarfed the long-term trends for many years after the innovations occurred.

Table 4. Work Sharing and Other Innovations

		Volume per Household		Revenue per Piece		Revenue per Household	
	d.f.	Sum of Effects	t-value	Sum of Effects	t-value	Sum of Effects	t-value
First-Class Letters	106	70.80%	5.80	-16.73%	-2.35	54.06%	3.83
First-Class Cards	105	52.32%	2.17	-43.24%	-5.79	9.07%	0.36
Periodicals	106	13.60%	1.21	35.87%	1.93	49.48%	2.28
Standard Regular	106	94.11%	11.78	-20.21%	-1.97	73.89%	5.68
Standard Nonprofit	106	-50.50%	-3.26	-35.31%	-3.63	-85.81%	-4.70
Parcel Post	105	469.62%	13.54	-96.06%	-3.80	373.56%	8.70
Bound Printed Matter	109	304.12%	4.14	-52.65%	-1.75	251.48%	3.16
Priority Mail	108	45.27%	5.13	-3.70%	-1.92	41.57%	4.61
Certified Mail	111	-35.27%	-2.21	-16.50%	-1.14	-51.76%	-2.40
Return Receipts	17	187.25%	4.55	-145.39%	-5.30	41.86%	0.85

The estimates of the long-term trend and the effects of innovations may explain a puzzle concerning the recent slowdown of growth in the volume of First-Class letters. For many years in the late 1970s and 1980s the volumes per household of First-Class letters grew robustly year after year. But during the 1990's this growth slowed down. By the year 2000 it had stopped altogether

and has since been replaced by a decline. The *ad hoc* explanation most often advanced for this reversal is that e-mail and electronic bill payment over the Internet are displacing letters as the preferred method for written communications and payment by many households. There is nothing actually wrong with this hypothesis; however, the estimates place these effects within a broader context. The model does not distinguish between the effects of the growth of the Internet and the effects of any of the other developing communication technologies that have encroached on the market for First-Class letters since 1971. All of these effects are merged by the model into a single linear trend.

The estimates indicate that the annual rate of change in First-Class letters per household is simply reverting to its long-term trend as the adaptive processes caused by product innovations run their course. The estimate of the rate of adaptation for First-Class letters is 19.86 percent per year so the Service's innovations stimulated growth in letter volumes for many years. However, the percentage increases caused by the innovations decreased over time while the long-term trend did not. Sometime during the year 2000 the tortoise finally caught the hare.

Although the Service's innovations have usually increased volumes per household, they have simultaneously depressed revenues per piece. This is hardly surprising since most of the innovations involve discounts for various forms of worksharing. Most large mailers can be expected to eventually use the opportunity provided by the discounts to do all of the worksharing for which they have a cost advantage. As they take more of the offered discounts, revenues per piece decline. However, this is not the only way that worksharing can affect revenues per piece. Worksharing discounts can also encourage mailers to increase the weight and the size of their pieces thus driving up revenue per piece. This is apparently what happened with publishers of Periodicals who cannot readily change the numbers of their subscribers but can easily change the size and weight of their publications.

To economists the most important behavioral characteristic of postal demand functions is the elasticity of volumes per household with respect to postal rates. The sums of the elasticities for all postal rates appearing in the demand equations are shown in Table 5. These values are the elasticities for simultaneous proportional changes in all postal rates. This is the way that real rates change between rate proceedings as the result of movements in the general level of prices. It also approximates the changes in the nominal rates recommended by the PRC at the conclusion of general rate proceedings. Typically, the PRC alters relative rates only gradually over several consecutive proceedings.

Table 5. Postal Rate Elasticities

		Volume per Household		Revenue per Piece		Revenue per Household	
	d.f.	Elasticity	t-value	Elasticity	t-value	Elasticity	t-value
First-Class Letters	106	-12.87%	-4.40	98.12%	-0.91	85.25%	23.77
First-Class Cards	105	-48.23%	-4.33	97.47%	-0.81	49.24%	4.26
Periodicals	106	-9.63%	-1.95	74.76%	-3.94	65.12%	8.05
Standard Regular	106	-29.95%	-5.97	76.24%	-5.39	46.29%	6.93
Standard Nonprofit	106	-13.23%	-2.55	74.85%	-7.01	61.61%	9.77
Parcel Post	105	-67.00%	-5.62	78.23%	-2.72	11.23%	0.78
Bound Printed Matter	109	-2.01%	-0.09	76.14%	-2.65	74.14%	3.21
Priority Mail	108	-63.51%	-5.33	95.22%	-1.57	31.71%	2.58
Certified Mail	111	-9.58%	-1.39	85.68%	-2.69	76.10%	8.76
Money Orders	113	-43.60%	-9.88	90.44%	-1.91	46.84%	7.02

The demand elasticities with respect to postal rates of the non-competitive subclasses of mail are all quite small. The non-competitive subclasses of mail and special services in Table 5 are First-Class letters and cards, Periodicals, Standard Regular, Standard Nonprofit, Bound Printed Matter and Certified mail. All of the other subclasses have fairly direct competitors and tend to

be more rate-elastic. However, none of the rate elasticities are less than minus 100 percent. Therefore, even the demand functions for the competitive services are somewhat rate-inelastic.

The t-values for revenue per piece are calculated for tests of the null hypothesis that the elasticity with respect to rates is 100 percent. These t-values allow us to test the assumption that revenues per piece are unit-elastic with respect to changes in postal rates as measured by changes in fixed-weight rate indexes computed from billing determinants. Table 5 shows that this assumption is simply wrong.

Revenues per piece are less than unit-elastic with respect to rates in every category. The t-values show that many of the elasticities are less than 100 percent at very high levels of significance. This result is exactly what would be predicted for mailers who re-optimize in response to changes in a complex tariff. These less-than-unit elasticities may be partly responsible for the Commission's tendency to over-estimate postal revenues when recommending higher rates.

The elasticities in the last column of Table 5 are the percentage increases in revenue per piece by subclass that would result from a 100 percent increase in postal rates under current conditions. All of these elasticities, with the exception of the elasticity for Parcel Post, are greater than zero by margins that are statistically quite large. This means that USPS presently has the power to raise revenues by raising rates in every postal market with the possible exception of the market served by Parcel Post.

The last columns of Table 5 also help to inform the current debate on whether the USPS could fall into a death spiral because of decreasing business demand and electronic substitutes. A death spiral for a subclass can happen only when the elasticity of revenue with respect to postal rates is below zero; a death spiral for USPS as an enterprise can occur only when all of these elasticities are negative. Even then, the drop in postal revenues has to exceed the cost saving from lower volumes in order to create a situation in which higher rates produce a self-defeating drop in revenue net of costs. The estimated rate elasticities of postal revenues per household, with the possible exception of Parcel Post, come nowhere near meeting this condition. Of course, these elasticities are local measures and they could increase significantly as volumes fall out of the ranges circumscribed by the sample, so the information provided here, while assuring, does not entirely preclude a death spiral from emerging in the future.

Table 6. Instantaneous Effects of the 9/11- Anthrax Attack

		Volume per Household		Revenue per Piece		Revenue per Household	
	d.f.	Pct. Change	t-value	Pct. Change	t-value	Pct. Change	t-value
First-Class Letters	106	-2.05%	-1.92	-1.62%	-2.23	-3.67%	-2.85
First-Class Cards	105	4.08%	1.41	0.95%	1.09	5.03%	1.67
Periodicals	106	-2.20%	-0.77	-1.69%	-0.53	-3.89%	-0.91
Standard Regular	106	-5.49%	-2.92	-0.57%	-0.29	-6.07%	-2.21
Standard Nonprofit	106	-7.61%	-2.26	-3.22%	-1.14	-10.83%	-2.46
Parcel Post	105	-7.88%	-1.32	2.45%	0.61	-5.44%	-0.76
Bound Printed Matter	109	-11.48%	-0.62	-4.15%	-0.48	-15.62%	-0.76
Priority Mail	108	-20.69%	-4.22	1.55%	1.27	-19.14%	-3.79
Express Mail	91	-12.29%	-2.85	-4.42%	-2.01	-16.71%	-3.45
Certified Mail	111	11.86%	1.54			11.86%	1.54
International Mail	115	-12.17%	-2.61			-12.17%	-2.61

The coefficient estimates for the reverse exponential path variables are direct estimates of the instantaneous effects of the 9/11-Anthrax attack. These estimates are collected and shown as percentages in Table 6 along with their t-values. Both volume per household and revenue per piece for most categories of mail were adversely affected by the attack. Reports of postal volumes during the weeks following the 9/11-Anthrax attack showed that postal customers had reacted measurably to the sudden realization that mail delivery was not as prompt, reliable or safe

as had been previously believed.[13] In effect, mailers responded as might be expected to a degradation in service quality by reducing the levels of demand for most postal services. The estimates in Table 6 confirm these initial observations.

Table 7 displays the maximum likelihood estimates of the rates of adaptation and confidence intervals for them obtained by reversing the arithmetic of a Wald test (see Appendix A). Most of the estimated rates of adaptation are low; the weighted average for all mail and services is only 21.81 percent per year. Most mailers, it seems, are slow learners. However, the confidence intervals bracketing the rates of adaptation are fairly wide. So this finding should be regarded with some caution.

Table 7. Rates of Adaptation

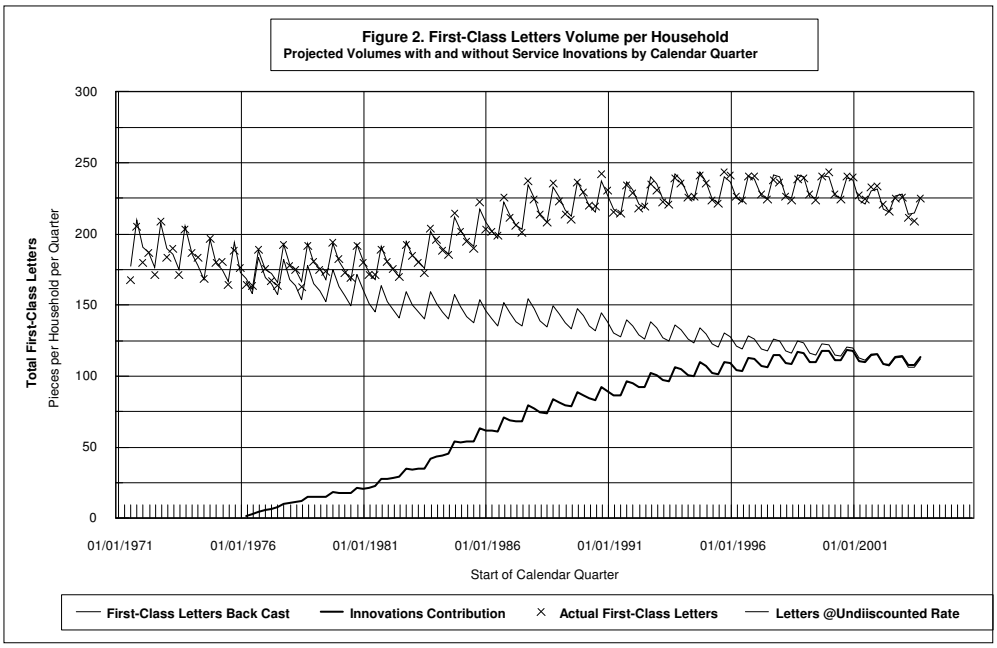
		99% Confidence Limits		95% Confidence Limits		90% Confidence Limits	
	ML Rate	Upper	Lower	Upper	Lower	Upper	Lower
First-Class Letters	19.86%	31.56%	8.16%	29.20%	10.52%	28.03%	11.69%
First-Class Cards	11.15%	22.90%	-0.60%	20.53%	1.77%	19.36%	2.95%
Periodicals	60.94%	86.20%	35.69%	81.10%	40.78%	78.57%	43.31%
Standard Regular	21.08%	34.91%	7.26%	32.12%	10.05%	30.74%	11.43%
Standard Nonprofit	17.33%	34.37%	0.28%	30.93%	3.72%	29.23%	5.43%
Parcel Services	13.91%	18.51%	9.32%	17.58%	10.25%	17.12%	10.71%
Priority, Express,..	48.78%	62.54%	35.02%	59.77%	37.80%	58.39%	39.18%
Weighted Average	21.81%						

9. The Effects of Postal Product Innovations

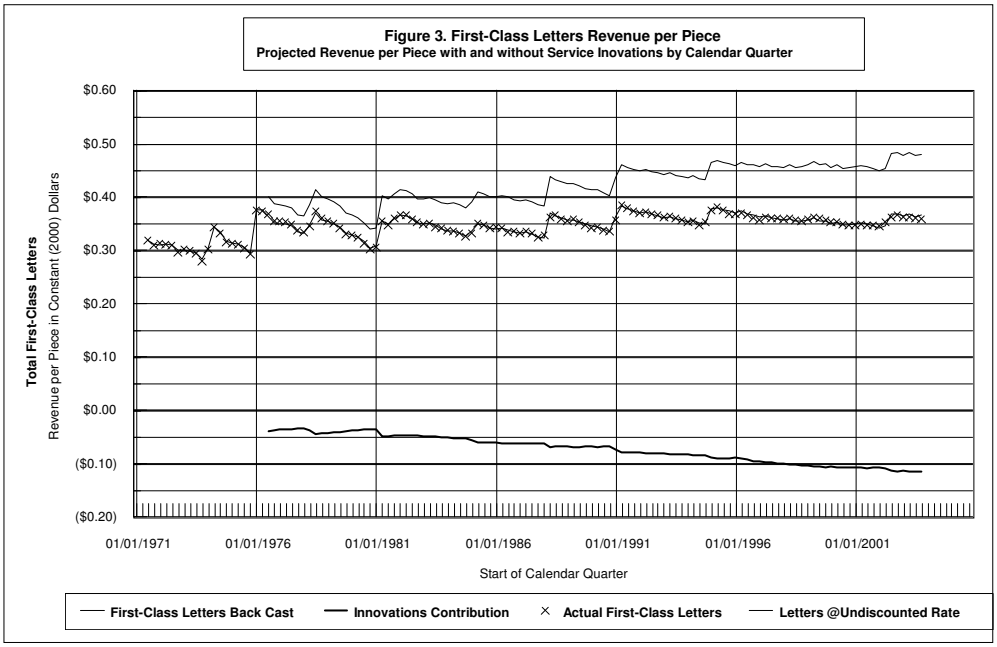
The historical effects of postal product innovations were gauged by comparing two sets of back-casts made with the fitted equations. The method is illustrated for First-Class letters volume per household in Figure 2. The first of the two back-casts is made with the same historical data used to fit the equations. This back-cast is just a reconstruction of the historical data generated by the econometric model but without the AR-4 process. In Figure 2 we can see that the first back-cast tracks the actual First-Class letters volume per household fairly closely.

The second back-cast is also made with the historical data but with the exponential path variables for postal product innovations omitted and with undiscounted postal rates. If USPS had not undertaken a far-reaching and long-term reform of its service offerings beginning in the mid-1970s, postal rates would have been higher because most of the innovations involved discounts for worksharing. To take a discount a mailer has to presort, prebarcode or drop ship his mail in a way that saves USPS some mail processing or transportation cost. Without the worksharing promoted by the innovations, the USPS' average costs per piece would have been higher for most subclasses of mail, thus raising the average rates. The single-piece First-Class letters rate was used to make the back-cast of letters at the undiscounted rate in Figure 2.

[13] Postal data systems continuously sample mail volumes. These reports are used to estimate volumes for postal accounting periods that are four weeks long. The reports for the accounting periods immediately before and after the 9/11-Anthrax attack showed a distinct drop in the volumes of most categories of mail and special services.



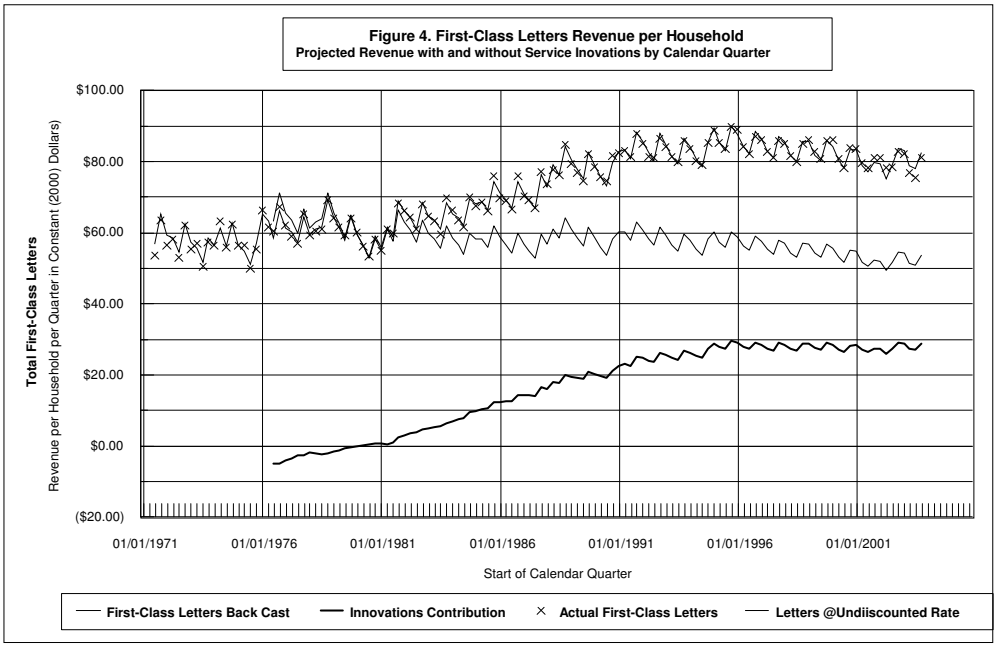
The contribution to volume per household by the product innovations in Figure 2 is the difference between the first and second back-casts. This contribution begins in 1976 with the introduction of 3/5-digit presorting, accelerates with the introduction of carrier-route presorting and zip+4 addressing in the early 1980s, decelerates when later innovations prove less effective, and shares the long-run downward trend of all First-Class letters beginning around 2000 as the adaptive processes triggered by the innovations flatten out.



Revenues per piece were back-cast in the same way as volumes per household. The results of these back-casts for First-Class letters are shown in Figure 3. Since 1976 this series has shown no overall tendency to increase or decrease. The sudden increases precipitated by rate decisions every 3 to 4 years have just about matched the intervening erosion caused by the rising general

level of prices. However, this picture of rate stability is somewhat misleading. When revenue per piece is back-cast without the effects due to product innovations the result is a path that has slowly but unmistakably increased since 1976. Therefore, actual First-Class letter revenues per piece have not increased since 1976 largely because postal customers have lowered their average rates by taking the discounts offered by USPS for worksharing.

Although First-Class letter volumes per household have increased since 1976, postal revenues per piece have been reduced by innovations over the same period of time. The product of the back-casts of volume per household and revenue per piece is a back-cast of revenue per household. It is the volume effects that mostly dominate this combination. USPS product innovations acted to increase postal revenues per household from 1976 up until about 1996. Since then the innovations contribution has remained essentially flat.



The effects of product innovations on all classes and subclasses of mail are summarized in Table 7. The back-casts of volumes per household and revenues per piece used to construct Table 7 were made as they were above for First-Class letters. The undiscounted rates used for First-Class letters and cards are the Single-Piece rates; the rates for Periodicals exclude discounts for drop shipping and presortation, the rates for Standard Regular and Standard Nonprofit bulk mail are the rates for the minimum required level of presorting; and, the rates for Parcels are the non-discounted rates for ordinary Parcel Service.

Volumes and revenues per household were multiplied by projections of the number of households (Census, 1996 and 2004) and aggregated from the date of the first important innovation shown as the "start date". Volumes are in millions of pieces; revenues are in millions of constant dollars. Current dollar values are converted to constant (2000) dollars using the implicit deflator for the chained GDP. The percent differences are the effects expressed as percentages of total volumes and revenues projected from the start date with the innovations at undiscounted rates. For example, the percent difference for First-Class letters volume (36.27%) is the ratio of the difference between accumulated volumes since 7/1/1976 back-cast with and without the innovations divided by the back-cast of accumulated volumes with the innovations.

Table 8. Volume and Revenue Effects of Innovations with Undiscounted Rates

		Effect from Start Date		Percent Difference		Asymptotic Difference	
	Start Date	Volume	Revenue	Volume	Revenue	Volume	Revenue
First-Class Letters	07/01/1976	787,372	$181,435	36.27%	23.62%	51.63%	37.53%
First-Class Cards	07/01/1976	37,905	$3,568	34.20%	16.04%	42.47%	8.31%
Periodicals	04/01/1978	34,212	$8,692	13.20%	18.10%	13.29%	28.98%
Standard Regular	01/01/1979	701,993	$84,035	53.81%	36.21%	66.60%	45.58%
Standard Nonprofit	01/01/1979	(35,900)	($16,832)	-12.30%	-56.79%	-67.33%	-121.18%
Parcel Services	01/01/1981	10,770	$16,450	57.66%	48.10%	99.88%	66.25%
Priority, Express,..	07/01/1975	7,775	$42,325	40.54%	46.24%	39.28%	37.54%
Special Services	10/01/1996	3,186	$1,962	45.29%	22.27%	55.19%	14.12%
Total		1,547,314	$321,635	37.00%	26.05%	46.23%	27.07%

The asymptotic differences are the percentage differences corresponding to the new equilibrium levels of volume per household and revenue per piece. These are the percentage differences that the innovations will cause when the adaptive processes have run their course. They are the limiting changes that the combined exponential paths approach over time. For example, 51.63 percent of First-Class letters volume and 37.53 percent of revenue will eventually be attributable to the product innovations affecting this subclass since 1976.

Most of the asymptotic percent differences are larger in magnitude than their corresponding historical percent differences. This occurs, first, because most of the innovations had a positive effect on volume, and second, because the effects grow along the time path described by the exponential path variables toward their asymptotic limits. Typically, the rates of adaptation are not very high so it takes several years for an innovation's effects to fully develop.

The percent differences and the asymptotic percent differences mostly conform to expected patterns. The innovations have produced increases in volumes in every subclass except Standard Nonprofit bulk mail.[14] They have also produced increases in revenues, which are proportionately smaller in most of the subclasses.

However, Periodicals mailers have responded somewhat differently. Periodicals volumes have increased very little as a result of the many discounts for presorting and drop shipping that have been offered to them. Instead, these mailers have taken advantage of the discounts to increase the average weight of their pieces. Therefore, the response to innovations in this class has been a large increase in revenue per piece accompanied by a much smaller percentage increase in volume.

The last line of Table 8 provides the best estimates from the econometric model of the historic and long-run impacts of worksharing and other product innovations on aggregate postal volumes and revenues. From the start dates to the end of 2003, postal volumes increased by 37.00 percent as the result of worksharing and other product innovations. Revenues were enhanced by 26.05 percent despite the fact that the worksharing was necessarily accompanied by discounts and that revenues per piece tended to drop in response to the innovations. The asymptotic percent differences describing the long-run impact on volumes and revenues are 46.23 percent for volume and 27.07 percent for revenue.

[14] An explanation for this exception to the general pattern may be found in the timing of the innovations. All of the innovations for Standard Nonprofit bulk mail were made at times that corresponded to almost identical innovations in Standard Regular bulk mail and, in some cases, First-Class letters. Standard Nonprofit bulk mailings tend to be much smaller than mailings in these other subclasses so the combined effect of the innovations may have been to shift mail out of Standard Nonprofit bulk and into First-Class letters or Standard Regular bulk where it could be combined with other mail to qualify for discounts.

11. The Effects of the 9/11-Anthrax Attack

Table 9 shows the estimated effects of the 9/11-Anthrax attack over a period of two years from 2001 Q3 to 2003 Q4. The initial percentage differences represent the immediate impact of the attack on postal volumes and revenues. The overall impact of minus 3.87 percent on volumes confirms and strengthens the impression one gains from comparing postal volume reports shortly before and shortly after the attack. However, the volume losses are only part of the story. The overall impact of minus 5.1 percent on revenues is higher because the attack also caused a drop in revenues per piece for most of the affected mail. Since the attack was totally unexpected by the Service, it is unlikely that much of this initial revenue loss could have been recovered by reductions in cost.

Table 9. Short Term Volume and Revenue Effects of 9/11- Anthrax Attack

	Rate of	Effect from 9/11/2001		Percent Difference		Initial % Difference	
	Adaptation	Volume	Revenue	Volume	Revenue	Volume	Revenue
First-Class Letters	19.86%	(3,653)	($2,359)	-1.53%	-2.76%	-2.07%	-3.74%
First-Class Cards	11.15%	439	$106	3.26%	4.01%	4.00%	4.90%
Periodicals	60.94%	(262)	($103)	-1.10%	-1.94%	-2.22%	-3.96%
Standard Regular	21.08%	(7,667)	($1,602)	-4.09%	-4.53%	-5.65%	-6.26%
Standard Nonprofit	17.33%	(2,127)	($364)	-5.96%	-8.60%	-7.90%	-11.44%
Parcel Services	13.91%	(186)	($319)	-6.65%	-6.12%	-8.57%	-9.53%
Priority, Express,..	48.78%	(439)	($2,162)	-17.28%	-15.93%	-22.35%	-20.87%
Special Services	Ltrs & Parcels	2	$232	0.08%	6.43%	0.59%	13.30%
Other Mail	Letters	(89)	($366)	-2.56%	-9.45%	-3.45%	-3.45%
Total	21.81%	(13,980)	($6,936)	-2.74%	-4.35%	-3.87%	-5.10%

The effects from the attack and their percent differences were computed by back-casting with the model without the reverse exponential path variables for the attack. The percent differences reflect the attenuation over time of the initial impacts on volumes and revenues described by the initial percent differences. The percentages are all somewhat smaller than the corresponding initial percent differences because they have been computed over a period of 2-1/2 years following the attack.

The annual rates of adaptation displayed in the first column of Table 9 show that the effects of the 9/11-Anthrax attack are diminishing only gradually over time. The estimates for Special Services and Other Mail were made using the rates of adaptation for First-Class letters and Parcel Services. The most notable characteristic of these rates is that most of them are fairly low numbers, so the effects of the 9/11-Anthrax attack on postal volumes and revenues are attenuating only slowly for most kinds of mail. Therefore, the total losses in volumes and revenues from the attack will eventually grow larger than the effects shown in Table 9.

In order to estimate the long term effects of the attack the model was used to make back-casts and forecasts over a 20-year period beginning with 2001 Q3. For the forecasts postal rates were assumed to be fixed in constant dollars. The number of households and the GDP per household were assumed to continue growing at the average rates exhibited since 1971. All of the other variables were set to continue as they normally would over time. The results are summarized in Table 10.

The cumulative effect over 20 years is a loss in volume amounting to over 39.5 billion pieces of mail and special service transactions. The revenue from this lost volume is $16,169 million. Unlike the Service's initial revenue loss, much of the long run revenue loss should be offset by reductions in cost as USPS adapts its operations to the reduced volumes. The first column of Table 10 is derived from the PRC's most recent general rate decision.[15] The figures show cost as

[15] PRC (2002, Appendix G).

a percentage of revenue for each subclass according to the Commission's current cost model.[16] These percentages tend to remain fairly stable over time and for small changes in volumes so they may be used to estimate the revenue loss net of cost for each subclass. The net revenue lost on the reduced volume is shown in the last column. According to the PRC's cost to revenue ratios, USPS' cost reductions will be $5,665 million smaller than the 20-year revenue loss from the attack. Since postal rates must be set to break even under current legislation, this is the amount that will ultimately have to be made up either with higher rates or Congressional appropriations.

Table 9. 20-Year Volume and Revenue Effects of 9/11- Anthrax Attack

	R2001-1	with 9/11-Anthrax		without 9/11-Anthrax		Revenue Loss	
	Cost/Revenue	Volume	Revenue	Volume	Revenue	Gross	Net Cost
First-Class Letters	52.08%	1,942,967	$737,495	1,952,785	$743,994	($6,498)	($3,114)
First-Class Cards	70.13%	102,290	$21,025	100,618	$20,609	$416	$124
Periodicals	98.71%	187,396	$40,687	187,742	$40,823	($136)	($2)
Standard Regular	61.35%	1,959,919	$386,501	1,981,678	$391,120	($4,619)	($1,785)
Standard Nonprofit	107.78%	461,164	$65,890	468,866	$67,319	($1,429)	$111
Parcel Services	85.94%	26,219	$39,356	26,986	$40,487	($1,132)	($159)
Priority, Express,..	61.40%	31,162	$163,579	31,649	$165,989	($2,410)	($930)
Special Services	70.69%	42,473	$34,894	42,520	$34,199	$695	$204
Other Mail	89.16%	29,449	$38,117	29,729	$39,173	($1,056)	($114)
Total	60.93%	4,783,039	$1,527,545	4,822,573	$1,543,713	($16,169)	($5,665)

12. Conclusions

The results presented in this paper bear on several questions that currently confront the international and the U. S. postal communities. For the international community, perhaps the most compelling of these questions is: what effect will liberalization have on the financial viability of the national postal services of the European Union? The results provide a partial answer. Upstream liberalizations of access to postal markets, of the kind increasingly allowed by USPS with worksharing discounts since 1975, are more likely to strengthen rather than weaken the financial position of a national postal service. The U. S. experience, repeated in all but one subclass, is that discounts for worksharing and other product innovations add substantially to both volumes and revenues. Revenues net of costs were also increased because the discounts were generally set equal to or below USPS' avoided costs per piece.

For the U. S. postal community the most compelling question may be: why have the rapid rates of growth in volume and revenue experienced in the 1980s and early 1990s slowed down? The short answer provided by the model is that USPS stopped innovating. The econometric results show that the historical growth pattern can be attributed almost entirely to the product innovations that USPS made starting about 1976. The early innovations were typically the most effective at stimulating postal demand. As their effects attenuated, the Service maintained the momentum for a while with more, but less effective, innovations. Eventually, during the 1990s, the adaptive processes for these additional innovations also largely ran their course. The last major product innovations by USPS were discounts introduced in 1996 for automation-related

[16] These percentages are the subject of a lively debate during most general rate proceedings. The percentages used by the PRC since 1997 are somewhat higher than those used by USPS in its annual Cost and Revenue Analysis (CRA) reports (USPS 1996-2002). However, many economists view both sets as improbably low for such a large business since they imply that the Service still enjoys very substantial economies of scope and scale. The PRC's percentages are used in Table 10 because they are the current basis for postal pricing decisions, not because the author believes that they are the best estimates that could be derived from a careful study of the cost of postal operations.

worksharing. These last innovations did little to stimulate additional demand in any of the larger subclasses, with the result that the long-run trends in postal demands are now reemerging as the predominant cause of the rates of growth of volumes and revenues. For many subclasses of mail and services the long-term trend of volume and revenue per household is downward.

For USPS the most compelling question may be whether to accept a long-run decline in the demand for many of its services, or try to restart the engine that once propelled volumes and revenues upward. Now that the econometrics has revealed how that engine worked, it is clear what USPS can do to restart it. USPS can continue to unbundle its remaining composite service offerings with respect to collection, processing and transportation - but not with respect to delivery. In addition, USPS can aggressively make other product innovations in the form of new or improved service offerings – again making delivery a part of every offering. USPS should also consider the possibilities for increasing the rather slow rates of adaptation that have been found to govern these processes. It may be advantageous for USPS to raise these rates by marketing new product offerings more intensively than has been its custom in the past.

For various responsible agencies of the U. S. government the most compelling question may be whether USPS will need to have its losses from the 9/11-Anthrax attack covered by grants or loans from the U. S. Treasury in order to avoid a massive future increase in postal rates. The estimates made with the model indicate that the Service's real gross revenue loss will eventually surpass $16 billion in constant (2000) dollars and the loss in revenue net of attributable cost will be around $5.7 billion. Slightly less than half of this loss had already occurred by the end of the sample period, the 4th quarter of 2003. Although this loss is large absolutely, it is not large relative to the current revenues and costs of USPS which are around $70 billion annually. Furthermore, the econometric fits of the model's equations show that USPS retains the ability to raise revenue by raising rates in virtually every subclass. Consequently, the effects of the 9/11-Anthrax attack on the finances of USPS can be entirely offset with only a small increase in the general level of postal rates spread over several years.

Appendix A: Notes on the Econometrics

There are two aspects of the model requiring special treatment in the econometrics. These are, first, the AR-4 processes for the disturbances, and, second, the rates of adaptation which enter the equations in a non-linear form. A non-iterative variant of the Cochrane-Orcutt procedure is used to deal with the auto-regressive disturbances while the rates of adaptation are held fixed.[17] This procedure is then performed iteratively to find the rates of adaptation that maximize the likelihood functions for the volumes equations taken in sets. The sets correspond to those equations with exponential path variables parameterized by the same rate of adaptation, for example, the four volume equations for First-Class letters.

The Cochrane-Orcutt procedure is more efficient than a direct least squares fit when the disturbances are generated by an auto-regressive process. First, an equation of the model is fit by least squares. The residuals from this preliminary fit are used to estimate the parameters of the AR-4 process by fitting a second linear equation, without an intercept, relating the residuals to their lagged values for the past four quarters. The coefficients from this second fit are used to perform an AR-4 transform on all of the variables (including a variable for the intercept) appearing in the equation. The equation is then refit by least squares to the transformed sample without the first four observations in the time series.

A rate of adaptation is estimated by maximizing a likelihood function formed from the AR-4 transformed disturbances for the set of volume equations (including the logit equations) that use the rate to determine the values of exponential path variables in the equations. To

[17] The Cochrane-Orcutt procedure can be found described for an AR-1 process in almost any standard modern text, for instance, Maddala (1977, 277-84). The extension for an AR-4 process is straightforward.

construct the likelihood function it is assumed that the transformed disturbances are all independently and normally distributed errors. The errors from individual equations are serially independent if the AR-4 transform succeeds in removing all of the serial correlation caused by auto regressive processes in the disturbances. However, the form of the likelihood function also depends upon the transformed disturbances being uncorrelated across the equations. This condition is approximately met by the residuals from the equations for volumes per household but not by the residuals from the revenue per piece equations.

The likelihood function is maximized by minimizing the scaled sum of the squared residuals from the last step of the Cochrane-Orcutt procedure. The scaling is necessary if there is more than one equation in the set because the disturbances for the several equations can be expected to have different variances. The scaling is performed using prior approximate estimates of the variances of the equation errors so the scaled sum is a sum of squares of standardized residuals. In effect, the likelihood function is maximized over a parameter set that includes the rate of adaptation, all of the coefficients of the linear equations and (approximately) the coefficients of the AR-4 processes for the equation. However, the elements of the variance-covariance matrix of the disturbances are not part of the maximizing parameter set. Instead these elements are assigned predetermined values if they are on the diagonal and are assumed to be zero otherwise.

All of the parameters except the rate of adaptation are estimated within the Cochrane-Orcutt procedure. This allowed the procedure to be operated as a sub-optimization for each volume equation of a class or subclass. These sub-optimizations were embedded within a simple search process that converged iteratively on the value of the rate of adaptation that minimized the weighted sum of squares. The parameter estimates for the model are taken from the final least squares fits of the Cochrane-Orcutt procedure using the minimizing rate of adaptation. The coefficients for the autoregressive disturbances are also taken from the final iteration of the Cochrane-Orcutt procedure.

Confidence intervals for the estimates of the rates of adaptation were derived by reversing the arithmetic for a Wald test.[18] The second derivative of the logged likelihood function, which summarizes the information on the rate of adaptation contained in the sample, is used to construct a test statistic having asymptotically a χ^2 distribution with one degree of freedom. The test has the practical advantage that it only depends on the properties of the likelihood function at its maximum. To apply the Wald test a parabolic fit of the logged likelihood function was computed numerically in the vicinity of the final estimate of the rate of adaptation. The maximum likelihood estimate of the rate occurs at the peak of the parabola. The confidence intervals are found by inserting the second derivative of the parabola in the statistic for the Wald test and solving for the rates of adaptation corresponding to the critical values of χ^2. Confidence intervals computed in this way are symmetric about the maximum likelihood estimate.

Appendix B: Equations of the Complete Model

Appendix B may be found on the PRC worldwide web site *www.prc.gov*. The file is reached from the Main page by selecting the following sequence: "Speeches & Papers", "Papers" and "Edward S. Pearsall". A Lotus 1-2-3 worksheet containing the RPW data before and after conversion to calendar quarters, data from other sources, computations of fixed weight indexes from postal tariffs, all regressions including the equations before and after the AR-4 transforms of the Cochrane-Orcutt process and the regressions for the coefficients of the AR-4 processes, the variance-covariance matrices for the final equations and the computations of the t-values for

[18] A clear and concise treatment of the subject of the Maximum Likelihood approach to nonlinearities in regression equations and the Wald test is Maddala (1977,176-81).

various linear combinations of the coefficients, the back-casts and forecasts with the model, the tables for the paper and Appendix B, and various graphs including those used in the paper.

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Table 1A. First-Class Letters Volume

Calendar Quarter Volumes per Household and Volume Ratios

Regressor	Effective Date	Ln 1st Cls Ltrs/ Household		Logit Single-Piece/ Work Shared		Logit Car-Rte Presort/ Non-Car.-Rte		Logit Automated NCR/ Non-Automated	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		4.170	12.214	3.325	3.064	-9.719	-1.282	6.844	0.701
2nd Quarter Seasonal Dummy Variable		-0.017	-1.754	0.047	2.769	0.110	1.570	0.046	2.042
3rd Quarter Seasonal Dummy Variable		-0.075	-9.538	0.017	0.954	0.076	1.036	0.053	1.777
4th Quarter Seasonal Dummy Variable		0.096	10.010	0.174	10.711	-0.010	-0.152	0.055	2.339
Linear Trend		-0.019	-5.305	-0.014	-0.656	-0.297	-3.878		
2nd Quarter Dummy Times Trend		-0.001	-2.857	-0.004	-3.644	-0.008	-1.529		
3rd Quarter Dummy Times Trend		0.000	1.004	-0.002	-1.856	-0.006	-1.021		
4th Quarter Dummy Times Trend		-0.003	-6.645	-0.008	-8.237	0.001	0.283		
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	-0.033	-3.349	0.055	1.990	0.140	1.287		
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	-0.002	-0.209	0.062	2.183	-1.093	-4.425	0.695	2.468
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.242	2.869	0.091	0.331	1.183	0.618	-1.003	-0.466
3/5-digit Presort Introduction (Exponential Path from the Effective Date)	07/06/1976	0.171	4.447	-3.419	-12.032				
Carrier-Route Presort Introduction (Exponential Path from the Effective Date)	03/21/1981	0.199	7.272	0.273	3.021	7.695	8.688		
Zip+4 Discount (Exponential Path from the Effective Date)	10/09/1983	0.171	4.236	0.176	1.478	-2.275	-3.942		
5-digit Prebarcode Discount (Exponential Path from the Effective Date)	04/03/1988	0.034	1.215	0.016	0.205	1.299	3.956		
3-digit Prebarcode Discount (Exponential Path from the Effective Date)	02/03/1991	0.094	2.827	-0.313	-2.906	1.184	3.050		
MC95-1 Automation Discounts (Exponential Path from the Effective Date)	07/01/1996	0.039	1.130	-0.220	-1.813	0.492	1.076	1.551	2.857
911 Attack/Anthrax Letters (Reverse Exponential Path from 9/11)	09/11/2001	-0.021	-1.921	-0.035	-1.017	0.237	1.782	0.047	0.605
First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.165	-2.679						
First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.037	0.642						
Single-Piece First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.667	-1.063				
Workshared First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.467	0.717	3.871	1.139	6.054	0.560
Carrier-Route First Class letters Rate (Ln of Fixed-Weight Index/GDP Deflator)						-3.291	-1.030		
Automated Non Car-Rte First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)								-4.579	-0.431
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		-0.016	-3.843	-0.013	-0.607	-0.279	-3.989	-0.015	-0.466
Sum of Coefficients for all Innovations (3/5-digit Presort to MC95-1 Automation)		0.708	5.805	-3.487	-5.645	8.395	5.126	1.551	2.857
Sum of Coefficients for all Postal Rates (1st Cls Letters to Auto Non Car-Rte Letters)		-0.129	-4.397	-0.200	-1.581	0.580	0.963	1.475	2.448
Regression Diagnostics		Adj. R^2	0.988	Adj. R^2	0.998	Adj. R^2	0.956	Adj. R^2	0.970
		Std. Error	0.013	Std. Error	0.037	Std. Error	0.117	Std. Error	0.052
		d.f.	106	d.f.	86	d.f.	68	d.f.	19
Estimated Annual Rate of Adaptation	19.86%	AR-1	0.003	AR-1	0.081	AR-1	0.203	AR-1	0.763
99 Percent Confidence Interval	+/- 11.70%	AR-2	0.104	AR-2	-0.043	AR-2	-0.022	AR-2	-0.480
95 Percent Confidence Interval	+/- 9.34%	AR-3	-0.036	AR-3	0.023	AR-3	-0.069	AR-3	0.184
90 Percent Confidence Interval	+/- 8.17%	AR-4	0.215	AR-4	-0.277	AR-4	-0.057	AR-4	-0.206

Table 2A. First Class Cards Volume

Calendar Quarter Volumes per Household and Volume Ratios

Regressor	Effective Date	Ln 1st Cls Cards/ Household		Logit Single-Piece/ Work Shared		Logit Car-Rte Presort/ Non-Car.-Rte		Logit Automated NCR/ Non-Automated	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		1.009	1.220	-9.158	-2.421	2.088	0.132	48.743	3.427
2nd Quarter Seasonal Dummy Variable		0.004	0.132	-0.050	-0.433	-0.259	-1.834	-0.047	-1.103
3rd Quarter Seasonal Dummy Variable		0.057	1.805	-0.162	-1.695	-0.291	-1.836	-0.015	-0.275
4th Quarter Seasonal Dummy Variable		0.041	1.511	0.021	0.183	-0.447	-3.292	-0.009	-0.203
Linear Trend		-0.021	-3.392	-0.009	-0.336	-0.504	-2.398		
2nd Quarter Dummy Times Trend		-0.001	-0.535	0.006	0.845	0.006	0.541		
3rd Quarter Dummy Times Trend		-0.002	-1.132	0.011	1.803	0.013	1.066		
4th Quarter Dummy Times Trend		0.000	0.287	0.002	0.224	0.024	2.267		
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	-0.182	-5.050	0.137	1.237	1.112	4.220		
1st Class/3rd Class Rate Crossover Dummy (One during the crossover, Zero otherwise)	04/03/1988	-0.013	-0.472	0.005	0.035	0.794	3.553		
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	0.061	2.366	-0.311	-1.823	-0.821	-2.942	0.596	1.160
1st Class/3rd Class Rate Crossover Dummy (One during the crossover, Zero otherwise)	01/01/1995	0.190	6.622	-0.486	-5.582	-0.148	-0.835		
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.133	0.633	3.040	3.217	-1.355	-0.338	-11.265	-3.474
3/5-digit Presort Introduction (Exponential Trend from the Effective Date)	07/04/1976	-0.031	-0.260						
Carrier-Route Presort Introduction (Exponential Trend from the Effective Date)	03/21/1981	0.856	8.631	-0.670	-1.257	14.783	4.772		
Zip+4 Discount (Exponential Trend from the Effective Date)	10/09/1983	-0.267	-1.790	-0.785	-1.658	-6.936	-3.147		
5-digit Prebarcode Discount (Exponential Trend from the Effective Date)	04/03/1988	0.779	7.541	-2.098	-5.133	3.140	2.474		
3-digit Prebarcode Discount (Exponential Trend from the Effective Date)	02/03/1991	-1.033	-7.569	2.317	5.028	5.902	4.823		
MC95-1 Automation Discounts (Exponential Trend from the Effective Date)	07/01/1996	0.219	2.269			-1.576	-1.066	4.594	4.115
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	0.041	1.414	-1.650	-4.447	0.405	1.656	0.044	0.250
First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.482	-4.333						
Single-Piece First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)				5.541	1.945				
Workshared First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)				-3.826	-1.346	-4.393	-1.092	15.324	1.245
Carrier-Route First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)						4.814	1.453		
Automated Non Car-Rte First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)								-15.420	-1.169
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		-0.019	-2.954	0.037	1.030	-0.524	-2.460	-0.170	-3.474
Sum of Coefficients for all Innovations (3/5-digit Presort to MC95-1 Automation)		0.523	2.167	-1.236	-1.098	15.313	2.560	4.594	4.115
Sum of Coefficients for all Postal Rates (1st Cls Cards to Auto Non Car-Rte Cards)		-0.482	-4.333	1.715	4.358	-3.988	-3.201	-0.097	-0.087
Regression Diagnostics		Adj. R^2	0.952	Adj. R^2	0.909	Adj. R^2	0.885	Adj. R^2	0.861
		Std. Error	0.050	Std. Error	0.153	Std. Error	0.250	Std. Error	0.095
		d.f.	105	d.f.	84	d.f.	65	d.f.	19
Estimated Annual Rate of Adaptation	11.15%	AR-1	0.030	AR-1	-0.159	AR-1	0.057	AR-1	0.324
99 Percent Confidence Interval	+/- 11.75%	AR-2	-0.307	AR-2	-0.073	AR-2	-0.250	AR-2	-0.384
95 Percent Confidence Interval	+/- 9.38%	AR-3	-0.149	AR-3	-0.246	AR-3	-0.070	AR-3	-0.299
90 Percent Confidence Interval	+/- 8.21%	AR-4	-0.115	AR-4	-0.032	AR-4	-0.281	AR-4	-0.168

Table 3A. Periodicals Volume

Calendar Quarter Volumes per Household

Regressor	Effective Date	Ln Within County/ Household		Ln All Periodicals/ Household		Ln Non-profit/ Household		Ln Classroom/ Household	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-0.004	-0.001	2.219	3.202	-3.732	-1.743	-9.665	-1.329
2nd Quarter Seasonal Dummy Variable		-0.024	-0.438	-0.011	-1.026	0.036	0.685	-0.139	-2.017
3rd Quarter Seasonal Dummy Variable		-0.044	-0.730	-0.052	-5.484	-0.034	-0.562	-0.064	-0.779
4th Quarter Seasonal Dummy Variable		0.019	0.349	-0.005	-0.474	0.098	1.937	-0.238	-3.384
Linear Trend		-0.078	-4.394	-0.023	-4.699	-0.051	-4.096	0.014	0.296
2nd Quarter Dummy Times Trend		0.002	0.677	0.001	1.231	-0.002	-1.033	0.005	0.855
3rd Quarter Dummy Times Trend		0.002	0.899	0.001	2.142	-0.001	-0.404	-0.009	-1.183
4th Quarter Dummy Times Trend		-0.000	-0.054	0.001	1.291	-0.003	-1.433	0.008	1.236
New Classroom Mailer (Zero before the Effective Date, One after)	03/14/1987							0.812	7.001
New Reporting Rules Dummy (Zero before the Effective Date, One after)	01/01/1985			0.043	2.079				
Sampling Method Change (Zero before the Effective Date, One after)	12/12/1992	-0.059	-0.973	-0.030	-1.176	-0.087	-2.604	0.186	1.994
MC95-1 Mail Reclassification (Zero before the Effective Date, One after)	07/01/1996	0.121	2.628	0.025	0.873	-0.036	-1.163	-0.002	-0.019
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.547	0.601	0.288	1.770	1.392	2.584	1.707	0.971
Ln of School Age Children per Household								10.943	5.765
Regular Rate Presort Introduction (Exponential Trend from the Effective Date)	05/29/1978			0.089	2.665				
Carrier-Route Presort Introduction (Exponential Trend from the Effective Date)	07/06/1981			-0.043	-1.222				
SCF Drop Ship Discount (Exponential Trend from the Effective Date)	02/17/1985			0.073	2.250	0.271	3.248	0.214	0.630
Miscellaneous Worksharing Discounts (Exponential Trend from the Effective Date)	02/03/1991	-0.001	-0.012	0.045	1.182	0.193	3.307	2.195	11.850
MC95-1 Automation Discounts (Exponential Trend from the Effective Date)	10/06/1996	0.033	0.387	0.004	0.091	-0.034	-0.616	0.594	2.628
In-County Separate 3/5-digit Discounts (Exponential Trend from the Effective Date)	01/10/1999	0.140	2.086	-0.032	-0.907	0.029	0.597	0.344	2.757
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	0.031	0.444	-0.022	-0.774	0.010	0.266	0.116	1.038
Within County Periodicals (Ln of Fixed-Weight Index/GDP Deflator)		-0.144	-0.651						
Regular Rate Periodicals Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.096	-1.953				
Non-profit Rate Periodicals Rate (Ln of Fixed-Weight Index/GDP Deflator)						-0.110	-1.320		
Classroom Rate Periodicals Rate (Ln of Fixed-Weight Index/GDP Deflator)								-0.011	-0.035
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		-0.070	-8.986	-0.019	-3.865	-0.030	-3.250	0.040	0.823
Sum of Coefficients for all Innovations (Reg. Rate Presort to In-County 3/5-digit Discounts)		0.172	1.519	0.136	1.206	0.459	4.807	3.346	5.555
Sum of Coefficients for all Postal Rates (Within-County to Classroom Periodicals)		-0.144	-0.651	-0.096	-1.953	-0.110	-1.320	-0.011	-0.035
Regression Diagnostics		Adj. R^2	0.970	Adj. R^2	0.965	Adj. R^2	0.919	Adj. R^2	0.800
		Std. Error	0.048	Std. Error	0.023	Std. Error	0.035	Std. Error	0.105
		d.f.	56	d.f.	106	d.f.	56	d.f.	53
Estimated Annual Rate of Adaptation	60.94%	AR-1	0.354	AR-1	0.275	AR-1	0.104	AR-1	0.081
99 Percent Confidence Interval	+/- 25.26%	AR-2	-0.056	AR-2	0.177	AR-2	-0.095	AR-2	-0.338
95 Percent Confidence Interval	+/- 20.16%	AR-3	-0.092	AR-3	-0.041	AR-3	0.051	AR-3	-0.164
90 Percent Confidence Interval	+/- 17.63%	AR-4	-0.207	AR-4	-0.043	AR-4	0.013	AR-4	-0.215

Table 4A. Standard Regular Rate Mail Volume

Calendar Quarter Volumes per Household and Volume Ratios

Regressor	Effective Date	Ln Std Bulk Reg Rate/ Household		Logit Carrier-Route/ Non-Car.-Rte. Bulk		Logit Automated NCR/ Non- Automated		Ln Single-Piece/ Household	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-0.728	-1.225	1.272	0.559	-12.219	-2.871	-2.677	-0.889
2nd Quarter Seasonal Dummy Variable		-0.053	-4.369	0.127	3.950	0.014	0.958	-0.025	-0.579
3rd Quarter Seasonal Dummy Variable		-0.050	-5.610	0.075	3.307	0.017	1.053	-0.175	-3.840
4th Quarter Seasonal Dummy Variable		0.011	0.947	0.116	3.662	0.008	0.510	0.042	0.976
Linear Trend		-0.010	-3.130	-0.127	-4.411			-0.070	-3.815
2nd Quarter Dummy Times Trend		0.003	3.985	-0.007	-3.296			0.005	1.660
3rd Quarter Dummy Times Trend		0.003	5.803	-0.003	-1.891			0.009	3.029
4th Quarter Dummy Times Trend		0.004	5.945	-0.002	-1.091			0.002	0.676
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	-0.011	-0.670	-0.043	-0.980			-0.415	-5.261
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	-0.001	-0.067	-0.011	-0.258	0.498	3.349	0.122	1.291
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		1.058	7.050	-0.654	-1.188	3.347	3.510	0.755	1.008
Carrier-Route Presort Introduction (Exponential Trend from the Effective Date)	01/28/1979	0.483	5.879	4.159	7.657			-1.781	-5.578
5-digit Presort Introduction (Exponential Trend from the Effective Date)	03/22/1981	0.419	6.687	-0.756	-1.778			0.579	2.181
Zip+4 Discount (Exponential Trend from the Effective Date)	04/03/1988	-0.220	-4.606	0.101	0.605			0.377	1.563
Prebarcode Discounts (Exponential Trend from the Effective Date)	02/03/1991	0.017	0.132	-0.005	-0.015			0.895	1.382
125 Walk Sequence Discounts (Exponential Trend from the Effective Date)	03/15/1992	0.210	0.682	0.485	0.625			-1.577	-1.070
Automated Flats Discounts (Exponential Trend from the Effective Date)	09/20/1992	-0.033	-0.139	0.152	0.259			0.413	0.364
MC95-1 Automation Discounts (Exponential Trend from the Effective Date)	07/01/1996	0.064	1.623	0.264	1.611	1.298	6.486	-0.001	-0.004
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.055	-2.918	0.045	0.847	0.080	1.876		
Standard Bulk Regular Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.299	-5.974						
Std. Bulk Reg. Carrier-Route Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.479	-1.897				
Std. Bulk Reg. Non Car-Rte Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.599	2.118	1.961	1.372		
Std. Bulk Reg. Automated Rate (Ln of Fixed-Weight Index/GDP Deflator)						-0.410	-0.300		
Standard Mail Single-Piece Rate (Ln of Fixed-Weight Index/GDP Deflator)								-1.092	-4.208
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.006	2.117	-0.137	-5.224	0.051	3.510	-0.059	-4.037
Sum of Coefficients for all Innovations (Car-Rte Presort to MC95-1 Automation Discounts)		0.941	11.780	4.401	6.908	1.298	6.486	-1.097	-3.125
Sum of Coefficients for all Postal Rates (Std. Bulk Reg. to Std. Single-Piece Mail)		-0.299	-5.974	0.121	0.805	1.551	5.561	-1.092	-4.208
Regression Diagnostics		Adj. R^2	0.998	Adj. R^2	0.969	Adj. R^2	0.995	Adj. R^2	0.984
		Std. Error	0.020	Std. Error	0.045	Std. Error	0.030	Std. Error	0.090
		d.f.	106	d.f.	75	d.f.	19	d.f.	87
Estimated Annual Rate of Adaptation	21.08%	AR-1	0.206	AR-1	0.318	AR-1	0.154	AR-1	0.366
99 Percent Confidence Interval	+/- 13.82%	AR-2	0.194	AR-2	0.227	AR-2	-0.202	AR-2	0.053
95 Percent Confidence Interval	+/- 11.03%	AR-3	-0.184	AR-3	-0.289	AR-3	-0.154	AR-3	-0.014
90 Percent Confidence Interval	+/- 9.65%	AR-4	0.057	AR-4	0.086	AR-4	-0.162	AR-4	-0.014

Table 5A. Standard Nonprofit Rate Volume

Calendar Quarter Volumes per Household and Volume Ratios

Regressor	Effective Date	Ln Std Nonprofit Rate/ Household		Logit Carrier-Route/ Non-Car.-Rte. Bulk		Logit Automated NCR/ Non- Automated	
		Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		0.452	0.432	9.371	1.853	-12.374	-2.204
2nd Quarter Seasonal Dummy Variable		-0.079	-4.091	-0.054	-1.197	-0.017	-0.826
3rd Quarter Seasonal Dummy Variable		-0.132	-5.400	0.300	6.008	0.032	1.455
4th Quarter Seasonal Dummy Variable		0.043	2.249	0.217	4.736	0.073	3.554
Linear Trend		0.027	4.824	-0.033	-0.766		
2nd Quarter Dummy Times Trend		0.002	2.360	0.005	1.593		
3rd Quarter Dummy Times Trend		0.005	4.061	-0.011	-2.854		
4th Quarter Dummy Times Trend		0.005	4.913	-0.005	-1.382		
Election Year Dummy Variable (One in even years, Zero in odd years)		0.020	3.105	0.071	3.284		
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	0.032	1.082	-0.184	-4.079	1.008	2.742
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.510	2.022	-2.864	-2.219	2.384	1.845
Std Regular Presort Introduction (Exponential Trend from the Effective Date)	01/28/1979	0.268	2.492				
5-digit Presort Introduction (Exponential Trend from the Effective Date)	03/22/1981	-0.203	-1.778	2.585	5.516		
Zip+4 Discount (Exponential Trend from the Effective Date)	04/03/1988	-0.307	-3.469	-0.132	-0.453		
Prebarcode Discounts (Exponential Trend from the Effective Date)	02/03/1991	0.012	0.043	0.419	0.934		
125 Walk Sequence Discounts (Exponential Trend from the Effective Date)	03/15/1992	-0.332	-0.532	-0.379	-0.332		
Automated Flats Discounts (Exponential Trend from the Effective Date)	09/20/1992	0.159	0.333	0.547	0.667		
MC95-1 Automation Discounts (Exponential Trend from the Effective Date)	10/06/1996	-0.101	-1.200	0.419	1.789	1.424	4.218
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.076	-2.262	-0.066	-0.839	0.054	1.444
Std Bulk Nonprofit Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.132	-2.553				
Std. Bulk Nonpr. Carrier-Route Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.141	-0.638		
Std. Bulk Nonpr. Non Car-Rte Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.204	0.912	-0.352	-1.066
Std. Bulk Nonpr. Automated Rate (Ln of Fixed-Weight Index/GDP Deflator)						-0.102	-0.198
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.034	7.022	-0.076	-1.975	0.036	1.845
Sum of Coefficients for all Innovations (Std. Reg. Presort to MC95-1 Automation Discounts)		-0.505	-3.263	3.460	3.542	1.424	4.218
Sum of Coefficients for all Postal Rates (Std. Bulk Nonprofit to Automated Rate)		-0.132	-2.553	0.063	0.440	-0.454	-1.347
Regression Diagnostics		Adj. R^2	0.968	Adj. R^2	0.893	Adj. R^2	0.988
		Std. Error	0.034	Std. Error	0.074	Std. Error	0.037
		d.f.	106	d.f.	67	d.f.	19
Estimated Annual Rate of Adaptation	17.33%	AR-1	0.445	AR-1	0.137	AR-1	-0.046
99 Percent Confidence Interval	+/- 17.04%	AR-2	-0.231	AR-2	-0.197	AR-2	-0.090
95 Percent Confidence Interval	+/- 13.60%	AR-3	0.084	AR-3	-0.199	AR-3	-0.004
90 Percent Confidence Interval	+/- 11.90%	AR-4	0.113	AR-4	-0.108	AR-4	0.003

Table 6A. Parcel Services Volume

Calendar Quarter Volumes per Household

Regressor	Effective Date	Ln Parcel Post/ Household		Ln BPM/ Household		Ln Special Rate/ Household		Ln Library Rate/ Household	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-5.437	-3.950	0.499	0.260	-4.309	-2.207	3.181	0.680
2nd Quarter Seasonal Dummy Variable		0.021	0.961	-0.431	-5.518	0.017	0.498	-0.119	-1.533
3rd Quarter Seasonal Dummy Variable		-0.152	-6.784	0.709	11.986	-0.105	-2.612	-0.396	-4.611
4th Quarter Seasonal Dummy Variable		0.364	16.541	-0.221	-2.858	-0.030	-0.900	0.016	0.205
Linear Trend		-0.161	-19.637	-0.019	-1.519	-0.081	-9.448	-0.006	-0.213
2nd Quarter Dummy Times Trend		-0.007	-6.171	0.017	4.146	-0.002	-1.043	0.003	0.767
3rd Quarter Dummy Times Trend		-0.000	-0.367	-0.021	-6.742	0.003	1.375	0.011	2.504
4th Quarter Dummy Times Trend		-0.009	-7.720	0.009	2.359	0.005	2.639	0.004	0.873
United Parcel Service Coverage Fraction (Fraction of the U.S. Market Covered by UPS)		-0.062	-0.632						
United Parcel Service Strike Fraction (Fraction of the Quarter UPS on Strike)		0.608	12.142						
BPM Base Shift from Pounds to Pieces (Switching Exp. Trend, Pieces on, Pounds off)	05/29/1978			1.534	6.655				
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	-0.097	-2.927						
Restatement of Parcel Post RPW Data (Zero before the Effective Date, One after)	09/19/1992	-0.093	-1.949						
1997 United Parcel Service Strike (Reverse Exponential Trend from the Strike)	08/15/1997	0.269	6.028						
Sears Catalog Discontinued (Zero before the Effective Date, One after)	01/01/1993			-0.140	-2.820				
Library Rate Rule Restricting Eligibility (Zero before the Effective Date, One after)	11/21/1993					0.282	4.312	-0.153	-1.033
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		1.396	4.262	-0.419	-0.898	1.033	2.200	-1.205	-1.038
Inter/Intra BMC Rate Differential (Exponential Trend from the Effective Date)	03/22/1981	1.020	6.709						
Various Discount & Service Changes (Exponential Trend from the Effective Date)	02/03/1991	1.474	8.733						
Machinable Inter-BMC Discounts (Exponential Trend from the Effective Date)	01/09/1999	0.516	2.768						
Machinable Intra-BMC Discounts (Exponential Trend from the Effective Date)	01/07/2001	1.686	5.773						
BPM Car-Rte Presort, Special rate Bundling (Exponential Trend from the Effective Date)	02/17/1985			2.649	7.926	0.267	1.656		
Prebarcode Discounts, Single Media Rate (Exponential Trend from the Effective Date)	01/10/1999			-0.045	-0.139	0.093	0.368	-0.671	-1.140
Destination BMC Drop Ship Discounts (Exponential Trend from the Effective Date)	01/07/2001			-0.162	-0.122				
Flat Rate for Prebarcoded Flats (Exponential Trend from the Effective Date)	07/01/2002			0.600	0.385				
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.079	-1.321	-0.115	-0.617	0.027	0.303	-0.165	-0.830
Parcel Post Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.670	-5.619						
Bound Printed Matter Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.020	-0.094				
Special Rate Parcels Rate (Ln of Fixed-Weight Index/GDP Deflator)						-0.079	-0.869		
Library Rate Parcels Rate (Ln of Fixed-Weight Index/GDP Deflator)								-0.190	-0.907
UPS Residential Rates with Parcel Post Weights (Ln of Fixed-Weight Index/GDP Deflator)		1.373	10.015			0.416	3.079		
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		-0.140	-15.753	-0.026	-1.940	-0.065	-8.028	-0.024	-1.240
Sum of Coefficients for all Innovations (Inter/Intra BMC Rates to Flat Rate for PBC Flats)		4.696	13.541	3.041	4.137	0.360	1.010	-0.671	-1.140
Sum of Coefficients for all Postal Rates (Parcel Post to Library Rate Parcels Rate)		-0.670	-5.619	-0.020	-0.094	-0.079	-0.869	-0.190	-0.907
Regression Diagnostics		Adj. R^2	0.990	Adj. R^2	0.976	Adj. R^2	0.957	Adj. R^2	0.868
		Std. Error	0.048	Std. Error	0.097	Std. Error	0.070	Std. Error	0.169
		d.f.	105	d.f.	109	d.f.	111	d.f.	113
Estimated Annual Rate of Adaptation	13.91%	AR-1	0.217	AR-1	0.112	AR-1	0.568	AR-1	0.446
99 Percent Confidence Interval	+/- 4.60%	AR-2	0.066	AR-2	0.083	AR-2	-0.152	AR-2	0.063
95 Percent Confidence Interval	+/- 3.67%	AR-3	0.033	AR-3	-0.181	AR-3	-0.031	AR-3	0.090
90 Percent Confidence Interval	+/- 3.21%	AR-4	-0.063	AR-4	0.266	AR-4	0.142	AR-4	0.091

Table 7A. Priority Mail, Express Mail, etc. Volum

Calendar Quarter Volumes per Household

Regressor	Effective Date	Ln Priority Mail/ Household		Ln Express Mail/ Household		Ln Mailgrams/ Household		Ln Special Dlvry/ Household	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-0.842	-0.769	-9.224	-5.268	2.859	0.438	-4.050	-0.511
2nd Quarter Seasonal Dummy Variable		0.082	3.501	0.041	3.225	0.087	1.203	0.351	2.006
3rd Quarter Seasonal Dummy Variable		0.001	0.042	-0.005	-0.374	0.082	0.913	0.414	1.877
4th Quarter Seasonal Dummy Variable		0.075	3.148	0.009	0.729	0.055	0.792	0.292	1.710
Linear Trend		0.012	2.469	-0.026	-2.274	-0.135	-4.274	-0.241	-7.725
2nd Quarter Dummy Times Trend		-0.005	-4.345	-0.002	-2.861	-0.007	-1.679	-0.029	-2.594
3rd Quarter Dummy Times Trend		-0.004	-2.523	-0.001	-1.263	-0.013	-2.446	-0.044	-3.084
4th Quarter Dummy Times Trend		-0.002	-1.808	-0.002	-2.269	-0.008	-1.881	-0.024	-2.156
United Parcel Service Coverage Fraction (Fraction of the U.S. Market Covered by UPS)		-0.361	-4.513						
United Parcel Service Strike Fraction (Fraction of the Quarter UPS on Strike)		0.119	2.469						
Maximum Weight for First-Class Mail (Ratio of Maximum Ounces to 12 Ounces)		-0.911	-5.191						
Federal Express Entry (Exponential Trend from the Effective Date)	04/12/1978			0.949	4.029				
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.598	2.224	1.209	3.279	-0.910	-0.569	-0.140	-0.076
Two-Pound Flat Rate (Exponential Trend from the Effective Date)	02/17/1985	0.183	3.489						
Two-Pound Envelope, Presort Discounts (Exponential Trend from the Effective Date)	02/03/1991	0.270	3.477	-0.141	-1.403				
Unzoned Rates up to 5 Pounds (Exponential Trend Reversing 07/01/2002)	01/01/1995	0.282	5.821						
Express Mail Startup (Exponential Trend from the Effective Date)	09/13/1975			1.367	3.051			2.166	7.250
Express Mail Zoned Rates (Exponential Trend from the Effective Date)	10/09/1977			-0.075	-0.224				
Express Mail Customer Pickup Service (Exponential Trend from the Effective Date)	03/21/1981			0.686	6.280				
Express Mail Dezoned Rates (Exponential Trend from the Effective Date)	04/03/1988			0.089	1.165				
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	01/01/1995	-0.207	-4.221	-0.123	-2.848	0.060	0.294		
Priority Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.635	-5.327						
Express Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.719	-5.391			1.475	1.641
Mailgrams Rate (Ln of Revenue per Piece/GDP Deflator)						-0.440	-2.368		
Special Delivery Rate (Ln of Revenue per Piece/GDP Deflator)								-1.097	-4.275
UPS Residential Rates with Parcel Post Weights (Ln of Fixed-Weight Index/GDP Deflator)		0.236	1.868	0.540	3.239				
Federal Express Average Revenue (Ln of Revenue Rate/GDP Deflator)				0.285	2.098				
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.021	5.270	-0.008	-1.054	-0.149	-10.301	-0.244	-11.200
Sum of Coefficients for all Innovations (Two-Pound Rate to Exp. Mail Dezoned Rates)		0.453	5.134	1.926	5.161			2.166	7.250
Sum of Coefficients for all Postal Rates (Priority Mail to Special Delivery Rate)		-0.635	-5.327	-0.719	-5.391	-0.440	-2.368	0.378	0.382
Regression Diagnostics		Adj. R^2	0.992	Adj. R^2	0.997	Adj. R^2	0.978	Adj. R^2	0.978
		Std. Error	0.046	Std. Error	0.031	Std. Error	0.161	Std. Error	0.327
		d.f.	108	d.f.	91	d.f.	99	d.f.	89
Estimated Annual Rate of Adaptation	48.78%	AR-1	0.362	AR-1	0.585	AR-1	0.726	AR-1	0.516
99 Percent Confidence Interval	+/- 13.76%	AR-2	-0.126	AR-2	0.062	AR-2	-0.137	AR-2	-0.306
95 Percent Confidence Interval	+/- 10.98%	AR-3	0.056	AR-3	0.080	AR-3	0.330	AR-3	0.117
90 Percent Confidence Interval	+/- 9.61%	AR-4	0.064	AR-4	-0.130	AR-4	-0.069	AR-4	-0.085

Table 8A. Special Services and Misc. Volume

Calendar Quarter Volumes per Household

Regressor	Effective Date	Ln Registered/ Household		Ln Insured/ Household		Ln Certified/ Household		Ln Money Orders/ Household	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-6.893	-2.526	-2.603	-1.369	-8.027	-6.430	-2.515	-1.852
2nd Quarter Seasonal Dummy Variable		0.189	4.777	0.104	2.062	0.022	0.570	0.017	0.972
3rd Quarter Seasonal Dummy Variable		0.135	2.032	0.038	0.929	0.017	0.333	0.008	0.360
4th Quarter Seasonal Dummy Variable		0.017	0.221	0.474	8.846	-0.192	-3.454	-0.100	-4.242
Linear Trend		-0.073	-7.494	-0.040	-3.713	0.026	5.922	-0.006	-1.132
2nd Quarter Dummy Times Trend		-0.005	-2.486	-0.008	-3.038	0.004	1.769	0.001	1.547
3rd Quarter Dummy Times Trend		-0.003	-1.231	-0.005	-2.503	0.002	1.012	0.001	1.101
4th Quarter Dummy Times Trend		0.000	0.088	-0.017	-6.486	0.008	3.278	0.003	2.809
RPW Accounting Separates Return Receipts (Zero before the Effective Date, One after)	09/14/1996	-0.139	-2.107			0.040	0.843		
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		-0.094	-0.153	0.329	0.723	0.007	0.015	0.464	1.391
Ln of 1st Class Letters/Household (Calculated from Volume Regression)		1.181	1.825			1.270	3.332		
Ln of Parcel Post/Household (Calculated from Volume Regression)				0.397	6.085			0.229	6.436
Ln of Priority Mail/Household (Calculated from Volume Regression)				-0.142	-0.884				
Special Services Reclassification (Exponential Trend from the Effective Date)	05/24/1997	0.256	0.929	1.505	7.169	-0.405	-2.457	-0.285	-2.668
Delivery Confirmation (Exponential Trend from the Effective Date)	09/11/1999	-0.168	-0.529	-0.531	-1.939	0.053	0.232		
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.091	-1.103	-0.085	-1.031	0.119	1.537	0.007	0.147
Registered Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.170	-1.409						
Insured Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.108	-1.359				
Certified Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)						-0.096	-1.393		
Money Orders Rate (Ln of Fixed-Weight Index/GDP Deflator)								-0.436	-9.878
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		-0.074	-6.374	-0.035	-2.954	0.026	3.682	0.001	0.393
Sum of Coefficients for all Innovations (Special Services Reclass. & Delivery Confirmation)		0.087	0.339	0.974	4.060	-0.353	-2.206	-0.285	-2.668
Sum of Coefficients for all Postal Rates (Registered Mail to Money Orders Rate)		-0.170	-1.409	-0.108	-1.359	-0.096	-1.393	-0.436	-9.878
Regression Diagnostics		Adj. R^2	0.986	Adj. R^2	0.979	Adj. R^2	0.964	Adj. R^2	0.957
		Std. Error	0.070	Std. Error	0.072	Std. Error	0.071	Std. Error	0.041
		d.f.	111	d.f.	111	d.f.	111	d.f.	113
Estimated Annual Rate of Adaptation									
Registered	19.86%	AR-1	0.514	AR-1	0.276	AR-1	0.204	AR-1	0.681
Insured	13.91%	AR-2	-0.149	AR-2	0.125	AR-2	-0.135	AR-2	-0.149
Certified	19.86%	AR-3	0.244	AR-3	-0.171	AR-3	0.059	AR-3	0.149
Money Orders	13.91%	AR-4	0.115	AR-4	0.279	AR-4	0.059	AR-4	-0.015

Table 8A continued. Special Services and Misc. Calendar Quarter Volumes per Household

Regressor	Effective Date	Ln Return Rec'pts/ Household		Ln COD/ Household		Ln Penalty Mail/ Household		Ln Free-for-the-Blind/ Household	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-0.670	-6.225	2.458	0.975	8.365	1.151	4.640	1.435
2nd Quarter Seasonal Dummy Variable		0.006	0.218	0.074	2.016	-0.016	-0.223	0.018	0.177
3rd Quarter Seasonal Dummy Variable		-0.058	-1.636	-0.104	-2.290	-0.035	-0.600	0.038	0.362
4th Quarter Seasonal Dummy Variable		0.040	1.416	0.064	1.761	0.191	2.816	-0.151	-1.514
Linear Trend				-0.057	-5.699	-0.002	-0.061	0.049	3.789
2nd Quarter Dummy Times Trend				-0.003	-1.561	0.005	0.634	0.001	0.194
3rd Quarter Dummy Times Trend				0.004	1.667	0.002	0.390	0.000	0.059
4th Quarter Dummy Times Trend				-0.001	-0.372	-0.007	-1.028	0.009	1.707
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)				-1.161	-1.832	-1.872	-1.094	-1.811	-2.269
Special Services Reclassification (Exponential Trend from the Effective Date)	05/24/1997	0.435	1.279						
Delivery Confirmation (Exponential Trend from the Effective Date)	09/11/1999	1.438	3.490						
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.020	-0.215	-0.355	-3.894	0.158	1.529	0.122	0.824
Return Receipts Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.355	1.029						
Collect on Delivery Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.200	-1.359				
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)				-0.075	-18.132	-0.031	-1.765	0.022	4.620
Sum of Coefficients for all Innovations (Special Services Reclass. & Delivery Confirmation)		1.873	4.545						
Sum of Coefficients for all Postal Rates (Return Receipts and COD Rate)		0.355	1.029	-0.200	-1.359				
Regression Diagnostics		Adj. R^2	0.976	Adj. R^2	0.986	Adj. R^2	0.852	Adj. R^2	0.480
		Std. Error	0.058	Std. Error	0.088	Std. Error	0.087	Std. Error	0.240
		d.f.	17	d.f.	115	d.f.	51	d.f.	116
Estimated Annual Rate of Adaptation									
Return Receipts	19.86%	AR-1	0.995	AR-1	0.786	AR-1	0.561	AR-1	0.228
COD	13.91%	AR-2	-0.614	AR-2	-0.211	AR-2	0.149	AR-2	0.044
Penalty Mail	19.86%	AR-3	0.300	AR-3	0.031	AR-3	-0.210	AR-3	0.044
Free-for-the-Blind	19.86%	AR-4	-0.244	AR-4	0.077	AR-4	0.275	AR-4	-0.128

Table 1B. First-Class Letters Revenue per Piece

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln 1st Cls Ltrs Real Rev/Pc		Ln Single-Piece Real Rev/Pc		Ln Car-Rte Real Rev/Pc		Ln Automated Real Rev/Pc	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-0.500	-2.135	0.281	0.922	0.607	0.745	-0.645	-1.181
2nd Quarter Seasonal Dummy Variable		0.007	1.958	0.004	0.972	0.021	2.196	0.007	2.906
3rd Quarter Seasonal Dummy Variable		0.009	2.701	0.002	0.460	-0.001	-0.105	-0.003	-1.442
4th Quarter Seasonal Dummy Variable		-0.013	-3.733	-0.016	-4.407	-0.020	-2.089	0.001	0.445
Linear Trend		0.004	2.020	-0.003	-0.474	0.007	0.783		
2nd Quarter Dummy Times Trend		0.000	1.053	0.001	3.485	-0.001	-1.054		
3rd Quarter Dummy Times Trend		-0.000	-1.314	0.000	1.753	0.000	0.304		
4th Quarter Dummy Times Trend		0.001	3.688	0.001	4.206	0.002	2.140		
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	0.004	0.572	-0.013	-1.879	-0.021	-1.703		
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	0.007	1.032	0.008	1.089	-0.044	-1.529	0.042	1.251
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.100	1.729	-0.121	-1.591	-0.149	-0.724	0.074	0.594
3/5-digit Presort Introduction (Exponential Path from the Effective Date)	07/06/1976	0.031	1.338	-0.009	-0.132	0.033	0.418		
Carrier-Route Presort Introduction (Exponential Path from the Effective Date)	03/21/1981	-0.060	-3.505	0.073	2.885	-0.005	-0.093		
Zip+4 Discount (Exponential Path from the Effective Date)	10/09/1983	-0.023	-0.870	0.000	0.016	-0.103	-2.939		
5-digit Prebarcode Discount (Exponential Path from the Effective Date)	04/03/1988	-0.017	-0.951	0.018	0.791	0.043	1.021		
3-digit Prebarcode Discount (Exponential Path from the Effective Date)	02/03/1991	-0.041	-1.942	0.075	2.651	-0.014	-0.304		
MC95-1 Automation Discounts (Exponential Path from the Effective Date)	07/01/1996	-0.058	-2.787	0.068	2.068	-0.017	-1.081	-0.003	-0.083
911 Attack/Anthrax Letters (Reverse Exponential Path from 9/11)	09/11/2001	-0.016	-2.232	-0.007	-0.848	0.655	1.719	0.009	2.482
First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)		1.035	24.764						
First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)		-0.054	-1.407						
Single-Piece First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)				1.190	9.370				
Workshared First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)				-0.280	-2.105	0.367	0.888	-0.526	-0.706
Carrier-Route First Class letters Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.655	1.719		
Automated Non Car-Rte First Class Letters Rate (Ln of Fixed-Weight Index/GDP Deflator)								1.277	1.764
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.006	2.410	-0.004	-0.840	0.005	0.591	0.001	0.594
Sum of Coefficients for all Innovations (3/5-digit Presort to MC95-1 Automation)		-0.167	-2.347	0.225	1.450	-0.064	-0.360	-0.003	-0.083
Sum of Coefficients for all Postal Rates (1st Cls Letters to Auto Non Car-Rte Letters)		0.981	-0.908	0.910	-3.043	1.022	0.287	0.751	-7.007
		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1	
Regression Diagnostics		Adj. R^2	0.984	Adj. R^2	0.990	Adj. R^2	0.912	Adj. R^2	0.951
		Std. Error	0.008	Std. Error	0.008	Std. Error	0.017	Std. Error	0.005
		d.f.	106	d.f.	86	d.f.	68	d.f.	19
Estimated Annual Rate of Adaptation	19.86%	AR-1	0.144	AR-1	0.180	AR-1	0.031	AR-1	-0.396
99 Percent Confidence Interval	+/- 11.70%	AR-2	0.156	AR-2	0.118	AR-2	-0.079	AR-2	-0.070
95 Percent Confidence Interval	+/- 9.34%	AR-3	0.042	AR-3	0.032	AR-3	-0.177	AR-3	0.294
90 Percent Confidence Interval	+/- 8.17%	AR-4	-0.094	AR-4	-0.147	AR-4	-0.229	AR-4	0.022

Table 2B. First Class Cards Revenue per Piece

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln 1st Cls Cards Real Rev/Pc		Ln Single-Piece Real Rev/Pc		Ln Car-Rte Real Rev/Pc		Ln Automated Real Rev/Pc	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-0.944	-3.741	-0.613	-2.397	0.618	1.010	-1.083	-1.298
2nd Quarter Seasonal Dummy Variable		-0.012	-1.885	-0.014	-2.561	0.002	0.218	0.007	1.811
3rd Quarter Seasonal Dummy Variable		0.006	0.924	0.000	0.082	0.014	1.822	-0.004	-1.056
4th Quarter Seasonal Dummy Variable		-0.002	-0.402	-0.005	-0.860	0.004	0.423	0.000	0.054
Linear Trend		0.006	3.356	-0.002	-1.021	0.010	1.298		
2nd Quarter Dummy Times Trend		0.001	2.432	0.001	2.551	0.000	0.476		
3rd Quarter Dummy Times Trend		-0.000	-0.467	-0.000	-0.195	-0.001	-1.553		
4th Quarter Dummy Times Trend		0.000	0.800	0.000	0.917	0.000	0.017		
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	-0.009	-0.902	0.002	0.277	0.006	0.643		
1st Class/3rd Class Rate Crossover Dummy (One during the crossover, Zero otherwise)	04/03/1988	0.017	2.279	0.013	1.191	0.006	0.760		
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	-0.011	-1.352	0.000	0.020	-0.008	-0.819	0.081	0.512
1st Class/3rd Class Rate Crossover Dummy (One during the crossover, Zero otherwise)	01/01/1995	-0.030	-3.472	-0.003	-0.510	-0.016	-2.323		
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.225	3.546	0.135	2.086	-0.175	-1.119	0.140	0.708
3/5-digit Presort Introduction (Exponential Trend from the Effective Date)	07/04/1976	-0.098	-2.718						
Carrier-Route Presort Introduction (Exponential Trend from the Effective Date)	03/21/1981	0.030	0.974	0.067	1.915	-0.068	-0.536		
Zip+4 Discount (Exponential Trend from the Effective Date)	10/09/1983	-0.185	-4.067	-0.100	-3.131	0.009	0.102		
5-digit Prebarcode Discount (Exponential Trend from the Effective Date)	04/03/1988	0.042	1.325	0.078	2.776	-0.094	-1.999		
3-digit Prebarcode Discount (Exponential Trend from the Effective Date)	02/03/1991	-0.049	-1.170	-0.066	-2.143	0.057	1.218		
MC95-1 Automation Discounts (Exponential Trend from the Effective Date)	07/01/1996	-0.172	-5.854	-0.022	-0.877	-0.065	-1.189	-0.057	-0.849
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	0.009	1.095	0.016	2.082	-0.002	-0.230	0.016	1.796
First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.975	31.257						
Single-Piece First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.779	3.774				
Workshared First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.158	0.772	0.934	8.103	0.617	0.775
Carrier-Route First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.001	0.009		
Automated Non Car-Rte First Class Cards Rate (Ln of Fixed-Weight Index/GDP Deflator)								0.177	0.208
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.010	4.902	0.000	0.105	0.007	0.951	0.002	0.708
Sum of Coefficients for all Innovations (3/5-digit Presort to MC95-1 Automation)		-0.432	-5.790	-0.042	-0.570	-0.162	-0.728	-0.057	-0.849
Sum of Coefficients for all Postal Rates (1st Cls Cards to Auto Non Car-Rte Cards)		0.975	-0.813	0.937	-2.169	0.935	-1.400	0.793	-2.964
		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1	
Regression Diagnostics		Adj. R^2	0.960	Adj. R^2	0.948	Adj. R^2	0.978	Adj. R^2	0.956
		Std. Error	0.013	Std. Error	0.011	Std. Error	0.011	Std. Error	0.007
		d.f.	105	d.f.	84	d.f.	65	d.f.	19
Estimated Annual Rate of Adaptation	11.15%	AR-1	0.025	AR-1	-0.085	AR-1	-0.296	AR-1	-0.171
99 Percent Confidence Interval	+/- 11.75%	AR-2	-0.041	AR-2	-0.099	AR-2	-0.130	AR-2	0.005
95 Percent Confidence Interval	+/- 9.38%	AR-3	-0.098	AR-3	-0.200	AR-3	-0.132	AR-3	0.068
90 Percent Confidence Interval	+/- 8.21%	AR-4	-0.120	AR-4	-0.301	AR-4	-0.093	AR-4	-0.023

Table 3B. Periodicals Revenue per Piece

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln Within County Real Rev/Pc		Ln All Periodicals Real Rev/Pc		Ln Non-profit Rate Real Rev/Pc		Ln Classroom Rate Real Rev/Pc	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-2.087	-1.398	-2.637	-2.771	-2.164	-1.221	9.271	2.878
2nd Quarter Seasonal Dummy Variable		0.046	5.127	0.013	0.997	-0.014	-1.005	-0.040	-0.852
3rd Quarter Seasonal Dummy Variable		0.031	3.333	-0.005	-0.334	-0.005	-0.307	-0.142	-2.538
4th Quarter Seasonal Dummy Variable		0.055	5.966	0.015	1.167	-0.014	-0.986	-0.003	-0.060
Linear Trend		-0.002	-0.230	-0.013	-1.578	0.006	0.495	-0.062	-2.656
2nd Quarter Dummy Times Trend		-0.003	-3.260	-0.000	-0.568	0.001	0.871	-0.002	-0.452
3rd Quarter Dummy Times Trend		-0.002	-2.566	-0.000	-0.077	0.000	0.159	0.006	1.115
4th Quarter Dummy Times Trend		-0.003	-3.542	0.000	0.309	0.001	0.935	0.008	1.875
New Classroom Mailer (Zero before the Effective Date, One after)	03/14/1987							-0.313	-5.836
New Reporting Rules Dummy (Zero before the Effective Date, One after)	07/01/1996			-0.036	-1.565				
Sampling Method Change (Zero before the Effective Date, One after)	12/12/1992	0.044	2.128	-0.002	-0.059	-0.031	-1.152	-0.094	-2.274
MC95-1 Mail Reclassification (Zero before the Effective Date, One after)	07/01/1996	-0.014	-0.731	0.016	0.505	-0.014	-0.541	0.052	1.357
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.338	0.901	0.473	2.052	0.346	0.813	-2.170	-2.772
Ln of School Age Children per Household								-6.946	-7.869
Regular Rate Presort Introduction (Exponential Trend from the Effective Date)	05/29/1978			0.100	1.991				
Carrier-Route Presort Introduction (Exponential Trend from the Effective Date)	07/06/1981			0.092	2.167				
SCF Drop Ship Discount (Exponential Trend from the Effective Date)	02/17/1985			0.107	2.301	-0.101	-1.069	0.138	0.806
Miscellaneous Worksharing Discounts (Exponential Trend from the Effective Date)	02/03/1991	-0.021	-0.520	0.091	1.653	0.034	0.701	-1.046	-12.596
MC95-1 Automation Discounts (Exponential Trend from the Effective Date)	10/06/1996	-0.046	-1.210	0.015	0.271	-0.041	-0.863	-0.130	-1.241
In-County Separate 3/5-digit Discounts (Exponential Trend from the Effective Date)	01/10/1999	0.010	0.325	-0.047	-1.007	-0.094	-2.224	-0.069	-1.151
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.014	-0.588	-0.017	-0.533	-0.006	-0.210	-0.161	-3.297
Within County Periodicals (Ln of Fixed-Weight Index/GDP Deflator)		0.741	7.715						
Regular Rate Periodicals Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.748	11.664				
Non-profit Rate Periodicals Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.627	7.733		
Classroom Rate Periodicals Rate (Ln of Fixed-Weight Index/GDP Deflator)								0.842	5.750
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.004	0.898	-0.006	-0.807	0.011	1.208	-0.095	-4.083
Sum of Coefficients for all Innovations (Reg. Rate Presort to In-County 3/5-digit Discounts)		-0.057	-0.159	0.359	1.934	-0.201	-0.450	-1.107	-1.397
Sum of Coefficients for all Postal Rates (Within-County to Classroom Periodicals)		0.741	-2.690	0.748	-3.939	0.627	-4.592	0.842	-1.078
		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1	
Regression Diagnostics		Adj. R^2	0.864	Adj. R^2	0.977	Adj. R^2	0.970	Adj. R^2	0.915
		Std. Error	0.016	Std. Error	0.023	Std. Error	0.022	Std. Error	0.053
		d.f.	56	d.f.	85	d.f.	55	d.f.	53
Estimated Annual Rate of Adaptation	60.94%	AR-1	0.423	AR-1	0.399	AR-1	0.438	AR-1	-0.078
99 Percent Confidence Interval	+/- 25.26%	AR-2	0.107	AR-2	0.078	AR-2	-0.124	AR-2	-0.308
95 Percent Confidence Interval	+/- 20.16%	AR-3	-0.023	AR-3	0.062	AR-3	-0.006	AR-3	-0.181
90 Percent Confidence Interval	+/- 17.63%	AR-4	-0.055	AR-4	-0.123	AR-4	0.026	AR-4	0.013

Table 4B. Standard Regular Rate Revenue per P

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln Std Reg Rate Real Rev/Pc		Ln Carrier-Route Real Rev/Pc		Ln Automated Real Rev/Pc		Ln Single-Piece Real Rev/Pc	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		-0.127	-0.198	1.183	1.802	1.314	1.756	-0.064	-0.029
2nd Quarter Seasonal Dummy Variable		-0.003	-0.382	-0.006	-0.764	0.000	0.158	0.020	0.783
3rd Quarter Seasonal Dummy Variable		0.031	3.736	-0.005	-0.659	-0.008	-3.135	0.024	0.857
4th Quarter Seasonal Dummy Variable		-0.009	-1.387	-0.014	-1.966	0.004	1.702	0.022	0.852
Linear Trend		0.007	1.736	0.005	0.681			0.039	3.000
2nd Quarter Dummy Times Trend		-0.000	-0.126	0.000	0.441			-0.003	-2.034
3rd Quarter Dummy Times Trend		-0.002	-3.770	0.000	0.888			-0.003	-1.529
4th Quarter Dummy Times Trend		0.000	0.862	0.002	3.939			-0.002	-1.297
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	-0.026	-1.467	-0.029	-2.459			0.063	1.065
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	-0.011	-0.669	-0.020	-1.656	-0.028	-1.371	-0.056	-0.822
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		-0.074	-0.464	-0.414	-2.596	-0.439	-2.457	0.170	0.304
Carrier-Route Presort Introduction (Exponential Trend from the Effective Date)	01/28/1979	-0.109	-1.255	0.081	0.683			0.932	4.081
5-digit Presort Introduction (Exponential Trend from the Effective Date)	03/22/1981	-0.003	-0.049	-0.004	-0.049			-0.865	-4.481
Zip+4 Discount (Exponential Trend from the Effective Date)	04/03/1988	0.031	0.534	0.022	0.536			-0.511	-2.808
Prebarcode Discounts (Exponential Trend from the Effective Date)	02/03/1991	-0.007	-0.051	-0.024	-0.242			-0.110	-0.212
125 Walk Sequence Discounts (Exponential Trend from the Effective Date)	03/15/1992	-0.269	-0.858	-0.109	-0.450			1.285	1.084
Automated Flats Discounts (Exponential Trend from the Effective Date)	09/20/1992	0.277	1.132	0.184	1.032			-1.630	-1.808
MC95-1 Automation Discounts (Exponential Trend from the Effective Date)	07/01/1996	-0.120	-2.524	-0.006	-0.154	0.007	0.116	-0.325	-1.193
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.006	-0.287	-0.017	-1.073	0.001	0.209		
Standard Bulk Regular Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.762	17.297						
Std. Bulk Reg. Carrier-Route Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.782	9.128				
Std. Bulk Reg. Non Car-Rte Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.585	2.225		
Std. Bulk Reg. Automated Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.049	0.199		
Standard Mail Single-Piece Rate (Ln of Fixed-Weight Index/GDP Deflator)								1.155	6.180
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.006	1.725	-0.001	-0.133	-0.007	-2.457	0.041	4.119
Sum of Coefficients for all Innovations (Car-Rte Presort to MC95-1 Automation Discounts)		-0.202	-1.969	0.144	0.876	0.007	0.116	-1.224	-3.462
Sum of Coefficients for all Postal Rates (Std. Bulk Reg. to Std. Single-Piece Mail)		0.762	-5.390	0.782	-4.446	0.634	-6.706	1.155	0.831
		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1	
Regression Diagnostics		Adj. R^2	0.974	Adj. R^2	0.976	Adj. R^2	0.933	Adj. R^2	0.950
		Std. Error	0.017	Std. Error	0.015	Std. Error	0.006	Std. Error	0.060
		d.f.	106	d.f.	75	d.f.	19	d.f.	87
Estimated Annual Rate of Adaptation	21.08%	AR-1	0.601	AR-1	0.197	AR-1	0.113	AR-1	0.556
99 Percent Confidence Interval	+/- 13.82%	AR-2	-0.098	AR-2	0.037	AR-2	0.189	AR-2	-0.008
95 Percent Confidence Interval	+/- 11.03%	AR-3	0.092	AR-3	-0.153	AR-3	0.297	AR-3	-0.070
90 Percent Confidence Interval	+/- 9.65%	AR-4	-0.045	AR-4	-0.188	AR-4	-0.062	AR-4	-0.070

Table 5B. Standard Nonprofit Revenue per Piece

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln Std Reg Rate Real Rev/Pc		Ln Carrier-Route Real Rev/Pc		Ln Automated Real Rev/Pc	
		Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		2.300	2.261	3.233	1.971	1.540	1.298
2nd Quarter Seasonal Dummy Variable		0.029	3.439	0.016	1.466	0.010	3.167
3rd Quarter Seasonal Dummy Variable		0.048	5.063	0.010	0.919	0.005	1.164
4th Quarter Seasonal Dummy Variable		0.011	1.284	-0.009	-0.853	-0.002	-0.674
Linear Trend		0.033	9.126	0.005	0.339		
2nd Quarter Dummy Times Trend		-0.001	-2.728	-0.001	-0.843		
3rd Quarter Dummy Times Trend		-0.002	-4.473	0.001	0.833		
4th Quarter Dummy Times Trend		-0.001	-1.610	0.002	2.847		
Election Year Dummy Variable (One in even years, Zero in odd years)		-0.006	-0.698	0.007	1.045		
MC95-1 Mail Reclassification Dummy (Zero before the Effective Date, One after)	07/01/1996	-0.020	-0.816	0.025	1.645	-0.031	-0.736
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		-0.786	-3.280	-0.925	-2.230	-0.379	-1.393
Std Regular Presort Introduction (Exponential Trend from the Effective Date)	01/28/1979	-0.070	-0.789				
5-digit Presort Introduction (Exponential Trend from the Effective Date)	03/22/1981	0.079	0.865	0.438	2.637		
Zip+4 Discount (Exponential Trend from the Effective Date)	04/03/1988	-0.314	-4.945	-0.115	-1.248		
Prebarcode Discounts (Exponential Trend from the Effective Date)	02/03/1991	0.439	1.670	0.344	2.259		
125 Walk Sequence Discounts (Exponential Trend from the Effective Date)	03/15/1992	-0.210	-0.327	0.253	0.667		
Automated Flats Discounts (Exponential Trend from the Effective Date)	09/20/1992	-0.226	-0.482	-0.556	-2.034		
MC95-1 Automation Discounts (Exponential Trend from the Effective Date)	10/06/1996	-0.052	-0.845	0.002	0.025	0.084	1.227
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.032	-1.139	0.007	0.292	-0.001	-0.180
Std Bulk Nonprofit Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.748	20.850				
Std. Bulk Nonpr. Carrier-Route Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.804	12.788		
Std. Bulk Nonpr. Non Car-Rte Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.051	0.736	0.374	5.625
Std. Bulk Nonpr. Automated Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.570	6.101
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.021	8.003	-0.009	-0.714	-0.006	-1.393
Sum of Coefficients for all Innovations (Std. Reg. Presort to MC95-1 Automation Discounts)		-0.353	-3.635	0.367	1.061	0.084	1.227
Sum of Coefficients for all Postal Rates (Std. Bulk Nonprofit to Automated Rate)		0.748	-7.006	0.855	-3.202	0.945	-0.882
		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1	
Regression Diagnostics		Adj. R^2	0.994	Adj. R^2	0.989	Adj. R^2	0.984
		Std. Error	0.027	Std. Error	0.020	Std. Error	0.008
		d.f.	106	d.f.	67	d.f.	19
Estimated Annual Rate of Adaptation	17.33%	AR-1	0.516	AR-1	0.243	AR-1	-0.026
99 Percent Confidence Interval	+/- 17.04%	AR-2	-0.031	AR-2	-0.053	AR-2	-0.128
95 Percent Confidence Interval	+/- 13.60%	AR-3	0.123	AR-3	-0.079	AR-3	0.254
90 Percent Confidence Interval	+/- 11.90%	AR-4	-0.457	AR-4	-0.166	AR-4	-0.211

Table 6B. Parcel Services Revenue per Piece

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln Parcel Post Real Rev/Pc		Ln BPM Real Rev/Pc		Ln Special Rate Real Rev/Pc		Ln Library Rate Real Rev/Pc	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		0.706	0.707	-0.600	-0.777	1.684	1.534	4.411	2.013
2nd Quarter Seasonal Dummy Variable		0.016	1.530	0.006	0.217	0.032	1.702	0.067	1.399
3rd Quarter Seasonal Dummy Variable		0.037	3.118	-0.140	-4.184	0.084	3.956	0.157	3.043
4th Quarter Seasonal Dummy Variable		0.037	3.460	-0.051	-1.830	0.060	3.209	0.060	1.270
Linear Trend		0.020	3.250	-0.002	-0.400	-0.006	-1.267	-0.001	-0.086
2nd Quarter Dummy Times Trend		-0.001	-1.828	-0.001	-0.692	-0.001	-0.940	-0.002	-0.655
3rd Quarter Dummy Times Trend		-0.002	-2.955	0.002	1.030	-0.003	-2.724	-0.003	-1.138
4th Quarter Dummy Times Trend		-0.002	-3.196	0.002	1.253	-0.003	-2.743	-0.002	-0.970
United Parcel Service Coverage Fraction (Fraction of the U.S. Market Covered by UPS)		-0.294	-3.965						
United Parcel Service Strike Fraction (Fraction of the Quarter UPS on Strike)		0.099	3.451						
BPM Base Shift from Pounds to Pieces (Switching Exp. Trend, Pieces on, Pounds off)	05/29/1978			-0.089	-0.987				
Government Mail Undistributed Dummy (One before the Effective Date, Zero after)	09/24/1988	0.049	2.009						
Restatement of Parcel Post RPW Data (Zero before the Effective Date, One after)	09/19/1992	-0.066	-2.032						
1997 United Parcel Service Strike (Reverse Exponential Trend from the Strike)	08/15/1997	-0.062	-1.904						
Sears Catalog Discontinued (Zero before the Effective Date, One after)	01/01/1993			-0.004	-0.222				
Library Rate Rule Restricting Eligibility (Zero before the Effective Date, One after)	11/21/1993								
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.028	0.117	0.170	0.902	-0.265	-1.003	-0.965	-1.771
Inter/Intra BMC Rate Differential (Exponential Trend from the Effective Date)	03/22/1981	0.021	0.186						
Various Discount & Service Changes (Exponential Trend from the Effective Date)	02/03/1991	-0.390	-3.170						
Machinable Inter-BMC Discounts (Exponential Trend from the Effective Date)	01/09/1999	-0.123	-0.848						
Machinable Intra-BMC Discounts (Exponential Trend from the Effective Date)	01/07/2001	-0.469	-2.124						
BPM Car-Rte Presort, Special rate Bundling (Exponential Trend from the Effective Date)	02/17/1985			-0.076	-0.602				
Prebarcode Discounts, Single Media Rate (Exponential Trend from the Effective Date)	01/10/1999			-0.121	-0.934	0.254	1.813	0.108	0.385
Destination BMC Drop Ship Discounts (Exponential Trend from the Effective Date)	01/07/2001			0.371	0.618				
Flat Rate for Prebarcoded Flats (Exponential Trend from the Effective Date)	07/01/2002			-0.700	-0.991				
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	0.024	0.611	-0.041	-0.481	0.012	0.253	0.017	0.181
Parcel Post Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.782	9.769						
Bound Printed Matter Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.761	8.446				
Special Rate Parcels Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.765	14.895		
Library Rate Parcels Rate (Ln of Fixed-Weight Index/GDP Deflator)								0.972	9.543
UPS Residential Rates with Parcel Post Weights (Ln of Fixed-Weight Index/GDP Deflator)		-0.272	-2.812			-0.130	-1.691		
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.020	3.059	0.001	0.134	-0.010	-2.173	-0.016	-1.660
Sum of Coefficients for all Innovations (Inter/Intra BMC Rates to Flat Rate for PBC Flats)		-0.961	-3.798	-0.526	-1.745	0.254	1.262	0.108	0.385
Sum of Coefficients for all Postal Rates (Parcel Post to Library Rate Parcels Rate)		0.782	-2.719	0.761	-2.646	0.765	-4.567	0.972	-0.275
		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1	
Regression Diagnostics		Adj. R^2	0.931	Adj. R^2	0.869	Adj. R^2	0.928	Adj. R^2	0.961
		Std. Error	0.027	Std. Error	0.042	Std. Error	0.040	Std. Error	0.093
		d.f.	105	d.f.	109	d.f.	111	d.f.	113
Estimated Annual Rate of Adaptation	13.91%	AR-1	0.521	AR-1	0.167	AR-1	0.450	AR-1	0.237
99 Percent Confidence Interval	+/- 4.60%	AR-2	0.007	AR-2	-0.161	AR-2	-0.009	AR-2	0.093
95 Percent Confidence Interval	+/- 3.67%	AR-3	0.072	AR-3	-0.045	AR-3	-0.008	AR-3	0.185
90 Percent Confidence Interval	+/- 3.21%	AR-4	-0.145	AR-4	0.200	AR-4	0.121	AR-4	0.141

Table 7B. Priority Mail, Express Mail, Rev. per P

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln Priority Mail Real Rev/Pc		Ln Express Mail Real Rev/Pc	
		Estimate	t-value	Estimate	t-value
Intercept		-0.552	-2.230	3.064	3.389
2nd Quarter Seasonal Dummy Variable		0.016	1.950	-0.009	-0.543
3rd Quarter Seasonal Dummy Variable		0.017	2.055	-0.005	-0.295
4th Quarter Seasonal Dummy Variable		0.064	7.882	0.036	2.324
Linear Trend		-0.002	-2.399	0.016	2.744
2nd Quarter Dummy Times Trend		-0.002	-3.962	0.000	0.099
3rd Quarter Dummy Times Trend		-0.002	-3.946	-0.000	-0.335
4th Quarter Dummy Times Trend		-0.002	-4.883	-0.002	-1.977
United Parcel Service Coverage Fraction (Fraction of the U.S. Market Covered by UPS)		0.075	4.306		
United Parcel Service Strike Fraction (Fraction of the Quarter UPS on Strike)		0.029	1.953		
Maximum Weight for First-Class Mail (Ratio of Maximum Ounces to 12 Ounces)		0.281	7.021		
Federal Express Entry (Exponential Trend from the Effective Date)	04/12/1978			-1.385	-10.412
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		0.068	1.123	-0.564	-3.091
Two-Pound Flat Rate (Exponential Trend from the Effective Date)	02/17/1985	0.007	0.587		
Two-Pound Envelope, Presort Discounts (Exponential Trend from the Effective Date)	02/03/1991	-0.044	-2.660	0.026	0.463
Unzoned Rates up to 5 Pounds (Exponential Trend Reversing 07/01/2002)	01/01/1995	-0.000	-0.009		
Express Mail Startup (Exponential Trend from the Effective Date)	09/13/1975			-0.375	-5.302
Express Mail Zoned Rates (Exponential Trend from the Effective Date)	10/09/1977			1.493	10.584
Express Mail Customer Pickup Service (Exponential Trend from the Effective Date)	03/21/1981			-0.100	-2.758
Express Mail Dezoned Rates (Exponential Trend from the Effective Date)	04/03/1988			-0.099	-2.817
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	01/01/1995	0.016	1.275	-0.044	-2.007
Priority Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.952	31.180		
Express Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.773	11.880
Mailgrams Rate (Ln of Revenue per Piece/GDP Deflator)					
Special Delivery Rate (Ln of Revenue per Piece/GDP Deflator)					
UPS Residential Rates with Parcel Post Weights (Ln of Fixed-Weight Index/GDP Deflator)		0.039	1.484	-0.026	-0.260
Federal Express Average Revenue (Ln of Revenue Rate/GDP Deflator)				0.069	0.872
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		-0.001	-1.519	0.008	1.936
Sum of Coefficients for all Innovations (Two-Pound Rate to Exp. Mail Dezoned Rates)		-0.037	-1.916	0.944	7.198
Sum of Coefficients for all Postal Rates (Priority Mail to Special Delivery Rate)		0.952	-1.567	0.773	-3.485
		t-value for Ho: B=1		t-value for Ho: B=1	
Regression Diagnostics		Adj. R^2	0.987	Adj. R^2	0.972
		Std. Error	0.016	Std. Error	0.030
		d.f.	108	d.f.	91
Estimated Annual Rate of Adaptation	48.78%	AR-1	-0.140	AR-1	0.009
99 Percent Confidence Interval	+/- 13.76%	AR-2	-0.069	AR-2	-0.240
95 Percent Confidence Interval	+/- 10.98%	AR-3	0.092	AR-3	-0.223
90 Percent Confidence Interval	+/- 9.61%	AR-4	-0.061	AR-4	-0.199

Table 8B. Special Services and Misc. Rev. per P

Revenue per Piece in Chained Dollars (Year 2000)

Regressor	Effective Date	Ln Registered Real Rev/Pc		Ln Insured Real Rev/Pc		Ln Certified Real Rev/Pc		Ln Money Orders Real Rev/Pc	
		Estimate	t-value	Estimate	t-value	Estimate	t-value	Estimate	t-value
Intercept		5.841	1.890	-1.547	-1.260	2.217	1.388	-4.110	-2.652
2nd Quarter Seasonal Dummy Variable		-0.093	-3.652	0.017	0.886	-0.019	-1.100	0.015	0.577
3rd Quarter Seasonal Dummy Variable		-0.074	-1.366	0.007	0.348	-0.026	-0.804	-0.023	-0.836
4th Quarter Seasonal Dummy Variable		0.060	0.840	-0.091	-4.175	0.036	0.870	0.036	1.153
Linear Trend		0.037	3.414	0.009	1.362	0.019	3.377	-0.015	-2.550
2nd Quarter Dummy Times Trend		0.003	1.725	0.001	0.586	-0.000	-0.010	-0.002	-1.268
3rd Quarter Dummy Times Trend		0.001	0.795	0.002	1.486	-0.000	-0.343	-0.000	-0.148
4th Quarter Dummy Times Trend		-0.001	-0.245	0.004	4.391	-0.001	-0.636	-0.001	-0.670
RPW Accounting Separates Return Receipts (Zero before the Effective Date, One after)	09/14/1996	-0.068	-1.061			-0.649	-17.288		
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)		-0.579	-0.965	0.298	1.018	0.208	0.593	1.007	2.647
Ln of 1st Class Letters/Household (Calculated from Volume Regression)		-0.772	-1.145			-0.533	-1.402		
Ln of Parcel Post/Household (Calculated from Volume Regression)				-0.011	-0.292			-0.081	-2.056
Ln of Priority Mail/Household (Calculated from Volume Regression)				0.086	0.852				
Special Services Reclassification (Exponential Trend from the Effective Date)	05/24/1997	-0.387	-1.223	-0.457	-3.707	-0.152	-0.921	-0.055	-0.466
Delivery Confirmation (Exponential Trend from the Effective Date)	09/11/1999	-0.133	-0.369	0.083	0.448	-0.013	-0.067		
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	-0.014	-0.179	0.088	1.430	-0.015	-0.322	0.032	0.537
Registered Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)		1.049	8.986						
Insured Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)				1.009	20.858				
Certified Mail Rate (Ln of Fixed-Weight Index/GDP Deflator)						0.857	16.112		
Money Orders Rate (Ln of Fixed-Weight Index/GDP Deflator)								0.904	18.085
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)		0.028	2.357	0.013	1.794	0.022	3.203	-0.000	-0.102
Sum of Coefficients for all Innovations (Special Services Reclass. & Delivery Confirmation)		-0.521	-1.873	-0.374	-2.303	-0.165	-1.135	-0.055	-0.466
Sum of Coefficients for all Postal Rates (Registered Mail to Money Orders Rate)		1.049	0.417	1.009	0.180	0.857	-2.694	0.904	-1.913
		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1		t-value for Ho: B=1	
Regression Diagnostics		Adj. R^2	0.909	Adj. R^2	0.965	Adj. R^2	0.970	Adj. R^2	0.954
		Std. Error	0.059	Std. Error	0.045	Std. Error	0.036	Std. Error	0.058
		d.f.	111	d.f.	111	d.f.	111	d.f.	113
Estimated Annual Rate of Adaptation									
Registered	19.86%	AR-1	0.578	AR-1	0.329	AR-1	0.568	AR-1	0.409
Insured	13.91%	AR-2	0.136	AR-2	0.101	AR-2	0.046	AR-2	0.049
Certified	19.86%	AR-3	0.188	AR-3	0.046	AR-3	0.059	AR-3	0.055
Money Orders	13.91%	AR-4	-0.103	AR-4	-0.154	AR-4	0.059	AR-4	0.016

Table 8B continued. Special Services and Misc. International Mail — Revenue per Piece (Year 2000) — Calendar Quarter Volumes per Household

Regressor	Effective Date	Ln Return Rec'pts Real Rev/Pc Estimate	t-value	Ln COD Real Rev/Pc Estimate	t-value	Ln International Mail/ Household Estimate	t-value
Intercept		0.106	1.558	-0.100	-0.129	1.027	0.809
2nd Quarter Seasonal Dummy Variable		0.068	2.807	-0.035	-1.770	0.076	3.061
3rd Quarter Seasonal Dummy Variable		0.031	0.922	-0.028	-1.460	-0.018	-0.670
4th Quarter Seasonal Dummy Variable		-0.034	-1.357	-0.023	-1.219	0.143	5.879
Linear Trend		-0.069	-0.291	0.011	3.629	0.002	0.314
2nd Quarter Dummy Times Trend				0.001	1.406	-0.007	-5.146
3rd Quarter Dummy Times Trend				0.001	0.920	-0.003	-2.356
4th Quarter Dummy Times Trend				0.002	2.015	-0.004	-2.861
Ln of Gross Domestic Product per Household (Chained 2000 Dollars)				-0.032	-0.164	0.049	0.156
Special Services Reclassification (Exponential Trend from the Effective Date)	05/24/1997						
Delivery Confirmation (Exponential Trend from the Effective Date)	09/11/1999	-1.454	-5.302				
911 Attack/Anthrax Letters (Reverse Exponential Trend from 9/11)	09/11/2001	0.222	5.068	0.059	2.061	-0.122	-2.609
Return Receipts Rate (Ln of Fixed-Weight Index/GDP Deflator)		0.143	0.949				
Collect on Delivery Rate (Ln of Fixed-Weight Index/GDP Deflator)				0.934	18.743		
International Mail Rate (Ln of Revenue per Piece/GDP Deflator)						-0.762	-10.505
Sum of Coefficients for the Long Term Trend (Linear trend + .0151*GDP/Household)				0.011	7.699	0.002	1.206
Sum of Coefficients for all Innovations (Special Services Reclass. & Delivery Confirmation)		-1.454	-5.302				
Sum of Coefficients for all Postal Rates (Return Receipts to International Rate)		0.143	-2.331	0.934	-1.875	-0.762	-10.505
		t-value for Ho: B=1		t-value for Ho: B=1			
Regression Diagnostics		Adj. R^2	0.974	Adj. R^2	0.980	Adj. R^2	0.922
		Std. Error	0.034	Std. Error	0.039	Std. Error	0.051
		d.f.	17	d.f.	115	d.f.	115
Estimated Annual Rate of Adaptation							
Return Receipts	19.86%	AR-1	1.460	AR-1	0.225	AR-1	0.439
COD	13.91%	AR-2	-1.314	AR-2	0.136	AR-2	0.050
		AR-3	0.940	AR-3	0.074	AR-3	0.029
International	19.86%	AR-4	-0.539	AR-4	0.072	AR-4	0.134