Narrative Explanation of Econometric Demand Equations for Market Dominant Products Filed with Postal Regulatory Commission on January 20, 2022

Prepared for the Postal Regulatory Commission

Estimation of Econometric Demand Equations

A. Basic Demand Equation

The econometric demand equations filed with the Postal Regulatory Commission on January 20, 2022 take the following form:

$$V_t = a \cdot x_{1t}^{e_1} \cdot x_{2t}^{e_2} \cdot \ldots \cdot x_{nt}^{e_n} \cdot \varepsilon_t \qquad \text{(Equation 1)}$$

where V_t is volume at time t, x_1 to x_n are explanatory variables, e_1 to e_n are elasticities associated with these variables, and ε_t represents the residual, or unexplained, factor(s) affecting mail volume.

In general, variables which are believed to substantially influence the demand for mail are introduced into an econometric equation as a quarterly time series in which the elasticity of mail volume with respect to the particular variable is estimated using a Generalized Least Squares estimation procedure. The explanatory variables considered here include Postal prices, measures of macroeconomic activity (e.g., employment, investment), measures of mail trends (e.g., volume losses to electronic and Internet diversion), seasonal variables, and other variables as warranted.

The functional form of Equation 1 is used by the Postal Service because it has been found to model mail volume quite well historically, and because it possesses two desirable properties. First, by taking logarithmic transformations of both sides of Equation 1, the natural logarithm of V_t can be expressed as a linear function of the natural logarithms of the X_i variables as follows:

$$\ln(V_t) = \ln(a) + e_1 \bullet \ln(x_{1t}) + e_2 \bullet \ln(x_{2t}) + e_3 \bullet \ln(x_{3t}) + \ldots + e_n \bullet \ln(x_{nt}) + \ln(\varepsilon_t) \qquad \text{(Equation } 1_L\text{)}$$

Equation 1_L satisfies traditional least squares assumptions and is amenable to solution by Ordinary Least Squares. Second, the e_i parameters in Equation 1_L are

exactly equal to the elasticities with respect to the various explanatory variables. Hence, the estimated elasticities do not vary over time, nor do they vary with changes to either the volume or any of the explanatory variables. Because of these properties, this demand function is sometimes referred to as a constant-elasticity demand specification.

For explanatory variables which are logged in the equation, then, the coefficients which come out of these demand equations can be interpreted directly as elasticities.

B. Explanatory Variables

1. Price

a. Own-Price Measures

The starting point for traditional micro-economic theory is a demand equation that relates quantity demanded to price. Quantity demanded is inversely related to price. That is, if the price of a good were increased, the volume consumed of that good would be expected to decline, all other things being equal.

This fundamental relationship of price to quantity is modeled in the Postal Service's demand equations by including the price of postage in each of the demand equations estimated by the Postal Service for mail categories and services which have a price (i.e., excluding Postal Penalty mail and Free for the Blind and Handicapped Mail).

The Postal prices entered into these demand equations are calculated as weighted averages of the various rates within each particular category of mail. For example, the price of First-Class single-piece stamped letters is a weighted average of the single-piece stamped letters rate (58 cents), the additional ounce rate (20 cents), and the nonstandard surcharge (30 cents)[1]. Product-by-product billing determinants provide the components of the market baskets which are used as weights in developing these price measures. The price indices used in the demand equations filed with the Commission on January 20, 2022, were constructed using chain-weighted price indices.

[1] Rates as of August 29, 2021.

Chain-weighted price indices compare each period with the proceeding one such that the weight and price reference periods are moved forward each period. In this way, chain-weighted price indices capture the substitution effect of price changes, as consumers may shift consumption between categories in response to changes in relative prices. In addition, chain-weighted price indices account for shifts in the mix of consumer goods over time due to non-price related consumer preferences which ultimately alters the effective average price of consumer goods. The periods referred to in the first sentence of the paragraph refer to specific price regimes so that the price indices do not change between quarters when Postal rates do not change.

The most recent set of weights used in constructing these prices were FY 2020 billing determinants.

Looking at the historical relationship between mail volumes and Postal prices suggests that mailers may not react immediately to changes in Postal rates. For some types of mail, it may take up to a year for the full effect of changes in Postal rates to influence mail volumes. To account for the possibility of a lagged reaction to changes in Postal prices on the demand for certain types of mail, the Postal price may be entered into the demand equations lagged by up to four quarters. The exact number of lags used is an empirical question which is answered on a case-by-case basis.

Prices are expressed in the Postal Service's demand equations in real dollars. The consumer price index (CPI-U) is used to deflate the prices.

In general, when the Postal Service refers to own-price elasticities, the reference is to long-run own-price elasticities. The long-run own-price elasticity of a mail category is equal to the sum of the coefficients on the current and lagged price of mail in the relevant demand equation. The long-run own-price elasticity therefore reflects the cumulative impact of price on mail volume after allowing time for all of the lag effects to be felt.

b. Other Price Measures

The price of postage is not the only price paid by most mailers to send a good or service through the mail. For those cases where the non-Postal price of mail is significant and for which a reliable time series of non-Postal prices is available, these prices may also be included explicitly in the demand equations used to explain mail volume.

There is one example of such a price included in some of the equations presented here, trade-weighted exchange rates, which are included as an explanatory variable in most of the econometric demand equations associated with International Mail (both inbound and outbound).

Changes in the value of the U.S. dollar vis-à-vis foreign currencies can make the price of foreign goods more or less attractive relative to the price of similar domestic goods, which may affect the volume of such goods delivered through the Postal Service.

c. Postal Cross-Price Relationships

In the past, some of the Postal Service's econometric demand equations have included cross-price measures with other Postal products, such as First-Class Single-Piece and Workshared Letters, and Bound Printed Matter and Media Mail. In some cases, these cross-price variables entered the equations in the same way as the own-price variables, i.e., as a measure of the average price of the product. In other cases, however, cross-price variables were measured in relative terms (i.e., the difference between the prices of two Postal products).

As has been the case for several years now, the econometric demand equations filed with the Postal Regulatory Commission on January 20, 2022, do not include any such cross-price variables. The exclusion of such variables was first discussed in some detail in the response to the Chairman's Information Request No. 8, question 5, which

was filed with the Commission on March 8, 2010. As explained in that response, the decision of whether to include a particular cross-price relationship in a particular econometric demand equation was made on a case-by-case basis. In all cases, the overriding goal of all of the Postal Service's econometric work is to produce the most accurate volume forecasts possible. As a general rule, the most accurate volume forecasts are obtained from econometric demand equations which best model the historical demand for mail volume. So, while it ended up being the case that, in fact, there were no cross-price or discount variables included in any of the econometric demand equations filed on January 20, 2022, this was not the result of a general decision to exclude all such variables from the Postal Service's equation, but was, instead, the result of a series of careful analyses of each of the Postal Service's individual demand equations.

This is not, however, to say that mailers may not at times shift from one mail subclass to another in response to a change in Postal rates. In fact, however, such changes tend to overwhelmingly be responses to specific and unusual changes in relative rate structures associated with a specific rate change. Rather than attempting to model such changes through a blunt one-size-fits-all instrument such as an aggregate price index or an average discount level, the effect of such changes is, instead, better modeled through the inclusion of either dummy variables or non-linear intervention analysis. An example of a case-specific mailer shift between mail subclasses is the impact of R2006-1 (May, 2007) on Marketing Mail Letters, when the elimination of Automation Carrier-Route Letters rates led to a shift of volume from Basic ECR to Marketing Mail Letters.

2. Impact of the Economy on Mail Volumes

In addition to being affected by prices, mail volumes are also affected by the state of the economy. For example, as incomes rise, people are able to purchase more goods and services, and this is generally true of the use of Postal services which tend to perform better during periods of stronger economic growth and stagnate or decline during periods of weaker economic growth (or economic decline). A stronger economy is also likely to increase business use of the mail. To model these relationships, the demand equations used by the Postal Service typically include one or more macroeconomic variables which relate mail volumes to general economic conditions.

a. Macroeconomic Variables Used Here

Three key macroeconomic variables are used in the Postal Service's econometric market-dominant demand equations: private employment, gross private domestic investment, and e-commerce retail sales. These data are compiled by the United States government and, with the exception of e-commerce sales, are obtained by the Postal Service from IHS Global Insight, an independent economic forecasting firm. At various times, consumption expenditures, total retail sales, mail-order retail sales, personal disposable income, gross domestic product (GDP), and the difference between actual and potential GDP (the output gap) have also been explored as candidate explanatory variables.

The specific variable choices are made on an equation-by-equation basis. The decision process in choosing macroeconomic variables includes an effort to develop equations which are both theoretically correct as well as empirically robust.

Dollar-denominated variables (e.g., business investment spending) are entered into the equations in real terms. All economic variables are also entered on a per adult basis, consistent with the structure of the mail volume demand equations which are estimated on a per adult basis.

(i) Employment

Total private employment is included in several of the Postal Service's econometric demand equations, including First-Class and Periodicals Mail.

The theoretical rationale for including total employment as a macro-economic variable is that in many cases, mail volume is not affected by the dollar value of economic transactions, so much as by the number of such transactions. Ultimately, the choice of which macroeconomic variable to use in a demand equation is an empirical decision based on which variable best fits the volume data.

(ii) Investment

Advertising can be viewed as a type of business investment in that it represents expenditures today for the purpose of generating revenues in the future. As such, direct-mail advertising volume is likely to be affected by the same factors which drive business investment spending. To reflect this relationship, real gross private domestic investment is included as an explanatory variable in the demand equations for Marketing Mail and Bound Printed Matter Flats filed with the Commission on January 20, 2022.

(iii) E-Commerce Sales

Parcel and package service volumes, such as Bound Printed Matter Parcels and Media Mail volumes consist, in large part, of the delivery of products bought by the sender or recipient of the mail. This type of mail volume derives primarily from retail sales. More specifically, package delivery services are largely a function of online retail sales which are subsequently delivered to the consumer. Hence, e-commerce retail sales are included directly in the demand equations for most of the Postal Service's parcel and package service equations.

3. The Internet and Electronic Diversion

One of the most significant issues facing the Postal Service in recent decades has been the threat, both realized and potential, of electronic diversion of mail. E-mail has emerged as a potent substitute for personal letters and business correspondence. Bills can be paid electronically, either as online payments or through an automatic deduction from a bank account, and bills and statements can be received through the Internet rather than through the mail. Virtually all magazines and newspapers now have an online edition as a complement to their print editions, and in some cases, the print edition has been eliminated in favor of an all-online format. Digital advertising now represents the majority of total advertising expenditures and is an alternative to direct mail advertising. Understanding the emergence of the Internet and its role vis-à-vis the mail is critical in understanding mail volume, both today and in the future.

Beginning in the early 2000s, the Postal Service introduced one or more explicit measures of Internet usage in several of its demand equations as a means of capturing the impact of the Internet (and other electronic delivery alternatives) on mail volumes. These variables – which included consumption expenditures on Internet Service Providers, the number of households with Broadband Internet access, and the number of Global Internet Servers - reflected primarily the number of people on the Internet.

The number of Internet users only told part of the story, however. The other factor driving mail diversion was increases in the number of activities for which the Internet can substitute for mail may increase, thereby increasing the overall level of substitution of the Internet for mail volume, even in the absence of an increase in the number of Internet users.

To better measure this increasing depth of Internet use, the Postal Service's methodology for modeling Internet and other electronic diversion changed over time. For the market-dominant demand equations filed with the Commission on January 20, 2022, diversion is not modeled via explicit Internet variables, but, instead, is measured through a series of linear time trends which start at various times within the sample periods over which the Postal Service's demand equations are estimated.

The use of trends to measure Internet diversion was discussed at length in Thomas Thress's responses to Presiding Officer's Information Requests (POIRs) in Docket No. R2013-11. See, for example, Mr. Thress's responses to POIR No. 3, question 1; POIR No. 6, question 12; and POIR No. 9, question 7 in that case.

Diversion trends of this kind are estimated in many of the Postal Service's demand equations. Time trends of this type are special cases of Intervention Analysis. The technical details of Intervention Analysis are described later in this document.

4. Intervention Analysis

In some cases, mail volumes may be affected by unique events, or "interventions". Oftentimes, the effect of such factors can be modeled via trend or dummy variables. In other cases, however, the impact of such "interventions" on mail volumes may be more complicated than can be fully captured by a set of linear variables. In such cases, a more elaborate non-linear Intervention analysis is undertaken to more accurately model the impact of some factors on some types of mail.

Examples of Interventions for which this type of analysis is undertaken include Internet diversion, the Great Recession, and the COVID-19 pandemic.

a. Non-Linear Intervention

Intervention analysis is a time series technique which allows one to identify the effects of an event over time. An "intervention" is an event which affects the demand for a given product. There are essentially three different types of impact of intervention events: step functions, pulse functions, and trends. A generalized Intervention Analysis technique allows for a functional form which is flexible enough to accommodate all of these possibilities as dictated by the underlying data. This function is called the *transfer function*.

The role of the transfer function is to allow the input variable to affect the volume in different ways and rates over time. Therefore, the impact of an intervention on volume is the product of a particular transfer function and an input variable. The general form of the transfer function is given by:

$$I_t = \frac{\omega(B)}{\delta(B)} B^S \xi_t^T = \frac{\omega_0 - \omega_1 B - \omega_2 B^2 - \omega_3 B^3 ... - \omega_i B^i}{1 - \delta_1 B - \delta_2 B^2 - \delta_3 B^3 ... - \delta_3 B^j} B^S \xi_t^T \qquad \text{(Equation 2)}$$

where *B* is the lag operator: $B^S y_t = y_{t-S}$. For the stability of the model, the roots of the equations $\omega_0 - \omega_1 B - \omega_2 B^2 - .. - \omega_i B^i = 0$ and $1 - \delta_1 B - \delta_2 B^2 - .. - \delta_j B^j = 0$ must lie outside the unit circle. Of course, a more generalized form of Equation 2 is necessary to limit the number of ω and δ parameters so that the equation can be uniquely estimated.

The ω(B) terms represent the level impact of the intervention event. For example, in Equation 2, if ω_i=0, for i>0, then the intervention will only affect volume in the current period, and Equation 2 will simplify to a dummy variable equal to one in the quarter of interest and zero elsewhere with coefficient ω_0. If, on the other hand, $\omega_i = \omega_j$, for all i,j,

with $\delta_i = 0$ for all i, then Equation 2 simplifies to a dummy variable equal to one from the quarter of interest forward with coefficient ω_0 ($=\omega_i$ for all i). Finally, if ω_i is an increasing (or decreasing) function of i, then the transfer equation identified above will simplify to a trend response to the intervention event of interest.

The δ(B) terms represent the rate of increase or decrease of the intervention events, e.g., the rate of change from a short-run to a long-run impact. For simplicity, δ_i is typically assumed to be constant across all i. That is, the rate of adoption of an intervention event is typically assumed to be constant over time.

A transfer function that allows for each of the three possibilities outlined above - pulse, step, or trend response to an intervention – is shown in Equation 3 below:

$$I_t = \{\omega_0 + \omega_1 B / (1 - \delta B) + (\omega_2 + \omega_3 t)B / (1 - B)\}P_t \qquad \text{(Equation 3)}$$

where P_t is a pulse function – i.e., $P_t = 1$ for the period of the intervention, zero elsewhere.

A step function (equal to 1 for the period of the intervention and all subsequent periods), S_t, can be expressed as a function of P_t using lag notation so that $S_t = P_t / (1-B)$.

In Equation 3, ω_0 is equal to the initial response to the Intervention event. If $\omega_1=\omega_2=\omega_3=0$, then the response to the Intervention will be equal to zero in all subsequent periods, and the transfer function will be a pure pulse function (P_t). If $\omega_0=\omega_1$ and $\delta=\omega_2=\omega_3=0$, then the transfer function will be a pure step function ($S_t = P_t / (1-B)$). If $\omega_1=\omega_2=0$ and $\omega_0= \omega_3$, then the transfer function will be a pure linear trend. If, on the other hand, none of these equalities are realized, then Equation 3 will explain a more flexible transfer function as dictated by the observed data.

The functional form of Equation 3, which expresses the transfer function as a function of the lag operators may not be intuitively obvious. Re-expressing the lag operator notation here into more conventional notation yields Equation 4:

$$I_t = \omega_0 \cdot P_t + \omega_1 \cdot (P_{t-1} + \delta^1 P_{t-2} + \delta^2 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \omega_3 \cdot T_t \cdot S_t \qquad \text{(Equation 4)}$$

where, as noted above, P_t is equal to one during the period of the intervention, zero elsewhere (both before and after), S_t is equal to zero prior to the intervention event being modeled, and equal to one thereafter, and T is a time trend equal to zero at the point of the intervention event, increasing by one each quarter thereafter.

While Equation 4 is a function of only 5 parameters – δ and ω_i for i = 0 to 3 – it nonetheless technically requires the inclusion of an infinite number of terms in the demand equation of interest. It turns out, however, that, at any given point in time, each of the P_{t-i} terms is equal to zero except for, at most, one. To see this, one can re-write Equation 4 as follows:

$$I_t = \omega_0 \cdot P_t + \omega_1 \cdot \sum_{i=1}^{\infty} (\delta^{i-1} P_{t-i}) + \omega_2 \cdot S_t + \omega_3 \cdot T_t \cdot S_t$$

When $T_t = 1$, the value of $P_{t-1} = 1$, $P_{t-i} = 0$, for all $i \neq 1$. Similarly, when $T_t = 2$, the value of $P_{t-2} = 1$, $P_{t-i} = 0$, for all $i \neq 2$. So, instead of a sum over all values of P_{t-i} one can instead replace i with T_{t-1} in the above equation. That is,

$$I_t = \omega_0 \cdot P_t + \omega_1 \cdot S_t \cdot (\delta^{T_{t-1}}) + \omega_2 \cdot S_t + \omega_3 \cdot T_t \cdot S_t \qquad \text{(Equation 5)}$$

Intervention variables of the form in Equation 5 are then added to the Postal Service's econometric demand equations as necessary. The Intervention parameters -

ω_0, ω_1, ω_2, ω_3, and δ – are estimated simultaneous with the other econometric parameters using non-linear least squares.

b. S-Curves

One common source of trends in data that are difficult to model econometrically by relating behavior to other economic variables is the problem of market penetration. Research into the rate at which new products or new technology are adopted has shown that a typical adoption cycle for a new product is initially gradual, followed by increasingly-rapid adoption until some point in time at which the adoption curve reaches an inflection point and the rate of adoption slows until the adoption curve eventually plateaus and the product or technology exhibits a more traditional stable growth pattern attributable to common economic factors. An adoption curve of this sort can be modeled through a type of logistic curve, commonly called an "s-curve" because its shape approximates the letter "s".

S-curves take the form:

$$S_t = z_1 \cdot d_t / (1 + z_2 \cdot \exp(-z_3 \cdot t_t)) + \ldots \qquad \text{(Equation 6)}$$

where d_t is a dummy variable equal to one starting in the initial period of the s-curve and is one thereafter, and t_t is a time trend, equal to zero in the initial period of the s-curve, increasing by one each quarter thereafter. This variable has an initial value in of $z_1/(1+z_2)$ and gradually attenuates to its ceiling value, z_1. The parameter z_3 controls the rate of attenuation.

c. Time Trends

Often the behavior of a variable that is being estimated econometrically is a function of other observable variables. For example, mail volume is a function of postal prices.

Sometimes, however, the behavior of a variable is due to factors that do not easily lend themselves to capture within a time series variable suitable for inclusion in an econometric equation. In such cases, it is common for such phenomena to be modeled in part using trend variables. For example, it has been found by the Postal Service (and others[2]) that trend variables do a better job of modeling the impact of electronic diversion on mail volume than specific measures of Internet usage, which do not necessarily reflect the gradual substitution of the Internet for correspondence and transactions which had previously been undertaken via the mail.

Given that trend variables are needed within particular demand equations, an equally important question becomes what forms these trend variables ought to take.

> A trend is a trend is a trend
> But the question is, will it end?
> Will it alter its course
> Through some unforeseen force,
> And come to a premature end?
>
> Sir Alec Cairncross

It is not sufficient to merely plug full-sample linear time trends into all of one's econometric equations. Rather, it is important to evaluate every demand equation individually and determine the appropriate trend specification for each equation, if any.

Many of the demand equations filed with the Commission on January 20, 2022 include full-sample linear time trends to account for trends in the volumes of these types of mail over the sample periods used here, for which economic sources do not readily lend themselves to inclusion in an econometric time series equation. Such long-run changes in mail volume are therefore most readily modeled by a trend variable.

[2] e.g., Veruete-McKay, Leticia; Soteri, Soterios; Nankervis, John C.; and Rodriguez, Frank (2011) "Letter Traffic Demand in the UK: An Analysis by Product and Envelope Content Type," Review of Network Economics: Vol. 10: Issue 3, Article 10.

Several equations include linear time trends over only a portion of their sample period. These trends capture new and changing influences which have affected mail volumes, including the introduction and expansion of Internet and other types of electronic diversion, as well as changes in long-run mail trends that may have been caused by the Great Recession. Trends of this nature are included, for example, in several of the demand equations for First-Class, Marketing, and Periodicals Mail.

Time trends are special cases of the non-linear intervention analysis described above. Trends appear in the econometric output as an "Intervention" variable, where the pulse, step, and attenuation rates of Intervention are constrained to be equal to zero. This result is mathematically identical to including a simple linear time trend starting at the relevant time in the demand equation.

d. Dummy Variables

In some cases, the effect of specific events may be modeled using dummy variables. For example, certain equations include dummy variables for some rate or classification changes that are inadequately modeled by the price indices used here. Dummy variables are special cases of the non-linear intervention analysis outlined above.

Of particular interest, the most recent year was among the most unusual years on record which saw unprecedented economic and societal changes due to the Covid-19 pandemic which first reached the U.S. during 2020PQ2. The year also saw substantial changes in mail volume as well, both positive and negative. Hence, for the most part, the equations which were filed with the Postal Regulatory Commission on January 20, 2022 used simple dummy variables (D2020Q3 and D2020Q4) to measure the unusual impacts of the pandemic on mail volume.

As the pandemic has receded, many of these unusual changes reversed while others may have become permanent. Work is ongoing to better understand the

relationship between the economy, current events, and mail volumes. It is anticipated that further insights will continue to be gained in the coming year.

6. Seasonality

Seasonality is primarily modeled through simple quarterly dummy variables, equal to one in the quarter of interest (Quarter 1, Quarter 2, Quarter 3), zero otherwise.

In some cases, the seasonal pattern of certain mail categories appears to have changed somewhat over time. In these cases, additional or alternate seasonal variables may be introduced into the equation over sub-samples of the relevant sample period. In most cases, these take the form of quarterly dummies which start at some time after 2000. For example, the First-Class Single-Piece Letters equation includes a dummy variable equal to one in the first Postal quarter starting in 2012Q2 (i.e., beginning in 2013Q1).

One additional seasonal variable is used in some equations, which is equal to either the number of Sundays (SUNDAYS) or the number of non-weekdays (SAT_SUN) within the quarter of interest.

Impact of Federal Election Cycle

One fairly significant use for the mail is for pre-election advertising by candidates, political parties, and special interest groups. Because of this, volumes for several categories of mail fluctuate with the election cycle, most notably with the federal election cycle of every two (Congressional) or four (Presidential) years.

Dummy variables equal to one during specific quarters within federal election years are included in several of the Postal Service's demand equations, most notably in the demand equations associated with Nonprofit Marketing Mail.

First-Class Mail

First-Class Mail is a heterogeneous class of mail. First-Class Mail includes a wide variety of mail sent by a wide variety of mailers for a wide variety of purposes.

First-Class Mail can be broadly divided into two categories of mail: Single-Piece and Workshared, which can be further divided by shape: letters, cards, and flats. For First-Class Single-Piece letters, separate equations are estimated for stamped and metered letters. Overall, then, for econometric estimation purposes, domestic First-Class Mail is divided into seven mail categories: First-Class Single-Piece metered letters, First-Class Single-Piece stamped letters, First-Class Single-Piece cards, First-Class Single-Piece flats, First-Class Workshared letters, First-Class Workshared cards, and First-Class Workshared flats. In addition, separate demand equations are estimated for inbound and outbound First-Class International letters, cards, and flats.

The relationship between the macro-economy and domestic First-Class Mail is modeled by including private employment in each of the domestic First-Class Mail demand equations. Employment was chosen as the macro-economic variable to be included in the domestic First-Class Mail equations based on a comparison of econometric results including several candidate macro-economic variables, including retail sales, consumption, and GDP.

First-Class Single-Piece Metered Letters

1. Explanatory Variables used in First-Class Single-Piece Metered Letters Equation

The First-Class Single-Piece Metered Letters demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between First-Class Single-Piece Metered Letters and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the First-Class Single-Piece Metered Letters equation.

The coefficient on Employment is stochastically constrained based on estimation of the demand for First Class Single Piece (Metered and Stamped) Letters, for which there is a longer time series.

(2) Postal Price

The First-Class Single-Piece Metered Letters equation includes a price index measuring the average price of First-Class Single-Piece Metered Letters (PC01SP_LM). Prices are entered current only.

(3) Average Days to Delivery

The First-Class Single-Piece Metered Letters equation includes the average days to deliver First-Class Single-Piece Mail, lagged three quarters.

The coefficient on average days to deliver is stochastically constrained based on estimation of the demand for First Class Single Piece (Metered and Stamped) Letters, for which there is a longer time series.

(4) Time Trend

The First-Class Single-Piece Metered Letters demand equation includes a full-sample linear time trend. This trend reflects the impact of mail-diverting technologies which have been continually adopted by businesses and households.

(5) Other Variables

The First-Class Single-Piece Metered Letters equation includes a dummy variable, called D_PANDEMIC, which is equal to one since 2020Q3, which is intended to capture the unique impact of events related to COVID-19.

Finally, the First-Class Single-Piece Metered Letters equation includes a set of seasonal variables.

2. Econometric Demand Equation: First-Class Single-Piece Metered Letters

The effect of these variables on First-Class Single-Piece Metered Letters volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
First-Class SP Metered Letters
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			6886.042
Own-Price	-5.06%	-0.271	1.42%
EMPLOY	-2.69%	0.472	-1.28%
AVGDEL_SP(-3)	2.09%	-0.089	-0.18%
Adult Population			3.92%
Interventions Starting in: 2014Q4			-26.39%
Seasonals			0.00%
Dummy Vars			-9.59%
Other Factors			-1.73%
Volume in FY 2021			4676.708
Total Change in Volume			-32.08%

First-Class Single-Piece Stamped Letters

1. Explanatory Variables used in First-Class Single-Piece Stamped Letters Equation

The First-Class Single-Piece Stamped Letters demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between First-Class Single-Piece Stamped Letters and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the First-Class Single-Piece Stamped Letters equation.

The coefficient on Employment is stochastically constrained based on estimation of the demand for First Class Single Piece (Metered and Stamped) Letters, for which there is a longer time series.

(2) Postal Price

The First-Class Single-Piece Stamped Letters equation includes a price index measuring the average price of First-Class Single-Piece Stamped Letters (PC01SP_LS). Prices are entered current only.

(3) Average Days to Delivery

The First-Class Single-Piece Stamped Letters equation includes the average days to deliver First-Class Single-Piece Mail, lagged three quarters.

The coefficient on average days to deliver is stochastically constrained based on estimation of the demand for First Class Single Piece (Metered and Stamped) Letters, for which there is a longer time series.

(4) Time Trend

The First-Class Single-Piece Stamped Letters demand equation includes a full-sample linear time trend. This trend reflects the impact of mail-diverting technologies which have been continually adopted by businesses and households.

(5) Other Variables

The First-Class Single-Piece Stamped Letters equation includes two dummy variables: D2020Q3, equal to one in 2020Q3 and zero elsewhere; and D2020Q4, equal to one in 2020Q4 and zero elsewhere. These dummies are included to capture the unique impact of events related to COVID-19.

Finally, the First-Class Single-Piece Stamped Letters equation includes a set of seasonal variables.

2. Econometric Demand Equation: First-Class Single-Piece Stamped Letters

The effect of these variables on First-Class Single-Piece Stamped Letters volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
First-Class SP Stamped Letters
VOLUME SINCE FY 2016

Volume in FY 2016			12041.671
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	2.65%	-0.201	-0.52%
EMPLOY	-2.69%	0.550	-1.49%
AVGDEL_SP(-3)	2.09%	-0.082	-0.17%
Adult Population			3.92%
Interventions Starting in: 2014Q4			-30.86%
Seasonals			0.00%
Dummy Vars			4.39%
Other Factors			-0.33%
Volume in FY 2021			8807.579
Total Change in Volume			-26.86%

First-Class Single-Piece Cards

1. Explanatory Variables used in First-Class Single-Piece Cards Equation

The First-Class Single-Piece Cards demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between First-Class Single-Piece Cards and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the First-Class Single-Piece Cards equation.

(2) Postal Price

The First-Class Single-Piece Cards equation includes a price index measuring the average price of First-Class Single-Piece Cards (PC01SP_C). Prices are entered current and lagged one quarter.

(3) Average Days to Delivery

The First-Class Single-Piece Cards demand equation includes the average days to deliver First-Class Single-Piece Mail, lagged four quarters.

(4) Time Trends

The First-Class Single-Piece Cards demand equation includes a full-sample linear time trend and a second linear time trend starting in 2010Q2. These trends reflect the impact of mail-diverting technologies which have been continually adopted by businesses and households.

(5) Other Variables

The First-Class Single-Piece Cards equation includes four non-seasonal dummy variables: R2006PHOP, equal to -1 in 2006Q1 and +1 in 2006Q2, is related to the Postal Service's measure of Postage in the Hands of the Public (PHOP) just before and after the implementation of R2005-1 rates in January 2006; D_R07, equal to one since the implementation of R2006-1 rates in May 2007, zero earlier; D2021Q1, which is equal to one in 2021Q1, zero elsewhere; and D2021Q2ON, which is equal to one since 2021Q2.

Finally, the First-Class Single-Piece Cards equation includes a set of seasonal variables since 2017Q2.

2. Econometric Demand Equation: First-Class Single-Piece Cards

The effect of these variables on First-Class Single-Piece Cards volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
First-Class Single-Piece Cards
VOLUME SINCE FY 2015

VOLUME SINCE FY 2016

Volume in FY 2016			796.372
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-6.39%	-0.363	2.43%
EMPLOY	-2.69%	0.919	-2.47%
AVGDEL_SP(-4)	3.32%	-0.062	-0.20%
Adult Population			3.92%
Interventions Starting in:			
2004Q1			-32.12%
2010Q2			-16.83%
Seasonals			-2.98%
Dummy Vars			-1.03%
Other Factors			-2.44%
Volume in FY 2021			436.372
Total Change in Volume			-45.21%

First-Class Single-Piece Flats

1. Explanatory Variables used in First-Class Single-Piece Flats Equation

The First-Class Single-Piece Flats demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between First-Class Single-Piece Flats and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the First-Class Single-Piece Flats equation.

(2) Postal Price

The First-Class Single-Piece Flats equation includes a price index measuring the average price of First-Class Single-Piece Flats (PC01SP_F). Prices are entered current and lagged one to three quarters.

(3) Average Days to Delivery

The First-Class Single-Piece Flats demand equation includes the average days to deliver First-Class Single-Piece Mail, lagged three quarters.

(4) Time Trend

The First-Class Single-Piece Flats demand equation includes a full-sample linear time trend. This trend reflects the impact of mail-diverting technologies which have been continually adopted by businesses and households.

(**5) Non-Linear Intervention Variable**

The First-Class Single-Piece Flats demand equation includes two non-linear intervention variables. These variables start in 2008Q4 and 2019Q2, respectively, and both take the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ in the initial period, 0 otherwise; and $S_t = 1$ beginning in the second quarter of the intervention period. This variable has an initial value of ω_0, which decays toward a long-run value of ω_2. This intervention measures the unique impact of the Great Recession on First-Class Single-Piece Flats volume.

(**6) Other Variables**

The First-Class Single-Piece Flats equation includes three non-seasonal dummy variables: D_R07, which is equal to one since the implementation of R2006-1 rates in May 2007, zero earlier; D_R14, which is equal to one since the implementation of R2013-11 rates in January 2014, zero earlier; and D2017Q3, which equal to one in 2017Q3 and zero elsewhere.

Finally, the First-Class Single-Piece Flats equation includes a set of full-sample seasonal variables, with additional Quarter 1 and Quarter 4 seasonal variables since 2013Q2.

2. Econometric Demand Equation: First-Class Single-Piece Flats

The effect of these variables on First-Class Single-Piece Flats volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
First-Class Single-Piece Flats
VOLUME SINCE FY 2015

VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			962.679
Own-Price	-10.43%	-0.157	1.75%
EMPLOY	-2.69%	0.326	-0.88%
AVGDEL_SP(-3)	2.09%	-0.146	-0.30%
Adult Population			3.92%
Interventions Starting in:			
2004Q1			-27.04%
2008Q4			-9.85%
2019Q2			-5.90%
Seasonals			0.00%
Dummy Vars			0.00%
Other Factors			-0.50%
Volume in FY 2021			619.367
Total Change in Volume			-35.66%

First-Class Workshared Letters

1. Explanatory Variables used in First-Class Workshared Letters Equation

The First-Class Workshared Letters demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between First-Class Workshared Letters and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the First-Class Workshared Letters equation.

(2) Postal Price

The First-Class Workshared Letters equation includes a price index measuring the average price of First-Class Workshared Letters (PC01WS_L). Prices are entered current and lagged one to four quarters.

(3) Average Days to Delivery

The First-Class Workshared Letters demand equation includes the average days to deliver First-Class Presort Mail, lagged four quarters.

(4) Time Trend

The First-Class Workshared Letters demand equation includes a linear time trend starting in 2007Q3. This trend reflects the impact of mail-diverting technologies which have been continually adopted by businesses and households.

(**5) Non-linear Intervention Variables**

The First-Class Workshared Letters demand equation includes two non-linear intervention variables, starting in 2008Q1 and 2016Q3, which take the form of an s-curve, i.e.,

$$Ln(Vol_t) = a + \ldots + z_1 \cdot d_t / (1 + z_2 \cdot \exp(-z_3 \cdot t_t)) + \ldots$$

where d_t is a dummy variable equal to one starting in the first period of the intervention (2008Q1 and 2016Q3, respectively) and is one thereafter, and t_t is a time trend, equal to zero through the first period of the intervention, increasing by one each quarter thereafter. Intervention variables of this form have an initial value of $z_1/(1+z_2)$ and gradually attenuates to a ceiling value of z_1. The parameter z_3 determines the rate of attenuation.

The first of these coincides with the start of the Great Recession and likely includes trends associated with the Great Recession including, for example, declines in home ownership and a slowdown in the rate of household formation. In addition, mail volume is likely to have been adversely affected by the decline in median household income which continued even after the recession had officially ended in 2009.

The second s-curve coincides with more recent increases in mail diversion, including increases in electronic presentation of some bills and statements.

(5) Other Variables

The First-Class Workshared Letters equation includes a dummy variable equal to one in the first Postal quarter of Federal election years; a dummy equal to the number of Saturdays and Sundays in the quarter; and a set of full-sample seasonal variables, with additional Quarter 3 and Quarter 4 seasonal variables since 2013Q1.

2. Econometric Demand Equation: First-Class Workshared Letters

The effect of these variables on First-Class Workshared Letters volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
First-Class Workshared Letters
VOLUME SINCE FY 2015

Volume in FY 2016			37745.771
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-7.35%	-0.292	2.26%
EMPLOY	-2.69%	0.618	-1.67%
AVGDEL_WS(-4)	2.27%	-0.059	-0.13%
Adult Population			3.92%
Interventions Starting in:			
2008Q1			-0.06%
2016Q3			-8.02%
2007Q3			-7.66%
Seasonals			0.00%
Elections			0.19%
Other Factors			-0.46%
Volume in FY 2021			33344.345
Total Change in Volume			-11.66%

First-Class Workshared Cards

1. Explanatory Variables used in First-Class Workshared Cards Equation

The First-Class Workshared Cards demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between First-Class Workshared Cards and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the First-Class Workshared Cards equation.

(2) Postal Price

The First-Class Workshared Cards equation includes a price index measuring the average price of First-Class Workshared Cards (PC01WS_C). Prices are entered current only.

(3) Average Days to Delivery

The First-Class Workshared Cards demand equation includes the average days to deliver First-Class Presort Mail, lagged four quarters.

(4) Time Trends

The First-Class Workshared Cards demand equation includes a full-sample linear time trend and a second linear time trend starting in 2008Q1.

The coefficient on the first of these trends is positive, reflecting the influence of factors which positively impacted First-Class Workshared Mail volume through the first decade of this century. These factors include shifts from First-Class Single-Piece to Workshared Mail, the increasing use of First-Class Mail for direct-mail advertising over

this period, and the positive impacts of increases in credit card usage and home ownership in the years immediately prior to the Great Recession.

The coefficient on the second trend, starting in 2008Q1, is negative, reflecting changes in the impact of Internet and other electronic diversion on First-Class Workshared cards as well as changes in other underlying trends that might have affected mail volume (some positive, some negative) over this time period. This includes trends associated with the Great Recession including, for example, declines in home ownership and a slowdown in the rate of household formation. In addition, mail volume is likely to have been adversely affected by the decline in median household income which continued even after the recession had officially ended in 2009. This trend likely captures increased electronic diversion as well, reflecting the impact of new technologies such as smartphones and social media to the extent such usage replaced mail.

(**5) Other Variables**

Finally, the First-Class Workshared Cards equation includes one non-seasonal dummy variable, D2020Q4ON, which is equal to one since 2020Q4; and a set of full-sample seasonal variables, with an additional Q1 seasonal variable since 2015Q1. The former of these dummies is included to capture the unique impact of events related to COVID-19.

2. Econometric Demand Equation: First-Class Workshared Cards

The effect of these variables on First-Class Workshared Cards volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
First-Class Workshared Cards
VOLUME SINCE FY 2015

Volume in FY 2016			2197.374
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-7.00%	-0.598	4.44%
EMPLOY	-2.69%	1.273	-3.41%
AVGDEL_WS(-4)	2.27%	-0.032	-0.07%
Adult Population			3.92%
Interventions Starting in:			
2004Q1			30.37%
2008Q1			-43.05%
Seasonals			0.00%
Dummy Vars			35.67%
Other Factors			-1.77%
Volume in FY 2021			2277.582
Total Change in Volume			3.65%

First-Class Workshared Flats

1. Explanatory Variables used in First-Class Workshared Flats Equation

The First-Class Workshared Flats demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between First-Class Workshared Flats and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the First-Class Workshared Flats equation.

(2) Postal Price

The First-Class Workshared Flats equation includes a price index measuring the average price of First-Class Workshared Flats (PC01WS_F). Prices are entered current and lagged one to two quarters.

(3) Average Days to Delivery

The First-Class Workshared Flats demand equation includes the average days to deliver First-Class Presort Mail, lagged three quarters.

(4) Time Trends

The First-Class Workshared Flats demand equation includes linear time trends starting in 2008Q1 and 2017Q2. These trends reflect the impact of mail-diverting technologies which have been continually adopted by businesses and households.

(5) Other Variables

The First-Class Workshared Flats equation includes two non-seasonal dummy variables: D_R07, equal to one since the implementation of R2006-1 rates in May 2007, zero earlier; and D_PANDEMIC, which is equal to one starting in 2020Q3 and remains equal to one thereafter. The latter of these dummies is included to capture the unique impact of events related to COVID-19.

Finally, the First-Class Workshared Flats equation includes a full-sample set of Q1 and Q2 seasonal variables, with an additional Q1 dummy since 2015Q1.

2. Econometric Demand Equation: First-Class Workshared Flats

The effect of these variables on First-Class Workshared Flats volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
First-Class Workshared Flats
VOLUME SINCE FY 2015

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			609.161
Own-Price	-15.42%	-0.416	7.21%
EMPLOY	-2.69%	1.575	-4.20%
AVGDEL_WS(-3)	3.26%	-0.038	-0.12%
Adult Population			3.92%
Interventions Starting in:			
2008Q1			-17.01%
2017Q2			-17.05%
Seasonals			0.00%
Dummy Vars			25.29%
Other Factors			-0.57%
Volume in FY 2021			556.923
Total Change in Volume			-8.58%

Outbound First-Class International Letters, Cards, and Flats

1. Explanatory Variables used in Outbound First-Class International Letters, Cards, and Flats Equation

The Outbound First-Class International Letters, Cards, and Flats demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Exports

The relationship between Outbound First-Class International Letters, Cards, and Flats and the general economy is modeled through the inclusion of exports (XR) as an explanatory variable in the Outbound First-Class International Letters, Cards, and Flats demand equation.

(2) Postal Price

The Outbound First-Class International Letters, Cards, and Flats equation includes a price index measuring the average price of Outbound First-Class International Letters, Cards, and Flats (PC1I_LCF). Prices are entered current only.

(3) Time Trend

The Outbound First-Class International Letters, Cards, and Flats equation includes a full-sample linear time trend. This trend reflects the impact of mail-diverting technologies which have been continually adopted by businesses and households.

(4) Other Variables

The Outbound First-Class International Letters, Cards, and Flats equation includes three non-seasonal dummy variables: D2009Q2, which is equal to one in 2009Q2, zero elsewhere; D2009Q3, equal to one in 2009Q3, zero elsewhere; and D2009Q4, which is equal to one in 2009Q4, zero elsewhere.

The Outbound First-Class International Letters, Cards, and Flats equation also includes a set of full-sample seasonal variables. with an additional Q1 dummy since 2013Q1.

2. Econometric Demand Equation: Outbound First-Class International Letters, Cards, and Flats

The effect of these variables on Outbound First-Class International Letters, Cards, and Flats volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
First-Class International Letters, Cards, & Flats
VOLUME SINCE FY 2015

Volume in FY 2016			172.309
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-7.62%	-0.170	1.36%
XR	-7.72%	0.496	-3.90%
Adult Population			3.92%
Interventions Starting in: 2001Q3			-41.48%
Seasonals			0.00%
Dummy Vars			0.00%
Other Factors			2.36%
Volume in FY 2021			104.478
Total Change in Volume			-39.37%

Marketing Mail

1. Overview of Direct-Mail Advertising

More than 90 percent of Marketing Mail can be characterized as direct-mail advertising. Hence, understanding the demand for direct-mail advertising is the key to understanding the demand for Marketing Mail volume.

The demand for Marketing Mail volume is the result of a choice by advertisers regarding how much to spend on direct-mail advertising expenditures. The decision process made by direct-mail advertisers can be decomposed into two separate, but interrelated, decisions:

(1) How much to invest in advertising?

(2) Which advertising medium to use?

These two decisions are integrated into the demand equations associated with Marketing Mail volume by including a set of explanatory variables in the demand equations for Marketing Mail that addresses each of these decisions. These decisions, and their implications for Marketing Mail equations, are considered separately below.

2. Advertising Decisions and Their Impact on Mail Volume

a. How Much to Invest in Advertising

Advertising represents a form of business investment. Hence, the Marketing Mail equations include real gross private domestic investment as a measure of the overall demand for business investment.

In addition to macroeconomic factors, the overall level of advertising is also affected by certain other regular events. In the United States, the election cycle is one factor which drives advertising demand. Variables which coincide with the timing of federal elections are included in most of the Marketing Mail demand equations which were filed with the Commission on January 20, 2022.

b. Which Advertising Media to Use

The choice of advertising media can be thought of as primarily a pricing decision, so that the primary determinant of the demand for direct-mail advertising (vis-à-vis other advertising media) would be the price of direct-mail advertising.

The most obvious way in which the price of direct-mail advertising is included in the Marketing Mail equations is through the price of Marketing Mail. Postage costs are included in the Marketing Mail equations through chain-weighted price indices which measure the average postage paid by Marketing Mailers.

One of the principal advantages of direct-mail advertising over other forms of advertising is that direct-mail advertising allows an advertiser to address customers on a one-on-one basis. By identifying specifically who will receive a particular piece of direct-mail advertising, direct-mail advertising is able to provide a level of targeting that is not necessarily available through other advertising media.

The ability to target a direct mailing to specific individuals, based on specific advertiser-chosen criteria, has increased dramatically. For many years, this had a positive impact on the demand for many types of Marketing Mail. The emergence of Internet and Mobile Advertising, often collectively referred to as digital advertising, have negatively affected the demand for Marketing Mail as marketers have shifted spending away from traditional forms of advertising. These factors are modeled via linear time trends in several of the demand equations presented to the Commission this year.

Additional changes to the overall advertising market as well as direct mail's role within that market in the wake of the Great Recession are modeled via Intervention analysis. The general concept of Intervention analysis was described earlier in this document.

3. Division of Marketing Mail Volumes for Estimation Purposes

Marketing Mail volume is divided across three dimensions for the purpose of estimating econometric demand equations.

Separate equations are estimated for mail that is classified by the Postal Service as "Political and Election Mail" (P&E) versus all other Marketing Mail (non-P&E). For both P&E and non-P&E Marketing Mail, separate equations are estimated for Commercial versus Nonprofit Mail. Finally, within non-P&E Mail, separate equations are estimated based on the shape and geographical density of the mail.

The specific demand specifications associated with the demand equations developed here for Marketing Mail are described below.

Marketing Mail Commercial Letters

1. Explanatory Variables used in Marketing Mail Commercial Letters Equation

The Marketing Mail Commercial Letters demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail Commercial Letters volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail Commercial Letters equation includes a price index measuring the average price of Marketing Mail Commercial Letters (PC3R_NCR_L). Prices are entered current and lagged one quarter.

(3) Time Trends

The Marketing Mail Commercial Letters demand equation includes a linear time trend starting in 2014Q3. This trend likely reflects shifts by advertisers from direct mail to digital advertising.

(4) Non-Linear Intervention Variable

The Marketing Mail Commercial Letters demand equation includes a non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the long-run value, ω_2, is set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(**5) Other Variables**

The Marketing Mail Commercial Letters equation includes three non-seasonal dummy variables.

A dummy variable, D2016Q1ON, equal to one from 2016Q1 forward, zero otherwise, is included in the Marketing Mail Commercial Letters equation. Another dummy variable, D2017Q1ON, equal to one from 2017Q1 forward, zero otherwise, is also included. Finally, a dummy variable, D2020Q4_21Q1, is equal to one in 2020Q4 and 2021Q1, zero elsewhere. The last of these variables is included to capture the unique impact of events related to COVID-19.

Finally, the Marketing Mail Commercial Letters equation includes a set of seasonal variables.

2. Econometric Demand Equation: Marketing Mail Commercial Letters

The effect of these variables on Marketing Mail Commercial Letters volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Mktg Mail: Commercial Letters (non-P&E)
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			39178.150
Own-Price	-4.74%	-0.527	2.60%
INVR	11.15%	0.359	3.86%
Adult Population			3.92%
Interventions Starting in:			
2014Q3			-13.68%
2020Q2			-9.47%
Seasonals			-0.95%
Dummy Vars			-4.21%
Other Factors			-0.41%
Volume in FY 2021			32036.083
Total Change in Volume			-18.23%

Marketing Mail Commercial High Density and Saturation Letters

1. Explanatory Variables used in Marketing Mail Commercial High Density and Saturation Letters Equation

The Marketing Mail Commercial High Density and Saturation Letters demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail Commercial High Density and Saturation Letters volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail Commercial High Density and Saturation Letters equation contains a price index for the price of Marketing Mail Commercial High Density and Saturation Letters (PC3R_HS_L). Prices are entered current and lagged one quarter.

(3) Non-Linear Intervention Variables

The Marketing Mail Commercial High Density and Saturation Letters demand equation includes a non-linear intervention variable, starting in 2012Q3, which takes the form of an s-curve, i.e.,

$$Ln(Vol_t) = a + \ldots + z_1 \cdot d_t / (1 + z_2 \cdot \exp(-z_3 \cdot t_t)) + \ldots$$

where d_t is a dummy variable equal to one starting in the first period of the intervention (2012Q3) and is one thereafter, and t_t is a time trend, equal to zero through the first period of the intervention, increasing by one each quarter thereafter.

Intervention variables of this form have an initial value of $z_1/(1+z_2)$ and gradually attenuates to a ceiling value of z_1. The parameter z_3 determines the rate of attenuation.

The Marketing Mail Commercial High Density and Saturation Letters demand equation includes a second non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the long-run value, ω_2, is set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(4) Other Variables

A dummy variable, D2020Q4_21Q1, equal to one in 2020Q4 and 2021Q1, zero otherwise, is included in the Marketing Mail Commercial High Density and Saturation Letters equation. These dummies are included to capture the unique impact of events related to COVID-19.

The Marketing Mail Commercial High Density and Saturation Letters equation also includes a set of seasonal variables.

2. Econometric Demand Equation: Marketing Mail Commercial High Density and Saturation Letters

The effect of these variables on Marketing Mail Commercial High Density and Saturation Letters volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Mktg Mail: Comm High-D/Saturation Letters (non-P&E)
VOLUME SINCE FY 2015

Volume in FY 2016			6261.052
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-1.09%	-0.619	0.68%
INVR	11.15%	0.319	3.43%
Adult Population			3.92%
Interventions Starting in:			
2012Q3			1.04%
2020Q2			-17.13%
Seasonals			0.00%
Dummy Vars			3.17%
Other Factors			-1.68%
Volume in FY 2021			5755.323
Total Change in Volume			-8.08%

Marketing Mail Commercial and ECR Basic Flats

1. Explanatory Variables used in Marketing Mail Commercial and ECR Basic Flats Equation

The Marketing Mail Commercial and ECR Basic Flats demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail Commercial and ECR Basic Flats volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail Commercial and ECR Basic Flats equation includes a price index measuring the average price of Marketing Mail Commercial and ECR Basic Flats. Prices are entered current and lagged one to two quarters.

(3) Time Trends

The Marketing Mail Commercial and ECR Basic Flats equation includes a full-sample linear time trend and a second linear time trend starting in 2016Q4. The factors underlying these trends likely include shifts by advertisers from direct mail to digital advertising.

(4) Non-Linear Intervention Variable

The Marketing Mail Commercial and ECR Basic Flats demand equation includes a non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the values of both ω_0 and ω_2 are set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(5) Other Variables

The Marketing Mail Commercial and ECR Basic Flats equation includes one non-seasonal dummy variable, D2021Q1, equal to one in 2021Q1, zero otherwise. The Marketing Mail Commercial and ECR Basic Flats equation also includes a dummy variable equal to one of Federal election years prior to 2014Q2 and a set of seasonal and election variables.

2. Econometric Demand Equation: Marketing Mail Commercial and ECR Basic Flats

The effect of these variables on Marketing Mail Commercial and ECR Basic Flats volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Mktg Mail: Commercial Flats & ECR Basic (non-P&E)
VOLUME SINCE FY 2015

Volume in FY 2016			11005.318
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	0.19%	-0.415	-0.08%
INVR	11.15%	0.284	3.05%
Adult Population			3.92%
Interventions Starting in:			
2012Q2			-25.58%
2016Q4			-25.49%
2020Q2			-10.98%
Seasonals			0.00%
Elections			0.00%
Dummy Vars			3.23%
Other Factors			-0.86%
Volume in FY 2021			5949.647
Total Change in Volume			-45.94%

Marketing Mail Commercial High Density and Saturation Flats

1. Explanatory Variables used in Marketing Mail Commercial High Density and Saturation Flats Equation

The Marketing Mail Commercial High Density and Saturation Flats demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail Commercial High Density and Saturation Flats volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail Commercial High Density and Saturation Flats equation contains a price index measuring the average price of Marketing Mail Commercial High Density and Saturation Flats. Prices are entered current and lagged one to two quarters.

(3) Time Trend

The Marketing Mail Commercial High Density and Saturation Flats demand equation includes a linear time trend starting in 2015Q3. This trend likely reflects shifts by advertisers from direct mail to digital advertising.

(4) Non-Linear Intervention Variable

The Marketing Mail Commercial High Density and Saturation Flats demand equation includes a non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the values of both ω_0 and ω_2 are set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(5) Other Variables

The Marketing Mail Commercial High Density and Saturation Flats equation includes two non-seasonal dummy variables: D2014Q2ON, equal to one from 2014Q2 forward, zero otherwise; and D2020Q4_21Q1, which is equal to one in 2020Q4 and 2021Q1, zero otherwise.

In addition, the Marketing Mail Commercial High Density and Saturation Flats equation includes dummy variables equal to one in the first, third, and fourth quarter of Federal election years, respectively, as well as a set of seasonal and election variables.

2. Econometric Demand Equation: Marketing Mail Commercial High Density and Saturation Flats

The effect of these variables on Marketing Mail Commercial High Density and Saturation Flats volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Mktg Mail: Comm High-D/Saturation Flats (non-P&E)
VOLUME SINCE FY 2016

Volume in FY 2016			10574.401
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-8.21%	-0.686	6.05%
INVR	11.15%	0.403	4.35%
Adult Population			3.92%
Interventions Starting in:			
2015Q3			-15.95%
2020Q2			-12.67%
Seasonals			0.00%
Elections			0.00%
Dummy Vars			0.64%
Other Factors			-1.14%
Volume in FY 2021			8881.463
Total Change in Volume			-16.01%

Marketing Mail Commercial Every Door Direct Mail (EDDM)

1. Explanatory Variables used in EDDM Equation

The Marketing Mail EDDM demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail EDDM volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail EDDM equation contains a price index for the price of Marketing Mail EDDM (PC3R_ED). Prices are entered current and lagged one quarter.

(3) Time Trend

The Marketing Mail EDDM demand equation includes a linear time trend starting in 2014Q3. This trend likely reflects shifts by advertisers from direct mail to digital advertising.

(4) Non-Linear Intervention Variable

The Marketing Mail EDDM demand equation includes a non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the values of

both ω_0 and ω_2 are set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(5) Other Variables

The Marketing Mail EDDM equation includes two non-seasonal dummy variables: D2014Q4, which is equal to one in 2014Q4 and zero otherwise; and D2016Q1ON, which is equal to one starting in 2016Q1 and zero before that time. The Marketing Mail EDDM equation also includes a set of seasonal variables.

2. Econometric Demand Equation: Marketing Mail EDDM

The effect of these variables on Marketing Mail EDDM volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Every Door Direct Mail (non-P&E)
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			795.639
Own-Price	-4.06%	-0.282	1.17%
INVR	11.15%	0.474	5.13%
Adult Population			3.92%
Interventions Starting in:			
2014Q3			-41.14%
2020Q2			-0.66%
Seasonals			0.00%
Dummy Vars			0.00%
Other Factors			1.50%
Volume in FY 2021			521.984
Total Change in Volume			-34.39%

Marketing Mail Nonprofit Letters

1. Explanatory Variables used in Marketing Mail Nonprofit Letters Equation

The Marketing Mail Nonprofit Letters demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail Nonprofit Letters volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail Nonprofit Letters equation contains a price index for the price of Marketing Mail Nonprofit Letters (PC3N_NCR_L). Prices are entered current and lagged one to two quarters.

(3) Time Trends

The Marketing Mail Nonprofit Letters equation includes a full-sample linear time trend as well as a full-sample linear time trend multiplied by the Q1 seasonal dummy.

(4) Non-Linear Intervention Variable

The Marketing Mail Nonprofit Letters demand equation includes a non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the values of both ω_0 and ω_2 are set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(5) Other Variables

The Marketing Mail Nonprofit Letters equation includes four non-seasonal dummy variables. A dummy variable equal to one starting with the implementation of R2006-1 rates in 2007Q3 (D_R07) is included in the Marketing Mail Nonprofit Letters equation. D_R07 is included current and lagged two quarters.

A dummy variable equal to one since the Postal Service's April 2011, rate change (2011Q3) is included in the Marketing Mail Nonprofit Letters equation. A dummy variable equal to one since the Postal Service's January 2013, rate change (2013Q2) is included in the Marketing Mail Nonprofit Letters equation.

The dummy variable, D2020Q4_21Q1, which is equal to one in 2020Q4 and 2021Q1, zero otherwise, is included in the Marketing Mail Nonprofit Letters equation. This dummy variable is included to capture the unique impact of factors unique to the latter half of the 2020 Election cycle.

Finally, the Marketing Mail Nonprofit Letters equation includes a set of seasonal and election variables.

2. Econometric Demand Equation: Marketing Mail Nonprofit Letters

The effect of these variables on Marketing Mail Nonprofit Letters volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Mktg Mail: Nonprofit Letters (non-P&E)
VOLUME SINCE FY 2016

Volume in FY 2016			9132.005
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-3.40%	-0.370	1.29%
INVR	11.15%	0.302	3.25%
Adult Population			3.92%
Interventions Starting in:			
2004Q1			-13.30%
2020Q2			-4.16%
Seasonals			0.78%
Elections			0.00%
Dummy Vars			0.97%
Other Factors			-1.82%
Volume in FY 2021			8239.360
Total Change in Volume			-9.77%

Marketing Mail Nonprofit High Density and Saturation Letters

1. Explanatory Variables used in Marketing Mail Nonprofit High Density and Saturation Letters Equation

Marketing Mail Nonprofit High Density and Saturation Letters demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail Nonprofit High Density and Saturation Letters volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail Nonprofit High Density and Saturation Letters equation contains a price index for the price of Marketing Mail Nonprofit High Density and Saturation Letters (PC3N_HS_L). Prices are entered current only.

(3) Time Trend

The Marketing Mail Nonprofit High Density and Saturation Letters equation includes a linear time trend starting in 2017Q2. This trend likely reflects shifts by advertisers from direct mail to digital advertising.

(4) Non-Linear Intervention Variable

The Marketing Mail Nonprofit High Density and Saturation Letters demand equation includes a non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the values of both ω_0 and ω_2 are set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(5) Other Variables

The Marketing Mail Nonprofit High Density and Saturation Letters equation also includes several other dummy variables: D2011Q1ON, equal to one since 2011Q1, zero elsewhere; D2014Q2ON, equal to one since 2014Q2, zero elsewhere; D2015Q3ON, equal to one since 2015Q3, zero elsewhere; and D2017Q2ON, equal to one since 2017Q2, zero elsewhere. The Marketing Mail Nonprofit High Density and Saturation Letters equation also includes D2020Q4 and D2021Q1, which are equal to one in 2020Q4 and 2021Q1, respectively, zero otherwise. These last two dummy variables are included to capture the unique impact of factors unique to the latter half of the 2020 Election cycle.

Finally, the Marketing Mail Nonprofit High Density and Saturation Letters equation includes a set of seasonal variables.

2. Econometric Demand Equation: Marketing Mail Nonprofit High Density and Saturation Letters

The effect of these variables on Marketing Mail Nonprofit High Density and Saturation Letters volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Mktg Mail: NP High-D/Saturation Letters (non-P&E)
VOLUME SINCE FY 2016

Volume in FY 2016			667.842
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	0.19%	-0.682	-0.13%
INVR	11.15%	0.496	5.39%
Adult Population			3.92%
Interventions Starting in:			
2017Q2			-48.40%
2020Q2			-17.37%
Seasonals			0.00%
Dummy Vars			3.62%
Other Factors			2.49%
Volume in FY 2021			330.804
Total Change in Volume			-50.47%

Marketing Mail Nonprofit and ECR Basic Flats

1. Explanatory Variables used in Marketing Mail Nonprofit and ECR Basic Flats Equation

The Marketing Mail Nonprofit and ECR Basic Flats demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail Nonprofit and ECR Basic Flats volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail Nonprofit and ECR Basic Flats equation contains a price index for the price of Marketing Mail Nonprofit and ECR Basic Flats. Prices are entered current only.

(3) Time Trend

The Marketing Mail Nonprofit and ECR Basic Flats equation includes a full-sample linear time trend.

(4) Non-Linear Intervention Variable

The Marketing Mail Nonprofit and ECR Basic Flats demand equation includes a non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the values of both ω_0 and ω_2 are set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(5) Other Variables

The Marketing Mail Nonprofit and ECR Basic Flats equation includes two non-seasonal dummy variables: D2013Q1, which is equal to one in 2013Q1, zero elsewhere; and D2021Q1, which is equal to one in 2021Q1, zero elsewhere. The last of these dummy variables is included to capture the unique impact of factors unique to the 2020 Election cycle.

Finally, the Marketing Mail Nonprofit and ECR Basic Flats equation includes a set of seasonal and election variables.

2. Econometric Demand Equation: Marketing Mail Nonprofit and ECR Basic Flats

The effect of these variables on Marketing Mail Nonprofit and ECR Basic Flats volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Mktg Mail: Nonprofit Flats & ECR Basic (non-P&E)
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			1555.537
Own-Price	-2.91%	-0.434	1.29%
INVR	11.15%	0.284	3.04%
Adult Population			3.92%
Interventions Starting in:			
2012Q1			-25.88%
2020Q2			-8.40%
Seasonals			0.00%
Elections			0.00%
Dummy Vars			2.90%
Other Factors			0.13%
Volume in FY 2021			1180.191
Total Change in Volume			-24.13%

Marketing Mail Nonprofit High Density and Saturation Flats

1. Explanatory Variables used in Marketing Mail Nonprofit High Density and Saturation Flats Equation

Marketing Mail Nonprofit High Density and Saturation Flats demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Mail Nonprofit High Density and Saturation Flats volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Mail Nonprofit High Density and Saturation Flats equation contains a price index for the price of Marketing Mail Nonprofit High Density and Saturation Flats. Prices are entered current and lagged one and two quarters.

(3) Non-Linear Intervention Variable

The Marketing Mail Nonprofit High Density and Saturation Flats equation includes a non-linear intervention variable that starts in 2021Q1 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2021Q1 and 0 otherwise; $S_t = 1$ if t >2021Q1 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the long-run

value, ω_2, is set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(4) Other Variables

The Marketing Mail Nonprofit High Density and Saturation Flats equation includes a dummy variable equal to one starting in 2015Q1 and equal to two since 2016Q1, as well as individual dummy variables for 2020Q2, 2020Q3, and 2020Q4. The Marketing Mail Nonprofit High Density and Saturation Flats equation also includes a set of seasonal and election variables.

2. Econometric Demand Equation: Marketing Mail Nonprofit High Density and Saturation Flats

The effect of these variables on Marketing Mail Nonprofit High Density and Saturation Flats volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Mktg Mail: NP High-D/Saturation Flats (non-P&E)
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			508.045
Own-Price	-12.89%	-0.391	5.55%
INVR	11.15%	0.482	5.22%
Adult Population			3.92%
Interventions Starting in: 2021Q1			-24.71%
Seasonals			-7.37%
Elections			0.00%
Dummy Vars			0.00%
Other Factors			-3.53%
Volume in FY 2021			394.516
Total Change in Volume			-22.35%

Commercial Marketing Political and Election Mail

1. Explanatory Variables used in Commercial Marketing Political and Election Mail Equation

The Commercial Marketing Political and Election Mail demand equation includes the following explanatory variables.

(1) Postal Price

The Commercial Marketing Political and Election Mail equation includes average revenue per piece for Commercial Marketing Political and Election Mail (RPP3R_PE) as a measure of the average price of Commercial Marketing Political and Election Mail. Prices are entered current only. The coefficient on this variable is constrained (stochastically) from an equation estimated ending in 2020Q1.

(2) Time Trend

The Commercial Marketing Political and Election Mail equation includes a full-sample linear time trend.

(3) Other Variables

The Commercial Marketing Political and Election Mail equation includes a dummy variable, D2020Q3, equal to one in 2020Q3, zero elsewhere. It also includes a dummy variable, D2020Q2EL_ON, which is equal to one from 2020Q2 through 2021Q1 as well as in 2021Q4 (i.e., all quarters since 2020Q2 except for the second and third quarters of non-election years). The Commercial Marketing Political and Election Mail equation also includes a set of seasonal and election variables.

2. Econometric Demand Equation: Commercial Marketing Political and Election Mail

The effect of these variables on Commercial Marketing Political and Election Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Commercial Marketing P&E Mail
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			810.680
RPP3R_PE	-6.10%	-0.461	2.94%
Adult Population			3.92%
Interventions Starting in: 2014Q2			42.17%
Seasonals			0.00%
Elections			-25.87%
Dummy Vars			0.00%
Other Factors			51.36%
Volume in FY 2021			1383.605
Total Change in Volume			70.67%

Nonprofit Marketing Political and Election Mail

1. Explanatory Variables used in Nonprofit Marketing Political and Election Mail Equation

Nonprofit Marketing Political and Election Mail demand equation includes the following explanatory variables.

(1) Postal Price

The Nonprofit Marketing Political and Election Mail equation includes average revenue per piece for Nonprofit Marketing Political and Election Mail (RPP3N_PE) as a measure of the average price of Nonprofit Marketing Political and Election Mail. Prices are entered current only. The coefficient on this variable is constrained (stochastically) from an equation estimated ending in 2020Q1.

(2) Time Trend

The Nonprofit Marketing Political and Election Mail equation includes a full-sample linear time trend.

(3) Other Variables

The Nonprofit Marketing Political and Election Mail equation includes a dummy variable, D2020Q3, equal to one in 2020Q3, zero elsewhere. It also includes a dummy variable, D2020Q2EL_ON, which is equal to one from 2020Q2 through 2021Q1 as well as in 2021Q4 (i.e., all quarters since 2020Q2 except for the second and third quarters of non-election years). The Nonprofit Marketing Political and Election Mail equation also includes a set of seasonal and election variables.

2. Econometric Demand Equation: Nonprofit Marketing Political and Election Mail

The effect of these variables on Nonprofit Marketing Political and Election Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Nonprofit Marketing P&E Mail
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			396.247
RPP3N_PE	-6.32%	-0.190	1.25%
Adult Population			3.92%
Interventions Starting in: 2014Q2			46.56%
Seasonals			0.00%
Elections			46.63%
Dummy Vars			0.00%
Other Factors			70.40%
Volume in FY 2021			1526.826
Total Change in Volume			285.32%

Marketing Parcels

1. Explanatory Variables used in the Marketing Parcels Equation

The Marketing Parcels demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Marketing Parcels volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR).

(2) Postal Price

The Marketing Parcels demand equation includes a price index measuring the average price of Marketing Parcels (PC3_P). Prices are entered current only.

(3) Non-Linear Intervention Variable

The Marketing Parcels demand equation includes a non-linear intervention variable starting in 2014Q3 which takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ in the initial period, 0 otherwise; and $S_t = 1$ beginning in the second quarter of the intervention period. This variable has an initial value of 0 and decays toward a long-run value of ω_2.

(4) Other Variables

The Marketing Parcels equation includes a dummy variable, D_EL1_PRES, which is equal to one in the first quarter of Presidential election years, zero otherwise, and a set of seasonal variables.

2. Econometric Demand Equation: Marketing Parcels

The effect of these variables on Marketing Parcels volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Marketing Parcels
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			45.017
Own-Price	7.38%	-0.557	-3.89%
INVR	11.15%	0.637	6.96%
Adult Population			3.92%
Interventions Starting in: 2014Q3			-27.54%
Seasonals			0.00%
Elections			4.00%
Other Factors			1.08%
Volume in FY 2021			36.638
Total Change in Volume			-18.61%

Periodicals Mail

The Periodicals Mail class is available for mail that is sent at regular intervals and contains at least a minimum level of editorial (i.e., non-advertising) content. This type of mail may include magazines, newspapers, journals, and newsletters. The Periodicals Mail class is divided into four subclasses, Periodicals Regular and three subclasses which offer preferred rates for certain eligible mailers. In-County Periodicals Mail is open to Periodicals which are sent within the same county as they are printed. Periodicals Nonprofit mail is open to Periodicals sent by qualified not-for-profit organizations. Periodicals Classroom mail is open to Periodicals sent to educational institutions for educational purposes. The latter two of these subclasses are combined within a single demand equation.

1. Factors Affecting Demand for Periodicals

The demand for Periodicals Mail is a derived demand, which is derived from the demand of consumers for magazines and newspapers. Those factors which influence the demand for newspapers and magazines would therefore be expected to be the principal drivers of the demand for Periodicals Mail.

The factors which would be expected to influence the demand for newspapers and magazines are drawn from basic micro-economic theory. These factors include the state of the overall economy, the price of periodicals, and the demand for goods which may serve as substitutes for newspapers and magazines.

The Periodicals demand equations include total private employment. Employment works better econometrically at explaining Periodicals Mail volumes than other macro-economic variables tested, including personal disposable income, consumption expenditures, and retail sales.

The price of periodicals is measured by the price of postage paid by publishers (and paid implicitly by consumers through subscription rates). In addition to affecting the

price of newspapers and magazines by being incorporated into subscription rates, the price charged by the Postal Service will also affect the demand for Periodicals Mail directly by affecting publishers' decisions over how and how often to send their Periodicals. For example, the delivery requirements of many weekly newspapers can be satisfied by either mail or private delivery. Publishers can also reduce the frequency of their publication by cutting the number of annual issues of a magazine or switching from twice-weekly to once-weekly newspaper circulation.

The Periodicals demand equations used here also include long-run time trends. These trends are the result of long-run shifts away from reading. In addition to the full-sample linear time trend, an additional negative trend is also included in the Periodical Regular demand equation to account for accelerating declines in Periodicals Mail volume due to increased substitution faced by Periodicals from the Internet, mobile devices, and e-readers.

Periodical Regular Mail

1. Explanatory Variables used in Periodical Regular Mail Equation

The Periodical Regular Mail demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between Periodical Regular Mail and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the Periodicals Regular Mail equation.

(2) Postal Price

The Periodical Regular Mail demand equation includes a price index measuring the average price of Periodicals Regular Mail (PC2R). Prices are entered current and lagged one quarter.

(3) Average Days to Delivery

The Periodical Regular Mail demand equation includes the average days to deliver Periodicals Mail, lagged one quarter.

(4) Time Trends

The Periodical Regular Mail demand equation includes a full-sample linear time trend, a linear time trend starting in 2011Q2, and a linear time trend starting in 2017Q4. The full-sample time trend reflects the general decline in reading that has contributed to a reduction in Periodicals Mail volumes for many years. The latter time trends reflect the additional decline in volume due to the emergence of online alternatives to printed magazines and newspapers.

(5) Non-Linear Intervention Variable

The Periodical Regular Mail demand equation includes a non-linear intervention variable that starts in 2007Q4 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2007Q4 and 0 otherwise; $S_t = 1$ if t >2007Q4 and 0 otherwise. This variable has an initial value in 2007Q4 of ω_0, which decays toward a long-run value of ω_2. This variable measures the unique impact of the Great Recession on Periodical Regular Mail volume.

(6) Other Variables

The Periodical Regular Mail equation also includes a set of seasonal variables.

2. Econometric Demand Equation: Periodical Regular Mail

The effect of these variables on Periodical Regular Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Periodical Regular Mail
VOLUME SINCE FY 2016

Volume in FY 2016			3720.946
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-4.65%	-0.145	0.69%
EMPLOY	-2.69%	1.009	-2.71%
AVGDEL_2C(-1)	14.45%	-0.052	-0.70%
Adult Population			3.92%
Interventions Starting in:			
2000Q1			-10.79%
2011Q2			-16.56%
2017Q4			-22.42%
2007Q4			-4.06%
Seasonals			1.32%
Other Factors			-0.17%
Volume in FY 2021			2107.842
Total Change in Volume			-43.35%

Periodicals Nonprofit and Classroom

A single demand equation is estimated for Periodicals Nonprofit and Classroom mail.

1. Explanatory Variables used in Periodicals Nonprofit and Classroom Mail Equation

The Periodicals Nonprofit and Classroom Mail demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between Periodicals Nonprofit and Classroom Mail and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the Periodicals Nonprofit and Classroom Mail equation.

(2) Postal Price

The Periodicals Nonprofit and Classroom Mail demand equation includes a price index measuring the average price of Periodicals Nonprofit and Classroom Mail (PC12_13). Prices are entered current and lagged one to four quarters.

(3) Average Days to Delivery

The Periodical Nonprofit and Classroom Mail demand equation includes the average days to deliver Periodicals Mail, lagged one quarter.

(4) Time Trend

The Periodicals Nonprofit and Classroom Mail demand equation includes a full-sample linear time trend.

(5) Other Variables

The Periodicals Nonprofit and Classroom Mail equation includes four non-seasonal dummy variables: D2016Q3ON, which is equal to one from 2016Q3 onward, zero prior to 2016Q3; D2018Q2, equal to one in 2018Q2, zero elsewhere; and D2018Q3, equal to one in 2018Q3, zero elsewhere; and D_AARP, which is equal to one in 2021Q1 and -1 in 2021Q2, reflective of the timing of an AARP mailing which fell in the second Postal quarter that year instead of its usual timing in the first Postal quarter.

Finally, the Periodicals Nonprofit and Classroom Mail equation includes a set of seasonal variables.

2. Econometric Demand Equation: Periodicals Nonprofit and Classroom Mail

The effect of these variables on Periodicals Nonprofit and Classroom Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Periodical Nonprofit & Classroom
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			1331.064
Own-Price	-4.43%	-0.286	1.31%
EMPLOY	-2.69%	0.164	-0.45%
AVGDEL_2C(-1)	14.45%	-0.037	-0.50%
Adult Population			3.92%
Interventions Starting in: 2000Q1			-17.72%
Seasonals			0.00%
Dummy Vars			-1.48%
Other Factors			-0.11%
Volume in FY 2021			1124.011
Total Change in Volume			-15.56%

Periodicals Within County Mail

1. Explanatory Variables used in Periodicals Within-County Mail Equation

The Periodicals Within-County Mail demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between Periodicals Within-County Mail and the general economy is modeled through the inclusion of private employment (EMPLOY) as an explanatory variable in the Periodicals Within-County Mail equation.

(2) Postal Price

The Periodicals Within-County Mail demand equation includes a price index measuring the average price of Periodicals Within-County Mail (PC11). Prices are entered current only.

(3) Average Days to Delivery

The Periodical Within-County Mail demand equation includes the average days to deliver Periodicals Mail, lagged one quarter.

(4) Time Trend

The Periodicals Within-County Mail demand equation includes a full-sample linear time trend and a second linear time trend starting in 2019Q1.

(5) Other Variables

The Periodicals Within-County Mail equation includes one dummy variable: D2016Q4_17Q1, which is equal to one in 2016Q4 and 2017Q1, and is equal to zero both before and after this time period.

The Periodicals Within-County Mail equation also includes a set of seasonal variables.

2. Econometric Demand Equation: Periodicals Within County Mail

The effect of these variables on Periodicals Within County Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Periodical Within-County
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			534.172
Own-Price	-5.30%	-0.153	0.84%
EMPLOY	-2.69%	0.831	-2.24%
AVGDEL_2C(-1)	14.45%	-0.081	-1.08%
Adult Population			3.92%
Interventions Starting in:			
2008Q1			-24.87%
2019Q1			7.91%
Seasonals			0.00%
Dummy Vars			1.96%
Other Factors			-0.07%
Volume in FY 2021			447.172
Total Change in Volume			-16.29%

Package Delivery Services

Package delivery services refer broadly to the delivery of goods. Examples of this type of mail include mail-order deliveries such as clothes or books, as well as packages sent by households (e.g., Christmas presents). Among market-dominant mail categories, this encompasses Marketing parcels, which were discussed earlier, and the Package Services mail class. As of January 2022, there were four market-dominant subclasses of mail in the Package Services class: Alaska Bypass, Bound Printed Matter (BPM) Flats, BPM Parcels, and Media and Library Rate Mail.

Most Package Delivery Services face significant competition from other delivery firms, including United Parcel Service and Federal Express. Because of this, most categories of mail that can best be described as Package Delivery Services are classified as competitive mail products and are not included as part of this report.

The demand for package delivery services will be largely driven by the demand for the goods being delivered. In the cases of most package delivery services, this relationship is modeled through the inclusion of e-commerce sales as an explanatory variable.

The specific demand equations for Market-Dominant Package Delivery Services are presented in more detail below.

Alaska Bypass

1. Explanatory Variables used in the Alaska Bypass Equation

The Alaska Bypass demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: E-Commerce

The relationship between Alaska Bypass volume and the economy is modeled through the inclusion of e-commerce retail sales (ECOMM) as an explanatory variable in the Alaska Bypass demand equation.

(2) Postal Price

The Alaska Bypass demand equation includes a price index for the average price of Alaska Bypass (PC25_AB). Prices are entered current and lagged one through four quarters.

(3) Time Trend

The Alaska Bypass equation includes a full-sample linear time trend and a second linear time trend starting in 2018Q1.

(4) Other Variables

The Alaska Bypass equation includes two non-seasonal dummy variables: D2019Q1, equal to one in 2019Q1, zero elsewhere; and D2021Q1ON, equal to one since 2021Q1, zero before then. The Alaska Bypass equation also includes a set of seasonal variables.

2. Econometric Demand Equation: Alaska Bypass

The effect of these variables on Alaska Bypass volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Alaska Bypass
VOLUME SINCE FY 2016

Volume in FY 2016			1.282
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-5.85%	-0.189	1.15%
ECOMM	98.10%	0.616	52.33%
Adult Population			3.92%
Interventions Starting in:			
2012Q3			-31.21%
2018Q1			-11.67%
Seasonals			0.00%
Dummy Vars			6.91%
Other Factors			0.18%
Volume in FY 2021			1.336
Total Change in Volume			4.20%

Bound Printed Matter Flats

1. Explanatory Variables used in Bound Printed Matter Flats Equation

The Bound Printed Matter Flats demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Investment

The relationship between Bound Printed Matter Flats volume and the general economy is modeled through the inclusion of gross private domestic investment (INVR). Investment is used in the BPM Flats equation because BPM Flats share the same basic characteristics as Marketing Flats.

(2) Postal Price

The Bound Printed Matter Flats equation includes a price index measuring the average price of Bound Printed Matter Flats (PC28_F). Prices are entered current and lagged one to two quarters.

(3) Time Trend

The Bound Printed Matter Flats equation includes a linear time trend starting in 2017Q3.

(4) Other Variables

The Bound Printed Matter Flats equation includes two non-seasonal dummy variables: D2016Q1, which is equal to one in 2016Q1, zero elsewhere; and D2020Q4ON, which is equal to one since 2020Q4, zero before then. The latter of these dummies is included to capture the unique impact of events related to COVID-19.

Finally, the Bound Printed Matter Flats equation includes a set of seasonal variables.

2. Econometric Demand Equation: Bound Printed Matter Flats

The effect of these variables on Bound Printed Matter Flats volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Bound Printed Matter Flats
VOLUME SINCE FY 2016

Volume in FY 2016			264.935
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-5.22%	-0.561	3.05%
INVR	11.15%	0.773	8.51%
Adult Population			3.92%
Interventions Starting in: 2017Q3			-21.62%
Seasonals			0.00%
Dummy Vars			-26.16%
Other Factors			1.85%
Volume in FY 2021			181.487
Total Change in Volume			-31.50%

Bound Printed Matter Parcels

1. Explanatory Variables used in Bound Printed Matter Parcels Equation

The Bound Printed Matter Parcels demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: E-Commerce

The Bound Printed Matter Parcels equation includes e-commerce retail sales (ECOMM) to model the relationship between package volumes and online shopping.

(2) Postal Price

The Bound Printed Matter Parcels demand equation includes a price index measuring the average price Bound Printed Matter Parcels (PC28_P). Prices are entered current and lagged one quarter.

(3) Time Trend

The Bound Printed Matter Parcels demand equation includes a full-sample linear time trend and a second linear time trend starting in 2019Q3.

(4) Non-Linear Intervention Variable

The Bound Printed Matter Parcels demand equation includes a non-linear s-curve starting in 2014Q3.

(5) Other Variables

Finally, the Bound Printed Matter Parcels equation includes one non-seasonal dummy variable: D2021Q3ON, equal to one since 2021Q3, zero elsewhere, and a set of seasonal variables.

2. Econometric Demand Equation: Bound Printed Matter Parcels

The effect of these variables on Bound Printed Matter Parcels volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Bound Printed Matter Parcels
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			249.957
Own-Price	-6.11%	-0.835	5.40%
ECOMM	98.10%	0.763	68.51%
Adult Population			3.92%
Interventions Starting in:			
2008Q1			-51.59%
2019Q3			-27.19%
2014Q3			36.60%
Seasonals			0.00%
Dummy Vars			4.17%
Other Factors			-1.81%
Volume in FY 2021			227.242
Total Change in Volume			-9.09%

Media and Library Rate Mail

1. Explanatory Variables used in Media and Library Rate Mail Equation

The Media and Library Rate Mail demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: E-Commerce

The Media and Library Rate Mail equation includes e-commerce retail sales (ECOMM) to model the relationship between package volumes and online shopping.

(2) Postal Price

The Media and Library Rate mail equation includes the price of Media and Library Rate Mail (PC29_30). Prices are entered current and lagged one to four quarters.

(3) Time Trends

The Media and Library Rate Mail demand equation includes a full-sample linear time trend and a second linear time trend starting in 2015Q4.

(4) Non-Linear Intervention Variable

The Media and Library Rate Mail demand equation includes a non-linear intervention variable that starts in 2020Q2 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q2 and 0 otherwise; $S_t = 1$ if t >2020Q2 and 0 otherwise. This variable has an initial value in 2020Q2 of ω_0, which decays toward a long-run value of ω_2. In this case, the values of

both ω_0 and ω_2 are set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(5) Other Variables

The Media and Library Rate Mail equation includes two non-seasonal dummy variables: D2020Q2, equal to one in 2020Q2, zero elsewhere; and D2021Q1, equal to one in 2021Q1, zero elsewhere.

Finally, the Media and Library Rate Mail equation includes a set of seasonal variables.

2. Econometric Demand Equation: Media and Library Rate Mail

The effect of these variables on Media and Library Rate Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Media and Library Rate
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			75.095
Own-Price	-3.78%	-0.518	2.01%
ECOMM	98.10%	0.927	88.47%
Adult Population			3.92%
Interventions Starting in:			
2011Q1			-61.45%
2015Q4			57.26%
2020Q2			13.43%
Seasonals			1.58%
Dummy Vars			1.89%
Other Factors			0.43%
Volume in FY 2021			107.260
Total Change in Volume			42.83%

Free Mail Services

There are two mail categories for which mail is free to the sender: Postal Penalty Mail, mail sent by the Postal Service; and Free-for-the-Blind Mail, which is free for blind or handicapped consumers. Because these mail categories are free, Postal prices are not included as explanatory variables in these equations. The specific demand equations used to model Postal Penalty and Free-for-the-Blind mail volumes are outlined below.

Postal Penalty Mail

1. Explanatory Variables used in Postal Penalty Mail Equation

The Postal Penalty Mail demand equation includes the following explanatory variables.

(1) Time Trend

The Postal Penalty equation includes a full-sample linear time trend.

(2) Other Variables

The Postal Penalty Mail equation also includes three non-seasonal dummy variables: D2013Q4, equal to one in 2013Q4, zero elsewhere; D2020Q2, equal to one in 2020Q2, zero elsewhere; and D2020Q4, equal to one in 2020Q4, zero elsewhere. The latter two of these dummies is included to capture the unique impact of events related to COVID-19.

Finally, the Postal Penalty equation includes a set of seasonal variables.

2. Econometric Demand Equation: Postal Penalty Mail

The effect of these variables on Postal Penalty Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Postal Penalty
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			421.787
Adult Population			3.92%
Interventions Starting in: 2011Q3			-19.26%
Seasonals			-17.96%
Dummy Vars			0.00%
Other Factors			-2.93%
Volume in FY 2021			281.854
Total Change in Volume			-33.18%

Free-for-the-Blind and Handicapped Mail

1. Explanatory Variables used in Free-for-the-Blind Mail Equation

The Free-for-the-Blind Mail demand equation includes the following explanatory variables.

(1) Time Trend

The Free-for-the-Blind Mail equation includes a full-sample linear time trend and a second linear time trend starting in 2018Q4.

(2) Other Variables

The Free-for-the-Blind Mail equation also includes two dummy variables: D2020Q3, equal to one in 2020Q3, zero elsewhere; D2020Q4ON, equal to one starting in 2020Q4, zero elsewhere. These dummies are included to capture the unique impact of events related to COVID-19.

2. Econometric Demand Equation: Free-for-the-Blind Mail

The effect of these variables on Free-for-the-Blind Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Free-for-the-Blind
VOLUME SINCE FY 2016

Volume in FY 2016			45.426
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Adult Population			3.92%
Interventions Starting in:			
2010Q4			-26.15%
2018Q4			-35.39%
Seasonals			0.00%
Dummy Vars			-13.35%
Other Factors			1.99%
Volume in FY 2021			19.909
Total Change in Volume			-56.17%

Ancillary and Special Services

General Overview

Ancillary services are not mail volumes but represent add-ons to mail volumes. That is, a certified letter would be counted as both a piece of Certified Mail as well as a First-Class Letter. Therefore, the volumes of ancillary services are not included in a calculation of total Postal Service volume.

Because ancillary services are add-ons to existing mail volumes, the demand for ancillary services may be affected directly by the demand for complementary categories of mail. For example, the volume of Stamped Envelopes is modeled in part as a function of the volume of First-Class Single-Piece Letters since all Stamped Envelopes are, in fact, First-Class Single-Piece Letters.

Special services are not add-ons to mail volumes but represent separate volume. Special service volumes are not generally viewed as “mail” volume *per se*. Econometric demand equations are estimated for two special services: Money Orders and Post Office Boxes.

The ancillary and special service volumes modeled here have generally exhibited long-run trends. For this reason, a time trend is included in the demand equation associated with most of these services.

Finally, the demand for ancillary and special services is also a function of the price charged by the Postal Service for these services. In addition, most of the ancillary and special service equations also include some equation-specific variables, which are described below.

Specific demand equations for ancillary and special services are described in detail below.

Registered Mail

1. Explanatory Variables used in Registered Mail Equation

The Registered Mail demand equation includes the following explanatory variables.

(1) Postal Price

The Registered Mail equation includes a price index measuring the average price of Registered Mail (PC35). Prices are entered current and lagged one to four quarters.

(2) Time Trend

The Registered Mail equation includes a full-sample linear time trend and a second linear time trend starting in 2017Q3.

(3) Other Variables

The Registered Mail equation contains four non-seasonal dummy variables: D2015Q3, equal to one in 2015Q3, zero elsewhere; D2015Q4, equal to one in 2015Q4, zero elsewhere; D2020Q3, equal to one in 2020Q3, zero elsewhere; D2020Q4ON, equal to one starting in 2020Q4, zero elsewhere.

The Registered Mail equation also includes a set of seasonal variables.

2. Econometric Demand Equation: Registered Mail

The effect of these variables on Registered Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Registered
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			2.095
Own-Price	-4.63%	-1.071	5.21%
Adult Population			3.92%
Interventions Starting in:			
2002Q1			-27.87%
2017Q3			-32.57%
Seasonals			0.00%
Dummy Vars			12.65%
Other Factors			-5.40%
Volume in FY 2021			1.187
Total Change in Volume			-43.34%

Insured Mail

1. Explanatory Variables used in Insured Mail Equation

The Insured Mail demand equation includes the following explanatory variables.

(1) Postal Price

The Insured Mail equation includes a price index measuring the average price of Insured Mail (PC36). Prices are entered current and lagged one to four quarters.

(2) Time Trend

The Insured Mail equation includes a full-sample linear time trend and a second linear time trend starting in 2017Q3.

(3) Non-Linear Intervention Variable

The Insured Mail equation includes a non-linear intervention variable that starts in 2020Q3 and takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2020Q3 and 0 otherwise; $S_t = 1$ if t >2020Q3 and 0 otherwise. This variable has an initial value in 2020Q3 of ω_0, which decays toward a long-run value of ω_2. In this case, the long-run value, ω_2, is set equal to zero by construction. This intervention variable is included to capture the unique impact of events related to COVID-19.

(4) Other Variables

The Insured Mail equation includes three non-seasonal dummy variables: D_FREEINS, which is set equal to one since the introduction of free insurance attached to Priority Mail, in the fourth Postal Quarter of FY 2013; D2015Q4, equal to one in 2015Q4, zero elsewhere; and D2020Q1, equal to one in 2020Q1, zero elsewhere.

The Insured Mail equation also includes a set of seasonal variables.

2. Econometric Demand Equation: Insured Mail

The effect of these variables on Insured Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN Insurance VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			15.862
Own-Price	-4.94%	-0.814	4.21%
Adult Population			3.92%
Interventions Starting in:			
2008Q1			-45.94%
2017Q3			43.68%
2020Q3			30.07%
Seasonals			0.00%
Dummy Vars			0.00%
Other Factors			0.24%
Volume in FY 2021			17.397
Total Change in Volume			9.67%

Certified Mail

1. Explanatory Variables used in Certified Mail Equation

The Certified Mail demand equation includes the following explanatory variables.

(1) Postal Price

The Certified Mail equation includes a price index measuring the average price of Certified Mail (PC37). Prices are entered current and lagged one quarter.

(2) Intervention Variable

The Certified Mail equation includes a non-linear intervention variable starting in 2011Q2. This variable takes the following form:

$$Ln(Vol)_t = a + \ldots + \omega_0 \cdot P_t + \omega_1 \cdot (P_t + \delta P_{t-1} + \delta^2 P_{t-2} + \delta^3 P_{t-3} + \ldots) + \omega_2 \cdot S_t + \ldots$$

where P_t is a pulse function and S_t is a step function, so that $P_t = 1$ if t=2011Q2 and 0 otherwise; $S_t = 1$ if t >2011Q2 and 0 otherwise. This variable has an initial value in 2011Q2 of ω_0, which decays toward a long-run value of ω_2.

(3) Other Variables

The Certified Mail equation includes two non-seasonal dummy variables: D2020Q3, equal to one in 2020Q3, zero elsewhere; and D2020Q4ON, equal to one since 2020Q4, zero before that. These dummies are included to capture the unique impact of events related to COVID-19.

The Certified Mail equation also includes a set of seasonal variables.

2. Econometric Demand Equation: Certified Mail

The effect of these variables on Certified Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN Certified VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			198.127
Own-Price	-4.96%	-0.514	2.65%
Adult Population			3.92%
Interventions Starting in: 2011Q2			-11.69%
Seasonals			0.00%
Dummy Vars			-16.22%
Other Factors			0.02%
Volume in FY 2021			156.412
Total Change in Volume			-21.05%

Collect-on-Delivery Mail

1. Explanatory Variables used in Collect-on-Delivery Mail Equation

The Collect-on-Delivery (COD) Mail demand equation includes the following explanatory variables.

(1) Time Trend

The COD Mail demand equation includes a full-sample linear time.

(2) Other Variables

The COD Mail equation includes two non-seasonal dummy variables - D2020Q3, equal to one in 2020Q3, zero elsewhere; and D2020Q4ON, equal to one since 2020Q4. These dummies are included to capture the unique impact of events related to COVID-19.

Finally, the COD Mail demand equation includes a set of seasonal variables.

2. Econometric Demand Equation: Collect-on-Delivery Mail

The effect of these variables on COD Mail volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN COD VOLUME SINCE 2016.2

Volume in First Year of Test Period			0.407
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Adult Population			3.64%
Interventions Starting in: 2016Q2			-24.32%
Seasonals			0.00%
Dummy Vars			-16.14%
Other Factors			0.23%
Volume in FY 2021			0.268
Total Change in Volume			-34.08%

Return Receipts

1. Explanatory Variables used in Return Receipts Equation

The Return Receipts demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between Return Receipts volume and the general economy is modeled through the inclusion of private employment (EMPLOY) in the Return Receipts demand equation.

(2) Certified Mail Volume

The Return Receipts demand equation includes the volume of Certified Mail (BGVOL37) as an explanatory variable. The relationship between Return Receipts volume and Certified Mail volume appears to have shifted over the past decade or so. Two terms are included in the Return Receipts equation to capture this shift: BGVOL37*(1-D2012Q4ON), which estimates the relationship between Certified Mail volumes and Return Receipts prior to 2012Q4 and BGVOL37*D2012Q4ON which estimates the relationship between Certified Mail volumes and Return Receipts since 2012Q4.

(3) Postal Price

The Return Receipts demand equation includes a price index measuring the average price of Return Receipts (PC_RR). Prices are entered current and lagged one to four quarters.

(4) Time Trend

The Return Receipts demand equation includes a linear time trend starting in 2016Q3.

(5) Other Variables

The Return Receipts demand equation includes five non-seasonal dummy variables: D_R07 equal to one since the implementation of R2006-1 rates in May 2007, zero earlier; D_R11, equal to one since the Postal Service's April 2011, rate change (2011Q3), zero earlier; D2012Q4ON which is equal to one since 2012Q4, zero earlier; D_R14, equal to one since the Postal Service's January 2014 rate change; and D2016Q3ON, equal to one since 2016Q3, zero earlier.

Finally, the Return Receipts equation includes a set of seasonal variables.

2. Econometric Demand Equation: Return Receipts

The effect of these variables on Return Receipts volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Return Receipts
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			153.797
Own-Price	-1.55%	-0.252	0.39%
EMPLOY	-2.69%	0.717	-1.94%
BGVOL37*(1-D2012Q4ON)	0.00%	0.837	0.00%
BGVOL37*D2012Q4ON	-23.82%	0.648	-16.15%
Adult Population			3.92%
Interventions Starting in: 2016Q3			-13.05%
Seasonals			0.00%
Dummy Vars			-2.16%
Other Factors			-1.97%
Volume in FY 2021			110.015
Total Change in Volume			-28.47%

Stamped Envelopes and Cards

1. Explanatory Variables used in Stamped Envelopes and Cards Equations

The Postal Service's RPW system only reports revenue for Stamped Envelopes and Cards, not volume. Volume is calculated here by dividing RPW revenue by the average price of Stamped Envelopes and Cards. RPW revenue tends to be highly volatile across quarters. Because of this, the dependent variable in these equations is the sum of respective volumes over the previous four quarters (per adult per business day).

Stamped Envelopes and Cards are modeled separately as a function of First-Class Single-Piece Letters and Cards volumes, respectively (BGVOL01SP_L, BGVOL01SP_C) and the price of Stamped Envelopes (PC_SE) and Cards (PC_SC). The coefficients on volume and price are constrained to be equal to 1 and -1, respectively.

The Stamped Envelopes equation also includes a linear time trend starting in 2016Q2. The Stamped Cards equation also includes a full-sample time trend.

2. Econometric Demand Equation: Stamped Envelopes

The effect of these variables on Stamped Envelopes volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Stamped Envelopes (4-qtr avg)
VOLUME SINCE FY 2016

Volume in FY 2016			414.103
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-5.39%	-1.000	5.70%
BGVOL01SP_L	-31.27%	1.000	-31.27%
Adult Population			3.92%
Interventions Starting in:			
2016Q2			61.13%
Seasonals			0.00%
Other Factors			6.21%
Volume in FY 2021			535.070
Total Change in Volume			29.21%

3. Econometric Demand Equation: Stamped Cards

The effect of these variables on Stamped Cards volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Stamped Cards (4-qtr avg)
VOLUME SINCE FY 2016

Volume in FY 2016			72.956
Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Own-Price	-8.38%	-1.000	9.15%
BGVOL01SP_C	-47.13%	1.000	-47.13%
Adult Population			3.92%
Interventions Starting in: 2012Q4			-27.07%
Seasonals			0.00%
Other Factors			76.71%
Volume in FY 2021			56.386
Total Change in Volume			-22.71%

Money Orders

1. Explanatory Variables used in Money Orders Equation

The Money Orders demand equation includes the following explanatory variables.

(1) Macro-Economic Variable: Employment

The relationship between Money Orders volume and the general economy is modeled by including private employment (EMPLOY) in the Money Orders demand equation.

(2) Postal Price

The Money Orders equation includes a price index measuring the average price of Money Orders (PC39). Prices are entered current and lagged one quarter.

(3) Time Trends

The Money Orders demand equation includes a full-sample linear time trend and a second linear time trend starting in 2016Q3.

(4) Other Variables

Finally, the Money Orders equation includes a set of seasonal variables.

2. Econometric Demand Equation: Money Orders

The effect of these variables on Money Orders volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Money Orders
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			90.289
Own-Price	-5.83%	-0.332	2.01%
EMPLOY	-2.69%	0.639	-1.73%
Adult Population			3.92%
Interventions Starting in:			
2002Q1			-29.82%
2016Q3			11.50%
Seasonals			0.00%
Other Factors			-2.88%
Volume in FY 2021			71.483
Total Change in Volume			-20.83%

Post Office Boxes

Historically, the Postal Service's RPW system did not report volumes for Post Office Boxes, only revenues. For this reason, the PO Box volumes that are used as the dependent variable for this equation are imputed by dividing PO Box revenue from the RPW system by a price index for PO Boxes constructed based on billing determinant data.

The Post Office Box equation includes a price index measuring the average price of Post Office Boxes (PC_PO). Prices are entered current and lagged one quarter. The Post Office Boxes demand equation also includes a full-sample linear time trend.

The effect of these variables on Post Office Box volume over the past five years is shown in the table below.

CONTRIBUTIONS TO CHANGE IN
Post Office Boxes
VOLUME SINCE FY 2016

Variable	Percent Change In Variable	Elasticity	Effect of Variable on Volume
Volume in FY 2016			12.461
Own-Price	27.87%	-0.240	-5.72%
Adult Population			3.92%
Interventions Starting in: 2012Q4			-11.25%
Seasonals			0.00%
Other Factors			-0.13%
Volume in FY 2021			10.822
Total Change in Volume			-13.16%