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Research on Updating Purchased Highway Transportation Variabilities to Account for Structural Changes*

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Table of Contents

I. Introduction

In recent years, there have been two major operational changes in the Postal Service's highway transportation network. First, the Postal Service has increased its reliance on additional highway transportation during the seasonal volume peak. Second, the Postal Service has introduced a new type of highway contract, called a Dynamic Route Optimization (DRO) contract. This new type of contract changes both the way highway transportation capacities are specified and how contractors are compensated. Both of these operational changes are large enough to qualify as what the Commission has termed "major structural reorganizations," and in that sense, they are sufficient to justify investigation of possible changes in highway variabilities:[1]

> Finally, to ensure that variabilities of purchased highway transportation cost reflect the current Postal Service transportation network structure, the Commission suggests the Postal Service update its variabilities the earlier of every 10 to 15 years or following completion of any major structural reorganization.

When taken together, the accrued cost to which the investigated variabilities are applied totaled $1.6 billion in FY 2019, so materiality of costs involved is not an issue. Moreover, the operational changes incorporate large enough differences from regular highway contracts to suggest that the changes in variabilities could also be material.

Consequently, both of these operational changes will be investigated in this report. In each case, the nature of the change will be described, the implications for variability estimation will be discussed, relevant data will be identified and obtained, and

[1] *See*, Postal Regulatory Commission, Order No. 3973, Docket No. RM2016-12, June 22, 2017, at 40.

new variability equations will be estimated. In addition, the impact of the proposed new variabilities will be presented and discussed.

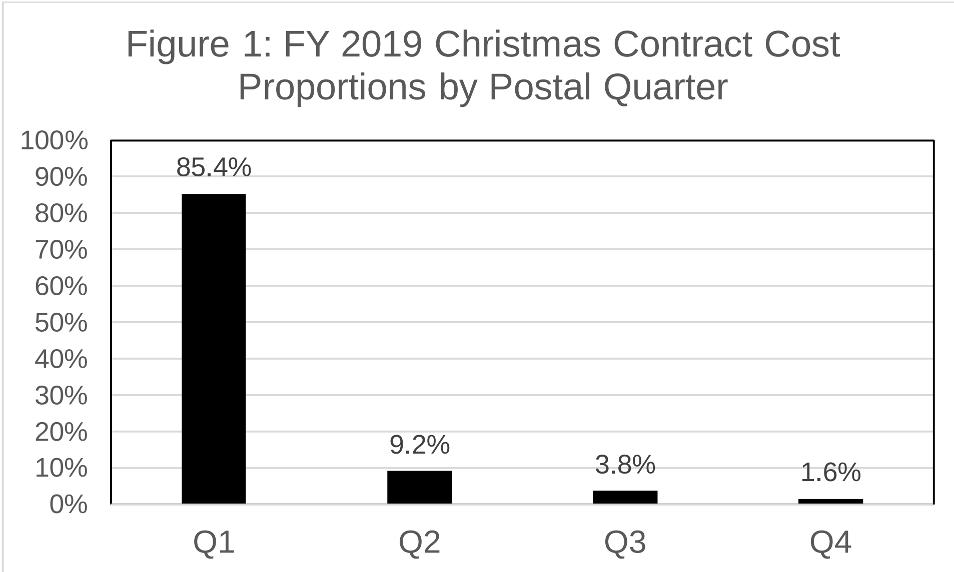
II. Peak Season Transportation Variabilities

A. Background

The Postal Service faces increases in volume for several different products during the winter holiday season. Substantial amounts of the increased volume must be handled in the Postal Service's purchased highway transportation network. The Postal Service's preferred approach to accommodating the volume increase is to use existing, but unused, transportation capacity to absorb the higher volume. But volume imbalances across the network can give rise to the need for additional capacity. That is, some seasonal volumes occur in parts of the network that already have high, not low, utilization, and the Postal Service must incur additional purchased highway transportation cost to handle the volume.

The additional seasonal highway transportation costs are incurred in a specific set of highway accounts which cover what are known as Christmas contracts.[2] Christmas contracts typically begin providing transportation around Thanksgiving and run until somewhere around the end of the calendar year. The overwhelming majority (85.4 percent) of the cost of these contracts occur in the first postal quarter, with 9.2 percent occurring in the second postal quarter. Apart from being in place for a relatively short period of time, Christmas contracts function like regular Highway Contract Route (HCR) contracts with pre-specified routes and compensation amounts.

[2] The nine accounts that capture Christmas transportation costs are 53604, 53608, 53613, 53617, 53622, 53623, 53624, 53625, and 53626.



In recent years, the cost incurred for Christmas contracts has increased substantially. In Fiscal Year 2014, the cost of Christmas highway transportation was just $83 million, but in Fiscal Year 2019, total Christmas highway transportation cost had increased to $285.6 million. This increase in accrued cost suggests that it is appropriate to investigate whether the current variabilities applied to accrued Christmas account costs should be revised.

In the established methodology, the variabilities for Christmas accounts are borrowed, in part, from their corresponding regular highway transportation accounts. Each overall purchased highway transportation variability is the product of two parts: the relevant cost-to-capacity variability and the relevant capacity-to-volume variability. The regular highway transportation cost-to-capacity variabilities were last estimated in Docket No. RM2014-6, based upon data collected for FY 2013. At that time, there was insufficient experience with, and insufficient data for, Christmas accounts to support separate estimation of Christmas cost-to-capacity variabilities. As a result, the cost-to-capacity variabilities from corresponding regular highway accounts were adopted and applied to the relevant Christmas accounts.

The capacity-to-volume variabilities for regular highway transportation were estimated in Docket No. RM2016-12. In that docket, the Commission determined that, subject to future research, the capacity-to-volume variabilities for Christmas accounts should be set at 1.0.[3] As a result, the established overall variabilities for the Christmas accounts are equal to the cost-to-capacity variabilities for their corresponding regular accounts.[4]

B. The Cost-to-Capacity Variability

The data required to estimate cost-to-capacity variabilities for Christmas transportation are available from the same source that was used to estimate the established cost-to-capacity variabilities for regular transportation, the Transportation Contract Support System (TCSS). This data source was presented and approved in Docket No. RM2014-6, and the following description from that case again applies, with the exception that the data were drawn for the fourth quarter of FY 2019 instead of FY 2013:[5]

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[3] See, Postal Regulatory Commission, Order No. 3973, Docket No. RM2016-12, June 22, 2017, at 38-40

[4] In the course of doing the research for this report, two inadvertent implementation errors were discovered in the transportation cost model (CS14-FY19.xlsx). In both instances, the variability applied to the relevant Christmas account is the overall variability for the corresponding regular account, rather than just the cost-to-capacity variability. First, the variability applied to the Inter Area Christmas account is 0.738 instead of 0.899. Second, the variability applied to the Inter NDC Christmas account is 0.803 instead of 0.947. In the event that new variabilities are approved as a result of this proposal, these errors will be rendered moot.

[5] See, Report on Updating the Cost-to-Capacity Variabilities for Purchased Highway Transportation, USPS-RM2014-6/1, June 20, 2014 at 6.

> TCSS is used to manage highway transportation requirements for contracts and payment processes. It supports the awarding of new contracts, modification to existing contracts, and renewal of contracts. It contains the data elements required for updating the purchased highway transportation variabilities. Because TCSS is a "live" data set, it changes through time, and to produce the required cross-sectional data set, an extract had to be derived at a specific moment in time. The dataset for this econometric analysis was drawn in the fourth quarter of FY2013. As with previous data sets, the extracted data reflect annual costs and transportation requirements.

The structure of the accounts for Christmas contracts generally follows the structure of accounts for regular contracts, albeit with far fewer observations. As was true for regular transportation in both Docket No. R2000-1, and Docket No. RM2014-6, the contract cost segment is the correct unit of observation for analyzing the cost-to-capacity variability for Christmas transportation:[6]

> In most instances, a contract cost segment and a contract are the same thing, as most contracts have just one cost segment. That segment sets the annual cost for the contract along with specifying the type of truck to be used, the route, the frequency of trips and the other variables needed to define the required transportation.
>
> In some instances, however, a single contract will cover more than one type of transportation. For example, a contract may have one set of trips that requires the use of a tractor trailer and another set of trips that requires a straight-body truck. When this occurs, the contract will have two different cost segments, one for the tractor trailer part and one for the straight-body truck part. Each cost segment has its own annual cost, truck specification, and designation of trips.

[6] Id. at 7.

The use of contract cost segments as the unit of observation is particularly appropriate for analyzing Christmas transportation, because it is possible for an individual contract to have both regular cost segments and Christmas cost segments. By using the contract cost segments, the analysis can be limited to just those costs and capacities that are added for the seasonal peak.

The structure of the regular transportation accounts for FY 2019 is provided in Table 1, along with the number of contract cost segments in each account type. There were 13,562 regular highway contract cost segment in the FY 2019 TCSS data, with the majority occurring in local (Intra SCF) transportation. For the purposes of variability estimation, it is important to determine if a sufficient number of observations exist in each account type, to check if separate variability equations can be estimated for the individual transportation categories.[7] For regular highway transportation, that is the case. For example, separate equations can be estimated for Inter P&DC costs, Inter Cluster costs, and Inter Area costs, rather than just estimating a single equation for Inter SCF costs. When there are sufficient data available at a more granular level, it is appropriate to estimate separate equations to check if the different transportation subtypes have the same variability.

[7] In fact, there are sufficient observations in the Intra SCF and Inter SCF account types so that not only can individual equations be estimated for the detailed breakouts, such as Intra P&DC or Inter Area, but also transportation types, like van or tractor trailer, within those breakouts. Inter NDC has only one transportation type, so all of the observations can be used to estimate a single equation.

Table 1

FY2019 TCSS Contract Cost Segments for Regular Highway Transportation

Account Type		**# of Contract Cost Segments**
Intra SCF		11,726
Intra CSD	*7,677*	
Intra P&DC	*4,049*	
Inter SCF		1,455
Inter P&DC	*241*	
Inter Cluster	*302*	
Inter Area	*912*	
Intra NDC		260
Inter NDC		121

As Table 2 indicates, a very different pattern of contract cost segments emerges for Christmas transportation.[8] That table presents the structure of the 1,560 contract

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[8] Although there are seven different transportation subtypes listed for Christmas transportation (Intra SCF, Intra CSD, Inter P&DC, Inter Cluster, Inter Area, Intra NDC and Inter NDC) in Table 2, there are actually nine accounts that contain Christmas transportation costs. The difference arises because some of the Christmas accounts cover the same type of transportation. Account 53625 is labelled as “Intra Area - Headquarters Christmas Network” but there is no “Intra Area” transportation type. It turns out that this is just another label for Intra P&DC Christmas transportation and covers that type of transportation. Therefore, account 53625 should be combined with account 53604 to form the Intra P&DC Christmas transportation account category. Similarly, account 53626 is labeled “Inter-Area - Headquarters Christmas Network,” but it covers Inter Area Christmas transportation under a different name and should be combined with Account 53622 to form the Inter Area Christmas account category.

cost segments for Christmas transportation, and shows they are not evenly distributed across the account types. For example, 923 of the 924 Intra SCF Christmas contract cost segments are in the Christmas Intra P&DC account and only 1 contract cost segment is in the Christmas Intra CSD account. Obviously, it is not possible to estimate separate variability equations for Christmas Intra P&DC and Christmas Intra CSD accounts. A similar situation occurs for the Christmas Inter SCF accounts, where nearly all of the contract cost segments are in the Christmas Inter Area subtype. There are only 21 contract cost segments for the Christmas Inter P&DC subtype and just 14 Christmas Inter Cluster contract cost segments. Again, separate equations cannot be reliably estimated for the three different subtypes because the data support analysis only at the Christmas Inter SCF level.

In sum, the distribution of contract cost segments across the subtypes for both Intra SCF Christmas transportation and Inter SCF Christmas transportation precludes the estimation of individual equations for the individual subtypes. There are only sufficient data to estimate a single variability equation for all Intra SCF Christmas transportation, and a single equation for all Inter SCF Christmas transportation. Finally, there are a very small number of contract cost segments in the Intra NDC and Inter NDC Christmas accounts, suggesting it may not be possible to accurately estimate a separate variability equation for those transportation types.

Table 2
FY2019 TCSS Contract Cost Segments for
Christmas Highway Transportation

Account Type		**# of Contract Cost Segments**
Intra SCF		924
Intra CSD	*1*	
Intra P&DC	*923*	
Inter SCF		545
Inter P&DC	*21*	
Inter Cluster	*14*	
Inter Area	*510*	
Intra NDC		61
Inter NDC		30

1. Model Specification

Before specifying the models to be used to estimate the variabilities for Christmas contract cost segments, it is worthwhile to review their characteristics and assess how those characteristics align with the characteristics of regular contracts. Because there is a thoroughly considered and established (Dockets R87-1, R97-1, R2000-1, and RM2014-6) econometric model for estimating regular transportation variabilities, it is appropriate to start the model specification process with consideration of the applicability of the established econometric model for estimating Christmas transportation variabilities.

Postal Service transportation experts have indicated that Christmas contracts function like regular contracts in terms of their operations, scheduling, and method of compensation. This similarity suggests that the regular highway transportation econometric model is also applicable to Christmas transportation contract cost segments.

To further evaluate that possibility, one can compare the recorded characteristics for Christmas contract cost segments with the recorded characteristics for regular contract cost segments of the same type of transportation. The comparison can be done for the same time period, FY 2019, with both Christmas and regular data taken from the same TCSS database. For example, one can compare the median values for the key variables for Christmas and Regular contract cost segments for Inter SCF transportation, as is done in Table 3.

That table shows that the primary difference between the two types of contract cost segments is that, as expected, the Christmas contract cost segments run only for a few weeks of the year, rather than the entire year. Thus, Christmas contract cost segments have a median operating frequency of just 25 days per year, as compared to a median frequency of 256 days for regular contract cost segments.[9] Because annual miles depend upon frequency, median annual miles are also smaller for Christmas contract cost segments. Finally, the lower frequency for Christmas contract cost segments also causes their cubic foot-miles to be smaller. In contrast, Table 3 shows

[9] Medians are used as measures of central tendency instead of means, to avoid using measures distorted by a small number of extreme observations. Such observations have arisen in previous research on purchased highway transportation contract cost segments.

that median truck sizes are identical across the two types of contract cost segments at 3,180 cubic feet. It also shows that the median route length for Christmas contracts is generally similar, but a bit longer, for Christmas contract cost segments.

Table 3

Median Values for Inter SCF Transportation

Variable	Christmas Contract Cost Segments	Regular Contract Cost Segments
Annual Cost	$102,455	$363,161
Annual Miles	29,475	169,113
Operating Frequency	25	256
Vehicle Cube	3,180	3,180
Trip Length	500	297
Cubic Foot Miles	93,085,914	446,340,412

Review of regular and Christmas contracts for Intra SCF and NDC transportation reveals a pattern similar to the pattern found for Inter SCF transportation. Generally, Christmas contract cost segment annual costs and cubic foot-miles are smaller than regular transportation contract cost segments due to Christmas transportation running at much lower frequency. But the two types of contracts seem otherwise similar, with comparable values for vehicle size and route length.[10] In sum, the Christmas contract cost segments have the characteristics of smaller regular contract cost segments and share a similar structure with regular contract cost segments.

[10] The medians for all types of Christmas and their associated regular highway transportation contract cost segments are presented in USPS-RM2021-1-1.

The established model's functional form has already been applied to a wide range of contract cost segment sizes from small Intra City, local, contract cost segments to large, long-distance, Inter NDC contract cost segments. The specification has shown that it is sufficiently flexible to estimate variabilities for transportation types with many different characteristics: large and small annual costs, large and small vehicle sizes, and short and long route lengths. It also has the flexibility to estimate a range of variabilities, reflecting the cost-causing characteristics of each type of transportation. On balance, the evidence indicates that it is appropriate to apply the established econometric model to Christmas cost segments.

The established model's functional form is translog. This functional form has been adopted by the Commission in Dockets No. R87-1, R97-1, R2000-1 and RM2014-6:

$$\ln Cost_j = \beta_0 + \sum_{i=1}^{n} \delta_i D_i + \beta_1 \, ln\left(\frac{CFM_j}{\overline{CFM}}\right) + \beta_2 \, ln\left(\frac{CFM_j}{\overline{CFM}}\right)^2 + \beta_3 \, ln\left(\frac{RL_j}{\overline{RL}}\right)$$

$$+ \beta_4 \, ln\left(\frac{RL_j}{\overline{RL}}\right)^2 + \beta_5 \, ln\left(\frac{CFM_j}{\overline{CFM}}\right) ln\left(\frac{RL_j}{\overline{RL}}\right) + \varepsilon_j$$

In these equations, CFM stands for cubic foot-miles, RL stands for route length, the "j" indexes individual contract cost segments, the "bar" notation indicates a mean value, the "D_i" are categorical variables, representing the various Postal Service areas in force in FY 2019, ε is a stochastic error term, and the β and δ coefficients are parameters to be estimated.

Because each of the right-hand-side variables is divided by its mean before natural logs are taken, the equation is mean centered. Consequently, the estimated variability is just the coefficient, β_1, which is associated with the first-order term for cubic foot-miles. That this coefficient is the variability can be demonstrated by taking the partial derivative of the variability equation with respect to the cubic foot-miles and evaluating the derivative at the mean values for the right-hand-side variables. The evaluated partial derivative is given by:

$$\varepsilon_{Cost,CFM} = \frac{\partial \ln Cost_j}{\partial \ln CFM_j} = \beta_1 + 2\,\beta_2 \ln(\overline{CFM}) - 2\,\beta_2 \ln(\overline{CFM}) + \beta_5 (\ln(\overline{RL}) - \ln(\overline{RL})),$$

Cancellation of like terms shows that this derivative just equals β_1.

Also, previous research on estimating purchased highway transportation equations consistently demonstrated that, like many cross-sectional regressions, they suffer from heteroscedasticity. If not corrected, heteroscedasticity can cause the estimated standard errors to be misstated, rendering statistical hypothesis testing inaccurate.[11] For the Christmas transportation equations, the standard errors will be corrected to account for heteroscedasticity and all hypothesis tests will thus be performed using the corrected (heteroscedastic-consistent) standard errors. The corrected standard errors can be calculated with the formula for the ordinary least squares variances of the estimated coefficients, under heteroscedasticity:

[11] Heteroscedasticity is a condition in which the variance of the error term is not constant across the range of the data.

$$V(\beta) = \frac{\sum_{i=1}^{N}[(x_i - \bar{x})^2 \sigma_i^2]}{[\sum_{i=1}^{N}(x_i - \bar{x})^2]^2}.$$

Note that this formula depends upon the values for the heteroscedastic errors, the σ_i. However, these errors are unknown, so to derive the heteroscedastic-consistent variances, one replaces the unknown errors with their consistent estimates, and applies the squared residuals:[12]

$$V(\beta)_{HC} = \frac{\sum_{i=1}^{N}[(x_i - \bar{x})^2 e_i^2] \ / \ (N-K)}{[\sum_{i=1}^{N}(x_i - \bar{x})^2]^2 \ / \ N}.$$

The resulting heteroscedastic-consistent standard errors will be used for all hypothesis tests.

As in previous estimations of highway transportation variability equations, categorical or "dummy" variables will be included in the Christmas transportation equations to control for possible differences in transportation costs across geographic areas. As there is no *a priori* basis for choosing which categorical variables should be included in each equation, the estimation will start with all of them included in each equation. The categorical variables are not part of the formal translog specification and

[12] See, White, Halbert, 1980, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity."Econometrica, Vol. 48, No.4, 817-838

following the established methodology, only those categorical variables whose estimated coefficients are statistically significant will be included in the final equation.

Table 4 presents descriptive statistics for the Christmas transportation account categories, by transportation type. Intra SCF Christmas transportation is split between van transportation and tractor trailer transportation. There are 420 van contract cost segments and 504 tractor trailer cost segments, so a sufficient number of cost segments exist for each transportation subtype to support estimation of separate equations. Separate van and tractor trailer equations will thus be estimated for Intra SCF Christmas transportation.

There are only six Inter SCF Christmas contract cost segments that use vans, so it is not possible to estimate separate equations by transportation subtype for that account category. A single equation will be estimated, but a categorical variable for van cost segments will be included to allow for different cost levels for that type of transportation. The same is true for NDC Christmas transportation, in which there are only 15 van contract cost segments. In fact, given that there are only 30 Inter NDC Christmas contract cost segments, it is not clear that separate equations for Intra NDC Christmas and Inter NDC Christmas transportation can be reliably estimated. A combined equation would have 91 observations and will thus be estimated, but its results will be checked against results from estimating separate equations. In sum, there will be four initial Christmas transportation equations estimated, Intra SCF van, Intra SCF tractor trailer, Inter SCF, and NDC.

Table 4

Descriptive Statistics for Christmas Highway Transportation Categories

Account Category	Type	# of Observations	Median Annual Cost	Median Route Length	Median Cube
Intra SCF	Van	420	$4,214	48.7	1,200
Intra SCF	TT	504	$16,459	75.8	3,180
Inter SCF	Van	6	$2,364	106.8	1,200
Inter SCF	TT	539	$103,707	501.0	3,180
Intra NDC	Van	15	$6,971	54.1	1,200
Intra NDC	TT	46	$15,199	120.5	3,180
Inter NDC	TT	30	$123,780	795.9	3,180

2. Results

Table 5 presents the initial estimation results.[13] All the equations fit well with R^2 statistics above ninety percent. The coefficients on the log of cubic foot-miles are well estimated, with high values for their heteroscedastic-consistent t-statistics. That is an important result, because in the mean centered equation, that coefficient determines the variability. The primary variability result is that all of the estimated variabilities are in the ninety percent range. This is not unusual for longer-distance tractor trailer variabilities, but is a bit surprising for the van variabilities which, for regular transportation, have been

[13] Complete results for each equation along with the associated programs and program listings can be found in USPS-RM2021-1-1.

in the sixty to seventy percent range. The higher variabilities for van transportation likely reflect the short-term characteristic of Christmas transportation, in that adding and subtracting trips is the primary way of adjusting capacity.

Table 5
Initial Estimates of Christmas Purchased Highway Transportation Variabilities

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
Intra SCF	Van	0.935	29.34	0.906	420
Intra SCF	TT	0.914	25.51	0.920	504
Inter SCF	Both	0.921	28.94	0.944	545
Intra and Inter NDC	Both	0.992	20.58	0.948	91

It has long been recognized that regular highway transportation equations have been subject to undue influence from a small number of extreme observations. These observations are atypical or erroneous, and have the potential for distorting the variability estimation. Given the similarities between Christmas and regular contract cost segments, it is prudent to investigate whether the Christmas variability equations are also affected. In Docket No. RM2014-6, the Postal Service proposed, and the Commission accepted, a method for identifying unduly influential data points:[14]

[14] See, Postal Regulatory Commission, Order No. 2180, Docket No. RM2014-6, September 10, 2014, at 15.

> The Postal Service has sufficiently described its method of identifying and removing outliers. The Postal Service's method of setting the Cook's D threshold for removing an observation equal to 0.1 is reasonable. A review of the SAS Log shows that of the 786 observations meeting the values that are often considered potential influential outliers (4 divided by the number of observations); only 80, or 10.2 percent, were removed by setting the threshold at 0.1. Overall, only 0.5 percent of initial observations were excluded. (Footnote omitted)

That an observation appears atypical is not enough justification, by itself, for removing it from the regression data set. Instead, one needs to identify observations that are not only far away from the regression line but also have the potential for influencing the estimated regression coefficients.[15] This can be done in two steps. First, one can calculate the Studentized Residual for each observation in the dataset to find any observations which are far from the regression line. Second, one can calculate a measure of leverage for each observation, to determine its potential to influence the regression line. To ensure that a particular observation meets both of these criteria, it is useful to have statistic that combines both the Studentized residual and leverage. The Cook's Distance (or "D") statistic does just that:

$$D_i = \frac{\sum_{j=1}^{n}\left(\hat{Y}_{j(i)} - \hat{Y}_j\right)^2}{p\hat{\sigma}^2}$$

[15] For a more complete explanation of how to identify unduly influential observations through the use of Cook's D statistic, see Report on Updating the Cost-to-Capacity Variabilities for Purchased Highway Transportation, USPS-RM2014-6/1, June 20, 2014 at 18-24.

The numerator of Cook's D is the squared difference in predicted values from omitting the observation and the denominator is the scaled variance of the residuals.

In establishing the use of Cook's D statistic with a cutoff of 0.10 as the appropriate metric to find anomalous observations, the Commission also specified that any omitted observations should be closely reviewed and identified as to the reason for the undue influence:[16]

> The Postal Service should describe the nature of excluded observations when it uses this method, as it did in the case of excluded Inter-Cluster tractor-trailer observations. *See* Postal Service Reply Comments, at 7 n. 9. By categorizing excluded observations according to the number or percent falling into the relevant "unusual categories," such as extremely high or low costs, mileage, or cubic foot miles, the unusual nature of excluded observations would be immediately obvious, and the additional effort would be minimal.

To identify anomalous and unduly influential observations, Cook's D statistic, with a cutoff of 0.10, will be again used. In addition, each omitted observation will be classified as to the relevant category, such as extremely low annual cost or extremely high route length, into which it falls.

Application of the Cook's D statistic to the Christmas transportation equations identified four unduly influential observations for the Intra SCF van equation, three for the Intra SCF tractor trailer equation, two for the Inter SCF equation and three for the NDC equation. This means that a total of 14 observations were identified for removal, out of a total of 1,560 observations, or less than one percent. So, the Cook's D approach is again parsimonious, as it was in Docket No. RM2014-6.

[16] See, Postal Regulatory Commission, Order No. 2180, Docket No. RM2014-6, September 10, 2014, at 15.

Table 6 presents the values for the relevant variables for the four anomalous observations identified in the Christmas Intra SCF van dataset. Review of those values provides the classifications for why each of the observations are anomalous. The observation for contract 92337, cost segment B has an extremely small annual cost of just $21.30, dramatically below the median annual cost of over $4,000. It also has very low annual miles of less than 50, when the median value is over 1,600 miles. Finally, it has a reported route length of just 6 miles. In contrast, contract 570BA, cost segment E has a very high cost (over seven times the median value) despite having cubic foot-miles close to the median value, meaning it has an unrealistic cost per cubic foot-mile. The observation for contract 023N0, cost segment B appears to be a misclassified regular highway contract cost segment as it has annual frequency is 303.1 days, which is not possible for peak seasonal transportation. Contract 83366, cost segment B has an extremely low annual cost of just $126, and dramatically small reported annual miles and cubic foot-miles.

Table 6
Anomalous Observations for the Intra SCF Van Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM	Route Length	Frequency
92337	B	$21.30	48.8	80,520	6.1	4.0
570BA	E	$30,320.30	1,482.0	1,778,400	1.7	25.0
023N0	B	$8,620.90	36,701.8	44,042,132	30.3	303.1
83366	B	$126.00	72.0	8,640	9.0	4.0
Median		**$4,214.20**	**1,616.0**	**1,904,080**	**48.7**	**15.0**

Table 7 presents the values for the three anomalous observations from the Christmas Intra SCF tractor trailer dataset. The first observation, for contract 841DD, cost segment B, has an extremely high annual cost for a cost segment with near a median value for cubic foot-miles. It also has an anomalous route length of just 2 miles. The observation for contract 841L0, cost segment E, has an annual cost that is nearly twice the median annual cost despite having extremely small cubic foot-miles and route length. Finally, the observation for contract 980RH, cost segment A, has an annual cost that is 19 times the median annual costs, while having an extremely small value for both cubic foot-miles and route length.

Table 7
Anomalous Observations for the Intra SCF Tractor Trailer Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM	Route Length	Frequency
841DD	B	$64,298.80	3,909	12,431,256	2.0	26.1
841L0	E	$30,002.40	24	76,320	0.5	6.0
980RH	A	$316,449.60	314	360,000	1.0	30.0
Median		**$16,458.70**	**4,515**	**12,968,432**	**75.8**	**20.2**

The values for the anomalous observations from the Inter SCF Christmas dataset are presented in Table 8. The first observation, for contract 900CH, cost segment B has annual miles, cubic foot-miles, and a route length that are small fractions (one to two percent) of the median values for those variables, but an annual cost that is twenty percent of the median value. The annual cost of nearly $21,000 is associated with a reported value for annual miles of just over 300, implying an unrealistic cost per mile. The observation for contract 207AE, cost segment C presents even more of a mismatch between cost and cubic foot-miles, as it has an annual cost above the median value, but a cubic foot-miles value that is less than one percent of the median value. The final two observations are also clearly anomalous. Contract 144EZ, cost segment B has an annual cost of just one cent for a single annual mile. Contract 450VZ, cost segment C also has a single annual mile, with a one-mile route length but a cost of over $3,000. Neither cost segment contains realistic values for Inter SCF Christmas transportation.

Table 8
Anomalous Observations for the Inter SCF Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM	Route Length	Frequency
900CH	B	$20,995.15	312	992,160	13.0	12.0
207AE	C	$111,370.58	215	682,428	3.7	29.0
144EZ	B	$0.01	1	3,180	1.0	1.0
450VZ	C	$3,527.78	1	3,180	1.0	1.0
Median		**$102,455.48**	**29,475**	**93,085,914**	**500.0**	**25.0**

Lastly, the anomalous observations for NDC transportation are presented in Table 9. All three observations share the same pattern of unusual values and two of them are different cost segments from the same contract, 320L4. All three contract cost segments report an annual cost which is in the range of 5 to 7 times the median annual cost, but annual miles, cubic foot-miles, and route length that are just fractions of their respective median values.

Table 9
Anomalous Observations for the NDC Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM	Route Length	Frequency
48391	B	$106,038.60	1,508	4,795,440	11.6	26.0
320L4	R	$150,273.10	2,088	6,639,840	24.0	29.0
320L4	S	$147,897.50	2,016	6,410,880	24.0	28.0
Median		**$21,819.20**	**5,194**	**16,020,000**	**161.9**	**19.3**

After this identification process was completed, the anomalous observations were removed from the individual data sets and the four variability equations were re-estimated. The results of that re-estimation, which reflect the removal of the anomalous observations, are presented in Table 10. The table shows the final cost-to-capacity variabilities, heteroscedastic t-statistics for the log CFM term, equation R^2 statistics, and numbers of observations for the four equations. It also shows how those values changed from the preliminary results.[17]

Removal of the small number of unduly influential observations has several effects. First, in all four cases, the model fit improves, as indicated by a higher R^2 statistic. In addition, the heteroscedasticity corrected t-statistics for the coefficient on log cubic foot-miles are all substantially higher in the re-estimation, indicating that it produces a more precise estimation of the variability. Finally, as a result of the removal of the anomalous observations, all four estimated variabilities have coalesced into a tight, one-percentage-point range between 95.3 and 96.4 percent. The Intra SCF van,

[17] Complete results for each equation along with the associated programs and program listings can be found in USPS-RM2021-1-1.

Inter SCF, and NDC variabilities are nearly identical and the Intra SCF tractor trailer variability is quite close.

Table 10
Final Estimates of Christmas Purchased Highway Transportation Variabilities

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
Intra SCF	Van	0.953	47.98	0.926	416
Intra SCF	TT	0.964	44.15	0.935	501
Inter SCF	Both	0.953	49.30	0.979	541
Intra and Inter NDC	Both	0.952	28.53	0.984	88

Differences from Initial Estimates

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
Intra SCF	Van	0.018	18.64	0.020	-4
Intra SCF	TT	0.051	18.64	0.015	-3
Inter SCF	Both	0.032	20.36	0.035	-4
Intra and Inter NDC	Both	-0.040	7.95	0.036	-3

Because of a limited number of observations, a single equation was estimated for both Intra NDC and Inter NDC Christmas contract cost segments. With only 30 observations, the estimation of the Christmas Inter NDC equation is particularly problematic. However, past research has shown both the Intra NDC and Inter NDC equations to be stable with annual costs closely driven by annual cubic foot-miles. This raises the possibility of estimating separate NDC equations on limited data when it would be otherwise inappropriate. To check if combining the two accounts into one is producing a distortionary result, separate equations were estimated for Christmas Intra NDC and Christmas Inter NDC contract cost segments. After removing the relevant anomalous observations, there were 56 observations available for estimating the Intra NDC equation and that equation produced a variability of 0.9696.[18] There were just 27 observations available for estimating the Inter-NDC equation and it produced a variability of 0.9276.

The results can be compared with the variability from the combined equation to assess the impact of combining data from the two accounts. In doing so, one must account for the fact that the accrued costs in the Christmas Inter NDC account are much larger than the accrued costs in the Christmas Intra NDC account. Under the established methodology for combining variabilities, the joint variability resulting from the two individual variabilities is calculated by multiplying each variability by its respective TCSS cost.[19] The resulting combined variability is 93.6 percent. This is close to, but a bit below, the variability estimated from the combined equation of 95.2 percent. This result suggests that no distortion is created by using the variability from the equation estimated on both Intra NDC Christmas and Inter NDC Christmas cost segments. Because it is based upon a larger number of observations, it is preferred.

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[18] The complete econometric results for separate Christmas Intra NDC and Christmas Inter NDC equations are provided in USPS-RM2021-1-1.

[19] For an explanation of the established methodology, see, Direct Testimony of Michael D. Bradley on Behalf of the United States Postal Service, USPS-T-18, Docket No. R2000-1, January 12, 2000 at 62.

C. Capacity to Volume Variability

In Docket No. RM2016-12, the Postal Service proposed, and the Commission approved, a methodology for estimating the variability of purchased highway transportation capacity with respect to volume.[20] The approved methodology used TRACS time series data to measure the relationship between highway transportation capacity and transported volume.

However, Christmas contracts were not included in the TRACS sampling frame, so separate capacity-to-volume variability equations could not be estimated for this type of highway transportation. Because of the unavailability of these data, the Commission determined that, pending future research, the capacity-to-volume variabilities for Christmas contracts should remain at 100 percent.[21] To date, TRACS data are not available for estimating capacity-to-volume variabilities for Christmas contracts, so the assumed variability of 100 percent will be maintained for this analysis.

D. Overall Variabilities and Impact

The overall Christmas highway transportation variabilities are the products of their cost-to-capacity variabilities and their capacity-to-volume variabilities. There are three groups of Christmas contract cost segments for which overall variabilities need to be calculated, Intra SCF, Inter SCF, and NDC. Because a single equation was estimated for the Inter SCF and NDC groups, those cost-to-capacity variabilities are

[20] See, Petition of the United States Postal Service for the Initiation of a Proceeding to Consider Proposed Changes in Analytical Principles (Proposal Four), Docket No. RM2016-12, August 22, 2016 and Postal Regulatory Commission, Order No. 3973, Docket No. RM2016-12, June 22, 2017, at 2.

[21] See, Postal Regulatory Commission, Order No. 3973, Docket No. RM2016-12, June 22, 2017, at 19.

ready for inclusion in calculating the overall variabilities. There are two equations and thus two variabilities for the Intra SCF group: one for van transportation and one for tractor trailer transportation. The Christmas highway transportation accrued cost accounts are similar to the regular highway transportation accounts, in that there are no separate accrued cost accounts for van and tractor trailer transportation. Consequently, in both cases, the separate variabilities must be combined into a single variability before being applied to accrued costs.

Calculation of the Christmas Intra SCF variability will follow the established methodology of using the relative costs from TCSS to form the proportions needed to calculate the overall variability. Based upon the two sets of costs and variabilities presented in Table 11, the cost-to-capacity variability for Christmas Intra SCF transportation is 96.3 percent.

Table 11
Calculating the Variability for Christmas Intra SCF Costs

Account	**Type**	**Cost**	**Proportion**	**Variability**
Intra SCF	Van	$4,302,856	11.94%	95.3%
	TT	$31,739,207	88.06%	96.4%

Although the overall Christmas transportation variabilities are the products of their cost-to-capacity variabilities and their capacity-to-volume variabilities, they end up being equal to the cost-to-capacity variabilities because the capacity-to-volume variabilities are all equal to 100 percent. The overall variabilities are presented in Table 12.

Table 12

Overall Variabilities for Christmas Transportation

Transportation Group	Cost to Capacity Variability	Capacity to Volume Variability	Overall Variability
Christmas Intra SCF	96.3%	100.0%	96.3%
Christmas Inter SCF	95.3%	100.0%	95.3%
Christmas NDC	95.2%	100.0%	95.2%

The current overall Christmas transportation variabilities are borrowed from their corresponding regular transportation accounts. Because in all cases, the new estimated Christmas variabilities are above the corresponding regular variabilities, the proposed new variabilities will lead to higher volume variable costs. Across the three types of Christmas account groups, the new variabilities increase volume variable cost by $35.2 million. In addition, the higher Christmas variabilities increase the variabilities applied to indirect costs such as transporting empty equipment and Alaska non-pref air transportation. These indirect effects of the new Christmas variabilities increase volume variable transportation costs by an additional $1.25 million, for a total increase of $36.5 million.

Table 13
Direct Impact of the New Christmas Variabilities

Transportation Group	FY 2019 Accrued Cost	Current Variabilities	Current Volume Variable Cost	Proposed Variabilities	Proposed Volume Variable Cost	Change in Volume Variable Cost
Christmas Intra SCF	$66,131	65.5%	$43,347	96.3%	$63,678	$20,331
Christmas Inter SCF	$203,837	88.9%	$181,192	95.3%	$194,257	$13,065
Christmas NDC	$15,649	83.7%	$13,094	95.2%	$14,904	$1,810
Christmas Total	$285,618	83.2%	$237,633	95.5%	$272,839	$35,206

III. Dynamic Route Optimization Variabilities

A. Background

In Fiscal Year 2018, the Postal Service began replacing traditional Intra P&DC highway contracts with a new type of transportation contract at a substantial number of sites. These new contracts, called Dynamic Route Optimization (DRO) contracts, have important differences from the traditional purchased highway transportation contracts. First, unlike regular contracts, DRO contracts do not have fixed routes. The routes travelled and number of stops made by a truck can change, depending upon the dynamics of volume flows. DRO contracts can experience varying departure times, lines of travel, and types of mail transported. Second, DRO contracts do not have fixed annual contract awards, but rather are paid on a per-mile rate. The per-mile rate is the same for all trips within a given contract cost segment.

In addition, the accrued costs of DRO contracts have risen substantially in a short period of time. In FY 2018, the Postal Service incurred $140 million in DRO transportation costs, but in FY 2019, that amount increased to $391 million. Because DRO contracts have important differences from regular contracts, and the cost for DRO contracts has become material, it is appropriate to investigate whether DRO contracts have a variability that is similar to traditional contracts. The differences between DRO contracts and traditional contracts have important implications for the nature of cost incurrence for DRO transportation, and for the associated variability of cost with respect to capacity.

B. The Cost-to-Capacity Variability

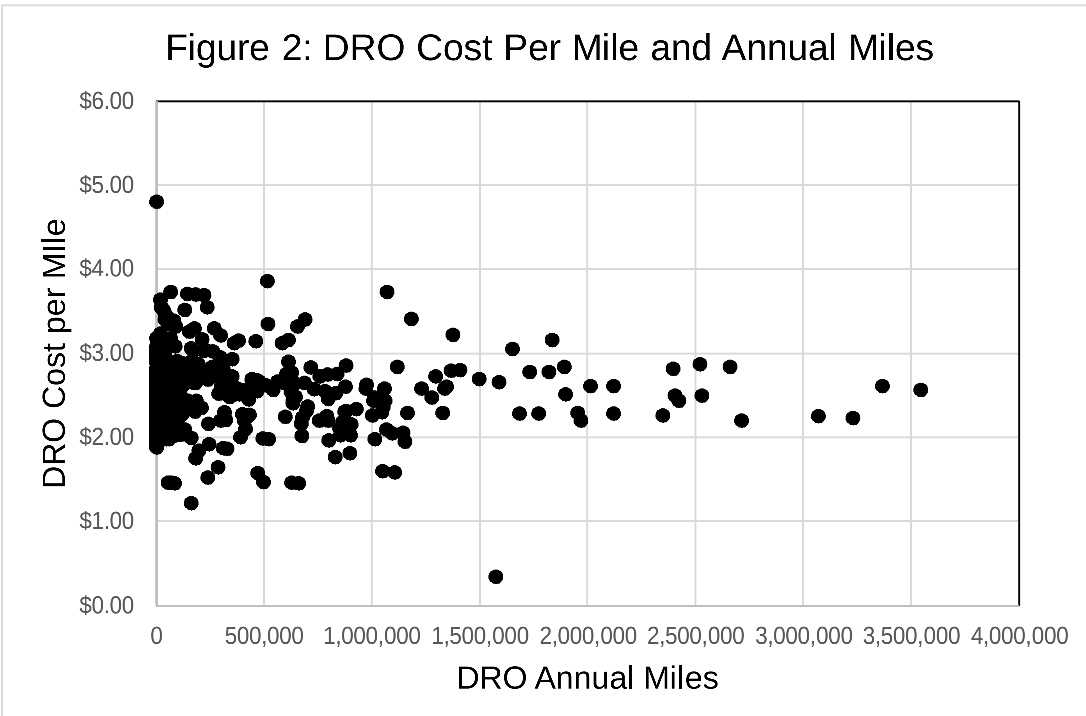
The differences between DRO contracts and traditional highway contracts have two primary implications for cost incurrence. First, the adjustment mechanisms that take place on traditional fixed price contracts in response to capacity changes are not in play for DRO contracts. When capacity needs change on a DRO contract, the Postal Service does not change truck sizes, annual trip frequencies, or routings. It just uses more or less of the contracted transportation. Next, DRO contracts are not subject to a traditional distance taper like regular highway contracts, because each contract cost segment pays the same rate per mile, regardless of how far a trip actually travels. DRO contracts do not have fixed routes, so the concept of route length is not part of their specification.

These differences in contract structure also seem likely to affect the way costs respond to capacity changes. When the need for transportation capacity changes in the DRO contract structure, the Postal Service can either: (1) change the cubic foot-miles it uses within existing DRO contracts, or (2) change the number of contracts it has in force. If the Postal Service changes the cubic foot-miles it uses within a contract cost segment, DRO transportation cost should change proportionately. The vehicle size is set by contract, so the Postal Service changes the cubic foot-miles of capacity, on a given contract cost segment, by changing the number of miles traveled. On an individual DRO contract cost segment, the rate per mile is constant, so a given percentage change in capacity should lead to the same percentage change in cost. This suggests proportionality of cost and capacity within individual contracts.

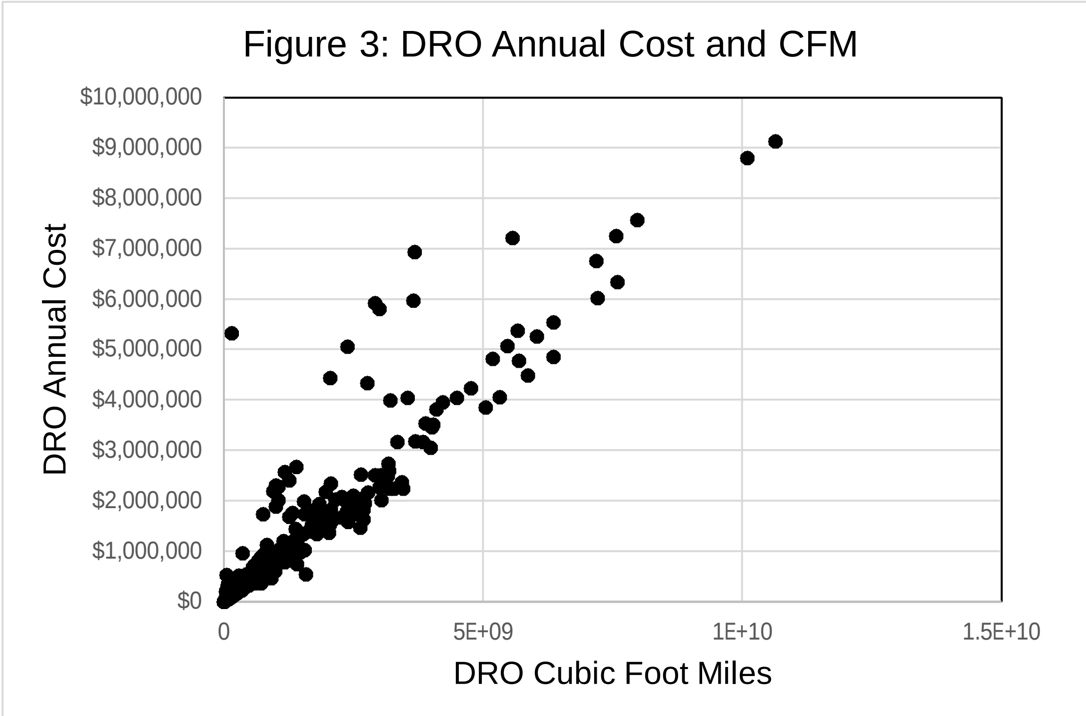
However, The Postal Service can also add or subtract contracts. In this instance, the degree to which DRO contract costs respond to capacity changes depends upon whether the rates per mile depend upon contract size. For example, if larger contracts (in terms of miles or cubic foot-miles) tend to have lower costs per mile, then costs will vary less than proportionately with capacity. In contrast, in an adjustment scenario in which rate per mile does not depend upon contract size, then one would also expect costs to vary approximately proportional to capacity, as changes in capacity would not affect the costs of acquiring that capacity.

The presumption of proportionality will be tested formally by estimating a cost-to-capacity variability for DRO contract cost segments. But insight can be gained by examining plots of how DRO cost per mile varies with contract size, as measured by either annual miles or cubic foot-miles.

Figure 2 presents a cross plot of cost per mile and the corresponding annual miles for the DRO contract cost segments. The cross plot shows no indication of a change in the cost per mile as a result of change in contract size, as measured by annual mile. While the plot does not provide formal evidence of proportionality, such a plot is consistent with the proportionality between annual cost and annual cubic foot-miles.



This intuition is reinforced by examination of the plot of DRO contract cost segment annual cost against the corresponding cubic foot-miles, as is done in Figure 3. The plot shows a tight relationship between the two variables, which is consistent with proportionality between the two.



1. Model Specification

Unlike Christmas highway contracts, which are quite similar to regular highway contracts, DRO contracts have important differences from regular highway contracts. For the purpose of specifying a variability equation, the important difference between the two types of contracts is the fact that DRO contracts do not have regular routes and the lines of travel for trucks can change over time. This means that DRO contracts do not have a fixed route length and are not subject to the same distance taper effect that occurs for regular highway contracts. That being the case, the established translog specification for econometric modeling of regular highway transportation is not applicable to DRO contracts. Instead, the costs of DRO contracts are based solely on the cubic foot-miles of transportation purchased and not on the length of a pre-specified route. The econometric model for DRO contracts thus should not include a route length variable and should only include a cubic foot-miles variable.

This point is reinforced by the fact that DRO contract cost segments do not record meaningful data for the route length variable. In fact, over half of DRO contract cost segments list a value of 99,999.99 for the route length variable, indicating that it is a meaningless variable for that type of contract.

The appropriate specification for the econometric model for DRO contracts is therefore simpler than the established model for regular transportation contracts as it includes only cubic foot-miles as a cost driver:

$$\ln Cost_j = \gamma_0 + \sum_{i=1}^{n} \delta_i D_i + \beta\gamma_1 \, ln\left(\frac{CFM_j}{\overline{\overline{CFM}}}\right) + \gamma_2 \, ln\left(\frac{CFM_j}{\overline{\overline{CFM}}}\right)^2 + \varepsilon_j.$$

Like other highway transportation equations, the DRO equation is likely to suffer from heteroscedasticity, so the standard errors for the model will be corrected to account for heteroscedasticity and all hypothesis tests will thus be performed using the corrected (heteroscedastic-consistent) standard errors. Dummy variables will also be included to account for possible differences in regional costs.

Table 14 shows that DRO transportation is primarily tractor trailer with just over ninety percent of the contract cost segments having that type of transportation, reducing the likelihood that separate van and tractor trailer contracts can be successfully estimated. But because the total number of DRO contract cost segments is over 450, there are enough van contract cost segments to consider the possibility of estimating separate van and tractor trailer variability equations. Investigating separate equations is motivated, in part, by the fact that there are some large contract cost segments in the van category. However, there may be an insufficient number of observations to estimate a separate DRO van variability, so a combined equation will also be estimated.

Table 14
Descriptive Statistics for DRO Highway Transportation Categories

Account Category	Type	# of Observations	Median Annual Cost	Median Cube
DRO	Van	43	$920,169	1,200
DRO	TT	410	$179,472	3,000

2. Results

As mentioned above, it is not clear that a separate equation for DRO van transportation can be accurately estimated. Consequently, estimation of three DRO variability equations will be attempted, one for van transportation, one for tractor trailer transportation, and one for both types of transportation. The combined equation will include a categorical variable for van contract cost segments, to account for any non-CFM-related variations in cost across the two types of contract cost segments.

Table 15 presents the initial results of estimating the three equations.[22] All three equations fit the data well and the important log of CFM term is statistically significant in all cases. Given the expectation of proportionality between cost and cubic foot-miles,

[22] Complete results for each equation along with the associated programs and program listings can be found in USPS-RM2021-1-1.

the van variability seems low, but that could reflect the relatively few observations available for its estimation, as well as the potential impact of anomalous observations. The tractor trailer equation has a variability close to one, as does the combined equation. The dummy variable for van transportation is positive and significant in the combined equation, signaling that van transportation tends to have a higher cost per cubic foot-mile than tractor trailer transportation.

Table 15
Initial Estimates of DRO Highway Transportation Variabilities

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
DRO	Van	0.869	14.79	0.959	43
DRO	TT	0.983	71.16	0.993	410
DRO	Both	0.979	71.96	0.992	453

As with the Christmas transportation equations, Cook's D statistic was used to identify anomalous and unduly influential observations for the DRO equations. Table 16 presents the values for the various variables for the two anomalous observations from the DRO Van dataset. Review of those values provides the basis for identifying why each one is anomalous.

Table 16
Anomalous Observations for the DRO Van Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM
954L2	A	$547,913	1,574,464	1,574,464,000
798AA	B	$481	100	120,000
Median		**$920,169**	**627,360**	**752,832,000**

The observation for contract 954L2, cost segment A has a level of cubic foot-miles that is 2.5 times the median, but its annual cost is just 60 percent of the median. This disconnect between cubic foot-miles and cost creates an unrealistically low cost per cubic foot-mile. The observation for contract 798AA, cost segment B is unusual because of its extremely small size. It reports just 100 annual miles as compared to the median value of 627,000 miles and an annual cost of just $481.

Table 17 presents the values for the relevant variables for the two anomalous observations from the DRO tractor trailer dataset. Review of those values shows them both to be highly unusual.

Table 17
Anomalous Observations for the DRO Tractor Trailer Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM
793L1	G	$533,462	16,080	48,240,000
250Q8	A	$5,325,565	2,346,990	149,435,514
Median		**$179,472**	**67,904**	**201,487,500**

The observation for contract 793L1, cost segment G has both annual miles and cubic foot-miles which are less than a quarter of the median, but a cost which is nearly three times the median cost. Together these values imply a cost per mile and cubic foot-mile that are unrealistic. For example, the implied cost per mile is $33.18. The observation for contract 250Q8, cost segment A has a very large value for annual cost of over $5,000,000. This places its value for annual cost at over 29 times as large as the median annual cost for tractor trailer contract cost segments. Yet, its value for cubic foot-miles is only three-quarters of the median cubic foot-miles for the transportation type. This mismatch implies unrealistic values for cost per cubic foot-mile.

A combined equation based upon the contract cost segments from both types of transportation was also estimated. Cook's D identified three anomalous observations for that equation, from contract 793L1, cost segment G, contract 954L2, cost segment A, and contract 250Q8, cost segment A. Review of tables 16 and 17 shows that all three of these observations were examined and discussed in the analyses of van and tractor trailer transportation and no further discussion of them is necessary.

The revised results, which reflect the removal of the anomalous observations are presented in Table 18. The table shows the revised cost-to-capacity variabilities, heteroscedastic t-statistics for the log CFM terms, the R^2 statistics for the revised equations, and the new numbers of observations. It also shows how those values changed from the preliminary ones.

Table 18
Revised Estimates of DRO Highway Transportation Variabilities

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
DRO	Van	0.946	20.74	0.949	41
DRO	TT	0.999	140.49	0.998	408
DRO	Both	0.994	118.3	0.997	450

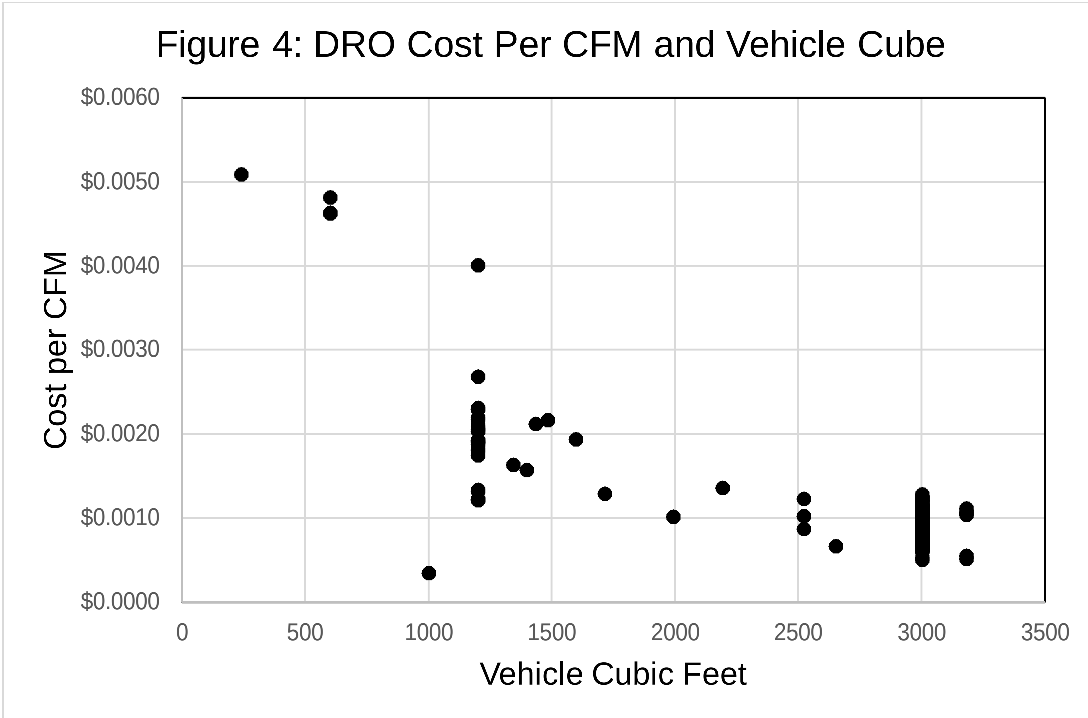
Differences from Initial Estimates

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
DRO	Van	0.077	5.95	-0.009	-2
DRO	TT	0.015	69.33	0.005	-2
DRO	Both	0.015	46.34	0.005	-3

Table 18 shows that the estimated variabilities for both the tractor trailer equation and combined equation are quite close to one hundred percent, as expected. The tractor trailer variability is 99.9 percent and the combined variability is 99.4 percent. The variability for the van equation, while high, is not quite at the 100 percent level, and is about 5 percentage points lower than the variabilities from the other two equations.

Further examination of the van data revealed the source of the lower than expected variability. Investigation of the pattern of relationship between cost per cubic foot-mile and vehicle cube, as shown in Figure 4, reveals there are a small number of van contract cost segments with very small vehicle cube (240 to 600 cubic feet). These observations also have unusually high cost per cubic foot-mile.

Taken together, this suggests that they form a somewhat separate subset of van transportation contract cost segments; a subset that appears to have a different cost structure than the balance of the van transportation cost segments. Not controlling for this difference in structure could be the cause of the lower estimated variability for van transportation, particularly because there are so few observations available for its estimation.



To test this possibility, a dummy variable for any contract cost segment with a vehicle cube less than 1000 cubic feet was inserted into both the van and combined equations and they were re-estimated.[23] In the van equation, the dummy variable for the small vehicle cube contract cost segments is positive and significant, indicating that these cost segments have higher cost per cubic foot-mile than the other van cost segments for the same level of cubic foot-miles. Controlling for this structural difference increases the van variability from 94.6 percent to 98.0 percent.[24] Including the same

[23] The impact of this small subset of observations on the combined variability is likely to be far smaller than its impact on the van variability, because there are so many more observations available for estimating the combined variability equation.

[24] As with the other econometric equations, the complete results for each equation, along with the associated programs and program listings can be found in USPS-RM2021-1-1.

dummy variable in the combined equation slightly increases that variability from 99.4 percent to 100.3 percent.

Table 19
Final Estimates of Two Types of DRO Highway Transportation Variabilities

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R2	# of Obs.
DRO	Van	0.980	30.22	0.985	41
DRO	Both	1.003	141.92	0.998	450

The estimation of both individual van and tractor trailer equations, and the combined equation, raises the question of which variability to apply to accrued DRO costs, the two-equation variability or the combined-equation variability. It turns out that there is little choice. Because the overwhelming majority of DRO transportation is tractor trailer, the two-equation variability is dominated by the tractor trailer variability and takes on a value of 99.5 percent. The combined variability is 100 percent. Given that the structure of DRO contracts is such that one would expect them to have 100 percent variability, and given the empirical evidence supports that presumption, a cost-to-capacity variability of 100 percent will be applied to DRO transportation.

C. The Capacity-to-Volume Variability

The approved methodology for estimating capacity-to-volume variabilities is based upon using a time series of TRACS data to estimate the relationship between capacity and volume. DRO contracts are relatively new, and the Postal Service has just started the process of collecting TRACS data on their volumes, so there is not yet sufficient data to estimate a separate capacity-to-volume variability equation for DRO transportation. Until such data are available, a proxy variability must be selected.

As explained above, DRO contracts replace standard Intra P&DC contracts. In other words, they serve the same type of facilities that are served by regular Intra P&DC contracts. Consequently, their costs are included in the set of accounts that comprise Intra SCF accrued costs. The best proxy, therefore, is the Intra SCF capacity-to-volume variability of 0.773.[25]

D. Overall Variability and Impact

The overall variability for DRO transportation is the product of the cost-to-capacity variability of 1.0 and the capacity-to-volume variability of 0.773. The overall variability is thus 0.773. Because DRO contracts fall within the Intra SCF group, the current variability applied to DRO contracts is the broad Intra SCF variability of 0.497. Application of the new variability will thus increase attributable cost.

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[25] This is a different situation than choosing a capacity-to-volume variability for Christmas or emergency contracts. In those cases, data for the type of transportation was not included in the variability estimation. In the case of DRO transportation, the volumes and capacities for the type of transportation DRO contracts provide were included in the estimation of the Intra-SCF cost-to-capacity variability. Moreover, the granularity of TRACS data does not support estimating separate capacity-to-volume variabilities for the individual accounts, such as Intra P&DC or Intra District, with the Intra SCF group. Finally, DRO contracts are currently receiving the Intra-SCF capacity-to-volume variability.

Table 20
Direct Impact of the New DRO Variability

Transportation Group	FY 2019 Accrued Cost	Current Variability	Current Volume Variable Cost	Proposed Variability	Proposed Volume Variable Cost	Change in Volume Variable Cost
DRO	$391,401	49.7%	$194,460	77.3%	$302,436	$107,975

The higher DRO variability leads to an additional $108 million in direct attributable cost. There is also an additional $3 million in attributable cost that comes through the higher DRO variability's contribution to variability applied to accounts like empty equipment and van damage. The $111 million dollar increase represents a 3.8 percent increase in volume variable highway transportation costs.

IV. Updating Intra P&DC Variability

A. Background

As explained in the previous section, Dynamic Route Optimization contracts have been replacing traditional fixed route Intra P&DC contracts. The introduction of DRO contracts has materially shifted transportation out of the regular Intra P&DC transportation account and into the DRO account. Between Fiscal Year 2014 and Fiscal Year 2019, Intra SCF transportation costs grew by 21.2 percent, but Intra P&DC transportation costs fell by 15.8 percent. Yet the combined Intra P&DC and DRO costs increased by 18.8 percent.

Table 21
Changes in Accrued Costs in Intra SCF Transportation

	FY 2014		**FY 2019**		**Change**	
	Accrued Cost	Proportion	Accrued Cost	Proportion	Accrued Cost	Percentage
Intra P&DC Regular	$1,130,613	68.16%	$951,652	47.34%	-$178,961	-15.83%
Intra CSD Regular	$425,803	25.67%	$518,719	25.80%	$92,916	21.82%
Emer. & Excep.	$86,642	5.22%	$82,267	4.09%	-$4,375	-5.05%
Christmas	$15,775	0.95%	$66,131	3.29%	$50,356	319.22%
DRO	$0	0.00%	$391,401	19.47%	$391,401	N/A
Total	**$1,658,833**	**100.00%**	**2,010,170**	**100.00%**	**$351,337**	**21.18%**

The characteristics of transportation removed from Intra P&DC account may not be the same as the characteristics of transportation that remains in the account. This raises the possibility that the variability of the remaining Intra P&DC transportation may differ from the currently estimated value. Thus, it bears investigation as to whether or not removal of the transportation that went into DRO contracts has had an impact on the variability for the remaining Intra P&DC transportation.[26]

B. The Cost-to-Capacity Variability

Intra P&DC contracts provide transportation of mail between a processing and distribution center and its stations and branches, and other mail points, like airports, within the P&DC's service area. When an Intra P&DC contract cost segment provides service within an individual city, it is designated as an Intra-City contract. Otherwise, Intra P&DC transportation is split between van transportation and tractor trailer

[26] A small part (about 1.5 percent) of Intra P&DC costs are for box route contracts. This type of service was not affected by the introduction of DRO contracts and will not be analyzed.

transportation. As a result, there are three variability equations to be estimated for Intra P&DC transportation, Intra City, Intra P&DC van, and Intra P&DC tractor trailer.

1. Model Specification

Because this estimation exercise is a re-estimation of an existing set of established models, model specification is straightforward. The established translog model, in both cubic foot-miles and route length, will be estimated for all three sets of contract cost segments:

$$\ln Cost_j = \beta_0 + \sum_{i=1}^{n} \delta_i D_i + \beta_1 \ln\left(\frac{CFM_j}{\overline{\overline{CFM}}}\right) + \beta_2 \ln\left(\frac{CFM_j}{\overline{\overline{CFM}}}\right)^2 + \beta_3 \ln\left(\frac{RL_j}{\overline{\overline{RL}}}\right)$$

$$+ \beta_4 \ln\left(\frac{RL_j}{\overline{\overline{RL}}}\right)^2 + \beta_5 \ln\left(\frac{CFM_j}{\overline{\overline{CFM}}}\right) \ln\left(\frac{RL_j}{\overline{\overline{RL}}}\right) + \varepsilon_j$$

As with the other transportation models, the standard errors will be corrected for heteroscedasticity and potentially anomalous observations will be investigated using the established Cook’s D procedure and examination of the individual observations.

Even with the departure of contract cost segments from Intra P&DC account to DRO account, there still are a large number of contract cost segments in the Intra P&DC account. This means that there are a sufficient number of observations in the Intra City, van, and tractor trailer subgroups, so that all three individual equations can be reliably estimated. As Table 22, shows, the smallest group, in terms of the number of contract cost segments, is Intra City and it has 247 observations.

Table 22
Descriptive Statistics for Intra P&DC Transportation Categories

Account Category	Type	# of Observations	Median Annual Cost	Median Route Length
Intra P&DC	City	247	$97,763	49
Intra P&DC	Van	2513	$108,373	40
Intra P&DC	TT	582	$353,720	49

2. Results

The initial results of estimating the three Intra P&DC equations on all available data points are presented in Table 23.[27] The fit of all three equations, in terms of their R^2 statistics and heteroscedasticity corrected t-statistics, are very similar to those from estimating the same equations in Docket No. R2014-6. The estimated variabilities are a bit higher, however.

Table 23
Initial Estimates of Intra P&DC Highway Transportation Variabilities

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
Intra P&DC	City	0.663	18.45	0.874	247
Intra P&DC	Van	0.753	33.54	0.853	2,513
Intra P&DC	TT	0.948	36.19	0.861	582

As with other two types of transportation equations, Cook's D statistic was used to identify anomalous and unduly influential observations for the three Intra P&DC equations. Although the Cook's D statistic identified a material number of potential

[27] Complete econometric results for each Intra P&DC equation can be found in USPS-RM2021-1-1.

influential observations, only a small number of such observations were identified anomalous. Just 12 of the 3,342 observations in the Intra P&DC dataset were so identified. Each of the twelve will be identified by equation type and have its values reviewed to determine the basis for its removal.

Only one anomalous observation was identified for the Intra City equation and it is presented in Table 24.

Table 24
Anomalous Observation for the Intra SCF City Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM	Route Length	Frequency
304BA	A	$206	102	61,200	26	1
Median		**$97,763**	**42,157**	**24,294,091**	**49**	**257**

The observation for contract 304BA, cost segment A is clearly anomalous, with an annual cost of just $206 and an annual frequency of one. There are six identified anomalous observations for the Intra P&DC Van equation, but that is still a very small number, given there are over 2,500 observations available for estimating the equation. The values for the six anomalous Intra P&DC contract cost segment observations are presented in Table 25.

Table 25

Anomalous Observations for the Intra P&DC Van Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM	Route Length	Frequency
442M9	A	$620	200	240,000	200	1
59237	B	$287	103	124,080	52	1
982B3	C	$21,589	2,666	2,132,800	1,333	1
86461	A	$390,000	4,023	40,234	8	251
12930	B	$404	20	15,000	0	50
21733	B	$43	2	2,000	1	1
Median		**$108,373**	**49,191**	**46,417,254**	**39.6**	**252.6**

Three of the anomalous observations (contract 442M9, cost segment A, contract 59237, cost segment B, and contract 21733, cost segment B) are single-run cost segments, with a tiny amount of annual cost and cubic foot-miles. The largest annual cost among the three is just $620, as compared with a median annual cost of over $100,000. These are all anomalous because of their atypically small size. The observation for contract 982B3, cost segment C reports a route length of over 1,300 miles, which isn't feasible for Intra P&DC transportation. The contract 12930, cost segment B observation is anomalous because it is very small, with an annual cost of just $404, and reports a route length of zero. Lastly, the observation for contract 86461, cost segment A, reports a relatively high annual cost, which is 3.5 times the median value for annual cost but also reports a very small value for cubic foot-miles, which is less than one-tenth of one percent of the median. It also has a very small reported number of annual miles, so the observation exhibits an unrealistic cost per mile and cost per cubic foot-mile.

Just 5 of the 582 Intra P&DC Van observations were identified as anomalous and their values are presented in Table 26. The observation for contract 19511, cost segment B reports a value for cubic foot-miles that is close to the median at 343.3 million, but reports an annual cost of just $257 dollars. In contrast, the contract 99730, segment D observation has a very high cost for an Intra P&DC contract cost segment (of nearly $7 million), but only 300 annual miles, a clear mismatch. A similar type of mismatch occurs for the observation for contract 117QJ, cost segment A which reports an annual cost that is 1.7 times the median annual cost, but reports cubic foot-miles which are less than 1 percent of the median cubic foot-miles. That observation also reports a route length of just one mile. The observation for contract 800N2, cost segment A reports a route length of 2,000 miles, which is not consistent with Intra P&DC transportation, making it anomalous. Finally, the contract 20637, cost segment B observation reports an annual cost of over $26,000 miles but only 78 annual miles, a mismatch which implies an unrealistic cost per mile.

Table 26
Anomalous Observations for the Intra P&DC Tractor Trailer Equation

Contract	Cost Segment	Annual Cost	Annual Miles	CFM	Route Length	Frequency
19511	B	$257	129,540	343,279,293	66.1	326.5
117QJ	A	$586,428	731	2,191,500	1.0	365.3
20637	B	$26,355	78	217,280	38.8	1.0
800N2	A	$11,780	4,000	12,720,000	2,000.0	1.0
99730	D	$6,965,154	300	900,000	300.0	1.0
Median		**$353,720**	**126,707**	**347,992,975**	**49.1**	**240.9**

As with the other types of transportation, removing the small number of anomalous observations improves the performance of the variability equations. The critical coefficient on cubic foot-miles is estimated more precisely after their removal, and both the van and tractor trailer equations have a noticeably higher R^2 statistic. The final variabilities reflect the same pattern previously found for Intra P&DC transportation, with the tractor trailer variability above the van variability, and the van variability above the Intra City variability. However, all three variabilities are higher than their corresponding values from RM2014-6, with the Intra City and tractor trailer variabilities increasing by about 2.5 percentage points and the van variability increasing by just over 7 percentage points.

Table 27
Final Estimates of Intra P&DC Highway Transportation Variabilities

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
Intra P&DC	City	0.693	30.74	0.875	246
Intra P&DC	Van	0.781	82.17	0.869	2507
Intra P&DC	TT	0.915	54.45	0.954	577

Differences from Initial Estimates

Account Category	Type	Estimated Variability	Heteroscedastic Consistent t-statistic	Equation R^2	# of Obs.
Intra P&DC	City	0.030	12.29	0.0004	-1
Intra P&DC	Van	0.029	48.63	0.016	-6
Intra P&DC	TT	-0.033	18.26	0.093	-5

C. The Capacity-to-Volume Variability

The TCSS dataset used to estimate the cost-to-capacity variability for the new DRO contracts was also used to update the cost-to-capacity variabilities for the remaining Intra P&DC transportation contract cost segments. However, the TCSS data do not include a volume measure and cannot be used to estimate capacity-to-volume variabilities. Thus, the capacity-to-volume variability for Intra P&DC transportation cannot not be updated with the extracted data, so the established value will be maintained. Specifically, the capacity-to-volume variability of 0.773, determined in Docket No. RM2016-12, will be applied.[28]

[28] See, Postal Regulatory Commission, Order No. 3973, Docket No. RM2016-12, June 22, 2017, at 38.

D. Overall Variability and Impact

The overall intra P&DC variability is the product of the cost-to-capacity variability and the associated capacity-to-volume variability. But, Intra P&DC account costs are made up of four types of costs: box route, Intra City, van and tractor trailer. Consequently, computing the overall Intra P&DC cost-to-capacity variability requires combining the variabilities for the four types of Intra P&DC contract cost segments. As has been done in other areas, the established methodology for combining variabilities was applied and, as Table 28 shows, the overall cost-to capacity variability for Intra P&DC is 81.6 percent.[29]

Table 28
Calculating the Cost-to-Capacity Variability for Intra P&DC Costs

Account	Type	Cost	Proportion	Variability
Intra P&DC	Box	$14,675,083	1.57%	24.2%
Intra P&DC	City	$82,860,460	8.84%	69.3%
Intra P&DC	Van	$485,525,544	51.79%	78.1%
Intra P&DC	TT	$354,414,631	37.81%	91.5%
Intra P&DC	**All**	**$937,475,718**	**100.00%**	**81.6%**

The proposed overall variability for Intra P&DC costs is 63.0 percent, the product of the cost-to-capacity variability of 81.6 percent and the capacity to volume variability of 77.3 percent. The proposed variability is 4.5 percentage points above the current variability and will result in higher volume variable Intra P&DC costs. Specifically, the

[29] Because box routes were not affected by the introduction of DRO contracts, there was no need to update the box route variability. The established variability for box routes will be used in calculating the overall Intra P&DC cost-to-capacity variability.

Intra P&DC volume variable costs increase by $42.8 million due to the higher variability. In addition, the higher P&DC variability increases the overall Intra SCF variability applied to other accounts, adding another $1.3 million increase in indirect volume variable costs. Total volume variable highway transportation costs increase by $44.1 million due to the higher Intra P&DC variability.

Table 29
Direct Impact of the New Intra P&DC Variability

Transportation Group	FY 2019 Accrued Cost	Current Variability	Current Volume Variable Cost	Proposed Variabilities	Proposed Volume Variable Cost	Change in Volume Variable Cost
Intra P&DC	$951,652	58.51%	$556,850	63.01%	$599,636	$42,786

V. Impact Analysis

Since the purchased highway cost-to-capacity variabilities were last estimated, there have been two material operational changes, an increase in the amount of seasonal highway transportation used, and the introduction of dynamic routing optimization contracts in Intra P&DC transportation. This report has demonstrated that both of these operational changes have caused changes in certain cost-to-capacity variabilities, specifically for Christmas transportation, DRO transportation, and Intra P&DC transportation. In all three cases, estimation of these variabilities has resulted in higher overall variabilities and higher attributable costs.

Table 30 presents the impact of the variability increases on FY 2019 attributable transportation costs. The higher seasonal variabilities add $36.5 million in attributable cost, the higher DRO variabilities add $111.0 million in attributable cost, and the higher

Intra P&DC variabilities add another $44.1 million. Taken together, the new variabilities add $191.5 million in attributable transportation costs.

Table 30

Impact of Proposed Variabilities on Market Dominant, Competitive, and International Transportation Costs (Millions of Dollars)

Product Type	Impact of Higher Christmas Variabilities	Impact of Higher DRO Variabilities	Impact of Higher Intra P&DC Variabilities	Combined
Domestic Market Dominant	$16.7	$50.7	$20.1	$87.5
Domestic Competitive	$18.4	$57.4	$22.9	$98.7
International	$1.4	$2.8	$1.1	$5.2
Total	**$36.5**	**$111.0**	**$44.1**	**$191.5**

Table 31 provides the breakout of the attributable cost increase by product, showing both the existing FY 2019 product-level attributable highway transportation costs and the recalculated FY 2019 product-level attributable highway transportation costs using the new variabilities. It also presents the percentage increase, by product, in attributable highway transportation costs.[30]

Although the absolute dollar increase in competitive attributable cost is larger than the absolute dollar increase in market dominant attributable cost, the percentage increases are about the same, because competitive products had a higher established highway transportation cost in FY 2019. Both the DRO and Intra P&DC variability increases affect local transportation costs, so products that have a relatively high

[30] The attributable cost increases for individual competitive products are presented under seal in the non-public folder USPS-RM2021-1-NP1.

proportion of their highway cost in local accounts, like high density and saturation products, will have a relatively high percentage increase. Products with a relatively low proportion of their highway costs in local transportation, like package services, will have smaller percentage increases.

Table 31

Impact of New Variabilities on Attributable Highway Costs By Product ($1,000s)

PRODUCT	Existing Highway Cost	New Highway Cost	% Change
Single-Piece Letters	$233,298	$249,933	7.1%
Single-Piece Cards	$7,008	$7,482	6.8%
Presort Letters	$239,462	$254,847	6.4%
Presort Cards	$8,944	$9,486	6.1%
Single-Piece Flats	$100,458	$108,010	7.5%
Presort Flats	$37,564	$39,237	4.5%
Total First-Class Mail	$626,734	$668,995	6.7%
H.D. & Saturation Letters	$6,823	$7,619	11.7%
H.D.& Saturation Flats/Parcels	$12,181	$13,588	11.6%
Carrier Route	$53,550	$58,730	9.7%
Letters	$183,354	$194,564	6.1%
Flats	$139,706	$149,106	6.7%
Parcels	$5,865	$6,214	6.0%
Total USPS Marketing Mail	$401,478	$429,821	7.1%
In County	$85	$99	16.6%
Outside County	$167,411	$178,140	6.4%
Total Periodicals	$167,497	$178,239	6.4%
Bound Printed Matter Flats	$10,222	$10,980	7.4%
Bound Printed Matter Parcels	$16,327	$17,411	6.6%
Media/Library Mail	$88,181	$91,096	3.3%
Total Package Services	$114,730	$119,487	4.1%
US Postal Service	$22,481	$23,600	5.0%
Free Mail	$2,628	$2,730	3.9%
Total Domestic Market Dominant	$1,335,548	$1,422,873	6.5%
Total Domestic Competitive	$1,463,460	$1,562,167	6.7%
Total International Mail	$131,241	$136,479	4.0%
Total Attributable	$2,930,249	$3,121,519	6.5%

Table 32 presents the impact of the higher variabilities on unit transportation costs.[31] Most market dominant products have relatively low transportation costs to start with, so their unit cost increases are modest. Package service unit transportation costs increase by about 0.7 cents and competitive product unit cost increases by 1.8 cents.

Table 32
Impacts on Unit Transportation Costs

PRODUCT	Existing Unit Cost	New Unit Cost	Change in Unit Cost
Single-Piece Letters	$0.0146	$0.0157	$0.0010
Single-Piece Cards	$0.0124	$0.0133	$0.0008
Presort Letters	$0.0068	$0.0072	$0.0004
Presort Cards	$0.0047	$0.0049	$0.0003
Single-Piece Flats	$0.1357	$0.1459	$0.0102
Presort Flats	$0.0677	$0.0707	$0.0030
Total First-Class Mail	**$0.0113**	**$0.0120**	**$0.0008**
H.D. & Saturation Letters	$0.0009	$0.0011	$0.0001
H.D.& Saturation Flats/Parcels	$0.0010	$0.0012	$0.0001
Carrier Route	$0.0084	$0.0092	$0.0008
Letters	$0.0040	$0.0042	$0.0002
Flats	$0.0366	$0.0391	$0.0025
Parcels	$0.1591	$0.1686	$0.0095
Total USPS Marketing Mail	**$0.0053**	**$0.0057**	**$0.0004**
In County	$0.0002	$0.0002	$0.0000
Outside County	$0.0405	$0.0431	$0.0026
Total Periodicals	**$0.0361**	**$0.0385**	**$0.0023**
Bound Printed Matter Flats	$0.0402	$0.0432	$0.0030
Bound Printed Matter Parcels	$0.0571	$0.0609	$0.0038
Media/Library Mail	$1.1006	$1.1370	$0.0364
Total Package Services	**$0.1845**	**$0.1922**	**$0.0077**
US Postal Service	$0.0790	$0.0829	$0.0039
Free Mail	$0.0770	$0.0800	$0.0030
Total Domestic Market Dominant	**$0.0098**	**$0.0104**	**$0.0006**
Total Domestic Competitive	**$0.2658**	**$0.2837**	**$0.0179**
Total International Mail	**$0.7921**	**$0.8237**	**$0.0316**

[31] The unit cost increases for individual competitive products are presented under seal in the non-public folder USPS-RM2021-1-NP1.