Report of Dr. Kevin Neels and Dr. Nicholas Powers

To Accompany UPS Comments

In Docket No. RM2016-12

October 17, 2016

Table of Contents

I. Qualifications

Dr. Kevin Neels is a Principal at The Brattle Group, an economic consulting firm headquartered in Cambridge, Massachusetts. He leads that company's transportation consulting practice. He has more than 30 years of experience providing economic analysis, research, and consulting services to a wide range of clients. These clients have included government transportation agencies, as well as firms in the parcel, railroad, airline, and auto manufacturing industries. His work has frequently addressed issues relating to regulatory policy and the proper relationship between the public and private sectors. He has previously submitted testimony before a number of different regulatory bodies. He has also testified in international arbitrations, and in state and federal courts.

Prior to joining The Brattle Group, Dr. Neels served with a number of other organizations, including Charles River Associates; the Rand Corporation; the Urban Institute; Peat, KPMG; and the consulting firm of Putnam, Hayes & Bartlett. He is a member of the American Economic Association and a former Chairman of the Committee on Freight Transportation Economics and Regulation of the Transportation Research Board, an arm of the National Academy of Sciences. He holds a Ph.D. from Cornell University. A copy of his resume is attached as Appendix A.

On a number of prior occasions he has been asked to offer expert testimony in legal and regulatory proceedings, including testimony relating to the regulation of postal rates. In particular, he has testified for UPS before this Commission. In Docket No. R97-1, Dr. Neels submitted testimony on a statistical analysis of mail processing cost variability presented by Dr. Michael Bradley on behalf of the United States Postal Service. In Docket No. R2000-1, he submitted testimony criticizing an updated version of that same study. In that same proceeding he also submitted testimony on transportation costs. In R2006-1 Dr. Neels again submitted testimony on mail processing costs. He submitted testimony on behalf of the Public Representative in N2012-1 on the regulatory implications of relaxing market dominant product service standards in the context of price cap regulation. He submitted testimony on behalf of UPS on city carrier costs in RM2015-7, and in support of UPS' petition to implement changes in Postal Service costing procedures in RM2016-2.

Dr. Nicholas Powers is a senior associate at The Brattle Group with expertise in industrial organization, econometrics, and regulatory economics. Since joining Brattle in 2010, he has conducted econometric analysis in a variety of regulatory and competition-related disputes, with a particular focus on the transportation and electricity sectors. His work has included estimation of damages in several large-scale price-fixing civil cases; estimation of the price effects of competitor entry and exit in geographic markets in the context of a proposed merger; and similar econometric work in antitrust matters in the payment card, plastics manufacturing, and transportation industries. He holds a Ph.D. in Business Economics from the Ross School of Business at the University of Michigan and is a member of the American Economic Association.

Dr. Powers has conducted econometric analyses and assisted in the preparation of reports and testimony in a number of Dockets before the Postal Regulatory Commission, including ACR2014, RM2015-7, RM2016-2, and RM2016-3. A copy of his resume is attached as Appendix B.

II. Background

A. Traditional Purchased Highway Transportation Variability Determination

Since Docket R87 the Postal Service has determined the variability of purchased highway transportation costs based upon the results of an econometric analysis of data describing the characteristics of contracts with private sector providers of highway transportation services. Over the years since that Docket the original econometric study that was approved and adopted by the Commission has been updated a number of times, most recently in Docket RM2014-6.[1] In all of the studies in this series the cost driver that has been used to measure the variability of purchased highway transportation costs has been the cubic foot miles of capacity provided.[2]

B. Overview of Proposal Four

Proposal Four purports to address what the Postal Service characterizes as an untested assumption in the accepted methodology for measuring the portion of purchased highway transportation costs that vary with changes in volume. The Report submitted on behalf of the Postal Service, which was written by Professor Michael Bradley of George Washington University ("Bradley Report"), argues that this methodology has two components: the variability of cost with respect to capacity; and the variability, or elasticity, of capacity with respect to volume. The first component has been the subject of numerous empirical investigations, as noted above. The Commission and the Postal Service have to date assumed that the second component is equal to 100 percent. In other words, the established methodology assumes that the amount of capacity purchased is directly proportional to mail volume.

The Bradley Report questions the validity of this assumption:

---

[1] Report on Updating the Cost-to-Capacity Variabilities for Purchased Highway Transportation, Docket RM2014-6/1, June 2014, pages 2-5.

[2] Report on Updating the Cost-to-Capacity Variabilities for Purchased Highway Transportation, Docket RM2014-6/1, June 2014, page 2.

> The investigation of the validity of this assumption of proportionality between volume and capacity has taken on additional importance as the Postal Service has experienced ongoing volume declines. Casual empiricism suggests that capacity utilization may have fallen when volume was falling, raising the possibility that even if the proportionality assumption were correct in the past, it may no longer be so.[3]

The Postal Service's new report presents the results of a number of new econometric studies designed to measure this variability. The results of these studies suggest that the variability of capacity with respect to mail volume is significantly less than 100 percent, which would imply that when mail volume grows (or declines), the amount of highway transportation capacity that is purchased will grow (or decline) by less than a proportionate amount.

III. Purpose of this Testimony

We have been asked to review and evaluate the new econometric studies that have been conducted by or on behalf of the Postal Service, assessing the appropriateness of the methodology that was employed, the accuracy, reliability and relevance of the data sources that were used, and the soundness and reliability of the conclusions and recommendations that have been presented. In particular, we have been asked to determine whether Proposal Four remedies a significant inaccuracy, or significantly improves the quality, accuracy, or completeness of Postal Service data or the attribution of costs to products.

IV. Summary of Findings

We have found that TRACS data, upon which these new studies are based, are totally unsuited to the job they have been asked to do. The samples that produce these data were designed for a different purpose. They are too small, and produce population estimates that are too noisy and error prone to support reliable econometric analyses.

Perhaps because of the limitations of the TRACS data, the conceptual framework underlying these new studies is sharply at odds with the Postal Service's own statements about how it manages its highway network. The models that have been estimated fail to capture the real determinants of capacity decisions.

---

[3] Bradley Report, page 3.

We show that the approach adopted here by the Postal Service is incapable of generating reliable estimates of capacity variability. It produces variabilities significantly below 100 percent, even in a setting in which by construction capacity and mail volumes move together in lockstep fashion.

We find nothing in Proposal Four that remedies a significant inaccuracy, or significantly improves the quality, accuracy, or completeness of Postal Service data or the attribution of costs to products.

V. Overview of the Postal Service's Capacity Variability Model

A. Initial Postal Service Efforts to Develop a Structural Model

The first substantive section of Professor Bradley's report, following its introduction, describes the results of an investigation of the possibility of using operational data to develop an econometric analysis and estimate of the elasticity (also referred to as variability) of purchased highway transportation capacity with respect to mail volume. This discussion emphasizes the importance of structuring such an analysis in a manner that it is "consistent with economic decision making by Postal Service transportation managers."[4] As I explain more fully below, it is clear that the key capacity decisions for the highway network are made at the individual route level, and, therefore, that the route level is the correct unit of observation to use in analyzing such decisions.

However, the Postal Service abandoned its effort to build from operational data a dataset capable of supporting reliable analysis at this level. The Bradley Report describes the difficulties encountered in trying to build a useable dataset. They included the need for a large amount of "data cleaning," difficulty in matching reported routings with building locations, missing observations for key variables, and apparent irregularities in the operations of some routes. Professor Bradley concluded that "the data were not sufficiently reliable for supporting an econometric analysis."[5] The number of potential observations that had to be discarded because of data problems ranged from 30 to 45 percent of the total.[6]

---

[4] Bradley Report, page 5.

[5] Bradley Report, page 5.

[6] Response to CHIR No. 2, Question 7.

B. THE COMMISSION'S N2010-1 ANALYSIS

In the Bradley Report the description of the unsuccessful effort summarized above is followed immediately by a discussion of work performed by Commission staff in connection with Docket N2010-1. That Docket dealt with a request by the Postal Service for an advisory opinion on a plan to eliminate Saturday mail delivery.[7] Given the subject matter of this Docket, it is not surprising to find within its record analyses exploring day to day variation in mail volumes and cost.

The specific analysis described in the Bradley Report used data from the TRACS system – a sampling system designed to provide distribution keys for attributing highway costs to products – to measure changes in capacity and volume on a day of the week basis. This analysis used data from four fiscal years ((FY 2005, FY 2008, FY2009 and FY 2010). PRC staff separated the TRACS data by contract type (Intra-SCF, Intra-BMC, Inter-SCF and Inter-BMC), and then summarized the data by year, quarter and day of the week to create four sets of contract-type specific observations. Thus there were 113 observations to test for each of the four contract types. PRC staff then ran four analyses on these samples, regressing the number of trips on a set of explanatory variables that included cubic feet of mail and year- specific dummy variables. From this information PRC staff developed estimates of the elasticity of the number of purchased highway transportation trips with respect to mail volume.[8]

C. DESCRIPTION OF THE ANALYSIS PRESENTED BY THE POSTAL SERVICE

The new analyses presented by the Postal Service in this Docket are based directly on this earlier PRC analysis. The new work whose results are reported here relies upon the TRACS data. The TRACS observation data have once again been broken down by contract type, and aggregated to form contract type-specific sets of observations grouped by year, quarter and day of the week. Using these dataset, the Postal Service has regressed capacity on mail volume in order to estimate elasticities of capacity with respect to mail volume for each of the four contract types.[9]

---

[7] Official Transcript of Proceedings Before the Postal Regulatory Commission, In the Matter of Six-Day to Five-Day Street Delivery and Related Service Changes, 2010, Docket N2010-1, April 27, 2010, Volume #1, Page 8.

[8] Technical Description of PRC Highway Transportation Cost Analyses, PRC-N2010-1-LR-5 - PRC Analysis of Highway Transportation Cost Savings, Docket N2010-1.

[9] Bradley Report, page 16.

Although these new analyses closely resemble the earlier Commission work on which they are based, the Postal Service has made a number of modifications. The new Postal Service analyses are based upon a different time period – FY2010 through FY2015.[10] The final models presented by the Postal Service are based upon a slightly different measure of capacity – what Professor Bradley calls "moving capacity," which is defined as the summation across all TRACS tallies of the product of the number of trip legs (or stops) represented by the tally and the cubic feet of capacity of the truck.[11] In addition to including the natural logarithm of mail volume, the final models include that same variable squared, turning the model into a univariate translog function. The model also includes a number of zero-one indicator variables that flag various sets of observations that Professor Bradley has issues with, and whose influence on the regression he seeks to reduce. The model includes a day of the week variable whose construction and interpretation I discuss in more detail below.[12] Finally, in estimating the model Professor Bradley tests and corrects for autocorrelation.[13]

The Bradley Report presents a number of alternative analyses. For the most part these alternative analyses involve re-estimating the same model on different datasets. These different datasets include a dataset aggregating TRACS data by week, rather than by year, quarter and day of the week;[14] including and excluding data from FY10, a year Professor Bradley regards as atypical because of its

---

[10] Bradley Report, page 13.

[11] Bradley Report, page 21. As we explain more fully below, the TRACS data consists of a random sample of truck trip legs. Thus, the universe from which this sample is drawn consists of all of the stops that purchased highway transportation trucks make at postal facilities. These stops represent the destination ends of the associated trip legs. The trips associated with each sample point, or "tally," are given by the sampling weight, which indicates how many trip legs in the total universe to which a sample tally corresponds. The capacity for an individual test is the cubic footage of the sampled truck. We refer to the units of the aggregated capacity and volume measures as "cubic foot legs," to distinguish it from the traditional highway transportation units of cubic foot miles.

[12] Bradley Report, page 21.

[13] Bradley Report, pages 23-29.

[14] Bradley Report, pages 31-33.

higher volumes;[15] and including and excluding TRACS observations in which the sampled truck contained no mail.[16]

D. THE POSTAL SERVICE'S CONCLUSIONS

Professor Bradley concludes that the elasticity of "moving capacity" with respect to mail volume is significantly less than 100 percent. His final estimates range from a low of 77.3 percent for intra-SCF transportation to a high of 84.8 percent for inter-NDC transportation. He argues that in order to calculate the true variability of purchased highway transportation costs, the variabilities of cost with respect to capacity developed in Docket RM2014-6 must be multiplied by the new variabilities estimated here. The effect of making this adjustment is shown below in Table 1.

Table 1: Proposed Highway Transportation Variabilities Under Proposal Four

Transportation Category	Cost to Capacity Variability	Capacity to Volume Variability	New Overall Variability
[A]	[B]	[C]	[D] = [B] x [C]
INTRA P&DC	75.7%	77.3%	58.5%
INTRA DISTRICT	38.0%	77.3%	29.4%
INTER-SCF	89.1%	82.1%	73.2%
INTER P&DC	85.0%	82.1%	69.8%
INTER CLUSTER	89.1%	82.1%	73.2%
INTER AREA	89.9%	82.1%	73.8%
INTRA-NDC	94.9%	78.8%	74.7%
INTER-NDC	94.7%	84.8%	80.3%

Source: Bradley Report, p. 34 (Table 15). Note that the first two rows apply Professor Bradley's Intra-SCF estimate for capacity to volume variability while the next four rows all apply the estimate from his Inter-SCF equation.

If adopted, the recommended changes would move over half a billion dollars of cost formerly attributed to products into the institutional cost category. Approximately $270 million of this total would come from market dominant products, and $250 million from competitive products.[17]

[15] Bradley Report, pages 29-31.

[16] Bradley Report, pages 18-20.

VI. Criticisms of the Postal Service's Approach

Our review has revealed a number of serious shortcomings with the analyses described in the Bradley Report. These shortcomings raise serious questions about the accuracy of the variability estimates that the Postal Service has produces, and the reliability of the entire approach upon which they are based. In this section we summarize the problems that we have identified. The analyses described in the Bradley Report are, as we have noted, based entirely upon the TRACS data. They attempt to use the TRACS data for a purpose for which it was never designed, and is ill-suited. They also fail to capture the true determinants of decisions regarding capacity, and so are based upon models that are seriously mis-specified. We show here how these two factors – reliance on noisy explanatory variables derived from thin samples, and failure to account for the true determinants of capacity decisions – interact to introduce downward bias into variability estimates.

A. Imprecision and Sampling Error Render the TRACS Data Incapable of Reliably Measuring Capacity Variabilities

1. Description of the TRACS Data Used by Professor Bradley

The primary purpose of the TRACS data used by Professor Bradley is to develop distribution keys for purchased highway transportation costs. This purpose is clearly stated in the Preface to USPS-FY15-36 and similar prior documents. The process for generating the TRACS Surface (Highway) portion of this dataset first samples stop-days along a subset of the many contracted highway routes. For each sampled stop fieldworkers record the size of the truck and the share of the truck's capacity that is unloaded, has remaining mail volume, or is empty are recorded. A sub-sample of pallets, containers, and non-containerized loose items is then selected, followed by a further sample of mail items within each selected container. Fieldworkers record the weight, volume, miles traveled, and category of sampled mail items. Eventually, the recorded data across roughly 9,000 "TRACS tests" per year are summarized to estimate each product's share of the Postal Services' total cubic foot miles (CFM) transported on contracted highway routes in a given fiscal year.[18]

Continued from previous page

[17] Bradley Report, Table 16.

[18] See Preface to USPS-FY15-36 ("TRACS Preface") at pp. 3-4.

The TRACS system distinguishes between four types of contract routes. The routes that carry mail the longest distances are called Inter-NDC routes, while the most local contract routes are the Intra-SCF routes. The TRACS sampling rates differ across contract types, ranging in Q4, FY15 from 0.01 to 0.5 percent, as shown in Table 2.[19]

Table 2: TRACS Sampling Rate in Q4, FY15

Mode	Total Stops	Sample Size	Sampling Rate
	[1]	[2]	[3]
Intra-SCF	6,824,038	749	0.01% (1 in 9,111)
Inter-SCF	1,325,220	715	0.05% (1 in 1,853)
Intra-NDC	316,134	550	0.17% (1 in 575)
Inter-NDC	106,054	547	0.52% (1 in 194)

Notes and Sources:
[1]: Preface to USPS-FY15-36, p. 6 (Table 1)
[2]: Preface to USPS-FY15-36, p. 8 (Table 3)
[3]: [2]/[1]
Note that within each mode or contract type, the sampling rate varies by stratum. The sampling rate presented in column 3 is the average for that mode.

To generate the aggregate capacity and volume measures he uses in his capacity variability analysis, Professor Bradley multiplies the volume and capacity measures for each TRACS test by its sample weight, or stratum weight, and sums across tests to produce population estimates of the total amount of system-wide volume and capacity (both expressed in cubic foot-legs), by year, quarter, and day of week (DOW).[20,21,22]

---

[19] The sampling rate was comparable in magnitude during the other 23 quarters analyzed by Professor Bradley.

[20] The sample weight is the inverse of the sampling rate, which varies by route type, sampling stratum, quarter and year. Sampling stratum refers to different kinds of stops within a route type. For example, the Inter-NDC trip-stops are further subdivided into three categories: Stop at NDC, Stop at SCF, and Stop at Other. See TRACS Preface at p. 7.

[21] Incidentally, the stratum weight variable is equal to a second variable in the dataset called "TRIPS", which Professor Bradley explains is an annual trip frequency, citing an example of 154.759 trips per year that corresponds to "a route that runs three days a week except holidays" (see Bradley report at

Continued on next page

The very low sampling rates employed in collecting the TRACS data produce population estimates of the total volume and capacity for a quarter that are extremely noisy – meaning they are measured with a high degree of imprecision. To put this another way, a population estimate based on a sample will tend to generate estimates that are higher than the true population measure if full or nearly-full trucks were over-represented in the samples drawn in a particular quarter. Similarly, it would be entirely plausible that a given quarter's estimate could, for example, understate the true population measure by sampling more empty or nearly-empty trucks than would normally be expected in a sample of that size. Similar problems can arise from variations in the sizes of the sampled trucks. Such error (or noise) declines as the sample size increases; in the extreme, a sampling procedure that "samples" every single trip should produce an estimate without any noise.

There is a great deal of evidence indicating that the TRACS sample is simply too small and too variable to produce reliable estimates of system wide capacity and mail volume, or of capacity-to-volume variabilities, a point which we illustrate below. Moreover, subdividing these small samples further to produce these population estimates by day of the week exacerbates this problem. Natural sampling variation (and the fact that the TRACS sample design does not stratify by day of the week) causes the share of TRACS tests pertaining to a given day of the week to vary, even if the share of system-wide stops for that day of the week do not.

2. Simple Diagnostic Tests Demonstrate the Error in Professor Bradley's TRACS-Based Estimates

Two simple diagnostic tests illustrate the extent of the errors contained in the TRACS-based estimates used by Professor Bradley in his regressions.

Continued from previous page

pp. 13-14). However, these variables take on values that appear to be inconsistent with his interpretation. For example, the values in FY15 range from 135.1 to 45,648.1 (which would imply a route that runs an average of more than 125 trips per day). Both stratum weight and "TRIPS" are calculated as the ratio of a variable called "FRMCOUNT", which is described in the FY15 TRACS "Readme" documentation as the "number of stop-days in the stratum" to a second variable "SAMPSIZE," which is simply the number of TRACS tests in a quarter sharing the contract type and stratum number of the observation in question.

[22] Strictly speaking, the volume measure used in Professor Bradley's regressions is further divided by a constant (the average volume across all 168 year-quarter-day of week observations for that contract type), but this has no bearing on the discussion of the potential issues posed by sampling variability.

a. Quarterly TRACS-Based Volume Estimates Are Inconsistent With Other More Reliable Postal Service Volume Data

For the first diagnostic test, we combined information in the current docket with widely-used RPW piece count data to construct a reliable measure of trends in the volumes carried by the purchased highway transportation network. The RPW data represent the more reliable and comprehensive measures of mail volume produced by the Postal Service. By themselves, however, they do not tell us how much volume is moving through the highway network. Fortunately, however, there is a reliable way to tie RPW volume counts to usage of that network. The link is provided by the TRACS distribution keys, which provide a measure of the relative highway network usage intensity of the various products listed in the RPW data. Combining these two data sets permitted us to produce a reliable measure of highway usage volume trends that was not distorted by sampling error.[23]

The development of this more reliable volume measure proceeded in two steps. First, for each route type, we used the distribution keys contained in the non-public material filed in this case and public data from the 2015 Revenue Pieces and Weights (RPW) report to develop a measure of the relative usage intensity of each mail class with respect to the four contract types under current costing procedures.[24] For example, on average, a first-class single-piece letter incurred a cost of approximately 0.5 cents per piece on Intra-SCF routes and 0.04 cents per piece on Inter-NDC routes, while an average piece of Media and Library Mail incurred a cost of 34.1 cents per piece on Intra-SCF routes and 36.2 cents per piece on Inter-NDC routes.[25]

---

[23] Because they are derived from the TRACS data, the measures of relative usage intensity that we develop are themselves subject to some degree of sampling error. However that sampling error is no greater than that contained in the TRACS distribution keys themselves, and those distribution keys have been judged by the Commission to be sufficiently reliable to be used to attribute purchased highway transportation costs to products.

[24] Specifically, we used the distribution keys in "CS14-NP-FY15.Proposed.Variabilities.xlsx" after resetting the capacity-to-volume variabilities that are the subject of this docket back to 1. Note, however, that while this adjustment reflects absolute weights, it does not reflect the relative weights and thus has no impact on the inference from this diagnostic exercise.

[25] The data needed to calculate the weights for the products cited as examples are public. The non-public data were required to calculate weights for individual competitive products. These weights

Continued on next page

We then multiplied the usage weight of each mail class by the corresponding piece counts contained in every quarter's public RPW reports, and summed over all classes to calculate weighted volume, where the weights refer to usage intensity with respect to purchased highway transportation. Comparisons of the weighted volume measure with the TRACS-based estimate of volume show clearly that the TRACS estimate does a poor job of tracking actual volumes.

In working with the TRACS data we realized that there are several pieces of the highway network that are systematically excluded from the TRACS sample. That sample covers only Regular routes. However, there are also Emergency, Exceptional, and Christmas routes which obviously carry mail, but are not part of the TRACS sampling frame. Thus, even if the population estimates generated by the TRACS data were perfect, they would not match the RPW data exactly, because there is some volume being handled outside of the TRACS universe. To assure that our conclusions regarding the accuracy of the TRACS data were not unduly influenced by the limited coverage of the TRACS Sample, we adjusted the RPW volume counts for this difference in coverage.[26] Accordingly, our final RPW-based volume measure is constructed as follows:

$$WV_{qt} = \frac{Regular\ Costs_{qt}}{Total\ Costs_{qt}} \sum_{c=1}^{C} P_{cq}\, w_q$$

where:

- WV is weighted volume;
- *Regular Costs* are the costs incurred on regular routes;
- *Total Costs* are the sum of costs incurred on regular, exceptional, emergency, and Christmas routes;
- P is piece count (from quarterly RPW reports);

Continued from previous page

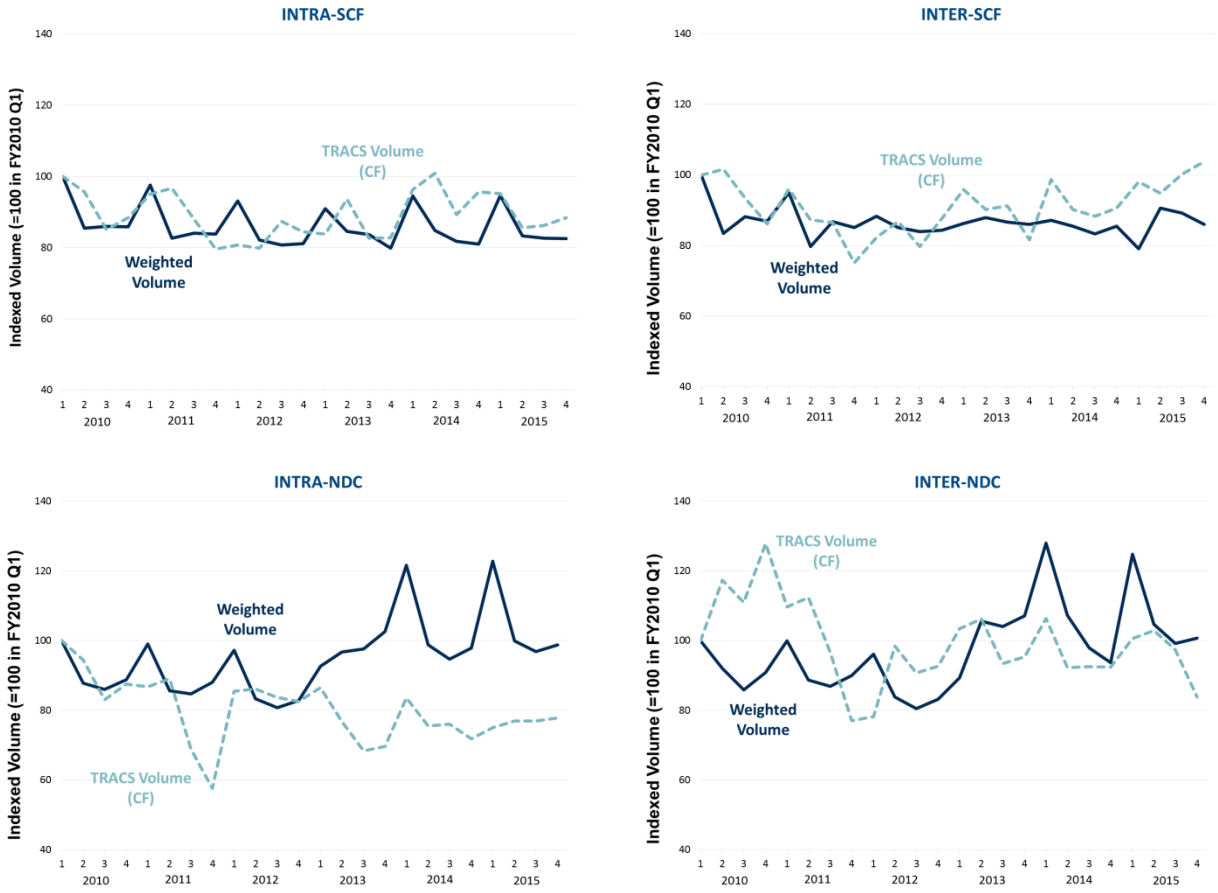
necessarily reflect 2015 product definitions, but we would expect any changes in the aggregate quarterly weighted volume measure we construct from these weights to be minimal and to not affect the conclusions we draw from this diagnostic exercise.

[26] See Response of the United States Postal Service to Chairman's Information Request No. 3, RM2016-12, dated October 5, 2016, Question 4. See also, *e.g.*, tab "WS14.3" of "CS14-PublicFY15.xlsx" in USPS-FY15-32 Library Reference.

- w is the average per-piece cost from 2015;
- q subscripts refer to quarter-years;
- t subscripts refer to contract types; and
- c subscripts refer to mail classes.

In Figure 1, we have plotted the resulting weighted volume measure and the TRACS volume measure for each quarter over the last six years. It is clear from these graphs that for most contract types, the TRACS volume estimate is an extremely noisy estimate of the RPW-based measure, which is more comprehensive, and which we believe more accurately captures variations in the volume of mail carried over time. In particular, the RPW-based measure (in dark blue) exhibits the clear seasonal variation that is widely believed to be characteristic of mail flows, while the TRACS-based measure (in light blue) for most contract types appears to fluctuate randomly, with little evidence of any regular seasonality or any other relationship to the RPW-derived measure. The exception is the Inter-SCF series, in which in many years the seasonal trend as portrayed in the RPW is in fact picked up, to some extent, by the TRACS population estimates.

Figure 1: TRACS Volume Estimates (in Cubic Foot-Legs) vs. RPW Weighted Volume



Source: Quarterly Revenue Pieces and Weights reports, FY10-FY15; CS14-NP-FY15.Proposed.Variabilities.xlsx; Proposal Four Data.
Note: Both volume series are indexed to equal 100 in FY2010 Q1.

The extent of the apparent mismatch between the TRACS estimate of system-wide volumes and RPW-based network-wide volumes can be measured by regression analysis. Regressing the TRACS-based volume measured and the RPW-based volume measures, we found that anywhere from 85 to 99.9 percent of the variation in the TRACS volume estimate is pure statistical noise. These results can be seen in Table 3. In none of the four regressions is the coefficient on the corresponding RPW-based estimate significant at the conventional 5 percent level (although one is significant at the 10 percent level), and the R^2 measure, which measures the share of the variation in the dependent variable that can be explained by the independent variable, ranges from 0.001 (in the Inter-NDC regression) to 0.150 (in the Intra-SCF regression).

Table 3: Regressions of TRACS System-Wide Volume Estimate (in Cubic Foot-Legs) on RPW-Based Weighted Volume

	Intra-SCF	Inter-SCF	Intra-NDC	Inter-NDC
	(4)	(2)	(3)	(1)
Weighted Volume	5,385*	2,289	-871.9	61.67
	(2,736)	(1,665)	(1,664)	(491.0)
Constant	1.811e+09**	5.882e+08	4.737e+08***	1.660e+08***
	(6.721e+08)	(3.667e+08)	(9.445e+07)	(3.561e+07)
Observations	24	24	24	24
R-squared	0.150	0.079	0.012	0.001
Implied Noise as Percent of Total Variation in TRACS Volume Estimate	0.850	0.921	0.988	0.999

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: Implied Noise equal to one minus R-squared.
Source: Quarterly Revenue Pieces and Weights reports, FY10-FY15; CS14-NP-FY15.Proposed.Variabilities.xlsx; Proposal Four Data.

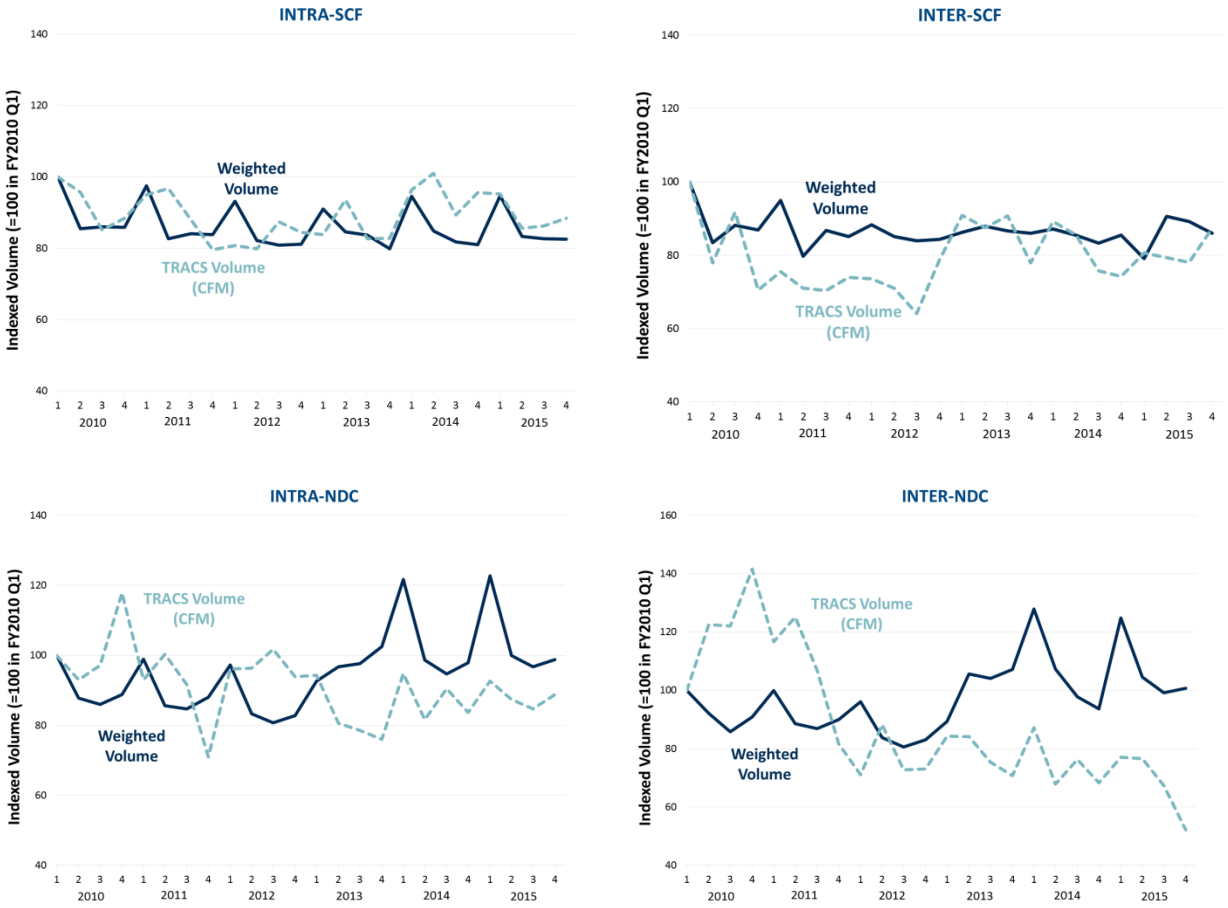
Thus far, the comparisons have focused on the TRACS system-wide volume estimates used in Professor Bradley's analyses, which are expressed in cubic foot-legs. However, the weights that we have applied to the RPW volumes are based on distribution keys that allocate highway transportation costs of a given contract type based on an estimate of each product's share of the total cubic foot *miles* (CFM) in a given contract type, rather than the unit of measure in the regression variables constructed by Professor Bradley. To assure that the TRACS/RPW discrepancies shown above are not simply an artifact of these definitional differences, we also constructed a TRACS-based measure that is expressed in cubic foot miles, and which as a result should be directly comparable to RPW-based measures.

In principle, one can convert the TRACS-based measure of system-wide cubic foot-legs to a system-wide measure of cubic foot-miles by multiplying the volume on each TRACS test by the highway miles traveled on the sampled leg. However, the primary purpose of the TRACS system is to sample mail unloaded from trucks in order to allocate the costs in accordance with each product's share of CFM, as described above. Accordingly, the distance traveled on the leg before the TRACS test is only recorded if mail is actually unloaded at that stop. So to construct a TRACS-based measure of system-wide volume expressed in CFM (such that mail that was on the truck but that was not unloaded is included in the resulting measure), we applied the average mileage for other tests sharing the same contract type, sampling stratum (or type of stop), and year-quarter to those TRACS tests that did not have mileage recorded.

After making this adjustment, we reach the same conclusion as before, as is shown in the four graphs presented in Figure 2. Again, the regular seasonal variation in mail volumes is evident in the weighted volume measures (in dark blue) while the light blue dashed lines, representing the TRACS-based estimates, fluctuate widely. The regression results presented in Table 4 again tell essentially the same story: when the dependent variable is expressed in CFM, the strength of the relationship, as measured by R^2, varies between 0.043 and 0.191, meaning that a large portion of the variation in the TRACS-based measure - anywhere from 81 to 96 percent - is statistical noise that cannot be explained by the RPW-based volume measure.[27]

[27] We also performed this graphical and regression-based analysis before applying the adjustment for the share of incurred costs that are on regular routes, as described earlier in this section. Those results are available in the Library Reference accompanying our report. They do not affect the conclusions drawn from this diagnostic exercise.

Figure 2: TRACS Volume Estimates (in Cubic Foot-Miles) vs. RPW Weighted Volume



Source: Quarterly Revenue Pieces and Weights reports, FY10-FY15; CS14-NP-FY15.Proposed.Variabilities.xlsx; TRACS data, FY10-FY15.
Note: Both volume series are indexed to equal 100 in FY2010 Q1.

Table 4: Regressions of TRACS Volume Estimate (in Cubic Foot-Miles) on Weighted Volume

	Intra-SCF	Inter-SCF	Intra-NDC	Inter-NDC
	(1)	(6)	(7)	(5)
Weighted Volume	5,385*	719,834**	-200,047	-731,820
	(2,736)	(316,262)	(201,383)	(534,065)
Constant	1.811e+09**	5.373e+09	6.721e+10***	1.407e+11***
	(6.721e+08)	(6.963e+10)	(1.143e+10)	(3.873e+10)
Observations	24	24	24	24
R-squared	0.150	0.191	0.043	0.079
Implied Noise as Percent of Total Variation in TRACS Volume Estimate	0.850	0.809	0.957	0.921

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: Implied Noise equal to one minus R-squared.
Source: Quarterly Revenue Pieces and Weights reports, FY10-FY15; CS14-NP-FY15.Proposed.Variabilities.xlsx; TRACS data, FY10-FY15.

b. A Digression on Regular Routes and Their Implications for Proposal Four

In examining the Impact files for this docket, we identified an additional issue with Proposal Four that, in light of the information we have been able to review in preparing this report, appears to be problematic. In addition to the existence of regular, exceptional, and emergency routes, the CRA costs for purchased highway transportation systems include costs incurred on Christmas routes. For example, in Q1 of FY15, 23 percent ($84M) of the $358M total for Inter-SCF costs was in one of three cost pools that appear to refer to Christmas routes.[28] The concentration of these Christmas route costs in Q1 is largely responsible for the fact that total Inter-SCF costs are 25-36 percent higher than in the other quarters in FY15, although costs are incurred in the cost pools associated with Christmas routes in the other three quarters of the year as well. Christmas routes are also separately accounted for

[28] For example, line 124 on the "WS14.3" tab of the file named "CS14-P-FY15.Proposed.Variabilities.xlsx" is labeled "TRNSP ML/EME-DOM-HS-INTER AREA CHRISTMAS" and reports $64M in costs in Q1 of FY15 and $80M overall in FY15. Within the set of purchased highway transportation costs pools across the various contract types, 5 contain the word "CHRISTMAS" and another two contain the term "XMAS."

among Intra-SCF and Intra-NDC cost pools, though they represent a smaller share of the totals for those contract types. In total, Christmas cost pools accounted for $124M in FY15.[29]

Two aspects of the treatment of these Christmas costs appear to be inconsistent with basic principles of cost causation underlying these routes. The first is that Proposal Four would apply the same variabilities to these Christmas cost pools as it would to the regular routes. The second is that the same distribution key that is developed to allocate costs incurred on regular routes is also used to allocate thes Christmas cost pools. We discuss each of these in turn.

The application of a capacity-to-volume variability of less than one is surprising, as previous statements by Postal Service representatives have indicated that the growth in their package business has caused them to add additional capacity to handle the Christmas rush.[30] It is counter-intuitive to suggest that additional capacity and all the associated costs specifically contracted for during the Christmas period to accommodate increases above and beyond volume levels in the other three quarters could be anything less than fully caused by increases in volume. The Postal Service response to Question 4 of Chairman's Information Request 3, regarding short-term purchases of highway transportation, did not specifically discuss these Christmas routes, but endnotes in the "CS14-P-FY15.Proposed.Variabilities.xlsx" file included in the public LR in this docket suggest that they are issued under emergency contract rules, so it appears to be the case that like emergency contracts, Christmas contracts are not included in the TRACS sampling frame. Accordingly, we are unaware of

---

[29] The numbers presented in this section are all simple calculations from the "WS14.3" tab of the "CS14-P-FY15.Proposed.Variabilities.xlsx" file. The "WS14.4.1" tab of the same file allocates all volume variable costs within a given contract type using a single quarterly distribution key per contract type.

[30] See, for example, the Postal Service press release located at https://about.usps.com/news/national-releases/2014/pr14_057.htm: "Due to continued e-commerce growth and improvements to its Priority Mail product line, the Postal Service is expecting double-digit growth in its package business this holiday season, likely in the range of 450 to 470 million packages. That equates to roughly 12 percent growth over the same period last year. 'Football has its season. But the holidays? That's our season,' said [Postmaster General Patrick] Donahoe. 'That's crunch time for us, and year after year, we step up our game. E-commerce package business continues to be a big player now more than ever, so we've enhanced our network to ensure America that we'll deliver their cards, gifts and letters in time for the holidays.'" While the press release specifically refers to city delivery, it is hard to imagine that the discussed spike in package volume isn't also a primary driver behind Christmas highway routes.

any data source that would allow the Postal Service or the Commission to justify a variability of capacity with respect to volume of anything less than 1 for Christmas or emergency contracts.

The apparent failure of the TRACS system to sample Christmas routes in developing distribution keys, while simultaneously applying those regular route-based distribution keys to Christmas routes, is similarly surprising. While the TRACS system does result in quarterly distribution keys, the mere existence of Christmas routes indicates that these are different in character from regular Q1 routes. The Postal Service has not provided any basis that we are aware of for applying distribution keys developed from other types of routes to Christmas routes, especially in light of the rather intuitive notion that seasonal volume growth at Christmas is driven by the spike in package volumes, and public statements consistent with that notion.

c. Quarterly TRACS-Based Cost Estimates Are Inconsistent With Other Postal Service Data

A second test provides further confirmation that any population estimates derived from the TRACS sample data are too noisy to be considered reliable. The TRACS data contain a cost measure, which is the estimated cost of one leg on the covering contract.[31] In the same way that Professor Bradley uses the TRACS data to estimate the aggregate system-wide volume of mail on each contract type, the estimated cost data can similarly be used to estimate system-wide costs on each contract type, by multiplying the estimated cost associated with each TRACS test by the corresponding stratum weight. These population estimates, whose construction is analogous to the construction of the dependent and independent variables used by Professor Bradley, can then be compared with quarterly cost totals on regular routes of each contract type from the CRA data as a further assessment of the relative noisiness of population estimates constructed from TRACS data.[32]

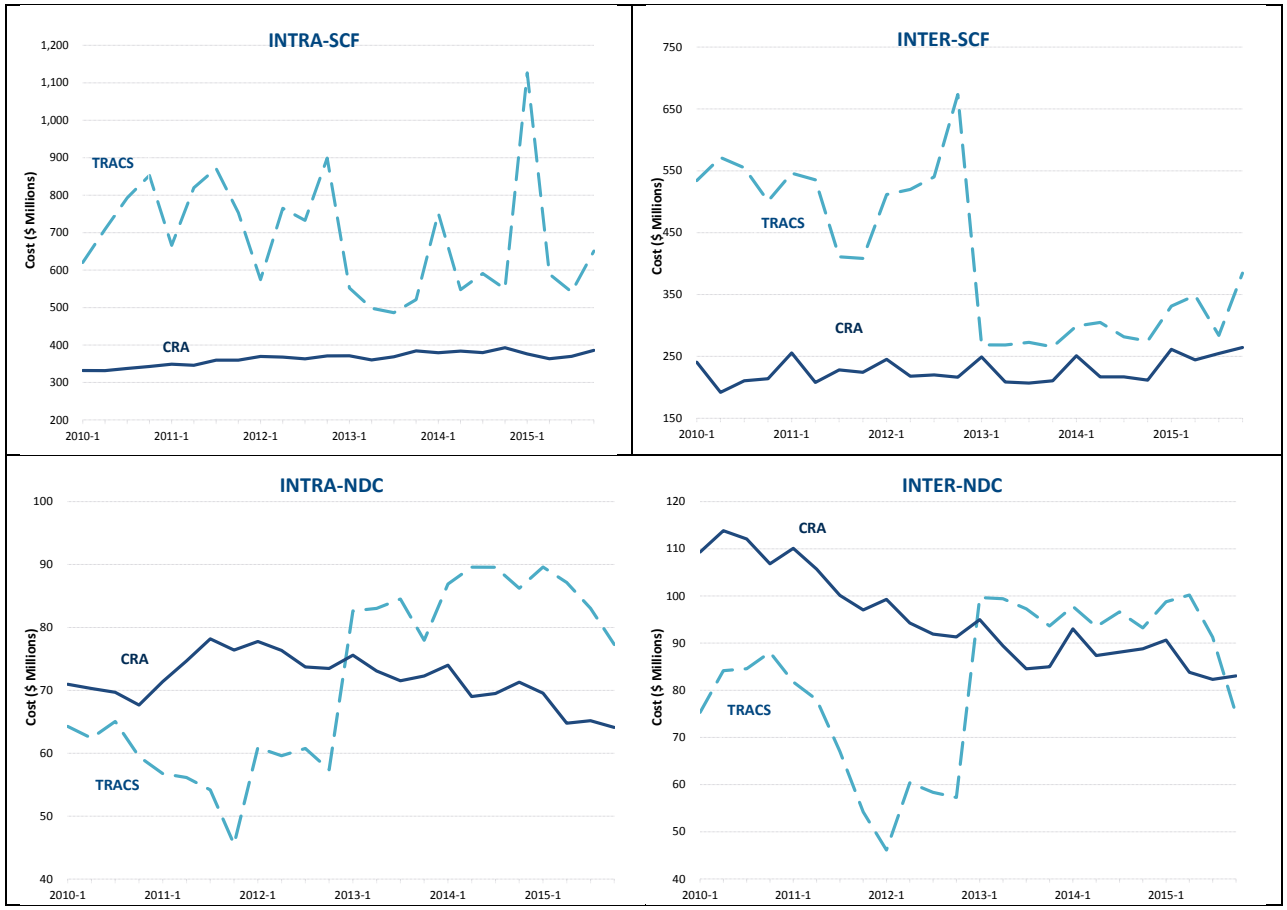
---

[31] See, *e.g.*, question 8 in "Response of the United States Postal Service to Chairman's Information Request No. 2," dated September 30, 2016. The Postal Service response states that the TRACS-level cost variable is "just" an estimate, but ultimately so is the volume measure, as we discuss in further detail below.

[32] These costs can be obtained from tab "WS14.3" of "CS14-PublicFY15.xlsx" in USPS-FY15-32 Library Reference, and similar files for the other five fiscal years used in Professor Bradley's analysis.

Inspection of the resulting population cost estimates suggests that something changed in the way the COST variable from the TRACS data was recorded in FY13, such that, for most contract types, the accuracy of the COST measure improves beginning in that year. Nonetheless, even focusing solely on the last three years, the graphs in Figure 3 below again demonstrate the futility of trying to use TRACS data to reliably construct system-wide estimates of economic measures of Postal Activity. This finding is particularly true of the Intra-SCF contract type, where the TRACS estimate ranges from 132 percent of CRA costs on regular routes (in the 3rd quarter of 2013) to 299 percent of costs (in the 1st quarter of 2015). The issue with these population estimates is not just that they persistently overestimate actual costs on regular routes. More importantly, the Commission should note the wide variation over time in the extent of this overstatement, as it illustrates of the tendency for sampling variation resulting from low sampling rates to yield unreliable estimates.

Figure 3: Comparison of TRACS-Based Estimates of Total Cost to CRA-Reported Total Costs on Regular Routes, FY2013-FY2015



Sources: FY10 - FY15 TRACS Highway data; FY10 - FY15 C/S 14 CRA B Workpapers.
Notes: CRA cost totals reflect only those costs accrued on regular routes.

3. Day of Week Variation Further Decreases Sample Size and Makes the Problem Worse

The decision by Professor Bradley to aggregate the data at the DOW-fiscal year-quarter level means that the volume and capacity estimates utilized in his regression analysis are based on even fewer TRACS tests and thus more prone to noise. This arises because the sample is not stratified by day of the week and thus the number of TRACS tests underlying each observation varies significantly. This fact is demonstrated in Table 5, which summarizes, for each day of the week and contract-type, that variation.

For example, focusing on the first column, we can see that on average across all quarters and years, roughly 15 percent of the TRACS tests in the sample of Intra-SCF stops fall on Monday. However, in particular quarters in the time period upon which Professor Bradley's analysis is based, the share is as low as 12 percent or as high as 19 percent. This oscillation in the Monday sampling rate means that the system-wide volume and capacity estimates in the Monday observations used in Professor Bradley's analysis will oscillate similarly, often by magnitudes that would never occur in reality. As we have just illustrated, even the quarterly estimates are exceptionally noisy. Further subdividing theses noisy estimates into day-of-week level observations exacerbates the sampling error problem.

Table 5: Variation in the Share of TRACS Tests per DOW-Quarter Year Observation That Fall on a Given Day of the Week

	INTRA-SCF			INTER-SCF			INTRA-NDC			INTER-NDC		
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
	[1]			[2]			[3]			[4]		
Sunday	0.6%	1.7%	2.7%	5.3%	7.4%	10.0%	8.0%	10.8%	13.2%	9.4%	12.1%	16.0%
Monday	11.9%	14.9%	19.0%	7.7%	10.0%	13.8%	8.8%	12.3%	16.3%	6.9%	9.3%	11.7%
Tuesday	13.5%	16.9%	20.0%	14.2%	16.7%	19.4%	13.3%	15.9%	18.8%	10.9%	15.3%	18.6%
Wednesday	13.3%	16.9%	19.9%	13.8%	16.9%	20.5%	13.9%	16.0%	18.5%	12.7%	16.6%	20.6%
Thursday	12.7%	16.6%	18.8%	13.5%	16.8%	20.1%	11.9%	15.1%	17.3%	11.2%	15.3%	17.6%
Friday	15.3%	17.3%	19.5%	13.8%	16.8%	20.4%	12.2%	15.8%	19.1%	13.2%	15.8%	19.6%
Saturday	12.4%	15.7%	19.5%	13.0%	15.5%	18.0%	11.6%	14.1%	16.7%	12.2%	15.8%	18.5%

Source: Calculations using the regression dataset used by Professor Bradley.

A priori, we would expect capacity and volume to move in the same direction, and by roughly comparable magnitudes. Strong growth in volume should be accompanied by strong growth in capacity. Modest declines in volume should be accompanied by modest declines in capacity. However, the system-wide capacity and volume measures in Professor Bradley's analysis often fail to meet this expectation. Growth rates of capacity and volume are often strikingly different, and sometimes differ in sign. For example, relative to the same day of week and quarter in FY14, the TRACS-based Intra-SCF volume estimate from Thursdays in the second quarter of FY15 increased

31.7 percent. Yet comparison of the TRACS-based capacity measure for the same two periods shows a decrease in capacity of -15.7 percent. It is clear that this change is much more likely to be a reflection of errors in the data than a true reflection of changes in volume and capacity over that year-long time period.[33] Yet, taken by itself, this observation would suggest that the elasticity of capacity with respect to volume is negative. This comparison (and many others like it) are a significant part of the variation informing Professor Bradley's variability estimates, as shown in Table 6. The prevalence of these types of examples – they occur on every contract type, every quarter, and in every year, and only a small subset are included in Table 6 – demonstrate once again the unreliability of the TRACS data for calculating variability estimates. [34]

Table 6: Selected Examples of Unbelievable Implications of the TRACS Data

FY	Quarter	Day of Week	Route Type	% Change in Volume relative to the same DOW-quarter one year earlier	% Change in Capacity relative to the same DOW-quarter one year earlier
[1]	[2]	[3]	[4]	[5]	[6]
2012	4	Friday	INTRA-SCF	101.39%	52.47%
2014	2	Thursday	INTRA-SCF	-7.48%	26.83%
2015	1	Thursday	INTRA-SCF	31.75%	-15.74%
2012	1	Monday	INTER-SCF	70.23%	5.72%
2012	4	Monday	INTER-SCF	-10.52%	14.41%
2015	4	Monday	INTER-SCF	98.34%	44.44%
2011	4	Monday	INTRA-NDC	-43.52%	-16.56%
2012	3	Monday	INTRA-NDC	54.82%	25.41%
2012	4	Monday	INTRA-NDC	85.06%	36.42%
2011	2	Monday	INTER-NDC	26.68%	-11.28%
2013	1	Monday	INTER-NDC	94.11%	32.26%
2013	1	Tuesday	INTER-NDC	13.13%	48.38%

Source: Calculations using the regression dataset used by Professor Bradley.

[33] If this is in fact a true reflection of how volume and capacity changed over that time, it raises serious questions about the nature and diligence of cost management in one of the Postal Service's largest cost centers.

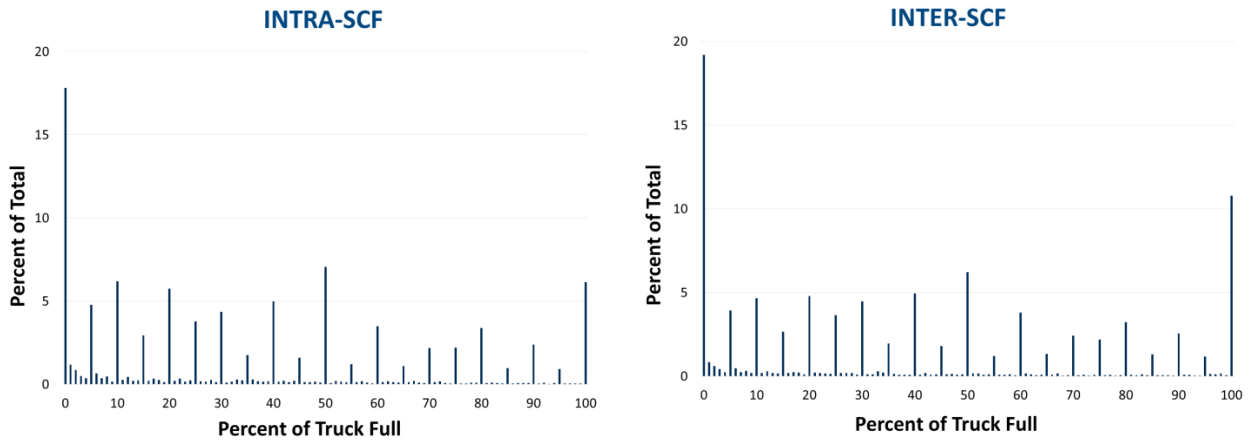
[34] The prevalence of these examples also suggests that the portion of the measurement error in volume that is independent of capacity – that associated with sampling variation in terms of at what point in their routes trucks are sampled – can swamp that portion of the measurement error that may be correlated with capacity (namely variation by day of the week or truck size).

Given the relatively small shifts in aggregate system-wide volume over time and the relative noisiness of the TRACS-based estimates as described above, it is clear that the sampling variability has caused the TRACS-based volume estimates to contain more noise than signal. The presence of such measurement error in independent variables in known to bias regression coefficient estimates.[35]

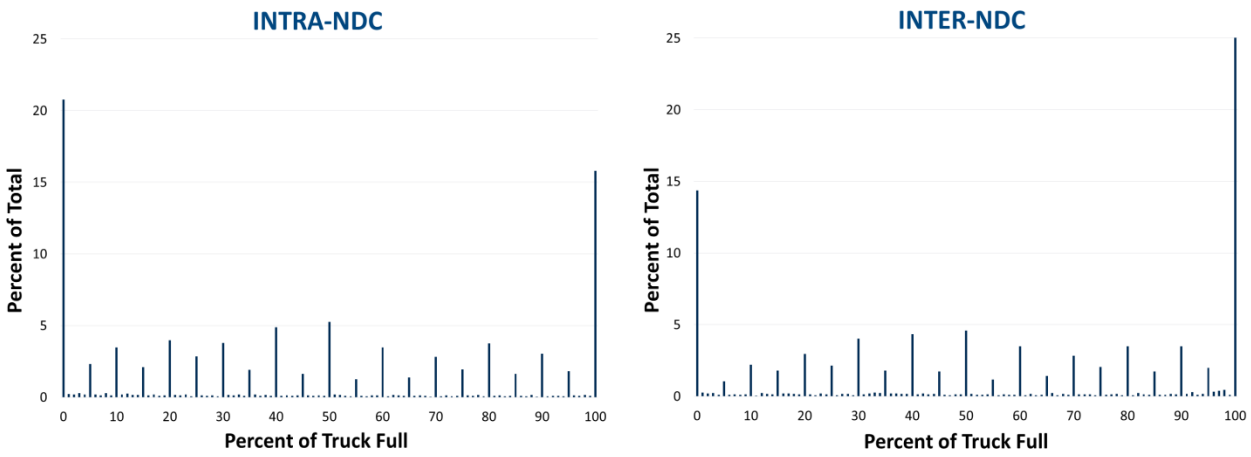
4. Measurement Error in the TRACS Data Collection Process Contributes to the Noisiness of Volume Estimates

Thus far, our discussion has focused on sampling variation as the source of noise and measurement error in the system-wide volume and capacity variables used by Professor Bradley. However, examination of the TRACS data reveals another clear source of measurement error that further reduces the reliability of his volume variable. His volume variables are based on measurements of how full a truck is upon completing the leg chosen for a TRACS test. However, it is clear from inspection of the data that the capacity utilization figures contained in TRACS are "guestimates" rather than the results of careful measurement, an outcome that is not surprising given the time and operational constraints on the data collection process. The imprecise nature of the data collection process is illustrated by the graphs presented in Figure 4.

Figure 4: Frequency Distribution of Truck Capacity Utilization Measurements from TRACS: FY10-FY15, by Contract Type



[35] See, *e.g.*, William H. Greene, *Econometric Analysis*, *Fifth Edition* (Pearson Education: 2003), pp. 84-86. This issue is discussed in further detail below.



Source: Proposal 4 data from USPS-RM2016-12-1 Library Reference.

The horizontal axes of these graphs present all possible values for the sum of two mail volume variables in the TRACS sample data – "unloaded" and "remain." These variables refer to the percentage of the truck volume that had been occupied by the mail that was unloaded, and the percent occupied by the mail remaining on the truck after the unloading process was completed. Their sum is the source of the test-level mail volume estimate that ultimately forms the basis for the aggregated volume estimates used by Professor Bradley in his regression analyses. The vertical axis in Figure 5 represents the relative frequency of a TRACS test taking a given value. The striking feature of these histograms is the overwhelming frequency with which the capacity utilization measurements fall on round numbers – those ending in 0 or 5. Across the four contract types, the share of observations that end in a number other than 0 or 5 is an improbably low 12 percent, as summarized in Table 7.

Table 7: Frequency of Capacity Utilization Measurements in TRACS Tests, FY10-FY15

	INTRA-SCF	INTER-SCF	INTRA-NDC	INTER-NDC	All Categories
% of tests that are:	[1]	[2]	[3]	[4]	[5]
Exactly empty	17.8%	19.2%	20.8%	14.4%	18.1%
Exactly full	6.2%	10.8%	15.8%	25.5%	13.8%
Between 1 and 99 and ending in 0	39.8%	37.1%	34.5%	31.4%	36.0%
Between 1 and 99 and ending in 5	21.3%	21.2%	18.8%	16.9%	19.7%
Between 1 and 99 and ending in number other than 0 or 5	15.0%	11.8%	10.1%	11.9%	12.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Proposal 4 data from USPS-RM2016-12-1 Library Reference.

It is clear that the Postal Service staff members recording TRACS measurements have a propensity to land on round numbers such as 40, 50, or 75 percent when estimating the capacity utilization of a partially-full truck. This happens 82 percent of the time for partially full trucks.[36] Furthermore, capacity utilization measurements from TRACS tests involving partially-full trucks are nearly twice as likely to end in 0 as they are to end in 5. We do not believe that these round numbers accurately reflect actual mail volumes. Rather, we believe that they reflect that fact that approximations are made in the data collection process – approximations that introduce some degree of measurement error. This rounding process means that measurements are persistently recorded with up to 5 percent of measurement error, assuming the rounding/estimation process is unbiased. Of course, the extent of the error could be greater if the measurements are inaccurate, which is certainly possible despite the best efforts of the TRACS measurers (which we are not questioning). This rounding process represents another source of measurement in the mail volume variables upon which Professor Bradley's analysis and conclusions rely.

B. THE MODEL PROPOSED BY THE POSTAL SERVICE IS MIS-SPECIFIED, AND FAILS TO CAPTURE THE TRUE DETERMINANTS OF CAPACITY DECISIONS

Our analysis has so far focused on the quality and reliability of the data upon which Professor Bradley's analysis is based. We turn now to the conceptual foundations of his analysis. The results of any regression analysis are only as good as the specification of the regression model that produced them. It is well established that in a regression analysis, failure to account for important factors affecting the variable of interest will introduce bias into the analysis results. Professor Bradley's model suffers from this type of bias.

The regression models estimated by Professor Bradley fail to account for numerous important factors shaping capacity decisions. His model does not reflect how such decisions are actually made. It reflects operationally and economically implausible assumptions about the capacity adjustment process. It ignores entirely the economic factors shaping decisions about capacity. And it fails to account for regional differences in mail volume trends.

We discuss these problems in more detail below.

---

[36] (35.7% + 19.5%) / (35.7% + 19.5% + 12.2%) = 82%. All numbers taken from Column 5 of Table 7.

1. Professor Bradley's Model Does Not Reflect How Capacity Decisions Are Actually Made

Professor Bradley's report recognizes the importance of analyzing the determinants of purchased highway transportation capacity at a level that is consistent with how decisions about capacity are made:

> We worked, in consultation with Postal Service experts, to identify and construct an appropriate unit of observation for investigating the relationship between volume and capacity. This unit of observation must both be consistent with economic decision making by Postal Service transportation managers and be consistent with collected variables in existing Postal Service data systems.[37]

There is ample evidence indicating that the correct unit of observation for such an analysis is a route. Immediately after the quoted passage Professor Bradley notes that the purchased highway transportation network is constructed using round trips from an origin facility to a destination facility with possible intermediate stops along the way.[38] The report submitted by the Postal Service in RM2014-6, in which the econometric analyses that provide the basis for determining the variability of cost with respect to capacity were updated, made a similar point:

> For this update, as was true for the Docket No. R2000-1 analysis, the appropriate unit of analysis is the contract cost segment, not the contract. 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.[39]

Even a brief consideration of operational realities suggests that one ought to analyze the determinants of capacity at the route level. Many if not most routes contain multiple stops at multiple facilities. At each, the truck will stop to drop off and/or pick up mail.[40] Thus, the volume of mail on the truck will

---

[37] Bradley Report, page 5.

[38] Ibid.

[39] "Report on Updating the Cost-to-Capacity Variabilities for Purchased Highway Transportation," Docket RM2014-6, June, 2014, page 7.

[40] Response to Question 1 of Chairman's Information Request No. 3.

vary continuously over the course of a route. It is generally neither operationally nor economically feasible to switch the vehicle used on a route at each point along the route where mail volumes change. The capacity of the vehicle assigned to a route must thus be large enough to accommodate the largest mail volume the vehicle is expected to encounter along the route. The volume of mail at the peak load point of the route will generally determine the amount of capacity that is provided at each stop along that route.

Despite the fact that the Postal Service's own documents emphasize the importance of analyzing capacity decisions at the route level, the econometric analyses upon which Proposal Four is based adopt a different approach. That analysis relies upon the TRACS data, which contain capacity and mail volume information for a sample of stops on the highway transportation network. The models presented in the Bradley Report relate capacity at a stop to the mail volume at that stop, and to little else.[41] There is nothing in the model describing the overall route, and it is only by chance that the volume measure included in the model will correspond to the volume at the peak load point along the route. For these reasons, the model is fundamentally mis-specified, and can be expected to produce biased results.

2. Professor Bradley's Model Implausibly Assumes That Capacity Can Be Adjusted in Response to Day to Day Variations in Mail Volume

As we have noted above, the econometric results presented by the Postal Service are derived from a dataset constructed by combining TRACS observations by day of the week and quarter. This structure is unusual. Indeed, aside from the predecessor analysis conducted by PRC staff that is discussed in the Bradley Report, we are aware of no other study based on a dataset constructed in this way. It is, as Professor Bradley concedes, "not a natural series in the sense of being regular observations at a known frequency like week, month, or quarter."[42] The focus in the predecessor study on day of the week related variation in mail volume and capacity was entirely understandable, given the issues addressed in the N2010-1 Docket. There are, however, no comparable issues in the current Docket suggesting that such an approach is needed, or even appropriate.

---

[41] The other variables in the regression model underlying the ultimate recommendations in Proposal Four also include a quadratic term in mail volume, a day-of-week scalar variable, and for the Intra-SCF routes, a Sunday indicator variable.

[42] Bradley Report, page 31.

Structuring the analysis in this way implies that all of the occurrences within a quarter of a specific weekday have so much in common that they can be grouped together and combined into a single observation. What they have in common is the typical day-of-the week related variation in mail volume. It is well established that there is a regular and somewhat predictable variation in mail volume using the highway transportation network over the days of the week.[43] Sunday is typically a low volume day, and Wednesday is typically a high mail volume day.

Treating the days of the week as distinct and separate observations implies that the amount of capacity provided on, say, a Friday is determined entirely by the typical mail volume on a Friday, and has nothing whatsoever to do with how much mail there is or how much transportation is provided on a typical Thursday, or a typical Saturday. This is a very strong and likely implausible assumption. There is no argument or evidence (other than citations to the predecessor study) in Professor Bradley's report suggesting that such an assumption is accurate or warranted. It would seem to be inconsistent with basic transportation economics and operational realities.

It goes without saying that any economically rational organization purchasing transportation will strive to minimize costs by purchasing only as much as it needs. The Postal Service has confirmed that it operates in this manner with respect to day of the week related variations in mail volume. In particular, it has stated that "To the extent possible, daily volume variations are taken into account by adjusting the frequency of the route schedule by day of week."[44] Although the Postal Service has stated clearly in this response what it strives to achieve, it is important to note that it has qualified its statement with the phrase "To the extent possible."

Although it is true that shippers strive to purchase no more transportation than they require, suppliers of transportation strive at the same time to keep their transportation assets fully utilized. A contractor who owns a truck will have to pay for that truck, regardless of whether or not it is productively employed and generating revenue. Given the choice between a contract that pays $200 per day for one day per week, and a second contract that pays $100 per day for five days per week, an economically rational truck operator will choose the latter because it offers higher utilization and

---

[43] That mail volume varies in a regular manner by day of the week is apparent from the TRACS data used in this docket. The day-of-week variation differs by contract type, but in all four contract types Sunday is among the lowest-volume days of the week while Wednesday is among the highest. See the public Library Reference accompanying my report for the calculation of average estimated volume by contract type and day of week.

[44] Response to Chairman's Information Request Number 3, Question 3a.

greater total revenue. An economically rational contractor may consider entering into a contract that uses his truck infrequently on high volume days, but will demand a premium to compensate him for the increased downtime that is likely to result from such an arrangement.[45]

These aspects of supplier behavior limit the ability and incentive of the Postal Service to adjust the capacity of its highway network to day of the week related fluctuations in mail volume. They also reduce its incentives to do so. The necessity of paying a premium for short term transportation services can result in a situation in which the cost of accommodating mail flows is minimized by supplying a more constant amount of transportation over the course of the week, sizing the amount of transportation provided to accommodate the highest volume day, and allowing the network to operate at partial capacity on other days. It is likely that the least cost solution will fall somewhere between running a distinct, customized network configuration for each day of the week, and supplying exactly the same amount of capacity on each day.

The plain implication of these economic realities is that decisions about how much capacity to supply on the different days of the week are interdependent. Another way to express this is that there are economies of scope connecting these decisions. Treating decisions about how much capacity to provide on the various days of the week as separate and independent decisions thus results in a model that is fundamentally mis-specified.

---

[45] Another way in which an economically rational contractor might respond to a request by the Postal Service that he transport mail one day a week might be to try to find other customers interested in hiring him on the other days of the week. In theory, he would be happy to enter into one day a week contracts if he could find enough one day a week customers with non-overlapping needs. However, putting such an arrangement together could require a lot of outreach, negotiation and transaction cost. There would always be a degree of risk that one or more of these individual contracts might expire or be terminated, leaving him with an underutilized vehicle. It is likely, therefore, that even if he could put such an arrangement together, a contractor would demand higher rates from his single day a week customers in order to compensate him for this risk.

It is not clear whether the contractors from which the Postal Service purchases highway transportation are free to enter into such arrangements. In response to Question No. 5 of Chairman's Information Request No.3 the Postal Service stated that "the vast majority of highway transportation contracts do prohibit the carriage of letters or goods outside the mail." However, it is not clear whether this statement means that the carriage of outside letters or goods is prohibited on the specific trips in which mail is being transported, or while the provider is under contract to transport mail.

Day of the week related variations in volume accounts for 60 to 88 percent of the total variation in volume contained in Professor Bradley's dataset.[46] Because of the factors discussed above, one would expect variations in mail volume across the days of the week to have much less effect on the amount of capacity that is provided than similar variations in volume across quarter or years. The net effect of treating the days of the week as separate observation is to bias downward estimates of the elasticity of capacity with respect to volume.[47]

3. Professor Bradley's Model Fails to Consider Economic Factors

The model presented by Professor Bradley is devoid of any economic content. There is nothing whatsoever in the model capturing relevant aspects of the economic environment, such as the price paid, the degree of competition among potential providers, or the value or time sensitivity of the mail that is being transported.

In addition, the plain implications of the model imply economically irrational behavior. Variabilities less than 100 percent imply that in the face of volume growth the Postal Service will add an increment of capacity that is less that the increment of mail volume. The clear mathematical implication of such behavior is that in the face of continued growth, the network will eventually reach a point where it is operating at 100 percent of capacity, and can no longer accommodate further growth in mail volume. And yet Professor Bradley's model indicates that the Postal Service would still underprovide capacity, allowing the volume of untransportable mail to grow without limit.

The situation described above need not be all that unrealistic. While it is widely-known that *piece counts* have dropped significantly over the last decade, it is not clear from the aggregate *volume*

---

[46] This percentage is based on a regression, for each route type, of the natural log of volume on day-of-week indicator variables. The resulting R-squared ranges from 0.604 (from the Intra-NDC regression) to 0.875 (from the Intra-SCF regression). These are available in the public Library Reference accompanying my report.

[47] Professor Bradley presents alternative results based upon a dataset constructed by aggregating TRACS observations by weeks. Bradley Report, pages 31-33. The variabilities produced by this alternative analysis are generally lower than those produced by his primary analysis. However, this alternative approach generates many more aggregated observations that have many fewer TRACS tallies per observations. As we explain below, we believe the lower variabilities produced by this alternative analysis are not, as Professor Bradley claims, an indication of the robustness of his results, but rather are an artifact caused by the much higher degree of observation-level measurement error associated with this approach.

estimates presented in Figure 1 and Figure 2 that the Postal Service is experiencing ongoing volume declines.[48] Furthermore, as we discuss in more detail below, mail volumes have been growing in some parts of the country. Review of the TRACS data indicates that 14 percent of the TRACS tests taken over the period analyzed by Professor Bradley found trucks that were operating at 100 percent of capacity. These facts suggest that there may well be places now within the network in which failure to add capacity in proportion to mail volume growth would threaten the ability of the Postal Service to accommodate the mail it is currently receiving.

Variabilities less than 100 percent imply that in the face of declines in volume the Postal Service will allow capacity utilization to fall without limit. There are a variety of ways in which the Postal Service can adjust and reconfigure its network. In response to changes in volume, the Postal Service has indicated that when mail volumes grow to the point where they can no longer be accommodated within the existing highway network the Postal Service tends to increase the number of trips made.[49] If that process works on the way up, it is hard to see why it would not also work on the way down. Furthermore, even in situations in which there is only a single trip a day along a route, it will often be possible to change the capacity of the vehicle deployed on that route. In addition, the Postal Service can and does sometimes reconfigure routes, creating the possibility of increasing capacity utilization by combining mail flows from a larger number of facilities. As we discuss in more detail below, the Postal Service also can and has restructured its facility network, achieving transportation savings in the process.

Despite the existence of all of these possible adjustment mechanisms, Professor Bradley's analysis implies that when faced with declining mail volumes the Postal Service will permit inefficiencies to accumulate within its highway network without limit.

4. Professor Bradley's Model Takes the Wrong Dependent Variable

A fourth fundamental problem with the econometric analysis contained in the Bradley Report is its failure to mesh with the models and analyses establishing the variability of cost with respect to capacity. The latter models relate changes in cost to changes in cubic foot miles of capacity, which is computed by definition as the product of truck capacity (measured in cubic feet), number of trips and

---

[48] As previously discussed, the ongoing volume declines were one of Professor Bradley's stated motivations for the research underlying Proposal 4. See Bradley Report, page 3.

[49] Response to Chairman's Information Request Number 3, Question 3a.

miles per trip.[50] However, the models that have been presented in the current docket focus on a different measure – "moving capacity," which is the product of truck capacity and number of trip legs.[51] These new models ignore the length-of-haul component of the cubic foot miles calculation.

One cannot merely assume that because route mileage is tied to plant locations it does not change over time. During the time period covered by this analysis the Postal Service carried out a significant reorganization of its network of mail processing plants. This reorganization involved the closure of numerous plants, the consolidation of mail processing activities in a smaller number of locations, and, necessarily, the restructuring of the transportation networks connecting those plants. During 2012 and 2013, the Postal Service consolidated 141 mail processing facilities during Phase 1 of its Network Rationalization Initiative.[52] In announcing this reorganization the Postal Service explained that part of the plan called for reductions in its transportation network.[53] The report on purchased highway transportation cost variability submitted in RM2014-6 noted that "in recent years, the Postal Service has been reorganizing its mail processing network, which could have implications for its transportation network."[54]

The fact that these extensive network restructuring activities were taking place throughout the period covered by Professor Bradley's data means that results from an analysis of the relationship between cubic feet of moving capacity and cubic feet of mail are likely at best a poor proxy for the results that might be expected to emerge from an analysis of cubic foot miles.

---

[50] "Report on Updating the Cost-to-Capacity Variabilities for Purchased Highway Transportation," Docket RM2014-6, June, 2014, page 2.

[51] Bradley Report, page 21.

[52] "Area Mail Processing Consolidations," Office of the Inspector General, United States Postal Service, Report Number NO-AR-15-007, June 5, 2015, page 1.

[53] "Lessons Learned from Mail Processing Network Rationalization Initiatives," Office of the Inspector General, United States Postal Service, Report Number NO-MA-13-004, March 27, 2013, page 10.

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

5. The Model Fails to Account for Geographic Variation in Mail Volume Trends

The regression results presented in the Bradley Report are based upon time series data on overall volume and capacity trends across the entire Postal Service network. This highly aggregated view masks and ignores important geographic differences in trends that can be expected to have important effects on the relationship between volume and capacity.

The Postal Service highway transportation network is made up of a large number of geographically distinct trips that are managed separately. The exact number of these trips is unclear. In its response to Question 1 of Chairman's information request No. 3 the Postal Service stated that the current highway network has over 120,000 trips operating daily. This number appears to be inconsistent with other facts in the record. In Q4 of FY15 there were nearly 8.6 million stops in the TRACS sampling frame, which amounts to approximately 94,000 stops per day, a figure that seems to imply that some of the 120,000 trips referred to above have no stops.[55] From the record in this Docket it is hard to determine the average number of stops per trip. However, the TRACS data do indicate the index number (i.e., whether the sampled stop was the first stop, the second stop, etc.) of each sampled stop. The highest value appearing in the data is 16. Inspection of the overall distribution of these values suggests that an average of 3 or 4 stops per trip is a reasonable estimate. Based on the lower end of this range, the 8.6 million stops per quarter reported in the TRACS documentation suggests that the highway network should have on average 31,000 to 32,000 trips per day – figures much smaller than what the Postal Service has reported.[56]

The facility codes used in the TRACS data represent distinct but unknown geographic locations. Based on route information in the raw TRACS data, it is possible to identify the codes that are used to refer to the 21 geographically dispersed NDCs.[57] We were able to associate most facility codes at which TRACS tests were taken to a single or dominant NDC. Focusing on those TRACS tests which we were able to map in this way to an NDC region, we developed a set of NDC-specific volume estimates. These estimates are admittedly imprecise, in that the regional mapping is incomplete, and

---

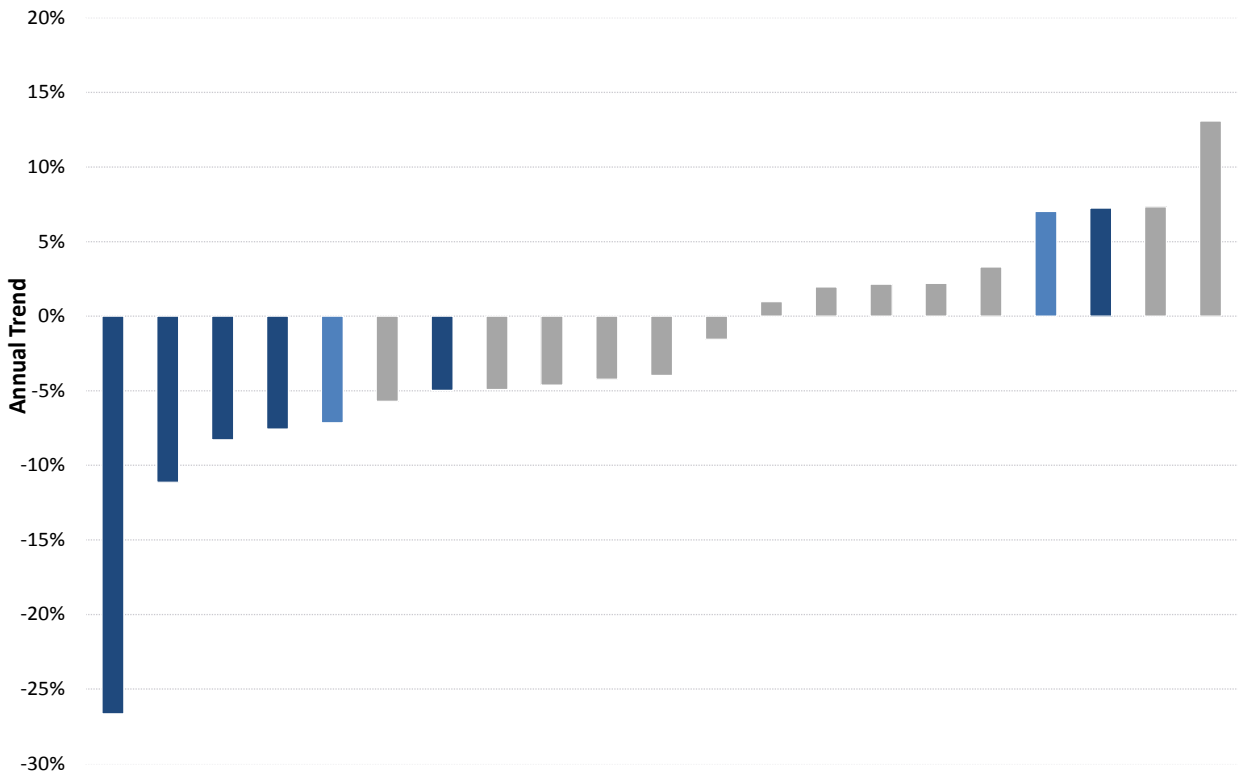
[55] See Preface to USPS-FY15-36, p. 1 (Table 6).

[56] 94,000 / 3 ≈ 31,000.

[57] The 21 NDC locations are Atlanta, Chicago, Cincinnati, Dallas, Denver, Des Moines, Detroit, Greensboro, Jacksonville, Kansas City, Los Angeles, Memphis, Minneapolis-St. Paul, New Jersey, Philadelphia, Pittsburgh, San Francisco, Seattle, Springfield (MA), Saint Louis, and Washington DC. See http://pe.usps.com/archive/html/dmmarchive20100607/L601.htm.

the volume estimates are comprised of a mix of mail volume coming into the region and leaving the region. Furthermore, because of the imprecision due to sampling variation, as we have discussed, they yield noisy estimates of these regional subtotals over time. Nonetheless, we have run simple regressions to estimate the time trend in each of the 21 regions. Despite the noisy data, we were able to discern some statistically significant trends. These simple regression analyses suggest that there is substantial variation across regions in volume trends over the 6 years analyzed in this docket. The point estimates of the regional annual growth trends for Intra-NDC volume are plotted in Figure 1, with those coefficients that were statistically significant highlighted in blue. The estimated average per year growth rates range from -27 percent to +13 percent. While these regional trends are not sufficiently well-established to use as the basis for a variability estimate in the current docket, they suggest that there is substantial geographic heterogeneity in mail volume trends that is not accounted for in Proposal Four.

Figure 5: Annual Volume Trend on Intra-NDC Routes by Approximate NDC Region



Source: 2010 – 2015 TRACS Data.

Note: Dark blue and navy blue indicate statistical significances with $p < 0.05$ and $p < 0.1$ respectively.

One cannot simply assume that volume growth in one region offsets volume declines in another region. There is likely to be an asymmetry in how the Postal Service responds to increases and decreases in volume. If growth in volume creates a situation in which the volume exceeds the available capacity, the Postal Service must either defer delivery of the excess mail, running the risk of failing to meet service standards, or else on short notice arrange for an increase in the amount of capacity provided. In its response to Question 6 of Chairman's Information Request No. 4 the Postal Service stated that it typically arranges additional trips in such a situation. In contrast, a decline in mail volumes creates no similar operational pressures. The Postal Service may decide to downsize the network in such a situation in order to reduce costs, but its ability to do so may be constrained by contractual commitments. And even if it is not constrained, it can exercise considerable discretion over when to carry out such a downsizing.

C. Because of Mis-Specification and Reliance on Imprecise, Error-Prone Data Postal Service Estimates of Capacity Variability are Biased Downward

Thus far, we have explored the shortcomings of the TRACS data and the mis-specification issues in Professor Bradley's analysis. In this section, we explain why these issues matter to the question at hand and provide evidence that the variability estimates presented by Professor Bradley are likely to understate the true variability.

1. Sampling Variation Biases the Variability Coefficient Downward

The sampling error infecting TRACS-based estimates of system-wide volume and capacity that we discussed at length above is important because it introduces bias into any regression coefficient estimates based on these independent variables. In the econometric literature, this noise is often referred to as measurement error. William Greene, the author one of the standard econometric textbooks states: "The general assessment of the problem is not particularly optimistic. The biases introduced by measurement error can be rather severe…A badly measured variable contaminates all the least squares estimates."[58] In the Postal Service's translog specification, more than one

[58] William H. Greene, *Econometric Analysis*, *Fifth Edition* (Pearson Education: 2003), pp. 84-86.

explanatory variable (both the linear and quadratic volume terms) is measured with error, which makes the direction of bias somewhat ambiguous.[59] However, as we explain below two relevant diagnostics suggest that in this case, the measurement error results in downward bias – that is, that the Postal Service estimates understate the true variability.

In this context, the "noise" takes the form of random variation in the aggregated measure of interest – specifically, volume – that is driven by random sampling variability, and is thus not reflective of true variation in volume that drives Postal Service capacity decisions. As an extreme illustration, consider the following thought experiment: suppose there are two successive quarters with identical mail volumes throughout the network (and thus at every stop-day), and that as a result the network administrator has set the number of trips and truck size at the same values in the two quarters. In the first quarter, the random sample from which the aggregate estimate of volume is comprised entirely of stop-days on which the trucks are 50 percent full, perhaps because the samples fall on intermediate points of routes in which the mail increases monotonically for the duration of the trip, or equivalently on intermediate points of routes in which the mail decreases monotonically for the duration of the trip. Suppose that the next quarter's aggregate estimate of volume is randomly comprised of stop-days on which the trucks are completely full, not because volume has changed but because the sampled stop-days correspond to legs that represent the peaks of their respective routes. The resulting aggregated estimates will indicate that volume has doubled but that capacity has not changed, which would imply a volume variability of capacity of zero. However, this is an illusion caused by the noise in the measures. We have not in fact learned anything about the relationship between capacity and true changes in volume. While this is an extreme example, Table 6 demonstrated that sampling variability in the TRACS data generates similarly nonsensical comparisons.

[59] Ibid, p. 86.

2. Evidence of Bias from the TRACS Data

After his initial econometric estimations, Professor Bradley makes a key modification to the construction of his regression data by eliminating TRACS tests with zero volume before aggregating up to the DOW-quarter-FY observations on which he runs his recommended regressions. Ultimately, the regression model he relies on for his recommended variabilities are based on this dataset constructed after dropping "zero-volume tests." His explanation for this modification is somewhat vague, though he recognizes that "[t]his potential mismatch could cause the data to understate the true relationship between the number of trips and volume and thus cause the estimated equations to understate the variabilities."[60]

These zero-volume tests are not evenly distributed throughout the DOW-quarter-FY observations, which is consistent with our sampling variability discussion thus far. On average, 19.5 percent of the TRACS tests underlying each aggregate observation had zero volume. However, this "zero volume share" ranged across Professor Bradley's constructed observations from as low as zero to as high as 77.8 percent. The presence of these zero volume observations illustrates the problem of mis-specification that we discussed above. The capacity of a route is determined by the volume at the stop corresponding to the peak load point of the route, but the sample is comprised of a random distribution of all stops. This is why we see zero-volume TRACS observations, which clearly are not determining the capacity of the routes to which they belong.

As Table 8 from the Bradley Report shows, excluding zero-volume tests significantly increases the variability estimates. Depending on the specification and contract type, removing zero volume tests increases variability estimates by anywhere from 7.4 to 21.7 percentage points relative to estimates where zero-volume tests are included.[61] Professor Bradley has estimated the equation on p. 16 of his report (where the natural log of the number of trips is the dependent variable) on two alternative datasets – one that is built using all 56,369 TRACS tests, and one that is built using only those 46,180 TRACS tests pertaining to non-empty trucks. The contrast between them illustrates how sensitive his results are to which points along a route happen to have been included in the TRACS sample.

---

[60] Bradley Report, page 18.

[61] See Bradley Report, p. 19.

To explore this sensitivity further we have estimated the equation shown on page 21 of Professor Bradley's report (where the dependent variable is the natural log of the TRACS-based capacity estimate) on five alternative datasets of observations constructed from the TRACS sample. The first two datasets are the same as those used by Professor Bradley – one built using all TRACS tests, and a second built excluding the subset of TRACS tests which recorded zero volumes. In addition, we constructed three additional datasets – one constructed using only TRACS tests where the truck was more than 10 percent full, a second constructed using only TRACS tests where the truck was more than 25 percent full, and one constructed using only TRACS tests where the truck was more than 50 percent full.

As we increasingly "concentrate" the sample to focus on TRACS tests that are closer to the peak load points on their routes, we derive higher and higher estimates of the variability of capacity with respect to volume. These results are presented in Table 8. The trend toward higher variabilities is visible in all four contract types. Concentrating the analysis in this way on the wheat and removing the chaff increases variability estimates substantially. When the regression dataset is built on TRACS tests that are closest to the peak load points on their routes – those where the truck was at least 50 percent full – the estimated variabilities are very close to 1.

Table 8: Variability Estimates Using Regression Datasets Based on Increasingly Full TRACS Tests

Subset of TRACS Tests Used to Construct the Regression Dataset	Intra-SCF Variability Estimate	Inter-SCF Variability Estimate	Intra-NDC Variability Estimate	Inter-NDC Variability Estimate
Full set of TRACS tests	0.611	0.751	0.621	0.763
Zero-volume TRACS tests dropped	0.773	0.821	0.788	0.848
TRACS tests with capacity utilization <=10% dropped	0.755	0.852	0.845	0.877
TRACS tests with capacity utilization <=25% dropped	0.916	0.911	0.928	0.932
TRACS tests with capacity utilization <=50% dropped	0.970	0.961	0.967	0.967

Source: Regressions using Proposal 4 data.

Notes: The values in this table are the implied variability estimates resulting from a series of regression analyses run on alternative estimation datasets built using the

TRACS data used in Proposal Four. In all cases, we used the translog specifications underlying the final recommendations in Proposal Four, with the exception of the autocorrelation correction used by Professor Bradley.

While we believe that focusing on the higher volume TRACS observations brings us closer to the true variability, we can hardly recommend this procedure as a solution to the problems we have identified. There is no way to determine how much sample trimming of this nature is enough. Given the design of the TRACS sample, it is impossible to determine whether the sampled stop corresponds to the peak point on that stop's route. In the absence of better data, limiting the TRACS tests included to those that are the most full only increases the likelihood that the remaining observations correspond to the peak point on a given route. At the same time, trimming the sample in this way reduces the available sample size and increases the sampling error in sytemwide estimates for capacity and volume. Nevertheless, this exercise clearly demonstrates the implications of Professor Bradley's failure to structure his analysis in a way that captures the actual Postal Service decision-making process.

3. Evidence from Simulated Data

Another way to test the reliability of Professor Bradley's methodology is to start with a dataset in which the parameter of interest – the variability of capacity with respect to volume – is known with certainty, apply that methodology, and then observe whether or not it produces the correct value for the variability. The only way, however, to find such a dataset is to build it from scratch. To do this we have constructed a representative model of the transportation of mail within a network whose structure mirrors that of the Postal Service. From this model we generate synthetic data with known properties. We then estimate Professor Bradley's model using these synthetic data.

a. Model Setup

A complete description of the model is contained in the Library Reference that accompanies this report. Here, we provide a high-level sketch of the model.

We first designate 10 delivery regions, and then randomly designate 50 population centers within each region. To these population centers we assign randomly-generated locations and populations. In this way we generate a total of 500 population centers. Within the largest such population center in each region we locate a transportation "hub" that is analogous to an NDC. In each of the remaining 49 locations in a region we locate a "node" that is analogous to an SCF. We use a gravity model to generate a base level of cubic mail volume for each of the resulting 249,500 origin-destination population center pairs.

Next, we specify an "outbound" (from the hub to the various nodes in the region) intra-regional route in each zone, using simple yet plausible choice heuristics. We also specify an "inbound" route which follows the outbound route in reverse order. We then specify an inter-regional route that minimizes the product of volume and distance, using the base level of mail volume discussed above. We again specify a corresponding route that goes in the reverse direction.

This simple network assigns a specific route to the mail flow between each possible origin and destination. Mail that originates in a specific population center is picked up by the intra-regional inbound route, and transported to the regional processing center. If it is destined to a population center in the same region, it will be carried by the intra-regional inbound route to that destination, or delivered on the intra-regional outbound route. If it is bound to a destination in another region, it will be transported to the processing center for that region on one on the inter-regional routes, and then will be transported to a destination population center on the intra-regional outbound route.

We generate daily mail volumes for each origin-destination ("O-D") pair, using the base level of mail volume matrix as the starting point. We incorporate day-of-week, quarterly, and annual variation in mail volume using multiplicative parameters that are based on observed Postal Service mail volume variation as measured in various Postal Service datasets. We also incorporate a multiplicative white noise parameter to O-D mail volumes to ensure that mail volumes do not move in rigid lockstep across the entire system.

Overall there are 22 routes, which fall into several categories. On the 10 "Part 1" routes (each of which has 49 legs), the mail generated on that day moves from the nodes toward the hubs. On the 2 "Part 2" routes (each of which has 9 legs), the mail that has originated in each region is transported to the hub serving its destination region. The 10 "Part 3" routes then distribute mail to its destination nodes.

This simple routing logic guarantees that each leg of the simulated highway network services a specific and known set of origin-destination mail flows. The volume of mail on that leg in any given time period can be computed simply by summing up the origin-destination mail flows, net of any mail that has been delivered at a previous point on the route. The resulting routes exhibit patterns of mail volume analogous to those described in the Postal Service's response to Question 1 of Chairman's Information Request No. 3. The simulated trucks on "Part 1" routes start their runs empty, and take on additional mail at each stop, arriving at the hub completely full. The trucks on "Part 3" routes start their runs completely full, and drop off mail at each stop.

By construction, we have specified that the capacity of each highway transportation route adjusts at the start of each quarter to accommodate exactly the maximum volume that will be encountered on a route. In this way we guarantee that variability of capacity with respect to volume at the route level is equal exactly to 1. Mail volumes across the system vary (apart from O-D level white noise) in a lockstep fashion based on year to year growth rates and quarterly and weekly variation in mail volumes. Trucks are fully loaded only at their peak load points. At all other stops capacity utilization is less than one hundred percent. Capacity utilization at any given stop depends upon where that stop is along the route, and on the pattern of mail pick-ups and drop-offs along the route. The capacity of each route changes from quarter to quarter. Because of the way the simulation is constructed, the expected percentage capacity utilization at any given stop is constant over time.

b. Variability Estimates Decrease as the Sampling Rate Decreases

Our final data frame has a total of 2,185,620 stop-days, or roughly 91,000 stop-days per quarter. This quarterly total is comprised of 1,638 inter-zonal stop-days per quarter and more than 89,000 intra-zonal stop-days per quarter. We specify a range of sampling rates (10%, 2.5%, and 1% for inter-zonal routes and 10%, 2.5%, 1%, and 0.1% for intra-zonal routes). From these samples we construct a set of Bradley-style aggregate capacity and volume estimates.

We first estimate the variability of capacity with respect to volume using the entire population of stop-days in this universe. The resulting variability estimates, as shown in Table 9 for inter-regional routes and Table 10 for intra-regional routes, are equal to 1, with some very small rounding error induced by the random noise in O-D level mail volumes. The p-values, indicating failure to reject the null hypothesis that variability equals 1, are also shown there. These results indicate that at a sampling rate of 100 percent the model is able to recover the correct variability.

Next, to explore the implications of taking increasingly small samples on the expected variability estimate, we draw 100 random samples of stop-days at each of the specified sampling rates. For each random sample we follow a process like that used by Professor Bradley, multiplying by the inverse of the sampling rate to construct aggregate measures that represent population estimates of quarterly system-wide capacity and volume. For each sample we estimate regressions that are comparable to those estimated by Professor Bradley. Specifically, we estimate regressions where the composite observation corresponds to capacity (in cubic foot legs) and volume (in cubic foot legs) in a given quarter-year. Those results are presented in Table 9 (for inter-zonal routes) and Table 10 (for intra-zonal routes). In both sets of results, we present the average of the 100 variability estimates, as well

as the percentage of the 100 replications in each sample rate for which the null hypothesis (that variability is equal to 1) is rejected.

Table 9: Results from Regressions on Synthetic Data: Quarterly Inter-Regional Specification

Population Results		
	Variability Estimate	p-Value on Null Hypothesis (Variability = 1)
	0.99	0.6090

Summary of Estimation Results from Sampling Exercise		
Sample Rate	Average Variability Estimate (over 100 samples)	Rejection Rate (over 100 samples)
Using a 10% Sample	0.48	0.96
Using a 2.5% Sample	0.17	1.00
Using a 1% Sample	0.08	1.00

Source: Simulation Data Output.
Notes:
[1]: Analysis excludes the starting point of each route.
[2]: Regression of population estimate ln(capacity) on ln(volume) with quadratic volume term. Regression includes quarter dummies (quarter 1 dummy omitted).
[3]: Rejection rate is the share of samples that yield a variability estimate that rejects the null hypothesis (variability = 1) at a 95% confidence level.

Table 10: Results from Regressions on Synthetic Data: Quarterly Intra-Regional Specification

Population Results

Variability Estimate	p-Value on Null Hypothesis (Variability = 1)
1.00	0.7872

Summary of Estimation Results from Sampling Exercise

Sample Rate	Average Variability Estimate (over 100 samples)	Rejection Rate (over 100 samples)
Using a 10% Sample	0.96	0.08
Using a 2.5% Sample	0.83	0.48
Using a 1% Sample	0.65	0.82
Using a 0.1% Sample	0.15	1.00

Source: Simulation Data Output.
Notes:
[1]: Analysis excludes the starting point of each route.
[2]: Regression of population estimate ln(capacity) on ln(volume) with quadratic volume term. Regression includes quarter dummies (quarter 1 dummy omitted).
[3]: Rejection rate is the share of samples that yield a variability estimate that rejects the null hypothesis (variability = 1) at a 95% confidence level.

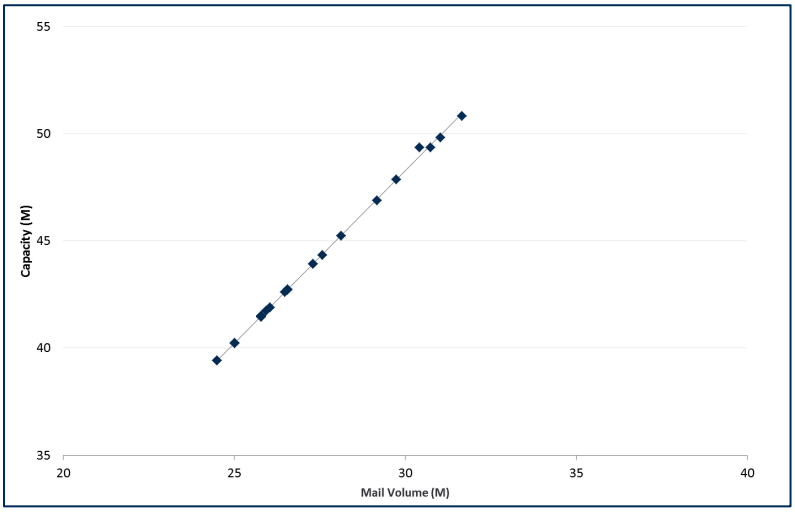
For both types of routes, the variability estimate declines noticeably as we draw smaller samples – as the volume and capacity estimates become increasingly noisy. Likewise, the percentage of samples for which the null hypothesis is rejected increases as the sample size decreases.

Figure 6 – Figure 8 demonstrate graphically the effect of the sample rate on the estimated variability of capacity with respect to volume, by comparing the quarterly population estimates with the actual population totals from the inter-zone routes.[62] The data in Figure 6, a scatter plot of the actual mail capacity on the actual mail volume, fit tightly to the linear trend line (with only slight variations, due

[62] Only the inter-zone figures are presented in this report for brevity and are intended to be demonstrative. Similar figures plotted for data from the intra-zone routes are presented in the Library Reference accompanying our report.

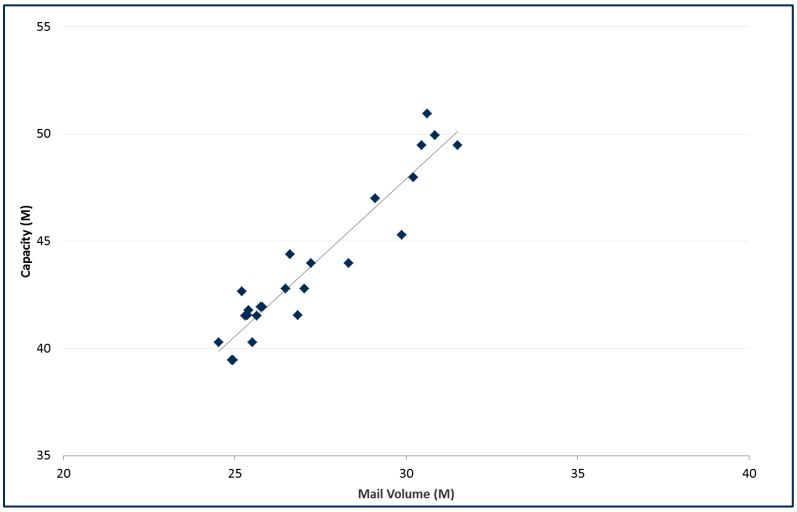
to the introduction of O-D level noise in the model). The quarterly population estimates in Figure 7, taken from one of the 10 percent samples of the synthetic dataset, exhibit the effects of introducing the additional noise from sampling variability. In particular, the relative imprecision of the volume and capacity estimates, relative to Figure 6, results in a slightly more "cloud-like" distribution of the data. The line of best fit has a flatter slope, implying a lower variability estimate. Finally, Figure 8 presents the volume and capacity estimates from a 1 percent sample from the data. Here, the data are even more dispersed, and the resulting trend line and variability estimate are even flatter. Despite the close fit of the population data to the linear trend line, the population estimates generated by smaller sample rates can falsely suggest a much weaker relationship between capacity and volume. This graphical illustration (which employs an identical scale across the three graphs) provides insight into how decreasing sample size, and the resulting imprecision in the sample-based population estimates of system-wide capacity and volume, decreases the accuracy and reliability of the corresponding variability estimate.

Figure 6: Scatter Plot of Inter-Zone Population Quarterly Capacity on Mail Volume



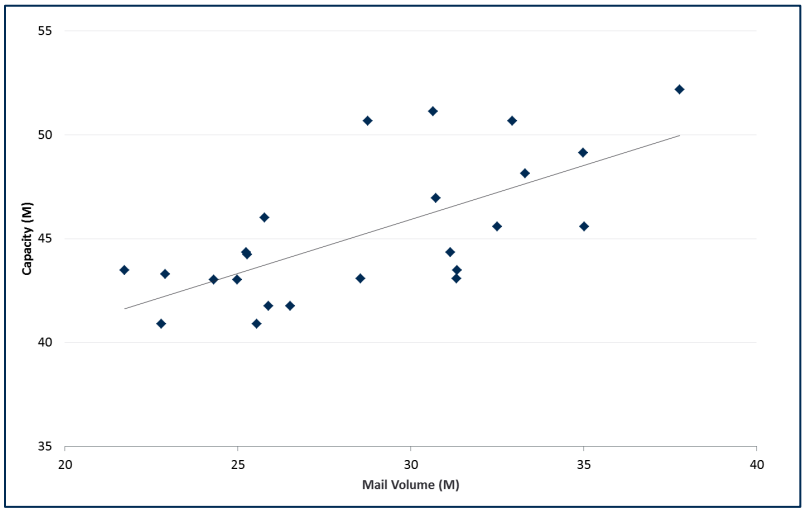
Source: Simulation Dataset
Notes: Population estimates exclude observations where mail volume = 0.

Figure 7: Scatter Plot of Inter-Zone Population Quarterly Capacity on Mail Volume Estimated Using a 10% Sample



Source: Simulation Dataset
Notes: Population estimates generated using 10% sample. Population estimates exclude observations where mail volume = 0.

Figure 8: Scatter Plot of Inter-Zone Population Quarterly Capacity on Mail Volume Estimated Using a 1% Sample



Source: Simulation Dataset
Notes: Population estimates generated using 1% sample. Population estimates exclude observations where mail volume = 0.

We recognize that some features of the synthetic network we have created abstract from some of the operational complexities inherent in the Postal Service's highway transportation network. This is at least in part a function of time constraints and constraints on computing power while still seeking to

generate a data universe that, while nowhere near as large as the actual purchased highway transportation network, is still sufficiently large to fulfill its purpose. Specifically, the intent of this exercise is to demonstrate the effect of sampling variation on the precision of estimates of capacity-to-volume variabilities using the approach and framework proposed by the Postal Service. Furthermore, we suspect that some of the abstractions we have necessarily made in this exercise – such as the relative homogeneity of the routes we have created – have the effect of understating the extent to which thin samples can understate variability estimates in the proposed framework. However, it is reasonable to conclude that the low sampling rates in the TRACS data – ranging from 0.01 to 0.5 percent - have resulted in a similar downward bias of the resulting variability estimates recommended by Professor Bradley. The model we have created is not similar enough to the actual Postal Service transportation network to quantify the extent of the downward bias and thus to calculate the true variability. But it is clear to us – and should be clear to the Commission – that the analysis underlying Proposal Four does not reliably establish that the variability of capacity with respect to volume is anything less than proportional.

VII. Conclusions

The Commission and the Postal Service have traditionally assumed that the amount of capacity provided by the purchased highway transportation network varies directly with mail volume. In our view this is not merely an assumption of convenience, but an eminently reasonable assumption. One of the first principles of efficient network design and operation is that one should strive to provide just enough capacity to meet demand, and no more.

Nonetheless, in this Docket the Postal Service, with the help of Professor Bradley, has called this assumption into question. They have presented the results of a series of econometric studies purporting to show that the variability of capacity with respect to volume is significantly below 100 percent. On the basis of these results, they have asked the Commission to move approximately half a billion dollars of attributable costs to the institutional cost category.

The request should be rejected. The studies supporting this request are based upon inappropriate data subject to an inordinate amount of sampling error, and these studies reflect a view of capacity decision making that is sharply at odds with the Postal Service's own statements about how it manages its highway network. Together, these defects introduce substantial downward bias into the estimates of capacity variability that the Postal Service has put forward. There is no reliable evidence

in these studies that calls into question the accuracy of the traditional assumption that capacity varies directly with volume.

In these studies the Postal Service has used the TRACS data for a purpose for which it was never designed and for which it is demonstrably unsuited. The estimates of system-wide capacity and mail volume generated form these data are imprecise, and inconsistent with information drawn from other more robust Postal Service data systems. They frequently imply wildly implausible quarter to quarter changes in what they purport to measure.

The conceptual framework upon which these studies are based reflects unrealistic assumptions about how routes operate and how decisions are made. The models that have been presented imply that the amount of capacity available at a particular point on a route is completely determined by the mail on the truck at that point, and has nothing to do with anything happening at other points. Such a view makes no operational sense.

We have shown that the approach adopted here by the Postal Service is incapable of generating reliable estimates of capacity variability. It produces variabilities significantly below 100 percent, even in a setting in which by construction capacity and mail volumes move together in lockstep fashion.

We find nothing in Proposal Four that remedies a significant inaccuracy, or significantly improves the quality, accuracy, or completeness of Postal Service data or the attribution of costs to products.

We are puzzled that out of all the areas in which Postal Service costing methodology requires refinement or improvement, the Postal Service has selected this one for empirical study. As we have stated, we are comfortable with the traditional assumption that capacity moves in direct proportion to volume. Nothing that has been presented here calls into question the accuracy of this assumption. We urge the Commission to reject Proposal Four, and we urge the Postal Service to move on to more pressing and urgent problems.

Appendix A:
Resume of Dr. Kevin Neels

Dr. Kevin Neels directs the Transportation Practice at *The Brattle Group*. Dr. Neels has more than 30 years experience as a consultant and expert witness in the rail, trucking, courier, postal, aviation, and automotive industries. He has led many significant engagements relating to competition, market structure, pricing, revenue management, distribution strategy, regulation, and public policy. His work has addressed issues related to system planning, competition policy, privatization, and congestion management.

Prior to joining *The Brattle Group*, Dr. Neels served as Vice President and leader of the transportation practice at Charles River Associates. He has also served as a researcher in the Urban Policy Program at the Rand Corporation and the Transportation Studies Program at the Urban Institute, as a Director in the Transportation Practice at the consulting firm of Putnam, Hayes & Bartlett, as a Management Consultant in the Transportation Practice of the firm now known as KPMG. Dr. Neels is currently Chairman of the Committee on Freight Transportation Economics and Regulation of the Transportation Research Board, an arm of the National Academy of Sciences. He is also a member of the Transportation Research Board's Committee on Airline Economics and Forecasting.

Dr. Neels has authored numerous research reports, monographs and articles for peer-reviewed journals. He has often been asked to offer expert testimony in legal and regulatory proceedings. He regularly serves as an invited speaker at conferences and industry forums, and his opinions and observations on industry developments are frequently quoted in the popular and trade press. Dr. Neels earned his Ph.D. from Cornell University.

A sample of the project experience of Dr. Neels is shown below.

EXPERIENCE

- ***Freight Transportation***

  - ♦ Dr. Neels served as the principal competition witness for the acquiring party in a proceeding before the Surface Transportation Board regarding the merger of the two largest short line railroad holding companies in the U.S. In connection with this work he analyzed every point of contain between the rail systems owned by these two companies, an analyzed the competitive implications of placing the combined networks under common control.

  - ♦ For an Ex Parte proceeding before the Surface Transportation Board Dr. Neels provided written testimony regarding procedures for settling disputes over the reasonableness of rail transportation rates. His testimony related to aspects of the Standalone Cost methodology employed by the Board in resolving these disputes, focusing in particular on the role that third party traffic plays in such analyses, and the manner in the revenues associated with such traffic are assigned to different portions of the routes followed by such traffic. His testimony discussed the typical structure of North American freight rail networks, and the roles that gathering, branch and main lines play in assuring the overall economic viability of the network as a whole.

  - ♦ For a major U.S. based freight railroad, Dr. Neels developed a system of models to predict traffic

levels and revenues by carrier for the North American freight rail market under alternative scenarios regarding market structure and regulatory policy. This modeling system incorporated detailed representations of the North American rail and highway networks, algorithms for determining shipment routing under alternative operating policies, and a series of statistical models capturing the underlying structure of freight traffic flows.

- ♦ For a non-U.S. government client, Dr. Neels led the team serving as fairness advisors in connection with the privatization of a government owned railroad. This engagement involved review of and commentary upon the bidding procedures employed in the transaction, analysis of the extent to which different bidders addressed and resolved policy concerns expressed by government officials, and advising government officials regarding the extent to which the various bids received reflected the full market value of the operation.

- ♦ On behalf of a provider of services to long-distance trucking firms, Dr. Neels offered expert testimony on the status of the trucking market, and on the extent to which a downturn in that market affected the value and economic viability of trucking firm service providers during a period in which his client concluded a series of acquisitions.

- ♦ In testimony before the U.S. Postal Rate Commission, Dr. Neels offered expert testimony analyzing the procedures used by the U.S. Postal Service to measure the transportation costs associated with its various products. His analysis addressed a wide range of issues, including the Service's use of its dedicated air network for transportation of expedited products, fieldwork procedures used to collect data on composition of the mail stream at different points in the rail network, potential biases in the assignment of transportation costs to products, and flaws in econometric analyses of transportation cost variability introduced by other witnesses in the proceeding.

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

- ♦ For a major U.S. railroad involved in a commercial dispute over trackage rights and trackage fees, Dr. Neels conducted a detailed analysis of over-the-track incremental operating costs. This analysis involved, among other things, extensive use of the Uniform Rail Costing System maintained by the Surface Transportation Board.

- ♦ For a major North American rail car manufacturer involved in a patent infringement lawsuit Dr. Neels offered expert testimony on the economic value of an innovative car design relative to existing designs, and on the damages imposed on the manufacturer as a result of infringement of its patents on this new design.

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

- *Airline Industry*

  - ♦ For a major U.S. network air carrier Dr. Neels was a key member of a team of consultants charged

with the development of an operations research strategy aimed at improving the carrier's performance and competitive standing across a broad range of areas of operation, including financial planning, scheduling, crew management, maintenance, flight operations, air cargo sales, marketing, reservations and distribution. This engagement involved extensive onsite interviews with numerous operating personnel at the carrier's headquarters. It identified a lengthy list of investment opportunities involving the application of a variety of advanced decision support tools.

- For a major international air carrier accused of monopoly leveraging and attempted monopolization of a key market, Dr. Neels prepared a report analyzing the carrier's use of corporate discounts and travel agent override commissions, and rebutting arguments that these agreements could be construed as exclusive dealing.

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

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

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

- In an antitrust dispute in the airline industry, Dr. Neels was retained by the defendant to critique and rebut damage calculations prepared by experts for plaintiffs. Dr. Neels conducted a detailed analysis of the assumptions underlying plaintiff estimates of lost profits, documenting numerous instances in which specific assumptions were contradicted by industry experience or by business plans prepared by the plaintiff prior to litigation. He showed that correcting these errors resulted in dramatic reductions in estimates of plaintiff damages. The case was eventually dismissed without an award of damages.

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

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

- *Airport and Airway System*

- For the International Air Transport Association, Dr. Neels conducted an analysis and critique of a proposed change in the structure of air traffic control user charges levied on foreign carriers

entering the U.S. and overflying its territory. He pointed out a number of serious flaws in the empirical analysis that formed the basis for the new system of charges. Implementation of the new charges was halted by a federal judge.

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

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

- For the operator of a major U.S. hub airport, Dr. Neels developed a series of forecasting models for use in evaluating likely passenger responses to the introduction of new types of ground access services.

- For the government of a Mexican province, Dr. Neels developed a framework for use in evaluating proposals for new airport development.

- For a conference sponsored by the National Academy of Sciences, Dr. Neels analyzed the policy issues raised by proposals for using pricing to manage demand and reduce delays at major airports. His analysis used standard antitrust tools to assess the extent of concentration in the market for airport services, and evaluated the potential for anticompetitive behavior in that market.

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

- For an international gateway airport, he evaluated the impacts and effectiveness of a wide range of strategies for reducing delays. The policies considered included regulatory constraints on aircraft size, diversion of service to adjacent airports, a variety of pricing and slot allocation mechanisms, and expansion of facility capacity.

- ***Aerospace Manufacturing***

- For a foreign manufacturer of high end business jet aircraft Dr. Neels offered testimony on the structure of the market within which these aircraft are sold and the relationship between this market and the market aftermarket retrofits and modifications. His testimony examined the turnover of the existing fleet of high end business jet aircraft, trends over time in resale values, the relationship between new aircraft sales and trade-ins of previously owned aircraft, and the factors influencing the commercial success of aftermarket modifications under FAA supplemental types certificates.

- For a consortium of aerospace manufacturers, Dr. Neels examined and evaluated the economic, financial and policy arguments for including manufacturers as members of government sponsored insurance against war and terrorism risks. His analysis examined the nature of the risks in question, the state of the commercial market for insurance against them, the realities of multi-party tort

litigation in settings where the parties enjoy dramatically different levels of insurance coverage, and the likely long-term economic impacts if aerospace manufacturers were because of the shut down of the commercial insurance market, forced involuntarily to self-insure against these risks.

- ♦ For a major manufacturer of business jet aircraft accused of monopoly leveraging and attempted monopolization Dr. Neels conducted an analysis of the structure of the business jet aircraft market, evaluating the extent to which availability of comparable models from other manufacturers constrained the ability of the defendant in the dispute to exercise market power.

- ♦ For a U.S. based manufacturer of business aircraft, Dr. Neels quantified the damages resulting from significant defects in a major subcontractor-supplied aircraft component. These defects had resulted in a number of plane crashes and the eventual grounding of a significant portion of the manufacturer's fleet. Dr. Neels developed a sophisticated econometric model that controlled for the effects of a number of market-related background factors, and isolated the effects of the component defects on sales, revenues and profits.

- ♦ For a manufacturer of high end business jet aircraft involved in a dispute over the closure of a manufacturing plant, Dr. Neels offered expert testimony on the status of the business jet aircraft market at the time of the closure and its effects on new orders, backlog and revenue for the manufacturer. His analysis focused in particular on the effects on the business jet aircraft market of the economic downturn that began in 2001 and the events on September 11, 2001. In response to testimony offered by opposing experts, he also analyzed the decision making process that led to closure of the plant, the options open to management, and the economic justifications for closing the plant.

- *Automotive Industry*

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

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

  - ♦ For a group of automobile dealers engaged in a dispute with a distributor, Dr. Neels offered expert testimony analyzing the new auto allocation procedures used by the distributor, the distributor's policies regarding accessorization of new vehicles, and their economic effects of individual dealers. This work involved extensive econometric modeling of the dynamics of dealer inventories and the determinants of time to sale for individual vehicles.

  - ♦ For a consortium of U.S., European and Japanese auto manufacturers and related firms, Dr. Neels played a key role in a major investigation of long-term trends in mobility. This study was worldwide in scope, addressing urban, rural and intercity passenger and freight transportation in both the developed and the developing world. Its particular focus was on the sustainability of the current transportation system, and the extent to which exhaustion of fossil fuels, environmental constraints, infrastructure shortages or institutional barriers were likely to constrain mobility over the next several decades.

- *Other Project Experience*

♦ For an operator of vehicle and passenger ferry services to offshore islands, Dr. Neels conducted a detailed analysis of fares, costs, market structure, the extent to which particular services are subsidized, the structure of the market for ferry services, and the likely effects of changes in conditions of entry.

♦ For a major U.S. manufacturer that had been the target of industrial espionage and the organized theft of technology and other trade secrets, Dr. Neels offered testimony involving the stolen technology and, using a reasonable royalties approach, the damages suffered by the U.S. manufacturer as a result of the theft. At the conclusion of a jury trial in the United States, the manufacturer received a substantial damage award.

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

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

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

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

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

♦ For the New York State Science and Technology Foundation, Dr. Neels participated in a project to facilitate the transfer to civilian firms and the commercial exploitation of photonics technology developed for military applications at a research center established at a major New York State military installation. This project included an assessment of the commercial value of the technology, the identification of firms in the vicinity of the research center with the research focus and capabilities to absorb the technology, and the design of institutional mechanisms for facilitating and supporting technology transfer.

PUBLICATIONS

"The Economic Cost of Airline Flight Delay". With Everett B. Peterson, Nathan Barczi and Thea Graham. *Journal of Transport Economics and Policy*, Volume 47, Part 1 (January 2013): 107-121.

"Federal Funding of Transportation Improvement in BRAC Cases." Transportation Research Board (2011).

"Private Sector: Lessons for the Public Sector" in Freight Modeling:State of the Practice in Current Practice Session of *Freight Demand Modeling Tools for Public-Sector Decision Making* in Conference Proceedings 40, Transportation Research Board, September 25-27, 2006, pp. 25,26.

"Pricing-Based Solutions to the Problem of Weather-Related Airport and Airway System Delay." *Air Traffic Control Quarterly*, Vol 10(3) 261–284 (2002).

"Congestion, Pricing and the Economic Regulation of Airports." Transportation Research Board, The Federal Aviation Administration, Conference on Airports in the 21st Century (April 20, 2000).

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

"Clinical and Economic Value of Cardiovascular Nuclear Medicine." With Carla Mulhern. (September 1996).

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

"Innovations in Cardiac Imaging," With Stan N. Finkelstein and Gregory K. Bell, in *Sources of Medical Technology: Universities and Industry*, Ed. Nathan Rosenberg, Annetine C. Gelijns and Holly Dawkins, Washington D.C., National Academy Press, 1995

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

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

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

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

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

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

Institution, 1984.

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

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

PROFESSIONAL AFFILIATIONS

- American Bar Association
- American Economics Association
- Licensing Executive Society
- Transportation Research Board

TESTIMONY

Before the Postal Regulatory Commission, Washington, D.C., Reply Report on Behalf of United Parcel Service, Docket No. RM2016-2, March 2016.

Before the U.S. International Trade Commission, Expert Report in the matter of Certain Activity Tracking Devices, Systems, and Components thereof, Investigation No. 337-TA-963, February 12, 2016.

Before the Postal Regulatory Commission, Washington, D.C., Report on Behalf of United Parcel Service, Docket No. RM2016-2, October 2015.

Before the United States District Court, Southern District of California, Expert Report Regarding Damages to Warsaw Orthopedic, Inc., Case No, 08-CV-01512-CAB (MDD), September 2015.

Before the Surface Transportation Board, Reply of the Kansas City Southern Railway Company, Verified Statement, Finance Docket No. 32760 (Sub-No.46), August 2015.

Before the Postal Regulatory Commission, Washington, D.C., Supplemental Report on Behalf of United Parcel Service, Docket No. RM2015-7, June 2015.

Before the Postal Regulatory Commission, Washington, D.C., Report on Behalf of United Parcel Service, Docket No. RM2015-7, March 2015.

"A Review of the Pipeline and Hazardous Materials Safety Administration's Draft Regulatory Impact Analysis," with Mark Berkman, prepared for The Railway Supply Institute, Committee on Tank Cars, submitted in Pipeline and Hazardous Materials Safety Administration Notice of Proposed Rulemaking for Hazardous Materials: Enhanced Tank Car Standards and Operational Controls for High-Hazard Flammable Trains, Docket No. PHMSA-2012-0082 (HM-251), November 2014.

Before the U.S. District Court, Southern District of Indiana, Evansville Division, Expert Report in the matter of Berry Plastics Corporation v. Intertape Polymer Corporation, Civil Action No. 3:10-cv-0076-

RLY WGH, April 2014.

Before the United States International Trade Commission, Washington, D.C., Expert Report in the matter of Crawler Cranes and Components Thereof, Investigation No. 337-TA-887, December 2013.

Before the U.S. District Court, Central District of California, Declaration in the matter of Otto Bock Healthcare, LP v. Ossur HF and Ossur Americas, Inc., August 2013.

Before the Surface Transportation Board, Docket No. FD 35654, Verified Statement in the Genesee & Wyoming, Inc., Control, RailAmerica Inc., et. al., July 2012.

Before the Postal Regulatory Commission, Expert Testimony in the matter of Mail Processing Network Rationalization Service Changes, Docket No. N2012-1, April 2012.

Before the U.S. District Court, District Court of Delaware, Expert Report in the matter of Finjan, Inc. v. McAfee, Inc., Symantec Corp., Webroot Software, Inc., Websense Inc., and Sophos, Inc., April 2012.

Before the U.S. District Court, Northern District of Ohio Eastern Division, Expert Testimony in the matter of Skurka Aerospace, Inc. v. Eaton Aerospace L.L.C., April 2012.

Before the U.S. District Court, Northern District of New York, Expert Report in the matter of X-Ray Optical Systems, Inc. v. Innov-X Systems, Inc., April 2012.

Before the Surface Transportation Board, Docket No. 33506, Verified Statement in the Western Coal Traffic League – Petition for Declatory Order, November 2011.

Before the U.S. District Court, Central District of California, Expert Report in the matter of PSI Systems, Inc., Plaintiff and Counterdefendant v. Stamps.com Inc., Defendant and Counterclaimant, Case No. CV08-05233 ODW(JEMx), September 2011.

Before the U.S. District Court, Southern District of California, Expert Testimony in the matter of Medtronic Sofamor Danek USA, Inc.; Warsaw Orthopedic Inc.; Medtronic Puerto Rico Operations Co.; and Medtronic Sofamor Danek Deggendorf, GmbH v. Nuvasive, Inc., September 2011.

Before the Court of Chancery of the State of Delaware, Expert Testimony in the matter of W.L. Gore & Associates, Inc., Plaintiff v. Darrell Long and BHA Group, Inc. (d/b/a GE Energy), Defendants, C.A. No. 4387-VEP, April 2011.

Before the Circuit Court for Baltimore City, Expert Disclosure in the matter of My Professional Advice, Inc. et al., v. Persels & Associates, LLC., et al., Case No. 24-C-09-004666, September 2010.

Before the U.S. District Court, District Court of Utah, Central Division, Testimony in the matter of K-Tec, Inc., v. Vita-Mix Corporation, Case No. 2:06-CV-108, May 2010.

Before the International Court of Arbitration of the International Chamber of Commerce, Testimony in the matter of Aviation Partners Inc., v. Dassault Aviation S.A., ICC Case No. 15948/VRO (c. 16047/VR), February 2010.

Before the Court of Common Pleas of Lehigh County, Pennsylvania Civil Division-At Law and in Equity, Testimony in the matter of DRS Newco III, Inc., n/k/a Night Vision Systems, LLC, vs. Night Vision

Equipment Company Holdings, Inc., f/k/a Night Vision Equipment Company, Inc., Excalibur Holdings, Inc., f/k/a Excalibur Electro Optics, Inc. William H. Grube, Jr. and Phyllis Grube, Civil No. 2006-C-3878, November 2008.

Before the United States International Trade Commission, Washington, D.C., Expert Testimony in the matter of Certain Hard Disk Drives, Components Thereof, and Products Containing the Same, Inv. No. 337-TA-616, July 2008.

Before the U.S. District Court for the Northern District of Georgia Rome Division, Testimony in the matter of Interface, Inc., et. al. v. Collins & Aikman Floorcoverings, Inc., et. al., Civil Action No. 4:05-CV-0133-HLM, October 2007.

Before the U.S. District Court, Northern District of California, San Jose Division, Testimony in the matter of Tele Atlas N.V. and Tele Atlas North America vs. Navteq Corporation, Case No. C 05-1673 RMW July 2007.

Before the U.S. District Court, Middle District of Florida, Testimony in the matter of erinMedia, LLC vs. Nielsen Media Research, Inc. Civil Action No. 8:05-CV-1123-T24-EAJ. June 2007.

Before the U.S. District Court, District of Massachusetts, Testimony in the matter of DePuy AcroMed, Inc., and Biedermann Motech GMBH vs. Medtronic Sofamor Danek, Inc., f/k/a Sofamor Danek Group, Inc. and Medtronic Sofamor Danek, USA, Inc. Civil Action No. 01-CV-10165 (EFH), June 2007.

Before the U.S. Postal Rate Commission, Postal Rate and Fee Changes, Docket R2006-1. Expert Report and Live Testimony, October 2006.

Before the American Arbitration Association, Testimony in the matter of The New Piper Aircraft, Inc. v. AVCO Corporation, on behalf of its Textron Lycoming Division. Arbitration No. 55 Y 181 00528 03. June 2006.

Before the Surface Transportation Board, Docket No. 657 (Sub-No.1), Verified Statement in the opening submission of Union Pacific Railroad Company, May 2006.

Before the U.S. District Court Western District Central District of Washington at Seattle, Expert Report in the matter of Esquel Enterprises Ltd. vs. TAL Apparel Ltd and TALTECH Ltd., April 2006.

Before the U.S. Tax Court, Docket No. 21342-03, Testimony in the matter of Van der Aa Investments, Inc., a dissolved Delaware Corporation; and Terry L. Van der Aa, Trustee vs. Commissioner of Internal Revenue, December 2005.

Before the U.S. District Court for the District of Massachusetts, Docket No. 03-10820-GAO, Testimony in the matter of Paul Quaglia vs. Eaton Corporation and Cutler-Hammer, Inc., November 2005.

Before the U.S. Department of Transportation, Docket No. OST-2004-19214, Submission in support of American Airlines' comments on the joint application of Alitalia-Linee Aeree Italiane-S.p.A., Czech Airlines, Delta Airlines, Inc., KLM Royal Dutch Airlines, Northwest Airlines Inc., and Société Air France for approval of and Antitrust Immunity for Alliance Agreements, June 2005.

In the Matter of and Arbitration under Chapter Eleven of the North American Free Trade Agreement and the UNCITRAL Arbitration Rules, United Parcel Service of America, Inc, Investor, and The Government of Canada, Party, March 2005.

Before the U.S. District Court, Western District of Oklahoma, Testimony in the matter of Ponder, *et al.* vs. Gulfstream Aero Corporation, *et al.*, Civil Docket No. 5:02cv739, October 2004.

Before the Surface Transportation Board, Docket No. 27590 (Sub-No.3), Verified Statement in support of Trinity Industries' comments on TTX Company's application for approval of pooling of car service with respect to flatcars, April 2004.

Before the American Arbitration Association, Commercial Arbitration Tribunal, Testimony in the matter of Solvay Pharmaceuticals, Inc. vs. Duramed Pharmaceuticals, Inc., Case No. 53 181 00564 02, November 2003.

Before JAMS Arbitration, Testimony in the matter of Transcore Holdings, Inc. vs. Rocky Mountain Mezzanine Funding II, L.P.; Hanifen Imhoff Mezzanine Fund, L.P.; Moramerica Capital Corporation; and NDSBIC, L.P., and W. Trent Ates and Fred H. Rayner, September 2003.

Before the U.S. District Court Southern District of Ohio Western Division (Cincinnati), Testimony in the matter of Gooby Industries Corp., Century Box Division, and David S. Kagan vs. Frank J. Veneziano, and Weltman, Weinberg & Reis Co., L.P.A., September 2003.

Before the U.S. District Court Central District of California Western Division, Testimony in the matter of Winn Incorporated and Ben Huang vs. Eaton Corporation, July 2003.

Before the Superior Court of New Jersey, Law Division Docket No. CAM-L-6235-00, Testimony in the matter of Bruce Zakheim, M.D. on behalf of himself and all others similarly situated vs. AmeriHealth HMO, Inc., October 2002.

Before the U.S. District Court, Eastern District of Pennsylvania, Testimony in the matter of National Steel Car, Ltd. vs. Canadian Pacific Railway, Civil Docket No. 2:02cv6877, August 2002.

Before the U.S. District Court for the District of New Hampshire, Affidavit in the matter of George Lussier Enterprises, Inc., d/b/a Lussier Subaru, et al. vs. Subaru of New England, Inc., Ernest J. Boch, and Joseph A. Appelbee, June 2002.

Before the U.S. District Court for the District of Massachusetts, Expert Report in the matter of City of New Bedford, and New Bedford Harbor Development vs. Woods Hole, Martha's Vineyard & Nantucket Steamship Authority, May 2002.

Before the Court of Common Pleas, Cuyahola County, Ohio, Affidavit in the matter of KeyBank National Association vs. Corrillian Corporation, et al, April 2002.

Before the U.S. District Court for the District of New Hampshire, Affidavit in the matter of George Lussier Enterprises, Inc., d/b/a Lussier Subaru, et al., vs. Subaru of New England, Inc., Ernest J. Boch, and Joseph A. Appelbee, February 2002.

Before the Court of Common Pleas, Cuyahola County, Ohio, Expert Report in the matter of KeyBank National Association vs. Corrillian Corporation, et al, January 2002.

Before the District Court of the Fourth Judicial District of the State of Idaho, in and for the County of Ada, Testimony in the matter of Dirk Dunham Construction, Inc. vs. Ada County Highway District, Case No. CV OC 0005122D, June 2001.

Before the Federal Court of Australia, Queensland District Registry, Expert Report in the matter of State of Queensland vs. Pioneer Construction Materials Pty. Limited, Boral Resources (QLD) Pty. Limited, CSR Limited, Hymix Industries Pty. Limited, Goodmix Concrete Pty. Limited, Amatek Limited (trading as Rocla Concrete), and Excel Concrete Pty. Ltd., January 2001.

Before the U.S. District Court, District of Massachusetts, Expert Report in the matter of J.E. Pierce Apothecary, Inc., Sutherland Pharmacy Inc., Meetinghouse Community Pharmacy Inc., and Medfield Pharmacy, Inc., on behalf of themselves and a class of similarly situated entities v. Harvard Pilgrim Health Care, Inc., Health New England, Inc., CVS Corporation, and Pharmacare Management Services, Inc., January 2001.

Before the U.S. Postal Rate Commission, Postal Rate and Fee Changes, Docket R2000-1. Expert Report and Live Testimony, May 2000.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix B:
Resume of Dr. Nicholas Powers

Dr. Nicholas Powers is a senior associate at The Brattle Group with expertise in regulatory economics, industrial organization, and energy economics. Since joining Brattle in 2010, he has conducted econometric analysis in a variety of regulatory and competition-related disputes, with a particular focus on the transportation and electricity sectors. His work has included estimation of damages in large-scale price-fixing civil cases; estimation of the price effects of competitor entry and exit in geographic markets in the context of a proposed merger; and similar econometric work in antitrust matters in the payment card, plastics manufacturing, and transportation industries.

In energy matters, he has conducted several key pieces of analysis of price effects and drafted expert testimony in two separate litigation proceedings arising from the California electricity crisis of 2000-2001. He has also managed renewable energy procurement processes for multiple Pennsylvania utilities, overseen the statistical analyses in several New Source Review cases, assisted in quantifying the economic benefits of infrastructure investments in the natural gas distribution system for a mid-Atlantic utility, and helped to advise a mid-sized electric utility on regulatory strategy and alternative regulation options.

EDUCATION

- Ph.D., Business Economics, University of Michigan, Ross School of Business, 2010
- B.S., Applied Economics and Management, Cornell University, 2000

AREAS OF EXPERTISE

- Antitrust and Collusion
- Energy Economics
- Environmental Economics and Regulation
- Renewable Energy

EXPERIENCE

Regulatory

- On behalf of United Parcel Service, manage analysis and support expert witness in several regulatory dockets before the Postal Regulatory Commission. Apply regulatory economic principles and econometric expertise to detailed knowledge of USPS costing models; provide input on economic arguments and regulatory strategy. Conducted econometric analyses and assisted in the preparation of reports and

testimony in a number of Dockets before the Postal Regulatory Commission, including ACR2014, RM2015-7, RM2016-2, and RM2016-3.

- For an express package delivery carrier, managed the construction of an integrated Excel-based cost and demand financial forecasting model of the United States Postal Service (USPS), based on public USPS data and filings in previous Postal Regulatory Commission dockets.
- On behalf of Growth Energy, co-authored a report analyzing the role that higher ethanol blends of gasoline (E85) could play in meeting the proposed 2017 renewable volume obligations (RVOs) under the Renewable Fuel Standards (RFS) program. The report was filed with Growth Energy's comments in the Environmental Protection Agency's rulemaking docket regarding proposed renewable fuel standards for 2017.
- Researched alternative rate plans and presented results to senior management of a mid-sized electric utility as part of a regulatory strategy consulting engagement.
- For a mid-Atlantic utility, estimated economic benefits to ratepayers from natural gas service, as portion of eventual PUC filing justifying investments related to storm resilience of distribution system.
- For multiple regulated utilities in Pennsylvania, assisted in the design and management of the procurement of solar photovoltaic alternative energy credits (SPAECs) and in drafting testimony describing the procurement process. Responsibilities included: (i) designing the auction rules and bid forms; (ii) building a financial model to determine the likely value of the solar energy credits; (iii) providing a benchmarking study to determine if the bids were reflective of market fundamentals; and (iv) drafting a report to the Pennsylvania Public Utility Commission to secure approval of the procurements.

Antitrust

- In a large civil case concerning alleged collusion, executed the econometric analysis forming the basis of a report critiquing the opposition's damages estimates. Supported the expert testimony of Nobel laureate Daniel McFadden.
- On behalf of plaintiffs in a class action civil suit, conducted econometric and other statistical analyses in order to estimate economic damages from alleged price-fixing. Supported the expert testimony of Nobel laureate Daniel McFadden.

- Advise counsel representing a large multinational industrial firm by estimating overcharges stemming from a series of price-fixing conspiracies covering several input commodities.
- Performed econometric estimates of the price effects resulting from competitor entry and exit in geographic product markets to support expert testimony that assessed anti-competitive effects from a proposed joint venture.
- Conducted econometric analysis in evaluation of previous expert testimony that sought to quantify network effects in the payment card industry.
- Identified flaws in the econometric analysis of opposing experts in the context of settlement negotiations arising from price-fixing allegations in the plastics manufacturing industry.
- Supported testifying expert, on behalf of plaintiffs, in a competition matter related to vertical restraints.

Energy and environmental

- For the California parties, conducted several key pieces of analysis evaluating effects of tariff violations in the Summer of 2000 on CAISO market prices and drafted portions of expert testimony, in a litigation matter before the FERC arising from the California electricity crisis.
- For the California parties, conducted econometric analyses detecting the exercise of market power and price discrimination in the 2001 "CERS" period of the California electricity crisis. This analysis formed the basis of key parts of the testimony of two expert witnesses.
- Supervised the analysis for four cases in support of testimony relating to alleged New Source Review (NSR) violations at coal-fired power plants. For a Southeastern power cooperative, analysis of government's claims included examination of alternative baseline emission calculations, analysis of changes in fuel quality, and evaluation of long-run patterns in utilization, generation, and emissions, as well as econometric analysis of the determinants of emissions. For a Midwestern utility, analysis consisted of identifying long-term trends in pricing strategy, market dispatch outcomes, and emissions prices to inform PROMOD runs in order to generate emissions projections that are consistent with NSR regulations. For a Mid-Atlantic utility, the analysis

focused on long-run variation in coal plant operations, including analysis of changing market conditions that influenced that variation.

- For a valuation matter concerning a back-office IT services provider to retail energy suppliers, supervised the analysis for and supported industry witness in a report assessing the status and prospects of the retail energy service business in restructured states.
- For the Department of Energy and Pacific Northwest National Laboratory, co-authored a baseline report on electric transmission, distribution, and storage infrastructure in the United States as part of the inaugural Quadrennial Energy Review process.
- For the Department of Energy and Pacific Northwest National Laboratory, co-authored a report on the valuation of electric power systems and technologies as part of the Quadrennial Energy Review process.
- For a Southeastern generation and transmission electric cooperative, oversaw preparation of expert damages report and advised counsel on same in the context of an arbitration proceeding stemming from an alleged breach of contract.
- For a utility in the Southeastern United States, conducted a review of NERC region load forecasts. This consisted of econometric analysis to weather-normalize actual loads and evaluate the portion of the forecast error that could be attributed to variations in weather.

PROFESSIONAL AFFILIATIONS

- American Economic Association
- Energy Bar Association

ACADEMIC HONORS AND FELLOWSHIPS

- Thomas W. Leabo Memorial Award (University of Michigan), 2007
- Fred and Barbara Erb Fellowship (University of Michigan), 2005-2009

PUBLICATIONS

"Peeking Over the Blendwall: An Analysis of the Proposed 2017 Renewable Volume Obligations," by Marc Chupka, J. Michael Hagerty, Nicholas E. Powers, and Sarah Germain. Prepared for Growth Energy, July 2016.

"Electricity Baseline Report for the US Power System," by Ira Shavel, J. Michael Hagerty, Nicholas Powers, and Yingxia Yang. Prepared for Pacific Northwest National Laboratory and the Department of Energy, April 2015.

"Competitive Effects of Exchanges or Sales of Airport Landing Slots," by James D. Reitzes, Brendan McVeigh, Nicholas E. Powers, and Samuel Moy, Review of Industrial Organization, August 2014.

"Developing a Market Vision for MISO - Supporting a Reliable and Efficient Electricity System in the Midcontinent," by Samuel A. Newell, Kathleen Spees, and Nicholas E. Powers. Prepared for the Midcontinent Independent System Operator, Inc. (MISO), January 2014.

"Measuring the Impact of the Toxics Release Inventory: Evidence from Manufacturing Plant Births," by Nicholas E. Powers, U.S. Census Bureau Center for Economic Studies Working Paper Series, March 2013.

"Does Disclosure Reduce Pollution? Evidence from India's Green Rating Project," by Nicholas E. Powers, Allen Blackman, Thomas P. Lyon, and Urvashi Narain, Environmental and Resource Economics, March 2011.

"Do State Renewable Portfolio Standards Promote In-state Renewable Generation?" (with Haitao Yin) Energy Policy, February 2010.

SELECTED PRESENTATIONS

"Analyzing the Competitive Effects of Exchanges or Sales of Airport Landing Slots" at the International Industrial Organization Conference (2012)

"The Toxics Release Inventory and Manufacturing Plant Births" at Penn State University (2010), University of Maryland (2010), U.S. Census Center for Economic Studies (2009)

"Does Disclosure Reduce Pollution? Evidence from India's Green Rating Project", at Association for Public Policy Analysis and Management Fall Conference (2009), Allied Social Sciences Association Annual Meetings (2008), Southern Economics Association Annual Meetings (2007)