The Navigation Economic Technologies Program

May 2007

navigation · economics · technologies

Transportation Demands for the Movement of Non-Agricultural Commodities Pertinent to the Upper Mississippi and Illinois River Basin

US Army Corps of Engineers®

IWR Report 07-NETS-R-1

Navigation Economic Technologies

The purpose of the Navigation Economic Technologies (NETS) research program is to develop a standardized and defensible suite of economic tools for navigation improvement evaluation. NETS addresses specific navigation economic evaluation and modeling issues that have been raised inside and outside the Corps and is responsive to our commitment to develop and use peer-reviewed tools, techniques and procedures as expressed in the Civil Works strategic plan. The new tools and techniques developed by the NETS research program are to be based on 1) reviews of economic theory, 2) current practices across the Corps (and elsewhere), 3) data needs and availability, and 4) peer recommendations.

The NETS research program has two focus points: expansion of the body of knowledge about the economics underlying uses of the waterways; and creation of a toolbox of practical planning models, methods and techniques that can be applied to a variety of situations.

Expanding the Body of Knowledge

NETS will strive to expand the available body of knowledge about core concepts underlying navigation economic models through the development of scientific papers and reports. For example, NETS will explore how the economic benefits of building new navigation projects are affected by market conditions and/or changes in shipper behaviors, particularly decisions to switch to non-water modes of transportation. The results of such studies will help Corps planners determine whether their economic models are based on realistic premises.

Creating a Planning Toolbox

The NETS research program will develop a series of practical tools and techniques that can be used by Corps navigation planners. The centerpiece of these efforts will be a suite of simulation models. The suite will include models for forecasting international and domestic traffic flows and how they may change with project improvements. It will also include a regional traffic routing model that identifies the annual quantities from each origin and the routes used to satisfy the forecasted demand at each destination. Finally, the suite will include a microscopic event model that generates and routes individual shipments through a system from commodity origin to destination to evaluate non-structural and reliability based measures.

This suite of economic models will enable Corps planners across the country to develop consistent, accurate, useful and comparable analyses regarding the likely impact of changes to navigation infrastructure or systems.

NETS research has been accomplished by a team of academicians, contractors and Corps employees in consultation with other Federal agencies, including the US DOT and USDA; and the Corps Planning Centers of Expertise for Inland and Deep Draft Navigation.

For further information on the NETS research program, please contact:

Mr. Keith Hofseth
NETS Technical Director
703-428-6468

Dr. John Singley
NETS Program Manager
703-428-6219

U.S. Department of the Army
Corps of Engineers
Institute for Water Resources
Casey Building, 7701 Telegraph Road
Alexandria, VA 22315-3868

The NETS program was overseen by Mr. Robert Pietrowsky, Director of the Institute for Water Resources.

May 2007

navigation · economics · technologies

TRANSPORTATION DEMANDS FOR THE MOVEMENT OF NON-AGRICULTURAL COMMODITIES PERTINENT TO THE UPPER MISSISSIPPI AND ILLINOIS RIVER BASIN

Prepared by:

Kenneth Train, PhD
University of California at Berkeley

Wesley W. Wilson, PhD
University of Oregon and
Institute for Water Resources

For the:

Institute for Water Resources
U.S. Army Corps of Engineers
Alexandria, Virginia

IWR Report 07-NETS-R-1

www.corpsnets.us

Table of Contents

List of Tables

List of Figures

1. EXECUTIVE SUMMARY AND INTRODUCTION

This report continues the line of research introduced by the Navigation and Economics Technologies (NETS) to examine the structure of transportation demands for use in planning models. A review by the National Research Council of Army Corps planning models, as well as various surveys of transportation demand modeling (e.g. Clark et al. (2005)), point to a need to develop models that reflect the alternatives that individual shippers face and the responsiveness of the choices they make in terms of mode, destination and volume to changes in rates, transit times and reliability. Most previous models of freight demand in the literature are based on aggregate data either in a cross section or in time. These studies generally yield aggregate demand estimates that do not apply at a disaggregate level. Hence, there was a general lack of demand studies that apply directly to Army Corps planning models.

Under NETS, this need has been addressed through a series of surveys of individual shippers located in the Upper Mississippi and Illinois Waterway (Train and Wilson (2004)), the Columbia-Snake Waterway (Train and Wilson (2006)), and the Ohio River (Sitchinava, Wilson and Burton (2005)).[1] In each case, survey methods were used to identify and target shippers that could plausibly use the waterway. To this end, survey methods focused on shippers of commodities that have a historical presence on the waterway and on shippers of varying distance from the waterway to capture the effects of space that are central to the decision to use the waterway. Using these survey data, demand models have been estimated that yield significant evidence that shippers do respond to rates, time in transit and reliability. The responsiveness is two-fold. Shippers' discrete decisions (where and how to ship the product) and continuous decisions (the volume of shipments) are both embedded in most of the studies. In all cases, the analyses reinforce the notion that shippers respond to changes in attributes that can be affected by Army Corps infrastructure decisions.

Many different goods are transported on the waterway. Such commodities include agricultural commodities, coal, aggregates, petroleum and others. ACE models require estimates at a "pool" level of demands for each of the commodities. In a companion report (Train and Wilson, 2007), we describe a survey of 480 *agricultural* shippers. We then use the data to provide disaggregated information on the behavior of demand in terms of choices (mode/destination) and the annual volumes that are shipped. In this report, we report the results of a survey of *non-agricultural* shippers, and an analysis of the associated choice and volume responses to changes in rate, transit time, and reliability. To estimate these responses, we use survey data collected by the Washington State Social and Economics Research Center and coordinated by Dr. Kenneth Casavant.

The goal of the survey is to collect information pertaining to individual shipments and annual volumes for shippers of non-agricultural commodities. Primary non-agricultural commodities were identified from the Waterborne Commerce Statistics. Geographically,

[1] There has also been a host of different studies that have been conducted using these data and are published in a variety of different outlets. The citations enumerated contain the primary reports for each of the surveys conducted.

the population was defined as shippers in AR, IL, IN, KY, LA, MS, OH, TN, TX. This geographic distinction captures a sizable proportion of the tonnages that terminate on the Upper Mississippi and Illinois waterways and reflect upstream traffic apart from Coal and Aggregates.[2] The survey was stratified by commodity and by distance to the waterway. Information was collected for 232 observations. The observations were dominated by shippers that report they have but one option in shipping, and there were a number of missing values for shippers that have multiple options. This prevented the use of statistical procedures that had been developed under NETS that combine revealed and stated preference. The survey did, however, provide considerable information i.e., a much better frequency of usable responses, on stated preference responses. By limiting the data used to stated-preference data gave a larger number of responses to analyze relative to procedures that use both revealed and stated preference data.

As in the previous studies, the estimated models were separated into mode/destination choices and to volume decisions. The findings of this report can be summarized as follows:

1. Both the choice and the volume models provide strong evidence that shippers respond to changes in rate, time, reliability, price, and distance.
2. In mode choices, the results suggest that there are statistically important differences with respect to rail shipments compared to truck and barge shipments, but little, if any, differences across commodity groupings.
3. Rate arc-elasticities from mode/destination choices range from .58 to 3.6. Rail shipments tend to be more elastic than either barge or truck. Elasticities tend to be largest for a commodity grouping that includes wood, paper, coal, chemicals, plastics and fuel.
4. Time arc-elasticities from mode/destination choice range from .39 to 2.98. The patterns follow similarly. The elasticities for rail shipments tend to be higher than for either truck or barge and tend to be largest for the same commodity groupings.
5. Reliability arc-elasticities follow the same patterns as for rates and times.
6. Rate arc-elasticity estimates are larger than time and reliability elasticity estimates. And reliability elasticity estimates are larger than time elasticities estimates. These results suggest that in some sense, shipment decisions are more responsive to rates than to time and reliability, and shipment decisions are more responsive to reliability than time.
7. The analysis of the responsiveness of annual volumes to changes in rates, transit time, and reliability indicates statistically significant effects for each, with rates having the "largest" effects.
8. The volume response models generally did not point to statistically significant effects across different groups of commodities or the access that shippers have to different modes.
9. Elasticity estimates were almost always less than one in magnitude.

[2] From Waterborne Commerce Statistics, most tonnages of non-agricultural commodities that terminate in the Upper Mississippi arise from the Upper Mississippi. However, such movements are dominated by coal and aggregates. Once excluded, tonnages that originate on the Lower Mississippi dominate.

10. Rate elasticities were calculated for rate changes that apply to the shipper and its competitors and changes that apply only to the shipper. The range of rate elasticities for common rate changes i.e., rate changes that apply to the shipper and it competitors range from .27 to 1.2
11. Time and Reliability elasticity estimates point to relatively inelastic demands with virtually all elasticity estimates less than one in magnitude.

In Section 2, we present the data sources and summary statistics for the analysis. Section 3 documents our analysis of shippers' choice of mode and destination. Section 4 documents our analysis of shippers' annual volume.

2. DATA SOURCES AND DESCRIPTION

The analysis in this report is based on a survey of shippers located in nine states of selected commodities conducted in the fall of 2006. The survey was conducted by the Social & Economic Sciences Research Center (WSESRC) of Washington State University. Both the survey and construction of data were overseen by Dr. Kenneth Casavant. Primary commodities moved on the river and matched to shippers constructed from Dun and Bradstreet data files. These files contain information on the name and address of firms by SIC (Standard Industrial Classification) and NAICS (North American Industry Classification System) codes along with various other data. Primary movements that terminate on the Upper Mississippi apart from Coal and Aggregates, tend to arise from firms located in Arkansas, Illinois, Indiana, Kentucky, Louisiana, Mississippi, Ohio, Tennessee, and Texas. Hence, firms in these states and of those commodities were the target of the survey. Since a focus of the survey is the choices that shippers have between the waterway and non-waterway route, the sample was further stratified by location vis-a-vis the Mississippi waterway. There were two separate mail lists compiled from a stratified random sampling technique. In the first mail list, there were 1003 firms that included 718 located within 30 miles of the Mississippi waterway, and the remainder located more than 30 miles from the waterway. Due to a low response rate on the original list, a second list was developed that included 2009 firms. In this list, there were 1149 located within 100 miles of the waterway, and the remainder located more than 100 miles.[3]

The survey proceeded as follows. Firms in group 1 of the table below were first sent a pre-contact letter and a survey form. Approximately two weeks later, a reminder post card was sent, followed by a second survey form approximately two weeks later. Given mediocre response rates (in the sense of completed questionnaires), a second list was developed and administered in the same manner with largely the same results. WSESRC then contacted non-respondents via telephone to solicit additional responses.

Table 1 provides a summary of the results. The overall response rate defined as the fraction of completed and returned questionnaires is satisfactory with an overall rate of 19.13 percent. However, the number of ineligible shippers was substantial. That is, the fraction of respondents to total survey forms sent (232/3012) is quite small (7.7 percent). The primary reason for non-response is that the firms do not ship or are not relevant to the survey (e.g., small package shippers). Once corrected for ineligibility, the response rate is much better (19.13 percent).

[3] In the preparation of the second list, the stratification buffer of 30 miles was increased to 100 miles to insure an adequate number of river or potential river shippers.

Table 1. Survey Description

	Description	Group 1	Group 2	Total
a.	Starting sample size	1003	2009	3012
b.	Completed Mail Questionnaires	97	135	232
c.	Mailed New Questionnaire/Not returned by respondent	95	320	415
d.	Contacted, but status unresolved (CB, GB, HB)	3	7	10
e.	Not contacted (AM, BZ, ED, NA, WN)	48	251	299
f.	Refusals	53	101	154
g.	Non-working phone numbers (CC, DS)	41	62	103
h.	Ineligible (No Shipping or not defined type of shipping)	524	842	1366
i.	Ineligible (Out of business)	27	36	63
j.	Others (OT, DP, DD, HC, LG)	4	7	11
k.	Return to sender/Undeliverable Mail	111	248	359
	Raw Response Rate (Completes/Sample Size) [b/a]	9.67%	6.72%	7.70%
	Completion Rate (Completes/Eligible Sample) [b / b+c+d+e+f+g]	28.78%	15.41%	19.13%

Tables 2 and 3 contain the frequencies of shippers in the mail list and the sample by state and by commodity, respectively. In both cases, the number of shippers in the mail list is much larger than those in the sample. However, there were a number of shippers in the mail list that reported they were not appropriate to the survey. Shippers in IL and LA account for about 41 percent of the mailed surveys, and about 44 percent of the shippers in the sample. In general, the mail list frequencies and the sample frequencies are very highly correlated. Table 3 contains the NAICS codes and descriptions along with shippers represented in the mailings as well as in the sample.

Table 2. Mail list and Sample State Coverage

	Mail list		Sample	
State	**Freq.**	**Percent**	**Freq.**	**Percent**
AR	141	4.68	16	6.9
IL	605	20.09	67	28.9
IN	183	6.08	15	6.5
KY	188	6.24	15	6.5
LA	636	21.12	35	15.1
MS	245	8.13	16	6.9
OH	314	10.42	25	10.8
TN	210	6.97	14	6.0
TX	490	16.27	29	12.5
Total	**3,012**	**100**	**232**	**100.0**

Table 3. Mail List and Sample Product Summary

NAICS	Description	Mail list	%	Survey	%
211	Oil and Gas Extraction	419	13.91	14	6.03
212	Mining (except Oil and Gas)	343	11.39	40	17.24
213	Support Activities for Mining	117	3.88	2	0.86
221	Utilities	5	0.17	0	0.00
321	Wood Product Manufacturing	33	1.10	2	0.86
322	Paper Manufacturing	129	4.28	10	4.31
324	Petroleum and Coal Products Manufacturing	171	5.68	15	6.47
325	Chemical Manufacturing	616	20.45	55	23.71
326	Plastics and Rubber Products Manufacturing	41	1.36	4	1.72
327	Nonmetallic Mineral Product Manufacturing	571	18.96	42	18.10
331	Primary Metal Manufacturing	478	15.87	43	18.53
332	Fabricated Metal Product Manufacturing	47	1.56	3	1.29
424	Merchant Wholesalers, Nondurable Goods	18	0.60	0	0.00
447	Gasoline Stations	3	0.10	0	0.00
486	Pipeline Transportation	5	0.17	0	0.00
551	Publishing Industries (except Internet)	3	0.10	0	0.00
999	Other	13	0.43	2	0.86
	Total	**3012**	**100.00**	**232**	**100.00**

As shown in Table 3, the shippers in the mail list were dominated by chemicals (325), Non-metallic Mineral Products (327), Primary Metals (331), Oil and Gas (211) and Mining (212).[4] These account for 80 percent of shippers receiving the questionnaire. In the sample, chemicals accounts for 24%, non-metallic minerals for 18%, primary metals for 19%, oil and gas for 6% and mining for 17%. In total, these account for about 84 percent of the sample. Again, the sample seems indicative of the list from which it was drawn.

The survey instrument, provided in Appendix A, solicits information with respect to the attributes of the shipper, the attributes of the last shipment and alternatives to the last shipment, and a host of stated preference questions related to shipment attributes and annual volumes. Each are discussed in turn.

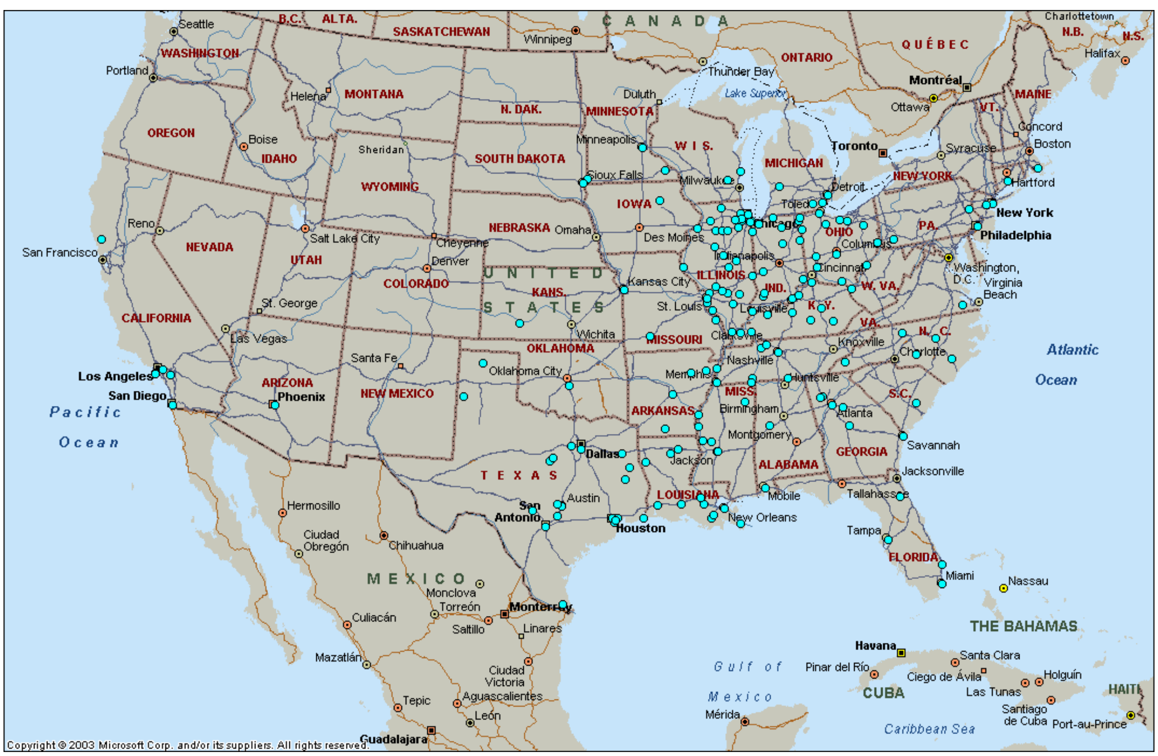
Locations of Shippers and Shipments

The locations of shippers and the destinations of shipments are presented in Figures 1 and 2. As indicated in Figure 1, the shippers tend to be located up and down the Mississippi and Illinois waterways (by sample design) but do reflect shippers located some distance from the waterways and with a number located at various distances from the waterway. The destinations of the last shipment made are presented in Figure 2. Again, these destinations tend to be clustered along the waterways, but also contain a wide variety of distances from the waterway. This is particularly important in the mode choice exercise in that the truck-barge versus rail alternative may become less attractive to shippers as the truck leg of the shipment increases in distance.

[4] The number in () is the frequency of firms.

Figure 1. Shipment Origins

Figure 2. Reported Destinations of Last Shipment



Shipper Characteristics

In addition to the products shipped and locations of shippers discussed above, there are a number of shipper attributes that are relevant. These include the access that shippers have to different modes, and, if they do not have access, how far they must travel to access other modes. In addition, shippers have different sizes, longevity in the market, etc.

In terms of mode access, Table 4 contains the results. As indicated, the sample has 45 shippers with barge access, 77 with rail service and 17 that have both barge and rail access. That is, they are located on a waterway and/or a rail line with the ability to load the associated mode.

Table 4. Modes and Access to Modes

Mode	# with Access	%	# total
Barge	45	20	216
Rail	77	35	215
Both	17	7	212

For shippers without access to a mode, distances to the nearest loading point was also solicited. In this regard, there were 104 shippers without direct rail access. On average, these shippers were located about 20 miles from a rail loading facility, and, in no case, was the distance greater than 200 miles. There were also 126 shippers without barge access. On average, they were located 80 miles from the nearest access point, with distances running up to 900 miles.[5] Together with the other data, the results suggest that there is significant heterogeneity in the locations of shippers and destinations as well as in the access firms have to modes.

Table 5 contains a variety of other firm attributes. These include how long the originating facility has been in its current location, size of firm, storage capacity of the firm, ownership of export facilities and the number of facilities operated by the firm. Because some of the variable attributes are heavily skewed, this table contains the average, the median and the 25th and 75th percentile values. As indicated, the mean values are much different from the median values. Firms have, on average, been in business about 31 years, with 75 percent of the sample in business 40 years or less. The volume and storage capacities demonstrate the same type of pattern. In terms of tonnages, total volumes average about 723,000 tons. However, the median firm ships about 67,500 tons per year, and 75 percent of the sample has total volumes less than 242,500 tons per year. Capacity figures are analogous. Finally, these firms tend not to have import and export facilities connected to their firm (only about 13 percent have export facilities), but the shippers tend to be part of a firm with multiple facilities (about

[5] By sample design, the distribution of distances to waterway is skewed towards the waterway. Thus, there are 94 that are located within 80 miles, and 32 that are located more than 80 miles from the nearest waterway.

11 facilities are operated by each firm). On this latter, however, the median firm operates two facilities.

In short, the sample tends to consist of firms that have been in business a reasonably long time period, with considerable volumes and associated capacity. The sample does not appear to reflect firms directly involved in importing and exporting, but tend to operate a modest number of facilities. However, there is a wide span on all variables pointing to significant heterogeneity amongst the respondents.

Table 5. Descriptive Statistics of Shipper Attributes

Variable	N	Mean	Std. Dev.	25^{th} Percentile	50^{th} Percentile	75% Percentile
Years	212	31	24.5	12	25	40
Total Volumes (tons)	168	723,278	4,013,530	4357	67,500	337550
Total Capacity (tons)	130	5,906,818	52,700,000	4750	40,000	242500
Export & Import Facilities	210	.13	0.34	NA	NA	NA
# of facilities	183	10.7	48.3	1	2	5

Shipment Characteristics

The survey form solicits information on the revealed choices and alternatives of shippers. Table 6 contains information relating to the modes chosen, and the alternatives that shippers consider. On the alternatives, shippers were queried as to their next best choice, and up to two additional alternatives. Thus, the choice set could reflect up to four alternatives considered by shippers.

As indicated, the sample consists of 232 shipments, which are dominated by truck movements. Of all shipments, there were 29 barge, 17 rail, 168 truck movements and 18 multimodal shipments. On alternatives, 101 shippers reported at least one alternative shipment to that chosen. Of these (Alternative 1), the relative frequency of rail seems to increase substantially, while the relative frequency of truck and barge shipments falls compared with the column marked chosen. This sample has, as in the other samples conducted, a number of shippers that state they have no options other than that chosen is high. In this regard, 80 of 129 (62%) reported that they could not ship to other locations, and 54 of 109 (50%) reported that they have no other modal options. Another 57 of 111 report that if they could not make the shipment they did (for a lengthy time period), they would choose to go out-of-business and cease operations.

An important result of Table 6, is first that a high proportion of firms report that they have no alternatives than that chosen; of the remaining, the number of options that firms report they have is very limited. That is, 101 firms report information on at least one alternative, but only 24 report information on at least two alternatives, and only 12 report information on at least three alternatives. This finding is very consistent with the other surveys with comparable information. That is, the number of options that shippers view themselves as having is very limited.[6]

Table 6. Frequency of Modal Choices and Alternatives

Mode	Alternative Chosen	%	Alternative 1	%	Alternative 2	%	Alternative 3	%
B	29	12.5	5	4.95	1	4.17	2	16.67
R	17	7.33	24	23.76	10	41.67	4	33.33
T	168	72.41	63	62.38	12	50	6	50
T-B	9	3.88	3	2.97	1	4.17	0	0
T-R	7	3.02	6	5.94	0	0	0	0
T-R-B	2	0.86	0	0	0	0	0	0
Total	**232**	**100**	**101**	**100**	**24**	**100**	**12**	**100**

There are a variety of different destination types. Shippers were asked to identify the type of destination. Table 7 identifies these types and summarizes the alternatives. These include river terminal, distribution center, railroad terminal processing plant (construction, fabrication, blending, energy, and other) and other destination types. For the chosen and each of the alternatives, the "other" category dominates. Inspection of the open-ended answers suggests a wide range of different destinations; many of which could be recoded into those offered. Nevertheless, the results suggest that processing tends to be a frequent destination and alternative. Of perhaps more interest to this study, are 29 shippers that report the destination is a river terminal. In most cases, these represent the truck leg of a truck-barge shipment.

Table 7. Destination Types

Destination	Alternative Chosen	%	Alternative 1	%	Alternative 2	%	Alternative 3	%
River Terminal	29	12.78	16	15.38	4	15.38	1	7.14
Distribution Center	28	12.33	16	15.38	3	11.54	2	14.29
Railroad Terminal	6	2.64	15	14.42	4	15.38	2	14.29
Processing Plant	71	31.28	28	26.92	7	26.92	3	21.43
Other	93	40.97	29	27.88	8	30.77	6	42.86
Total	**227**	**100**	**104**	**100**	**26**	**100**	**14**	**100**

Shipment Attributes

There are several shipment attributes that are central to modeling shipper choices. These include price, rate, time-in-transit, and distance. These statistics along with rate per ton-mile and miles per hour are presented in Table 8 by mode. It is noted that the ideal data set would enumerate all possible choices considered by shippers. The choice set, however, is limited to four options as discussed earlier. Most shippers reported less than

[6] This has been a recurrent theme throughout the recent ACE surveys of a similar nature. There are a variety of explanations. These include the very fact that many of these firms operate in competitive markets and must compete with other firms. If the preferred option is taken away, they may not continue in operation.

four options, and, these reflect the shippers' consideration sets. In Table 8, a data set was constructed that included all barge, rail and truck actual and potential movements available in the data. A detailed review of the data suggested that there were a number of egregious outliers which are not included in the presentation of the statistics, and the various filters used are reported in the notes to the Table 8.

By and large the statistics are as expected. The average price (value of product shipped) per ton is lower for barge than for rail or truck. The rate per ton is lower for barge than for rail or truck. Shipment times (inclusive of waiting, scheduling, and transit) are much lower for truck than for barge or rail. Truck provides a more reliable service than barge or rail. Reliability is the percentage that shippers expect their shipments to arrive on time. As reported by shippers, truck shipments arrive on-time an average of 91.6 percent of the time; barge shipments arrive on-time an average 78 percent of the time; while rail shipments arrive on-time an average of about 70 percent of the time. Truck shipments are, on average, shorter than either rail or barge shipments. Revenues per tonmile are also as expected. Truck, rail and barge rates per tonmile are 23.7, 16.7 and 11.2 cents, respectively. And, as expected, trucks move faster than rail which moves faster than barge with miles per hour statistics of 19.9, 6, and 2.7, respectively.

Table 8. Shipment Summary Statistics

Variable	Barge	Rail	Truck	Overall
Price/Ton	169 (194) 23	350 (499) 39	329 (472) 136	307 (442) 213
Rate/Ton	17.0 (13.46) 27	49.7 (64.98) 33	39.8 (63.17) 155	38.4 (58.32) 232
Time (hours)	181.4 (191.3) 33	148.4 (117.7) 49	24.2 (28.8) 231	65.2 (103.1) 337
Reliability (%)	78.7 (21.6) 35	70.2 (26.9) 52	91.6 (14.7) 236	85.8 (20.1) 356
Distance (miles)	479 (473) 37	530 (596) 52	321 (454) 238	387 (491) 356
Rate/Tonmile (Cents)	11.2 (21.1) 27	16.7 (23.6) 33	23.7 33.5 155	21.2 (31.4) 232
Miles per Hour	2.65 (1.39) 33	6.02 (10.7) 49	19.86 (15.1) 230	15.4 (15.1) 336

Note A: There are three numbers per cell. The top number is the mean, the number in () is the standard deviation and the bottom number is the number of observations.

Note B: There were a number of extreme outliers in the data. By variables:

1. Price statistics are based on trimmed values. The lower and upper 5% observations were not included.
2. Rate/ton statistics are based on movements less than 500 miles, revenue per tonmile less than 2 and greater than .01.
3. Time (hours) statistics are based on a reduced set of observations. Time was regressed on mode and distance. Observations with extreme residuals were not included in the calculations.
4. Reliability and distance statistics include all observations for which data are available.
5. Rate per tonmile are calculated on data with rate/ton outliers removed.
6. Miles per hour are calculated with time outliers removed.
7. Multimodal shipments are not reported owing to the lack of sufficient number of observations.

A particularly disappointing feature of the survey result is the general lack of information provided that is necessary to estimate a model of shippers' choice of mode and destination. First, there 129 observations in the data with one option (that chosen), such that the shipper apparently has no choice and their data cannot be used in a choice model.[7] Of the remaining 103 that indicate they have alternatives, 80 report only one alternative to their chosen mode and destination, 12 report two alternatives, and 11 report three alternatives. Second, the survey data contain a number of missing responses for the attributes of the alternatives. To estimate a model with consideration of price, rate, time, reliability and distance, not only must the shipper report choices, the shipper also must report detailed information on each of these variables. In the data, there are 129 that only

[7] In the companion report for agricultural commodities, we were able to estimate such a model. In that model, we did include a variable to reflect shutdown with success.

report one choice, and, of those only 64 provide complete data. The remaining 103 shippers have multiple options, but only 35 provide information on all options available.[8]

Choice models were attempted on the available observations. However, the results indicated that the data do not support meaningful parameter estimates. In particular, the coefficient of transit time was estimated to be positive, which is illogical, and the price and rate coefficients were highly insignificant, with t-statistics below 1. In an attempt to remedy this problem, values for missing variables were constructed as follows. Rate and time schedules were estimated as functions of distance and commodity (and other variables were considered), and the predicted values used. Price (commodity value) was constructed as median values by NAICS code, and reliability was constructed as median values by NAICS code and by mode. Even with these constructions, the number of usable observations is small. Of the 103 shipper, 86 observations provide enough information to complete data on all options, and 88 observations provide enough information to complete data on the chosen and next best options. Unfortunately, models estimated on these constructed data evidenced the same problems, namely, time entering with the wrong sign and insignificant rate and price coefficients.

Stated Preference Responses to Shipment Attributes

As discussed in previous reports of this nature, revealed data reflect decisions that are actually made by economic agents and have been used in a wide variety of studies that model choices. It is widely recognized that often data used in such studies have limited variation in attributes which may make it difficult to identify key parameters in the model. In addition, the collection of attributes can be quite difficult as illustrated by the previous section. An alternative is to use stated preference data to estimate choice function parameters. Most commonly, under this approach, decision-makers are confronted with two or more sets of attributes and asked which they would choose. This approach substantially reduces the data requirements of revealed data, and the models are much simpler to estimate. However, such an approach is often criticized as confronting the decision- maker with situations that do not reflect situations in which they make decisions and lack the realism of actual decision making. In recent work, the authors along with others have begun the using stated preference questions that are based on revealed data. This largely overcomes the standard criticisms of stated preference data and has allowed statistical evaluations of the consistency of stated and revealed preference data.

In the survey at hand, there are multiple stated preference questions. With respect to choice modeling, these are built directly off of the revealed data. In particular, each of the questions are framed as follows: "For your last shipment, if the [attribute changed] xxx%, would you continue with the original mode and destination or switch to your best alternative choice?" The shippers would identify whether they would continue to use the original choice, switch to a best alternative choice, or go out of business. The attributes queried included the transportation rate, the time in transit, and the reliability. The level

[8] The stated preference data reflect only the chosen and next best alternative. In this regard, the number of non-missing observations i.e., those that report complete data on the chosen option and the next best option, is only 40.

of the attribute change was randomly determined from a set of six possibilities (10, 20, …, 60 percent). Each set of responses is discussed below.

The responsiveness of shippers to rate increases is provided in Table 9 for different levels of rate increases. As indicated, 198 shippers responded to this question. For a 10 percent rate increase, 84% of shippers would not deviate from their original choices. As the level of the rate change increases, it is expected, and is generally observed, that greater the switch rate would increase. However, even for large changes in rates e.g., 60 percent only 38 percent of shippers would switch. Further, there were 15 shippers that reported that for some level of rate change they would be forced to shut down (7.6 percent of the sample).

Table 9. Stated Preference – Rate Responses

% Change	No Switch	Switch	Shutdown	Total	% No	% Switch	% Shutdown
10	28	4	1	33	84	12	3
20	26	9	0	35	74	25	0
30	16	6	4	26	61	23	15
40	20	11	4	35	57	31	11
50	17	18	3	38	44	47	7
60	16	12	3	31	51	38	9
Total	123	60	15	198	62	30	7

The responsiveness of shippers to increases in time-in-transit is provided in Table 10. As indicated, there are 199 shippers that responded. This table is very similar to that associated with rates; except for the fact that the switch rates tend to be lower. This suggests that shippers are more responsive to rates than to time. In terms of transit times, 81 percent of shipper responded that they would not change the choice they made in response to a 10 percent increase in transit times. As expected, and generally observed, the switch rates increase with the level of the change. In the case of transit time, the switch rates are relatively low until transit times increase 50 and 60 percent.

Table 10. Shipment Stated Preference – Time Responses

% Change	No Switch	Switch	Shutdown	Total	% No	% Switch	% Shutdown
10	22	4	1	27	81	14	3
20	26	5	0	31	83	16	0
30	22	8	5	35	62	22	14
40	36	3	1	40	90	7	2
50	24	12	2	38	63	31	5
60	14	14	0	28	50	50	0
Total	**144**	**46**	**9**	**199**	**72**	**23**	**4**

The responsiveness of shippers' discrete choices to *decreases* in reliability is provided in Table 11. As indicated, there are 193 shippers that responded. This table mirrors the other two related (rates and times). Unlike the other two tables, the prompt on reliability is for a decrease in the reliability measure. Recall, that the prompts on the attributes should, if anything, involve a switch. Increases in rates and time reduce the attractiveness of the original choice, while decreases in reliability reduce the attractiveness of the original choice. In total, at all levels of reliability changes 51 of 193 (26%) state they would switch, while 13 of 193 (6%) state they would shutdown. This leaves 129 of 193 (66%) that would not switch in response to the increases in reliability. As before, small changes do not tend to lead to switches, and the proportion of switches (the switch rate) tends to increase with the level of the change. In this case, it appears that the most of the incremental change is from a 10 to 20 percent reduction in reliability.

Table 11. Shipment Stated Preference – Reliability Responses

% Change	No Switch	Switch	Shutdown	Total	% No	% Switch	% Shutdown
10	29	2	2	33	87	6	6
20	21	8	0	29	72	27	0
30	26	12	2	40	65	30	5
40	18	9	3	30	60	30	10
50	14	10	4	28	50	35	14
60	21	10	2	33	63	30	6
Total	129	51	13	193	66	26	6

Stated Preference Response of Annual Volumes Attributes

The volume shipped is a second component of demand germane to Army Corps modeling. In this subsection, stated preference responses to the question "If the [attribute increases] by XXX% would your annual volume shipped decrease?" As before, the attributes include rates, time-in-transit, and reliability. In the case of rates, two questions are posed, one in which the increase applies to both the shipper and its competitors and one in which it applies to only the shipper.[9] As before, the percentage change in the attribute is randomly drawn from values of 10, 20,…., 60.

Table 12 contains the responses with respect to rate increases that apply to all shippers. There are a total of 209 responses. As expected, as the level of the rate change increases, the proportion of shippers that adjust volumes increases. For a 10 percent rate increase, 20 percent of shippers adjust volumes, and this increases to 58 percent for changes in rates of 60 percent. Thus, volumes do appear to adjust to rate changes. The level of the change, given a change occurs generally tends to fall with the level of the rate change.

Table 12. Volume Stated Preference – Common Rate Changes

Rate Change	Change	No Change	Total	% Change given a Change Occurs
10	7	28	35	25
20	8	27	35	35
30	16	23	39	38.5
40	13	22	35	28.3
50	14	20	34	30
60	18	13	31	43.1
Total	**76**	**133**	**209**	**34**

Note: Of the 76 observations that indicate a response, only 36 shippers who provided the level of the rate change.

Table 13 contains the same results only when rate changes apply to the shipper but not its competitors (an idiosyncratic rate increase). As expected, when the level of the attribute change increases, the proportion of shippers that adjust volume also generally increases. For a 10 percent increase, about 17 percent of the shippers (6 of 36) adjust volumes, but as the level of the rate change increases to 60 percent, nearly 60 percent of shippers adjust volumes. These statistics are very comparable to those of Table 12 i.e., the increases in rates induce a change in volumes. However, unlike Table 12, when the rates apply only to the shipper and they adjust volumes, the magnitude of the changes tends to be larger.

[9] This is an attempt to capture any impact from the spatial environment in which shippers compete. It is clear from any number of spatial models, that idiosyncratic effects have a larger effect than to common effects.

Table 13. Volume Stated Preference – Idiosyncratic Rate Changes

Rate Change	Change	No Change	Total	% Change given a Change Occurs
10	6	30	36	20
20	11	23	34	51
30	18	17	35	46
40	17	14	31	49
50	25	13	38	45
60	17	12	29	67
Total	**94**	**109**	**203**	**50**

Note: Of the 94 responses that indicate a change, there were a total of 52 shippers who provided the level of the change.

Table 14 contains the results with respect to shipment times. The same general patterns of increasing rates of adjustment as the level of the change in transit time increases. That is, the proportion of shippers that adjust volumes with the level of the time change. The level of the change, given a change occurs, is generally larger with the level of the time change. In comparison with the rate table in which the rate change applies only to the respondent but not its competitors (Table 13), however, the rates of adjustment and the associated changes in volumes given a time change tends to be smaller. This is consistent with the notion that shippers have a greater sensitivity to rates than to time.

Table 14. Volume Stated Preference – Transit Time Changes

Time Change	Change	No Change	Total	% Change given a change occurs
10	5	33	38	10
20	11	24	35	18
30	11	15	26	40
40	12	19	31	31
50	14	22	36	27
60	15	21	36	47
Total	**68**	**134**	**202**	**32**

Note: Of the 68 that indicate a change, there were 38 shippers who provided the level of the change.

Table 15 contains the results with respect to reliability. As with all of the other related Tables, the rate of adjustment tends to increase with the level of the attribute change. However, for small changes in reliability, most shippers do not adjust quantities. This increases relatively quickly as the percentage change in reliability increases. The change in volumes given a change occurs generally increases with the percentage change in reliability. But, generally, the results, as with time, appear to be lower than with rate changes that apply only to the respondent.

Table 15. Volume Stated Preference – Reliability Changes

Reliability Change	Change	No Change	Total	% Change given a Change Occurs
10	4	37	41	10
20	13	16	29	39
30	14	21	35	12
40	15	19	34	32
50	12	15	37	50
60	17	17	34	52
Total	**75**	**125**	**200**	**35**

Note: Of the 75 that indicate a change, there were 39 shippers who provided the level of the change.

3. SWITCH RATES FOR CHANGES IN RATES, TIME AND RELIABILITY

As described in section 2 above, each respondent was asked whether they would stay with their chosen mode and destination or switch to an alternative if the rates, times or reliability for their chosen mode and destination changed by a specified amount. Each respondent was asked a question of the form "For your last shipment, if the transportation rate increased X percent, would you continue with the original mode and destination or switch to your next best alternative?" The amount of change X, which is called the "prompt," was randomly chosen from 10, 20, up to 60. The questionnaire explicitly allowed for the fact that the next best alternative might be to shut down, and so shippers who are apparently "captive" in the sense of having no other viable shipping options could nevertheless switch from their previous mode and destination by shutting down. Similar questions were asked for increases in transit time and decreases in reliability.

The responses to these questions were used to estimate models of shippers' decision of whether or not to switch in response to changes in rates, time and reliability. Note that switching can be to their next-best alternative (which could be a different mode, a different destination, or a different mode and destination combination) or to shut down. The models take the form of binary logits:

$$P = \frac{e^{\beta x}}{1 + e^{\beta x}}$$

where P is the probability that the shipper switches, and the explanatory variables x include the prompt as well as mode and commodity indicators. Separate models are estimated on the data for prompts based on rate, times, and reliability. In each model, the log of the prompt is entered, such as log(10) for a prompt of ten percent. This specification of the explanatory variable assures that a zero change in rates, time or reliability translates into a zero probability of switching (since $\log(0) = -\infty$ such that $e^{\beta x} = e^{-\infty} = 0$.) We discuss each of the models in turn.

Switching Induced by Changes in Rates

Table 16 gives the model for shippers' response to rate increases. The size of the rate increase enters with a positive sign, implying, as expected, that larger rate increases induce more shippers to switch away from their current mode and destination. The variable is highly significant, with a t-statistics in excess of 3. Switch rates are differentiated by mode and commodity groups, with the modes and commodity groups defined to be mutually exclusive. In particular, a barge dummy identifies shipments that use barge, either alone or in combination with another mode. A rail dummy identifies shipments that use rail, either alone or in combination with truck, but not in combination with barge (that is, a rail-barge shipment is categorized as barge.) The third category, whose coefficient is normalized to zero, is for shipments that use truck only (i.e., do not use barge or rail.) The estimated coefficients indicate that rail shippers switch more readily in response to rate increases for their chosen mode and destination than barge and truck shippers, and that barge shippers switch less than either rail or truck shippers (though the difference between barge and truck shippers is not statistically significant.)

Since there are many commodities and relatively few surveyed shippers for each commodity, we aggregated the commodities into three groups: These are Commodity Group A which are commodities with NAIC codes in the 200's (oil and gas extraction, mining, aggregates), Commodity Group B which are commodities with NAIC codes of 300-326 and 454 (wood, paper, petroleum, coal, chemicals, plastics, and fuel), and Commodity Group C which are commodities with NAIC codes 327-332 (minerals, metals). The estimates imply that switch rates are lowest for commodity group A and highest for commodity group C. However, the differences are small and not statistically significant different from one another.

Table 16. Model of whether shippers switch from their current mode and destination in response to increases in rates

Explanatory variable	Estimated coefficient	Standard Error	t-statistic
Log of percent increase in rates	1.163	0.2951	3.94
Barge shipments	-0.398	0.426	0.93
Rail shipments	1.286	0.524	2.45
Commodity group A	-4.642	1.087	4.27
Commodity group B	-4.611	1.072	4.3
Commodity group C	-4.538	1.081	4.2
LL at convergence	-119.101		
Number of observations	198		

The model in Table 16 can be used to forecast the share of shippers who would switch from their current mode and destination if the rates for that mode and destination rose. The forecasted switch rates for the sampled shippers are given Table 17, along with the implied arc elasticities. The percent who switch rises, of course, with the percent increase in rates; however, the arc elasticities drop, which implies that the switching rate rises less than proportionately with the size of the rate increase. The arc elasticity is slightly more than 1 for small rate increases and drops to be less than 1 for larger rate increases. Even for very large rate increases, many shippers continue to use their current mode and destination. For example, a doubling of rates is forecast to induce 61 percent of shippers to switch, which leaves nearly forty percent who would continue to use their current mode and destination.

Table 17. Percent of Shippers forecasted to switch in response to rate increases for their current mode and destination

Percent increase	Percent who switch	Arc elasticity
10	14.5	1.45
20	27.7	1.39
30	36.4	1.21
40	44.0	1.10
50	50.2	1.00
60	55.3	0.92
70	59.5	0.85
80	63.1	0.79
90	66.1	0.73
100	68.7	0.69

The switch rates given in Table 17 are for the entire sample of shippers. The model in Table 16 implies different switch rates by mode and commodity. To examine these differences, Tables 18 and 19 give forecasted switch rates and arc elasticities for each mode and commodity group. Switch rates are lowest for barge shippers and highest for rail shippers.[10] For all sizes of rate increases, the arc elasticities for barge shippers are below 1. The finding of inelastic response by barge shippers is consistent results in our earlier studies (Train and Wilson, 2004 and 2006). For all modes, switch rates in response to rates are estimated to be highest for commodity group C and lowest for commodity group A.

[10] One explanation is that railroads' may price up to the "switch" point. This is also true in the shipment time model discussed below. In that model, it may be that service levels are adjusted to a "switch" point. Of course, this is not a study of rail pricing, and these conjectures are left to future research.

Table 18. Percent of Shippers forecasted to switch in response to rate increases for their current mode and destination

Percent increase	Barge cmd A	Barge cmd B	Barge cmd C	Rail cmd A	Rail cmd B	Rail cmd C	Truck cmd A	Truck cmd B	Truck cmd C
10	8.6	8.9	9.5	33.6	34.3	36.0	12.3	12.6	13.5
20	17.4	17.9	18.9	53.2	53.9	55.7	23.9	24.4	25.8
30	25.2	25.8	27.2	64.5	65.2	66.9	33.5	34.1	35.8
40	32.1	32.7	34.3	71.8	72.4	73.8	41.3	42.0	43.8
50	37.9	38.7	40.4	76.7	77.3	78.5	47.7	48.4	50.2
60	43.0	43.8	45.6	80.3	80.8	81.9	52.9	53.7	55.5
70	47.5	48.3	50.1	83.0	83.4	84.4	57.4	58.1	59.9
80	51.4	52.1	53.9	85.0	85.4	86.3	61.1	61.9	63.6
90	54.8	55.5	57.3	86.7	87.1	87.9	64.3	65.0	66.7
100	57.8	58.5	60.3	88.1	88.4	89.1	67.1	67.8	69.3

Table 19 Arc elasticities with respect to rate increases

Percent increase	Barge cmd A	Barge cmd B	Barge cmd C	Rail cmd A	Rail cmd B	Rail cmd C	Truck cmd A	Truck cmd B	Truck cmd C
10	0.86	0.89	0.95	3.36	3.43	3.60	1.23	1.26	1.35
20	0.87	0.89	0.95	2.66	2.70	2.79	1.19	1.22	1.29
30	0.84	0.86	0.91	2.15	2.17	2.23	1.12	1.14	1.19
40	0.80	0.82	0.86	1.79	1.81	1.85	1.03	1.05	1.09
50	0.76	0.77	0.81	1.53	1.55	1.57	0.95	0.97	1.00
60	0.72	0.73	0.76	1.34	1.35	1.36	0.88	0.90	0.93
70	0.68	0.69	0.72	1.19	1.19	1.21	0.82	0.83	0.86
80	0.64	0.65	0.67	1.06	1.07	1.08	0.76	0.77	0.79
90	0.61	0.62	0.64	0.96	0.97	0.98	0.71	0.72	0.74
100	0.58	0.59	0.60	0.88	0.88	0.89	0.67	0.68	0.69

Switching Induced by Changes in Transit Times

Table 20 gives the model estimated on respondents' answers regarding increases in transit time. The model has the same form as for rates. The time prompt enters with a highly significant positive coefficient, implying that larger increases in transit time induced more switching. Also, as was found for rate increases, rail shippers switch more readily in response to time increases than barge and truck shippers.

Table 20 Model of whether shippers switch from their current mode and destination in response to increases in transit times

Explanatory variable	Estimated coefficient	Standard Error	t-statistic
Log of percent increase in shipment times	0.738	0.317	2.33
Barge shipments	-0.152	0.438	0.35
Rail shipments	1.023	0.497	2.06
Commodity group A	-3.581	1.195	3.00
Commodity group B	-3.630	1.163	3.12
Commodity group C	-3.683	1.151	3.20
LL at convergence	-112.075		
Number of observations	199		

Table 21 gives the forecasted switch rates and arc elasticities for the sample of shippers, for each level of rate increase. The switch rates are lower than those in Table 18 for rate increases. As with rate increases, the arc elasticity decreases as the time increase rises. A doubling of transit time induces 46 percent of shippers to switch, with over half of shippers remaining with their current mode and destination.

Table 21. Percent of Shippers forecasted to switch in response to transit time increases for their current mode and destination

Percent increase	Percent who switch	Arc elasticity
10	14.0	1.40
20	21.1	1.06
30	26.4	0.88
40	30.6	0.76
50	34.1	0.68
60	37.1	0.62
70	39.7	0.57
80	42.0	0.53
90	44.1	0.49
100	46.0	0.46

Tables 22 and 23 give forecasted switch rates and arc elasticities for each mode and commodity group. Switch rates are lowest for barge shippers and highest for rail shippers. Interestingly, for small changes, barge shippers are found to be more responsive to transit time than rates; for example, a ten percent increase in transit times induces about 11 of barge shippers to switch, while the same percent increase in rates induces about 9 percent to switch. However, for larger increases, barge shippers respond less to transit time increases than to rate increases. Another interesting difference is that, in response to time, switch rates are highest for commodity group A and lowest for commodity group C, which is the opposite of what was found for response to rates. Of course, as stated above, the differences across commodity groups are not statistically significant.

Table 22. Percent of shippers forecasted to switch in response to transit time increases for their current mode and destination

Percent increase	Barge cmd A	Barge cmd B	Barge cmd C	Rail cmd A	Rail cmd B	Rail cmd C	Truck cmd A	Truck cmd B	Truck cmd C
10	11.6	11.1	10.6	29.8	28.8	27.7	13.2	12.7	12.1
20	17.9	17.2	16.5	41.4	40.3	39.0	20.3	19.5	18.7
30	22.8	21.9	21.0	48.8	47.6	46.3	25.5	24.6	23.6
40	26.7	25.8	24.7	54.1	52.9	51.6	29.8	28.8	27.7
50	30.1	29.0	27.9	58.2	57.0	55.7	33.3	32.3	31.1
60	33.0	31.9	30.7	61.4	60.3	59.0	36.4	35.3	34.1
70	35.5	34.4	33.2	64.1	62.9	61.7	39.1	37.9	36.7
80	37.8	36.7	35.4	66.3	65.2	64.0	41.4	40.3	39.0
90	39.9	38.7	37.4	68.2	67.2	66.0	43.6	42.4	41.1
100	41.8	40.6	39.3	69.9	68.9	67.7	45.5	44.3	43.0

Table 23. Arc elasticities with respect to transit time increases

Percent increase	Barge cmd A	Barge cmd B	Barge cmd C	Rail cmd A	Rail cmd B	Rail cmd C	Truck cmd A	Truck cmd B	Truck cmd C
10	1.16	1.11	1.06	2.98	2.88	2.77	1.32	1.27	1.21
20	0.90	0.86	0.82	2.07	2.01	1.95	1.01	0.97	0.93
30	0.76	0.73	0.70	1.63	1.59	1.54	0.85	0.82	0.79
40	0.67	0.64	0.62	1.35	1.32	1.29	0.74	0.72	0.69
50	0.60	0.58	0.56	1.16	1.14	1.11	0.67	0.65	0.62
60	0.55	0.53	0.51	1.02	1.00	0.98	0.61	0.59	0.57
70	0.51	0.49	0.47	0.92	0.90	0.88	0.56	0.54	0.52
80	0.47	0.46	0.44	0.83	0.82	0.80	0.52	0.50	0.49
90	0.44	0.43	0.42	0.76	0.75	0.73	0.48	0.47	0.46
100	0.42	0.41	0.39	0.70	0.69	0.68	0.45	0.44	0.43

Switching Induced by Changes in Reliability

Table 24 gives the model for shippers' response to decreases in reliability. Like the models for rate and time changes, the prompt enters with a highly significant positive coefficient, indicating that, as expected, greater decreases in reliability induce more shippers to switch away from their current mode and destination. Also, barge shippers are found to respond the least, and rail shippers the most.

Table 24. Model of whether shippers' Switch from their current mode and destination in response to decreases in reliability

Explanatory variable	Estimated coefficient	Standard Error	t-statistic
Log of percent of decrease in reliability	0.892	0.296	3.01
Barge shipments	-0.218	0.423	0.51
Rail shipments	0.792	0.502	1.58
Commodity group A	-3.523	1.08	3.26
Commodity group B	-4.002	1.077	3.71
Commodity group C	-3.878	1.088	3.57
LL at convergence	-115.348		
Number of observations	193		

Table 25 gives the forecasted switch rates and arc elasticities for the entire sample. The switch rates are generally lower than those for rates and higher than those for transit time. Like rates and times, the arc elasticities are slightly above 1 for small changes in reliability and drop to below 1 for larger changes. A 100% decrease in reliability, which implies that the shipment will definitely not arrive on time, induces more than half of the shippers to switch to a different mode/destination or shut down. Importantly, though, about forty percent remain with their current mode and destination, even knowing that their shipment will not arrive on time.

Table 25. Percent of Shippers forecasted to switch in response to reliability decreases for their current mode and destination

Percent increase	Percent who switch	Arc elasticity
10	15.5	1.55
20	25.1	1.25
30	32.3	1.08
40	37.9	0.95
50	42.6	0.85
60	46.5	0.78
70	49.9	0.71
80	52.8	0.66
90	55.3	0.61
100	57.6	0.58

Tables 26 and 27 give forecasted switch rates and arc elasticities for each mode and commodity group. As with rates and times, switch rates in response to decreased reliability are lowest for barge shippers and highest for rail shippers. For all modes, switch rates in response to reliability are lowest for commodity group B and highest for commodity groups A.

Table 26. Percent of shippers forecasted to switch in response to reliability decreases for their current mode and destination

Percent increase	Barge cmd A	Barge cmd B	Barge cmd C	Rail cmd A	Rail cmd B	Rail cmd C	Truck cmd A	Truck cmd B	Truck cmd C
10	15.6	10.3	11.5	33.7	24.0	26.3	18.7	12.5	13.9
20	25.6	17.6	19.4	48.5	36.9	39.8	29.9	20.9	23.1
30	33.1	23.4	25.7	57.5	45.6	48.7	38.0	27.6	30.1
40	39.0	28.3	30.9	63.7	52.0	55.1	44.2	33.0	35.7
50	43.8	32.6	35.3	68.1	57.0	60.0	49.2	37.5	40.4
60	47.8	36.2	39.1	71.5	60.9	63.8	53.3	41.4	44.4
70	51.3	39.5	42.4	74.3	64.1	66.9	56.7	44.8	47.8
80	54.2	42.3	45.4	76.5	66.8	69.5	59.6	47.7	50.8
90	56.8	44.9	48.0	78.3	69.1	71.7	62.1	50.3	53.4
100	59.1	47.3	50.3	79.9	71.1	73.6	64.3	52.7	55.8

Table 27. Arc elasticities with respect reliability decreases

Percent increase	Barge cmd A	Barge cmd B	Barge cmd C	Rail cmd A	Rail cmd B	Rail cmd C	Truck cmd A	Truck cmd B	Truck cmd C
10	1.56	1.03	1.15	3.37	2.40	2.63	1.87	1.25	1.39
20	1.28	0.88	0.97	2.43	1.84	1.99	1.50	1.05	1.15
30	1.10	0.78	0.86	1.92	1.52	1.62	1.27	0.92	1.00
40	0.97	0.71	0.77	1.59	1.30	1.38	1.11	0.82	0.89
50	0.88	0.65	0.71	1.36	1.14	1.20	0.98	0.75	0.81
60	0.80	0.60	0.65	1.19	1.02	1.06	0.89	0.69	0.74
70	0.73	0.56	0.61	1.06	0.92	0.96	0.81	0.64	0.68
80	0.68	0.53	0.57	0.96	0.84	0.87	0.74	0.60	0.64
90	0.63	0.50	0.53	0.87	0.77	0.80	0.69	0.56	0.59
100	0.59	0.47	0.50	0.80	0.71	0.74	0.64	0.53	0.56

4. VOLUME ADJUSTMENTS TO CHANGES IN RATES, TIME, AND RELIABILITY

In addition to the switching models examined above, shippers can also respond to changes in rates, shipment times, and reliability by adjusting the volumes shipped. This second form of adjustment is examined in this section. Each shipper was asked if it would adjust annual volumes in response to an increase in the average rate and shipment times and a reduction in reliability. If they answered yes, they were then asked the magnitude of the change, which could be at most a 100 percent change. If they answered no, then the response is zero. Thus, the range of possibilities includes no change in annual volumes or a total reduction i.e., response is in the closed interval {0,100}. Since the range of the dependent variable (change in annual volumes) is limited. In such cases, Tobit models are commonly used.[11]

A problem in applying the Tobit model to the data at hand is that there are an undue number of missing values on the level of a change given there was a change. In the case of common rate changes (i.e., rate changes that apply to both the respondent and its competitors), there are 209 respondents that stated whether they would adjust annual volumes or not.[12] There were 76 that stated they would adjust, and 133 that stated they would not adjust. However, of the 76 that stated they would adjust only 36 gave the level of the volume adjustment. In implementing the Tobit model using Stata[13], all the observations with missing values are not used. This dramatically overstates the sample proportion of shippers that state they would not adjust volume due to the rate prompt which in turn would overstate the probability of a zero response and understate the resulting elasticity estimates. Specifically, the log-likelihood consists of two components – the discrete part and the continuous part. With the missing values, the discrete part has too much weight relative to the continuous part i.e., the proportion of non-adjusters is overstated in the useable data.

To overcome this issue, we implemented a form of bootstrapping. First, the number of non-adjusters was randomly reduced so that the proportions were correct. Operationally, there were 133 observations of 209 that reported they would not adjust. This represents 64 percent of the observations, while those that report an adjustment would occur constitute 36 percent. Using only the 36 shippers that gave the level, the total sample size should appropriately be about 100 (36/x=36% implies N=100). This means that of the 133 that report they should not adjust, only 100-36=64 should be used to maintain the proportions of adjusters and non-adjusters in the sample. Effectively, this means that 69 non-adjusting responses are not used in the estimation.

For estimation, we randomly selected 64 of the 133 non-adjusting shippers to estimate the tobit model. However, since these shippers are randomly selected, any random draw generates a different set of data, and hence a different set of estimated parameters. To address this point, a form of bootstrapping was used. In the present case, the tobit model was run 1000 times. The coefficient estimates, standard errors, and t-values reported are averages of the 1000 results. While the proportions differ, this same approach was used for each of the four prompting variables – a percentage response of volumes to: 1. A percentage change in rates that applies to the respondent and its competitors; 2. A percentage change in rates that applies to the respondent but not its competitors; 3. A percentage change in transit times; and 4. A percentage change in reliability. Each is discussed in turn.

[11] We also experimented with Heckman models, but the lack of sufficient observations hampered, in many cases, convergence, and a two-step did not tend to yield statistical significance.

[12] The same issue arose with the other attribute variables (as indicated by tables 13-15). We illustrate the issue in detail using a change in rates that apply to both the shipper and its competitors. The others follow similarly and are not discussed in detail.

[13] STATA is a commonly used econometric/statistics program. See www.stata.com.

Common rate changes

The stated preference question asked shippers if they would adjust annual volumes to a randomly drawn percentage change in rates that applied to the shipper as well as its competitors. If they responded that they would change, the percentage level of the change was solicited.

These data were used to construct a specification of quantity adjustments to rate adjustments. The dependent variable is directly the percentage change in quantity given a change in the rate. As discussed above, this change can range from 0 to 100 percent.[14] In the data, we do not observe any quantity adjustments that are 100%, but there are a number of observations reporting zero adjustment. Whether an adjustment occurs or not is taken as a function of the rate prompt (10, 20, …, 60 percent). In addition, we consider other explanatory variables. These include commodity and mode dummies as well as total sales volume, total capacity, the number of facilities operated, etc. We report that of the base model (the rate prompt), that with commodity dummies alone, that with mode dummies, and that with both. The commodity dummies were identical to those used in previous section. The modal dummies, however, are defined differently. Specifically, there are dummy variables for shippers that have, in addition to truck, access to rail and access to barge. Finally, variables to reflect total storage capacity, total sales volume, number of facilities operated by the firm, export facilities, and others. The other variables were not statistically important sample.

To illustrate the bootstrap technique, a histogram of the 1000 different estimates for the coefficient on the rate change variable is presented in Figure 3. For the 1000 iterations, the coefficient estimates averages .614 with minimum and maximum values .261 and .967, respectively. Table 28 (base model) contains the average of the bootstrapped estimated parameters for the tobit model along with standard errors. The results indicate that the effect of the rate change is positive, as expected, and statistically important. This provides strong evidence that annual volumes are affected by changes in rates.

In addition to the base model (only the rate prompt), Table 28 also provides estimates with commodity dummies, with access dummies and with both. In no case does the addition of these variables affect statistical significance. Further, the coefficient on the rate prompt appears to be quite stable across specifications both in terms of magnitude and statistical importance. The result suggests that rate responses vary little across shippers with different access or of different commodities.

[14] We also examined double log specifications as in our companion report. The results reported do not differ qualitatively, and the results of the base model are similar numerically in terms of elasticities to those reported in this section.

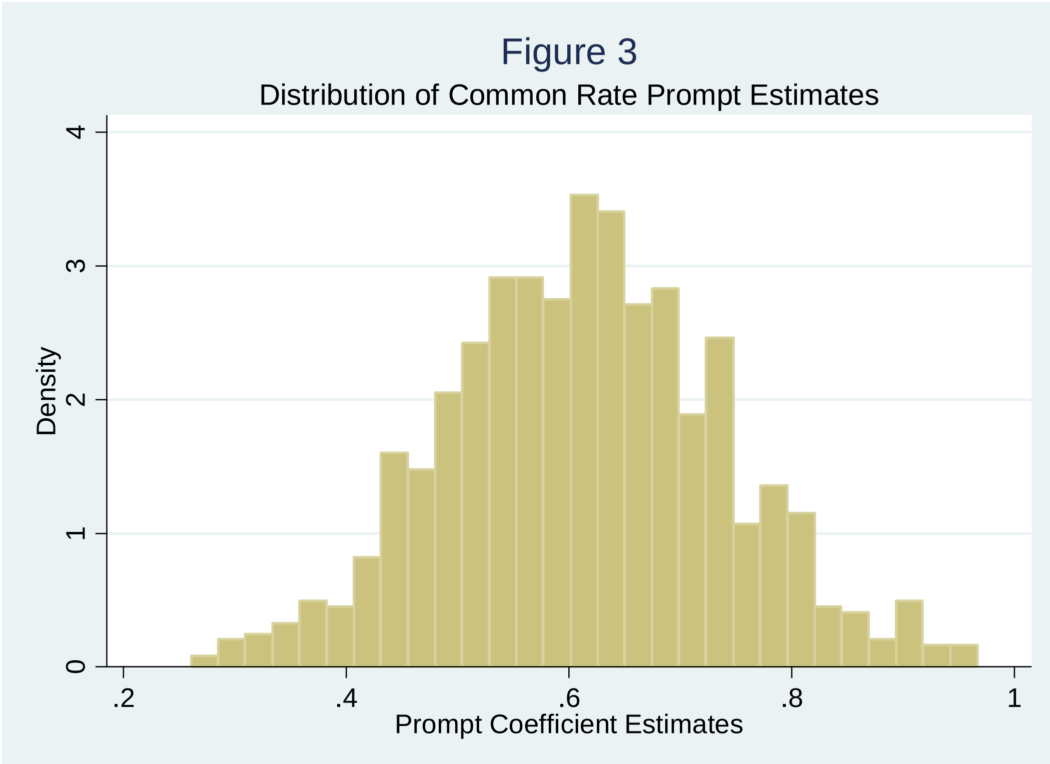


Table 28. Bootstrapped Tobit Model Estimates – Volume Changes when Rates to Shipper and Competitors Increase

Variable	Base Model	Commodity Dummies	Access Dummies	Commodity and Access Dummies
Rate prompt	0.614**	.619*	0.727*	0.729*
	(0.318)	(0.312)	(0.349)	(0.341)
Commod B	n.a.	-6.792	n.a.	-7.808
		(13.584)		(16.220)
Commod C	n.a.	-13.855	n.a.	-18.144
		(13.157)		(13.824)
Access Rail	n.a.	n.a.	-9.971	-10.196
			(13.286)	(13.167)
Access Barge	n.a.	n.a.	-4.553	-5.395
			(16.755)	(16.220)
Access Rail and Barge	n.a.	n.a.	1.059	-1.118
			(22.597)	(22.417)
intercept	-33.910*	-25.066	-35.134	-23.643
	(13.514)	(15.797)	(14.507)	(16.617)

Note: A * and a ** indicate statistical significance at the 5 and 10 percent levels, respectively. Standard errors are in ().

A central focus is the provision of elasticities across modes, commodities and different level of rate prompts. The elasticities are fuelled by two sources of change. These include the level of the change given a change occurs and the probability that a chance occurs. The multiple of the elasticity and the probability give the expected change and are the elasticities reported in Table 29 along with the probability of change at each rate prompt for the base model. The elasticities are all less than one in magnitude, which suggests that volume adjustment to rate increases that apply to shippers and competitors are inelastic. Further, as one would expect, the likelihood of adjustments to rate changes increases with the rate prompt.

Table 29. Estimated Elasticities and Probabilities of Adjustment for an Increase in Rates – Rate Increase Applies to Shipper and Competitor

Rate Prompt	Elasticity	Probability
10	0.677	0.258
20	0.424	0.305
30	0.350	0.356
40	0.321	0.409
50	0.311	0.462
60	0.310	0.515

While the estimation results in table 28 do not point to statistically different differences in quantity adjustments across commodities or shippers with different access, the point estimates of these effects may indeed point to sizeable differences. To address this possibility, we also calculate the elasticities using the specification with both commodity and access dummies. These are provided in table 30. As with the results in table 29, the elasticities tend to be small (less than one in magnitude) with probabilities of adjustment that are also small but increasing in the rate prompt.

Table 30. Estimated Elasticities and Probabilities of Adjustment for an Increase in Rates – Rate Increase Applies to Shipper and Competitor by Commodity and Mode Access

	Elasticity				Probability			
	Commodity Group A							
Rate Increase	Truck	Rail	Barge	Rail and Barge	Truck	Rail	Barge	Rail and Barge
10	1.019	0.722	0.866	1.015	0.349	0.269	0.307	0.342
20	0.647	0.467	0.554	0.643	0.411	0.325	0.366	0.402
30	0.539	0.396	0.466	0.534	0.475	0.386	0.428	0.464
40	0.497	0.373	0.433	0.491	0.538	0.449	0.491	0.525
50	0.481	0.369	0.423	0.475	0.596	0.513	0.551	0.582
60	0.478	0.374	0.424	0.470	0.647	0.573	0.606	0.632
	Commodity Group B							
10	0.771	0.523	0.637	0.770	0.285	0.212	0.246	0.280
20	0.500	0.346	0.417	0.497	0.344	0.263	0.301	0.337
30	0.425	0.300	0.358	0.421	0.407	0.320	0.361	0.397
40	0.399	0.289	0.341	0.395	0.471	0.381	0.424	0.459
50	0.394	0.292	0.340	0.389	0.533	0.445	0.487	0.520
60	0.397	0.302	0.347	0.392	0.591	0.509	0.547	0.577
	Commodity Group C							
10	0.513	0.341	0.418	0.525	0.210	0.151	0.178	0.208
20	0.341	0.231	0.281	0.347	0.261	0.192	0.224	0.258
30	0.298	0.205	0.248	0.301	0.319	0.241	0.277	0.313
40	0.287	0.202	0.242	0.289	0.380	0.296	0.335	0.372
50	0.291	0.209	0.247	0.290	0.444	0.356	0.397	0.433
60	0.301	0.222	0.259	0.299	0.507	0.418	0.460	0.494

Note: Commodity group A has NAIC 200 codes, B has NAIC 300-326 and 454, and C has NAIC codes of 327-332.

Shipper Specific Rate Changes

In some cases, rate changes may not be commonly experienced by all shippers. Rather, the rate change may accrue only to one shipper. In this case, the question posed to the survey respondent followed that of common rate changes with the added caveat that the rate change applies only to that shipper but not to its competitors. In such cases, it is normally expected that the responsiveness would be larger than that of a common rate shock. The same procedures as those in the previous section are applied to this question. The coefficient estimates and associated elasticities and probabilities are provided in tables 31-33, respectively.

The coefficient estimates in table 31 are similar qualitatively to those of table 28. That is, the coefficient on the rate prompt is positive and statistically important. It is also larger than the coefficient in table 28, which suggests that shippers tend to be more responsive to rate changes when the changes apply to them but not their competitors. As in table 28, the addition of commodity or access variables do not suggest statistical significance, and their addition does not have a material effect on the rate prompt findings.

Table 31. Bootstrapped Tobit Model Estimates – Volume Changes when Rates to Shipper but not to Competitors Increase

Variable	Base Model	Commodity Dummies	Access Dummies	Commodity and Access Dummies
Rate prompt	1.891*	1.897*	2.028*	2.021*
	(0.441)	(0.444)	(0.467)	(0.466)
Commod B	n.a.	-13.444	n.a.	-18.231
		(23.272)		(18.964)
Commod C	n.a.	-7.960	n.a.	-14.074
		(16.919)		(18.025)
Access Rail	n.a.	n.a.	9.495	11.308
			(15.643)	(15.776)
Access Barge	n.a.	n.a.	6.972	4.084
			(20.075)	(20.362)
Access Rail and Barge	n.a.	n.a.	-43.836	-46.471
			(40.361)	(40.899)
Intercept	-71.912*	-63.801*	-80.713*	-67.549*
	-19.637	(23.273)	(21.895)	(25.515)

Note: A * and a ** indicate statistical significance at the 5 and 10 percent levels, respectively. Standard errors are in ().

Elasticity estimates for the base model are provided in table 32, and for the full model in table 33. The results suggest inelastic elasticities and low probabilities of adjustments. Comparisons of table 32 with those of table 29 are generally as expected. That is, the elasticities in table 32 are generally larger than those of table 29 (responses are greater when the rate changes apply to the single shipper as opposed to all shippers). As before, the elasticities of the full model are also presented (even though the individual coefficients are not statistically significant). Table 33 contains the results for the full model. These results point to largely inelastic demands as do the results in tables 29, 30, and 32.

Table 32. Estimated Elasticities and Probabilities of Adjustment for an Increase in Rates – Rate Increase Applies to Shipper but not Competitor

Rate Prompt	Elasticity	Probability
10	0.765	0.218
20	0.634	0.315
30	0.654	0.418
40	0.713	0.511
50	0.778	0.575
60	0.835	0.596

Table 33. Estimated Elasticities and Probabilities of Adjustment for an Increase in Rates – Only to Shipper not to Competitors

	Elasticity				Probability			
	Commodity Group A							
Rate Increase	Truck	Rail	Barge	Rail and Barge	Truck	Rail	Barge	Rail and Barge
10	0.729	1.002	0.827	0.192	0.209	0.263	0.229	0.067
20	0.624	0.819	0.695	0.187	0.309	0.369	0.331	0.117
30	0.661	0.830	0.723	0.226	0.417	0.473	0.437	0.189
40	0.732	0.883	0.788	0.288	0.513	0.552	0.526	0.280
50	0.808	0.939	0.856	0.364	0.576	0.589	0.579	0.381
60	0.871	0.980	0.910	0.449	0.590	0.575	0.582	0.475
	Commodity Group B							
10	0.416	0.592	0.479	0.109	0.134	0.178	0.150	0.040
20	0.382	0.520	0.433	0.110	0.217	0.272	0.237	0.073
30	0.434	0.565	0.483	0.138	0.319	0.380	0.341	0.125
40	0.514	0.642	0.562	0.185	0.427	0.483	0.447	0.198
50	0.605	0.727	0.650	0.246	0.522	0.561	0.535	0.289
60	0.691	0.802	0.732	0.319	0.581	0.594	0.583	0.388
	Commodity Group C							
10	0.472	0.669	0.546	0.127	0.149	0.195	0.166	0.045
20	0.427	0.579	0.485	0.126	0.236	0.293	0.257	0.082
30	0.478	0.619	0.532	0.157	0.341	0.402	0.363	0.138
40	0.559	0.693	0.610	0.206	0.449	0.502	0.467	0.215
50	0.648	0.773	0.695	0.271	0.538	0.572	0.548	0.309
60	0.731	0.843	0.772	0.347	0.589	0.594	0.587	0.407

Increases in Transit Times

In addition to rates, shipper may also adjust quantities to changes in attributes such as shipment time. In this case, shippers are asked if volume are affected (yes/no) to a randomly drawn change in shipment times (10, 20,…, 60 percent). If the shipper responded yes, the shipper was asked by what percentage its annual volume would change. Using the same model as with rates, the same missing value issue was confronted in the same manner. In this case, there were 202 respondents on whether annual volumes would adjust or not. Of these 202, 68 reported that annual volumes would change, and, of those, 38 reported how much annual volumes would be affected. Given the unduly high number of "zeros" in the data relative to those that give the level of change in the data, the same bootstrapping technique was used.

Table 34 contains estimation results for shipment times following the same procedures and specifications as with rate prompts. As expected, the effect of an increase in transit times is to reduce annual volumes. The coefficient on the size of the time prompt however, is much smaller than those associated with rates. Further, as with rate prompts, the addition of commodity or access dummies are not important statistically.

Table 34. Bootstrapped Tobit Model Estimates – Volume Changes when Shipment Times Increase

Variable	Base Model	Commodity Dummies	Access Dummies	Commodity and Access Dummies
Time prompt	0.787*	0.728*	0.703*	0.653*
	(0.283)	(0.270)	(0.2844)	(0.273)
Commod B	n.a.	4.800	n.a.	6.527
		(11.533)		(11.960)
Commod C	n.a.	-21.737	n.a.	-19.406
		(12.367)		(12.639)
Access Rail	n.a.	n.a.	-0.805	-3.799
			(13.609)	(11.535)
Access Barge	n.a.	n.a.	12.145	8.844
			(13.412)	(12.933)
Access Rail and Barge	n.a.	n.a.	-22.633	-23.519
			(23.847)	(22.815)
Intercept	-44.468	-34.901*	-40.323*	-31.576*
	(13.225)	(14.222)	(13.609)	(14.566)

Elasticity estimates and the probability of annual volumes being affected are presented in table 35 for the base model and table 36 for the full model with commodity and access delineations. Consistent with the previous models, the time elasticities are generally inelastic (i.e., have values less than one). For the base model, the elasticities are all less than one in magnitude, and the probability of an adjustment in quantities due to a change in shipment times tends to be quite small. By and large the estimates are smaller than those of each of the rate prompts. This finding suggests that responses to shipment time changes are smaller than those of rates. Table 36 contains the elasticity estimates for the full model. Almost without exception, the elasticities are quite small as are the probabilities that adjustments occur.

Table 35. Estimated Elasticities and Probabilities of Adjustment for an Increase in Shipment Times, base model.

Time Prompt	Elasticity	Probability
10	0.457	0.194
20	0.315	0.248
30	0.283	0.309
40	0.279	0.376
50	0.289	0.446
60	0.304	0.515

Table 36. Estimated Elasticities and Probabilities of Adjustment for an Increase in Transit Times , full model

	Elasticity				Probability			
	Commodity Group A							
Time Increase	Truck	Rail	Barge	Rail and Barge	Truck	Rail	Barge	Rail and Barge
10	0.630	0.544	0.905	0.219	0.262	0.233	0.340	0.112
20	0.409	0.357	0.572	0.151	0.318	0.286	0.401	0.146
30	0.349	0.306	0.475	0.137	0.379	0.344	0.464	0.187
40	0.329	0.291	0.438	0.137	0.442	0.405	0.527	0.234
50	0.325	0.291	0.423	0.144	0.505	0.468	0.588	0.287
60	0.330	0.297	0.420	0.154	0.567	0.530	0.643	0.345
	Commodity Group B							
10	0.823	0.705	1.155	0.307	0.319	0.285	0.402	0.148
20	0.524	0.454	0.717	0.207	0.379	0.343	0.464	0.188
30	0.438	0.384	0.585	0.183	0.442	0.405	0.527	0.234
40	0.406	0.359	0.529	0.180	0.505	0.468	0.588	0.287
50	0.395	0.353	0.504	0.185	0.567	0.532	0.644	0.344
60	0.395	0.356	0.493	0.195	0.625	0.592	0.693	0.406
	Commodity Group C							
10	0.257	0.214	0.404	0.074	0.130	0.111	0.185	0.045
20	0.176	0.148	0.269	0.054	0.168	0.145	0.231	0.062
30	0.159	0.135	0.234	0.052	0.212	0.186	0.284	0.084
40	0.158	0.135	0.227	0.055	0.263	0.234	0.342	0.113
50	0.165	0.143	0.230	0.061	0.320	0.287	0.403	0.147
60	0.176	0.154	0.239	0.069	0.381	0.345	0.466	0.188

Decreases in Reliability

The results with respect to changes in reliability are given in tables 37, 38 and 39. A difference between reliability and the others (common rate, idiosyncratic rate, and time) is that the question posed is if reliability *decreases* rather than increases. Thus, volumes increase rather than decrease.

The coefficient estimates presented in table 37 suggests that reliability indeed has a statistically important effect. As with the other variables, the addition of commodity and access dummies does little to change the basic result. Indeed, as with the other specifications, the parameter on the prompt variable changes little with different specifications.

Elasticity estimates for the base model are in table 38. The results suggest elasticities that are less than one, and also that probability that volumes adjust to changes in reliability tend to be somewhat small. Elasticity estimates for the full model are in table 39. Here again, the elasticities are small and vary little across modal access and commodities.

Table 37. Bootstrapped Tobit Model Estimates – Volume Changes when Reliability Changes

Variable	Base Model	Commodity Dummies	Access Dummies	Commodity and Access Dummies
Reliability prompt	1.136*	1.075*	1.117*	1.069*
	(0.338)	(0.335)	(0.338)	(.333)
Commod B	n.a.	-12.387	n.a.	-13.929
		(13.655)		(13.688)
Commod C	n.a.	-15.658	n.a.	-14.955
		(13.470)		(13.551)
Access Rail	n.a.	n.a.	4.419	5.334
			(12.522)	(12.482)
Access Barge	n.a.	n.a.	9.195	6.091
			(14.389)	(14.380)
Access Rail and Barge	n.a.	n.a.	-35.426	-37.494
			(28.516)	(28.090)
Intercept	-53.955*	-40.281*	-52.583*	-38.797*
	(15.218)	(18.075)	(16.383)	(19.005)

Table 38. Estimated Elasticities and Probabilities of Adjustment for a Decrease in Reliability, base model.

Time Prompt	Elasticity	Probability
10	0.423	0.173
20	0.328	0.243
30	0.326	0.326
40	0.351	0.418
50	0.386	0.510
60	0.427	0.594

Table 39. Estimated Elasticities and Probabilities of Adjustment for a Change in Reliability, full model

	Elasticity				Probability			
	Commodity Group A							
Reliability Decrease	Truck	Rail	Barge	Rail and Barge	Truck	Rail	Barge	Rail and Barge
10	0.682	0.837	0.859	0.134	0.258	0.299	0.305	0.068
20	0.499	0.600	0.614	0.112	0.341	0.386	0.393	0.106
30	0.469	0.553	0.565	0.121	0.432	0.478	0.484	0.157
40	0.480	0.555	0.565	0.141	0.524	0.566	0.572	0.221
50	0.505	0.574	0.583	0.168	0.608	0.643	0.648	0.299
60	0.536	0.599	0.607	0.202	0.678	0.702	0.706	0.386
	Commodity Group B							
10	0.383	0.478	0.501	0.064	0.165	0.197	0.204	0.036
20	0.297	0.363	0.378	0.057	0.233	0.272	0.279	0.059
30	0.295	0.354	0.366	0.065	0.314	0.358	0.365	0.093
40	0.317	0.374	0.385	0.080	0.404	0.450	0.456	0.140
50	0.350	0.406	0.416	0.101	0.496	0.541	0.546	0.201
60	0.389	0.443	0.452	0.127	0.583	0.623	0.626	0.275
	Commodity Group C							
10	0.364	0.461	0.482	0.060	0.159	0.191	0.197	0.034
20	0.283	0.351	0.365	0.054	0.225	0.264	0.271	0.056
30	0.282	0.343	0.355	0.061	0.305	0.349	0.356	0.089
40	0.305	0.363	0.374	0.076	0.395	0.441	0.447	0.135
50	0.339	0.395	0.405	0.096	0.487	0.532	0.538	0.195
60	0.378	0.432	0.441	0.122	0.576	0.615	0.619	0.267

5. SUMMARY

This report summarized the results of a survey and analysis of shippers of non-agricultural products. In principle, they survey consists of shippers that may or may not use the waterway, but plausibly could. The survey produced a set of 232 respondents. Information was solicited on the last shipment and alternatives to the last shipment. In this regard, the sample was dominated by shippers that report the lack of alternatives. That is, only 101 of respondents reported at least one alternative to that chosen. After removal of missing values, there were relatively few observations that allowed a choice model on the basis of revealed data to be estimated. However, the data also solicited stated preference data, and these were used to estimate choice functions and the sensitivity of shipper model/destination choices to changes in rates, transit time and reliability. The results strongly suggest that shippers respond to each with the largest effects emanating from changes in rates. While choices do appear to be sensitive to changes, the estimated arc-elasticities tend to be less than one in magnitude i.e., the responses to rates, transit time and reliability tend to be relatively inelastic.

In addition to the stated preference data on choices, information was also solicited on the responsiveness of annual volumes to changes in rates, transit times and reliability. Estimation results mirror those of the mode/destination choices. That is, shipper responses do suggest that annual volumes adjust to changes in rates, transit times and reliability. However, as with mode/destination choices, the results suggest that the reaction is relatively small i.e., the estimated arc elasticities point to relatively inelastic responses (estimates less than one in magnitude).

REFERENCES

Clark, Chris, Helen Naughton, Bruce Proulx, and Paul Thoma. 2005. "A Survey of the Freight Transportation Demand Literature and a Comparison of Elasticity Estimates." IWR Report 05-NETS-R-01. Weblink: http://www.nets.iwr.usace.army.mil/docs/other/05-NETS-R-01.pdf.

Sitchinava, Nino, Wesley Wilson, and Mark Burton. 2005. "Stated Preference Modeling of the Demand for Ohio River Shipments. IWR Draft Report. Weblink: http://www.nets.iwr.usace.army.mil/docs/other/OhioStatedPreferenceDemand.pdf.

Train, Kenneth, and Wesley W. Wilson. 2004. "Shippers' Responses to Changes in Transportation Rates and Time: The Mid-American Grain Study." IWR Report 04-NETS-R-02. Weblink: http://www.nets.iwr.usace.army.mil/docs/ModelPrefUpperMissGrain/04-NETS-R-02.pdf.

Train, Kenneth, and Wesley W. Wilson. 2005. "Analysis of Stated-Preference Experiments Constructed from Revealed-Preference Choices. IWR Report 05-NETS-P-08. Weblink: http://www.nets.iwr.usace.army.mil/docs/ColumbiaSnakeTransportation/05-NETS-P-08.pdf.

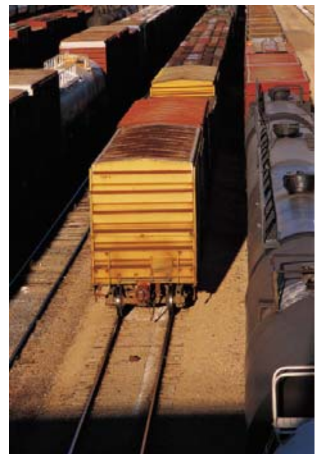
Train, Kenneth, and Wesley W. Wilson. 2006. "Transportation Demands in the Columbia-Snake River Basin." IWR Report 06-NETS-R-03. Weblink http://www.nets.iwr.usace.army.mil/docs/ColumbiaSnakeTransportation/06-NETS-R-03.pdf.

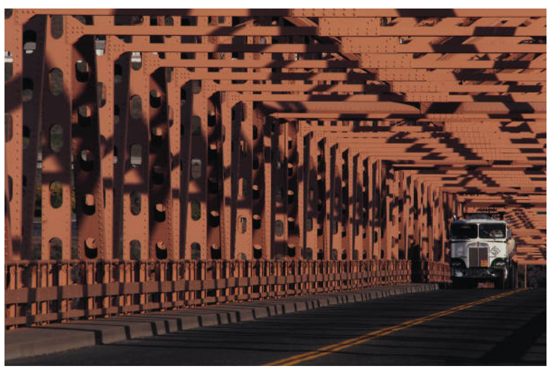
Train, Kenneth, and Wesley W. Wilson. 2007. "Transportation Demands for Agricultural Products in the Upper Mississippi and Illinois River Basin." IWR Report.

APPENDIX A

SURVEY FORM FOR NON-AGRICULTURAL SHIPPERS

2006 Survey of Transportation Needs in the Midwest





Sponsored by

United States Army Corps of Engineers
and
Washington State University

Your responses to this survey will help us understand the need for transportation investments in your region. This information will be used by the U.S. Army Corps of Engineers to evaluate and support public provision of transportation infrastructure improvements. Two types of information are necessary to complete the task. These deal with the shipments you made, as well as some information about you as the shipper. The survey should take only about 15 minutes.

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it has a valid Office of Management and Budget (OMB) control number. The valid OMB number for this information collection is OMB 0710-0001and the expiration date is November 2007. The time required to complete this information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Your participation is voluntary and all responses will be kept confidential.

SHIPMENT INFORMATION

Choice: Consider your last shipment from this or your major facility ***«Company_Name»*** ***«Mail_Address»***.

Q1. What commodity was shipped in <u>your very last freight shipment</u>? ___________
commodity

Q2. Where was this commodity shipped to: ________________________ city _______ state

Q2b. What type of destination is this?

☐1 River terminal ☐2 Distribution center ☐3 Railroad terminal ☐4 Processing Plant { ☐1 Construction ☐2 Fabrication ☐3 Blending ☐4 Energy ☐5 Other (Specify): }
☐5 Other (please specify): ______________________

Q3. How large was your last single outbound shipment (payload weight)? _________

__________________________ payload weight

☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Shipment ☐5 Other (specify): ________________

Q4. What types of transportation modes were used for this shipment, approximately what distance did each travel (in miles), and what was the transportation rate?

Mode (check if used)		Distance traveled		Transportation rate		**Per Unit type for commodity** Tons	Cwt	Gallons	Shipment	Other
☐	Truck	_________	miles	_________	rate	☐1	☐2	☐3	☐4	☐5
☐	Rail	_________	miles	_________	rate	☐1	☐2	☐3	☐4	☐5
☐	Barge	_________	miles	_________	rate	☐1	☐2	☐3	☐4	☐5

__________ What were the *total* transport costs? ☐1 ☐2 ☐3 ☐4 ☐5

__________ What was the *total* shipment distance in miles?

Q5. What do you estimate was the shipment time (include scheduling time, wait for equipment and transit time)
________ days + ________ hours.

Q6. How reliable is the service? That is, for shipments like this one, what percent of the time do you expect them to arrive on time?

_________ percent on-time arrivals

Q7. What price did you receive for your commodity at the destination terminal?

_________ dollars

☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Shipment ☐5 Other (specify): ________________

SHIPPING ALTERNATIVES

We want to know what options you could take if the mode and destination you used for your last shipment had not been available and would never be available. For example, if the rail system were shut down, shippers who used rail could use truck instead of rail, or could use barge with truck access to a barge loading facility, or could have sent the shipment to a different destination. We need to know what these alternatives are for you. Nearly everyone has some kind of shipping alternatives. If not, then the only alternative is to shut down and go out of business. Please provide us with information on these alternatives for you.

Q8. First, do you have any shipping alternatives?

☐1 Yes → **skip to Q11**
☐2 No → **Q8b. Please explain why you have no shipping alternatives.**

Q9. Does this mean you could not ship to any other locations or that you have no other transportation mode options? (Check all that apply)

☐1 Could not ship to other locations
☐2 Do not have other transportation modes

Q9b. If either or both boxes are checked, please explain.

Q10. If the shipment you made could not have been made, i.e., the mode, the location, or both were not available for a lengthy time period and you have no alternatives, does this mean your establishment would go out-of-business and cease operations? (e.g., Katrina shut down the river and New Orleans for a lengthy time period.)

☐1 Yes
☐2 No } **skip to Q25**

FIRST SHIPPING ALTERNATIVE

Q11. Where would it be shipped to? ________________ city ______ state

Q11b. What type of destination is this?

☐1 River terminal ☐2 Distribution center ☐3 Railroad terminal ☐4 Processing Plant { ☐1 Construction ☐2 Fabrication ☐3 Blending ☐4 Energy ☐5 Other (Specify): }
☐5 Other (please specify): ______________________

Q12. What types of transportation modes would be used for this shipment, approximately what distance did each travel (in miles), and what was the transportation rate?

Mode (check if used)	Distance traveled	Transportation rate	Per Unit type for commodity: Tons	Cwt	Gallons	Shipment	Other
☐ Truck	________ miles	________ rate	☐1	☐2	☐3	☐4	☐5
☐ Rail	________ miles	________ rate	☐1	☐2	☐3	☐4	☐5
☐ Barge	________ miles	________ rate	☐1	☐2	☐3	☐4	☐5

________ **What would be the *total* transport costs?** ☐1 ☐2 ☐3 ☐4 ☐5

________ **What would be the *total* shipment distance in miles?**

Q13. What do you estimate would be the shipment time (include scheduling time, wait for equipment and transit time)

________ days + ________ hours.

Q14. How reliable is the service? That is, for shipments like this one, what percent of the time do you expect them to arrive on time?

__________ percent on-time arrivals

Q15. How large would your shipment be (payload weight)?

_____________________________ payload weight

☐ 1 Tons ☐ 2 Cwt. ☐ 3 Gallons ☐ 4 Shipment ☐ 5 Other (specify): ____________________

Q16. What price would you receive for your commodity at the destination terminal?

__________ dollars

☐ 1 Tons ☐ 2 Cwt. ☐ 3 Gallons ☐ 4 Shipment ☐ 5 Other (specify): ____________________

OTHER SHIPPING ALTERNATIVES

If you have any other shipping alternatives, please complete the table below, otherwise skip to Q24.

	Second Alternative	Third Alternative
Q17. Where would it be shipped to?	______________ city _____ state	______________ city _____ state
Q18. What type of destination is this?	☐ 1 River terminal ☐ 2 Distribution center ☐ 3 Railroad terminal ☐ 4 Processing Plant→Type ________ ☐ 5 Other (specify): _______________	☐ 1 River terminal ☐ 2 Distribution center ☐ 3 Railroad terminal ☐ 4 Processing Plant→Type ________ ☐ 5 Other (specify): _______________
Q19. What type of transportation modes would be used for this shipment?	Mode (Check if used) ▼ / Distance traveled ▼ / Transportation rate ▼ ☐ Truck _____miles ____rate ☐ Rail _____miles ____rate ☐ Barge _____miles ____rate ☐ 1 Tons ☐ 2 Cwt. ☐ 3 Gallons ☐ 4 Shipment ☐ 5 Other (specify):	Mode (Check if used) ▼ / Distance traveled ▼ / Transportation rate ▼ ☐ Truck _____miles ____rate ☐ Rail _____miles ____rate ☐ Barge _____miles ____rate ☐ 1 Tons ☐ 2 Cwt. ☐ 3 Gallons ☐ 4 Shipment ☐ 5 Other (specify):
Q20. What do you estimate would be the shipment time?	_____ days + _____ hours	_____ days + _____ hours
Q21. How reliable is the service?	_____% on-time arrivals	_____% on-time arrivals
Q22. How large would the shipment be?	__________ payload weight ☐ 1 Tons ☐ 2 Cwt. ☐ 3 Gallons ☐ 4 Shipment ☐ 5 Other (specify):	__________ payload weight ☐ 1 Tons ☐ 2 Cwt. ☐ 3 Gallons ☐ 4 Shipment ☐ 5 Other (specify):
Q23. What estimated price would you receive for your commodity at the destination terminal	__________ dollars ☐ 1 Tons ☐ 2 Cwt. ☐ 3 Gallons ☐ 4 Shipment ☐ 5 Other (specify):	__________ dollars ☐ 1 Tons ☐ 2 Cwt. ☐ 3 Gallons ☐ 4 Shipment ☐ 5 Other (specify):

Best Alternative Choice

Q24. Of the alternative shipments, what is your "preferred alternative"? That is, if you did not make the shipment you made, what shipment would you have made?

☐1 First Alternative
☐2 Second Alternative
☐3 Third Alternative
☐4 Other Alternative (please specify): ____________________

Transportation Rate sensitivity

We generally know how important transportation rates and service are to a shipper. We need to have a sense of how you would react to rate and service changes. In each of the next three questions relating to rate and service changes, please regard the changes as **permanent** changes. Also, **if you marked you have no alternatives in Q8, page 3, please consider "out-of-business" as your alternative.**

Q25. For your last shipment, if the transportation rate increased «Percent_change1»%, would you continue with the original mode and destination or switch to your best alternative choice?

☐1 Continue to use Original mode
☐2 Switch to Best Alternative Choice → **Skip to Q26**
☐3 Go out-of-business → **Skip to Q26**

Q25b. If you would continue to use your Original mode, what <u>percentage increase in the transportation rate</u> would be necessary to cause you to switch to the Alternative transportation mode?

______ % increase

Transit Time

Q26. For your last shipment, if the transit time (including scheduling and wait for equipment) for the original option increased «Percent_change2»%, would you continue with the original mode and destination or switch to the alternative at this location?

☐1 Continue to use Original mode
☐2 Switch to Best Alternative Choice → **Skip to Q27**
☐3 Go out-of-business → **Skip to Q27**

Q26b. If you would continue to use your Original mode, what <u>percentage increase in the transit time</u> would be necessary to cause you to switch to the Alternative transportation mode?

______ % increase

Reliability

Q27. For your last shipment, if the reliability (percentage of time shipments arrived on-time) of the original option decreased «Percent_change3»%, would you continue with the original mode and destination or switch to the alternative at this location?

☐1 Continue to use Original mode
☐2 Switch to Best Alternative Choice → **Skip to Q28**
☐3 Go out-of-business → **Skip to Q28**

Q27b. If continue to use Original mode, what <u>percentage decrease in the reliability</u> would be necessary to cause you to switch to the Alternative transportation mode?

______ % increase

VOLUME SENSTIVITY

Q28. If the average transportation rate you pay increased by «Percent_change4»%, would your annual volume shipped decrease (assume the rate increase applies to *BOTH* you and to your competitors)**?**

☐1 Yes
☐2 No → **Skip to Q29**

Q28b. If yes, by how much would the volume decrease (assuming the rate increase applies to both you and to your competitors)**?**

__________ volume decrease

Q29. If the average transportation rate you pay increased by «Percent_change5»%, would your annual volume decrease (assume that the rate increase applies *ONLY* to your firm and *NOT* to your competitors)**?**

☐1 Yes
☐2 No → **Skip to Q30**

Q29b. If yes, by how much would the volume decrease (assuming that the rate increase applies ONLY to your firm and NOT to your competitors)**?**

__________ volume decrease

Q30. If the average time in transit increased by «Percent_change6»%, would your annual volume decrease?

☐1 Yes
☐2 No → **skip to Q31**

Q30b. If yes, by how much would the volume decrease?

__________ volume decrease

Q31. If the average time that shipments arrive on-time decreased by «Percent_change7»%, would your annual volume decrease?

☐1 Yes
☐2 No → **skip to Q32**

Q31b. If yes, by how much would the volume decrease?

__________ volume decrease

SHIPPER CHARACTERISTICS

Q32. How long has this facility been at its current location?

_____ years

Q33. Do you have rail access at your facility?

☐1 Yes → **Q33b. What is your rail car loading capacity?** _____ # of cars
☐2 No

Q34. How far is it to the nearest rail facility you use or would use?

______ miles (mark zero if you have rail service at your facility)

Q35. Do you have barge access at this facility?

☐1 Yes
☐2 No

Q36. How far is it to the nearest barge facility you use or would use?

______ miles (mark zero if you have barge service at your facility).

Q37. How large is your facility?

__________________ **Total Amount of Annual Units Shipped**

please check the type of unit for this facility

☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Shipment ☐5 Other (specify): ____________________

__________________ **Total Amount of Storage Capacity**

☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Shipment ☐5 Other (specify): ____________________

Q38. Does your firm (or parent firm) own export or import facilities?

☐1 Yes
☐2 No

Q39. How many facilities such as this one does your firm own and/or operate?

_______________ number of establishments.

LOCATION DECISIONS

Q40. If you were offered an alternative plant location that would result in «Percent_change8»% lower logistic and transportation costs, would you relocate?

☐1 Yes
☐2 No

Q40b. If no, by what percent would the costs have to decrease to cause you to relocate?

_____ % decrease in logistics costs

☐ Check this box if you would not relocate ever.

Q41. Suppose you were a start-up business and you considered two different locations with different investment and different logistics costs, which would you choose? (Investments have a 25-year life and all other factors are the same.)

Location A has «Percent_change9»% lower logistics costs but *«Percent_change10»%* higher investment costs than Location B.

☐1 Location A
☐2 Location B

Q42. Finally, if we have any questions and wish to follow up, may we contact you?

☐1 Yes
☐2 No → **Skip to Q43**

Q42b. Name: ____________________ Telephone: ____________________

Email: ____________________

Q43. Would you like a copy of the survey results?

☐1 Yes
☐2 No → **Skip to Q44**

Q43b. Yes, please email the website for the report. Email: ____________________
Yes, please send a hard copy to:

Name: ____________________

Address: ____________________

City, State Zip: ____________________

Q44. Thank you for your help with this study. We would welcome any additional comments you would like to provide about shipping.

Please return your completed questionnaire to:

Social & Economic Sciences Research Center
Washington State University
PO Box 644014
Pullman, WA 99164-4014

«ID» - 2

APPENDIX B

TECHNICAL REVIEWS

Technical Review of Draft Report
Upper Mississippi and Illinois Transportation Demands for Non-Agricultural Products

U.S. ArmyCorps of Engineers
Institute for Water Resources

April 2007

Independent Technical Review of
Draft Report

Upper Mississippi and Illinois Transportation Demands for Non-Agricultural Products

By

Kenneth Train and Wesley W. Wilson

Independent Review Report Compiled by:

CDM
1050 North Reed Station Road, Suite D
Carbondale, IL 62902
(618) 351-4530

A Report Submitted to:

U.S. Army Corps of Engineers
Institute for Water Resources
7701 Telegraph Road
Casey Building
Alexandria, VA 22315

under

Task Order #67
Contract No. W912HQ-04-D-0007

April 2007

Preface

Under Contract Number W912HQ-04-D-0007, Delivery Order Number 67, CDM is contracted to select independent reviewers to evaluate written products for the U.S. Army Corps of Engineers Institute for Water Resources (IWR). This report provides an independent technical review of a study sponsored by IWR titled, *Upper Mississippi and Illinois Transportation Demands for Non-Agricultural Products*. The objective of the independent technical review is to validate analytical procedures, verify conclusions and enhance the quality of the said study. Two independent reviewers, who remain anonymous to IWR, were selected from a working list of qualified peer reviewers that is maintained by CDM.

The review document follows a four-section editorial structure that was established in consultation with IWR: (1) written statement by IWR on its original purpose and objectives for the study being reviewed, (2) summary paraphrasal of study conclusions, (3) summary review statement on validity and quality of findings and (4) individual comments and issues for resolution.

Following this introduction and in adherence to IWRs guidelines, Section 1 describes the purpose and objectives of the work being reviewed. Section 2 provides the summary of conclusions as paraphrased by the reviewer, while Section 3 provides summary review statements on the validity and quality of findings. Finally, individual comments and issues for resolution are provided in Section 4.

Contents

Section 1
Purpose and Objectives

The purpose of this work is to provide the Institute for Water Resources (IWR) with an independent technical review of the report *Upper Mississippi and Illinois Transportation Demands for Non-Agricultural Products* (Train and Wilson, 2006). The objective of the review is to validate analytical procedures, verify conclusions and enhance the quality of the research report.

This report investigates the behavior of shippers of non-agricultural products from the Upper Mississippi and Illinois Region. The specific elements of shipping behavior considered are the effect on mode and destination choice behavior as well as the annual volume of shipments in response to changes in shipping rates, transit time and transit time reliability. The primary purpose is to provide models and information to support the planning models used by the U.S. Army Corps of Engineers.

The objectives of the work are to (1) provide an understanding and ability to forecast how the demand for different shipment modes and destinations changes in response to changes in tariffs, transit time and transit time reliability (percent of on time arrivals) and (2) provide an ability to forecast how the total volume of shipments is likely to change in response to changes in the same variables.

Section 2
Summary of Study Conclusions

2.1 Reviewer 1

This research analyzes the results of a survey of firms that produce non-agricultural commodities and are located in the central part of the nation.

The authors were unable to derive meaningful information about shippers' choice sensitivities from that part of the survey that asked about actual rates and shipping characteristics.

The primary findings, drawn from the part of the survey that asks shippers to respond to hypothetical changes in the cost or quality of shipping are that:

1. Shippers are not insensitive in their shipping decisions to changes in rates.
2. Shippers are not insensitive in their shipping decisions to the quality of service.

Based on the same survey of hypothetical changes in shipping rates and service quality, the authors further find that for non-agricultural commodities:

1. Barge shippers have a price elasticity of shipping choice of roughly 0.9.

2. Rail shippers have a price elasticity of shipping choice for roughly 3.5.

3. Truck shippers have a price elasticity of shipping choice of roughly 1.3.

4. The measured elasticities of shipping choice are almost identical across broad commodity classifications.

5. Barge shippers have a service time elasticity of shipping choice of roughly 1.1.

6. Rail shippers have a service time elasticity of shipping choice of roughly 2.8.

7. Truck shippers have a service time elasticity of shipping choice of roughly 1.3

8. The measured service time elasticity of shipping choice are almost identical across broad commodity classifications.

9. Barge shippers have an elasticity of shipping choice with respect to reliability of roughly 1.3

10. Rail shippers have a price elasticity of shipping choice with respect to reliability of roughly 2.6.

11. Truck shippers have a price elasticity of shipping choice with respect to reliability of roughly 1.5.

12. The measured elasticities of shipping choice with respect to service reliability do vary across commodity classifications.

13. The elasticity of shipping volume with respect to shipping prices for barge shippers is roughly 0.8, assuming that barge rates increase simultaneously for the shipper and its competitors.

14. The elasticity of shipping volume with respect to shipping prices for rail shippers is roughly 0.7, assuming that rail rates increase simultaneously for the shipper and its competitors.

15. The elasticity of shipping volume with respect to shipping prices for truck shippers is roughly 1.0 assuming that trucking rates increase simultaneously for the shipper and its competitors.

16. The elasticities do vary across broad commodity classifications.

17. The elasticity of shipping volume with respect to shipping prices for barge shippers is roughly 0.9, assuming that barge rates increases only for the shipper and not for its competitors.

18. The elasticity of shipping volume with respect to shipping prices for rail shippers is roughly 1.1, assuming that barge rates increases only for the shipper and not for its competitors.

19. The elasticity of shipping volume with respect to shipping prices for truck shippers is roughly 0.6, assuming that barge rates increases only for the shipper and not for its competitors.

20. These elasticities vary substantially across broad commodity classifications.

21. The elasticity of shipping volume with respect to transit time for barge shippers is roughly 0.6.

22. The elasticity of shipping volume with respect to transit time for rail shippers is roughly 0.5.

23. The elasticity of shipping volume with respect to transit time for truck shippers is roughly 0.6.

24. The elasticity of shipping volume with respect to transit time for rail/barge shippers is roughly 0.6.

25. These elasticities vary substantially across broad commodity classifications

26. The elasticity of shipping volume with respect to service reliability for barge shippers is roughly 0.7.

27. The elasticity of shipping volume with respect to service reliability for rail shippers is roughly .6.

28. The elasticity of shipping volume with respect to service reliability for truck shippers is roughly 0.5.

29. The elasticity of shipping volume with respect to service reliability for rail/barge shippers is roughly 0.1.

30. These elasticities vary slightly across broad commodity classifications

2.2 Reviewer 2

According to the authors, the report they prepared fulfills a requirement for the U.S. Army Corps of Engineers to develop models that reflect the alternatives that individual shippers face and the responsiveness with respect to the choices they make in terms of mode, destination and volume to changes in rates, transit times and reliability. Previous efforts have focused on agricultural commodities. This effort focused on non-agricultural commodities and products.[1]

To prepare the report, the authors surveyed shippers of non-agricultural commodities and products, stratifying by commodity and distance to the waterway. A survey instrument was prepared and sent to 3,012 potential respondents (using two separate lists). The response rate was about 8 percent or 232 firms. The authors contend that the non-response rate was low because those non-responsive firms did not ship or were not relevant to the survey. In this review, there were additional issues regarding the sample's validity as well as its "correspondence to reality" for modeling purposes as described in more detail in Section 4 of this review; mainly related to geographic concerns.

The survey list was developed through an exhaustive use of a Dun and Bradstreet database delineated on select NAICS codes. The survey effort moved through a series of steps including a mailed pre-contact letter and a survey form, a mailed reminder card, followed by a second mailed survey and finally with telephone calls.

The authors summarized their key findings of the report in the "Executive Summary and Introduction." In essence, through the use of a survey of shippers and elaborate statistical models, the authors concluded (what is logically and intuitively accepted in business), that freight rates, transit times and reliability matter and influence shipper transportation and logistics decisions. Quite frankly, the elaborate data work and statistical modeling were deemed "overkill" relative to the conclusions reached and as described above subject to "data" limitations. In short, the data limitations bring the coefficients that were generated in the models into question, thus defeating the purpose of the study to quantify and establish a predictive model for shipments relative to select economic and business drivers.

A final general comment relates to the quality of the writing and the numerous typographical errors as well as incomprehensible tables and charts. This paper requires a thorough editing effort before public release as these factors prevent the reader from understanding the process, results and conclusions for the study.

[1] A moderately detailed review of literature regarding the agricultural commodity findings would have been useful as opposed to just oblique references.

Section 3
Summary Review Statement on Validity and Quality of Findings

3.1 Reviewer 1

1. This study uses generally accepted econometric techniques to understand the results of an interesting survey with a low response rate.

2. The sampling frame for the study is unclear and thus it is unclear what the population is for which the results are assumed to be valid.

3. Revealed preference estimates were suppressed, leading to the possibility of publication bias; since the estimates were suppressed, it is impossible to tell whether the implementation of the technique is valid.

4. Stated preference estimates of modal choice are based on the somewhat unusual concept of a switching sensitivity rather than a modal split sensitivity.

5. The motivation for an analysis of switching vs staying is not presented; it is unclear whether there is a spatial motivation for this model.

6. The techniques used to evaluate volume adjustments appear to be appropriate given the very small number of observations available. However, the results of this estimation appear to be somewhat illogical.

7. Except for the limitations noted in points 2-6 above, the results appear to be correctly estimated and well presented.

3.2 Reviewer 2

The report addresses the U.S. Army Corps of Engineers need to model non-agricultural shipper responses to changes in rates, transit time and reliability. A detailed survey effort was developed while a series of statistical models were used to parse the results.

The quality of the writing distracts the overall effectiveness of the report conclusions. The report is in need of a solid editorial review to correct grammatical and spelling errors (for example, the title page has errors, Mississippi is spelled incorrectly and the date should probably be January 2007). Moreover, there are incorrect references to tables from the text. Also, table titles, column and row headings do not allow tables to stand-alone. In some instances it seems the authors simply copied tables and replaced the values without making necessary changes to row headings. For example, it appears that the model descriptions and statistical results tables are misstated. Moreover, one must work hard to decipher what each variable used in the model actually represents and in some cases, it is not something the reader can determine.

The title of the report, "Upper Mississippi and Illinois Transportation Demands for Non-Agricultural Products" does little to truly define the geographic coverage of the study. From the title, a reader could interpret the scope of the report to mean the upper portion of the State of Mississippi and the State of Illinois. A sense of the geography is presented in the "Executive Summary and Introduction" on page 1, the second paragraph. But, it is not until page 3 under the "Data Sources and Description" section that a more specific geography is presented; even then, the geographic attention seems counter-productive given the nature and scope of this study.

Shippers were surveyed from nine states, including Arkansas, Illinois, Indiana, Kentucky, Louisiana, Mississippi, Ohio, Tennessee and Texas. Through stratification, the respondents were stratified by location vis-à-vis the Mississippi River. A concern is that respondents from Texas were included, but they are not directly tributary to the Mississippi River. Yet, other states that are directly tributary to the Mississippi River such as Iowa, Missouri, Minnesota and Wisconsin are not included in the survey. The states of Ohio and Indiana were included, but they are directly tributary to the Ohio River not the Mississippi River. For practical purposes, many government agencies, such as the U.S. Army Corps of Engineers, often refer to the Mississippi River System as including its tributaries and connecting waterways, such as the Arkansas, Illinois, Missouri, Ohio, Tennessee and Cumberland Rivers, and the Gulf Intracoastal Waterway. By extending the definition to the broader sense, the list of states then expands to Alabama, Florida, Nebraska, Oklahoma, Pennsylvania and West Virginia for a total of 15.

The more appropriate title for this report should be the "Upper Mississippi River and Illinois Waterway Transportation Demand for Non-Agricultural Products," that includes the section of the Mississippi River from St. Louis north for example.

While an extensive survey methodology was employed using a detailed survey instrument to capture as high a response rate as possible, a number of problems are apparent that might have mitigated the non-responsiveness. As mentioned above, the issue with the state coverage is important. If other states that are tributary to the "Mississippi River System" were included then more respondents likely would have been expected.

With respect to commodity groupings, the use of the NAICS (North American Industry Classification System, not referenced in the report) is an appropriate tool to use with the Dun and Bradstreet database. But, there was no discussion on how these commodities vary in form, such as liquid or dry. This is an important distinction because different types of barges are used to move commodities. For practical purposes, there are three types of barges: covered dry, open dry and tank or liquid barges. On page 17, the authors conveniently placed commodities into three groupings, Commodity Group A (oil and gas extraction, mining and aggregates), Commodity Group B (wood, paper, petroleum, coal, chemicals, plastics and fuel) and Commodity Group C (mineral and metals). The problem with this approach is that commodity form types are commingled into broad categories, ignoring the type of movement that is a dry or liquid movement. For example, aggregates and coal compete with each other for cargo carrying transportation assets while aggregates and oil do not have any relationship to each other for cargo carrying transportation assets.

While the authors did mention that the U.S. Army Corps of Engineers (ACE, as specified by the authors on page 1) uses models that require estimates at a "pool" level of demands for each commodity, there was no reference or discussion of key commodity movements in the pools or river segments. A review of river segment movement data from the U.S. Army Corps of Engineers is readily available with specific detail by date, commodity, volume and direction of move (up river or down river). This would have helped to clarify the commodity groupings while allowing the authors to better appreciate the type of responses received.

The first question of the survey ("Q1. What commodity was shipped in your very last freight shipment?") is somewhat misleading. That is, the survey firm may in fact ship numerous commodities and products, but the last shipment could have been a small or unimportant shipment (i.e., business-wise to the respondent). A better approach would have been to ask the respondent to use the last shipment of the largest volume of a commodity they shipped during the year to complete the survey or some other question that would have generated data related to important shipments.

The authors focused on shippers owning export facilities while ignoring the possibility, and perhaps more importantly, shippers that own import facilities as referenced on page 7 for Table 5. However, in the survey instrument, under the "Shipper Characteristics" section, Q38, respondents were asked, "Does your firm, (or parent firm) own export or import facilities," "Yes" or "No?" The authors assumed the respondents meant export facilities based on the discussion on page 7 and as presented in the descriptive statistics in Table 5 on page 8.

Section 4
Individual Comments and Issues for Resolution

4.1 Reviewer 1

4.1.1 Individual Comments From Project Report

4.1.1.1 The Survey

The 2006 Survey of Transportation Needs, on which this research is based, was an ambitious attempt to develop data to provide answers to the questions about the needs for transportation infrastructure to support freight shipping in the Midwest. The survey instrument correctly is not directed solely to barge shippers since there is an assumed fluidity of modal choices across shippers. However, from the description of the firms to be surveyed it is not clear to this reader what the sampling frame was intended to be or what tests were done to guarantee that the sample was representative of a broader class. Moreover, since the contacted firm was not asked about shipping volumes, it is impossible to tell what fraction of existing tons are represented by the survey.

The authors note that the response rate to the survey is extremely low and thus there is a concern about the representativeness of the responses.

The survey instrument asks, "Consider your last shipment from this or your major facility." All of the survey information is then about this shipment. It is not clear to this reader that this was the ideal way to ask about bulk shipments. Truck shipments make up the vast majority of all shipments, while the aggregate tons will be skewed towards rail or water shipments. It seems to me that this question should cause truck shipments to be over-represented in the sample. As noted by the authors, this method caused shipments to Boston, Phoenix and San Diego to be captured in addition to those that are related to river transport. This reader is unsure how the authors intended these off-river shipments to be taken into account. Is the sampling frame intended to include these destinations as well? It appears that the authors used a rule to decide on whom to receive surveys that is based on distance of an establishment from the river. But while this may be good for deciding which firms to include, it will also include many firms whose shipping decisions are unrelated to river transportation. In estimating elasticities, it is important that the authors clarify what the sampling frame is that they believe that they are operating with.

The critical questions in the survey are numbered 8, 9 and 10 in which the respondent is asked if there are shipping alternatives and then asked two clarifying questions. The modal response is that there are no alternatives. This is, of course, technically untrue and therefore the respondent must have had a different question in mind—presumably something like, is there another combination of mode and destinations that at current rates would be approximately as profitable as my current choice. The same idea appears to repeat in Question 25, with the clarification that the establishment would "go out of business." This seems to be unnecessarily extreme for an establishment that ships to multiple destinations. For example, I can imagine that an establishment whose last shipment was a coil of specialty steel to a customer in Phoenix who is served from this location only three times a year would not go out of business if the truck rate to Phoenix were to rise by 50 percent; that customer would not be served from that location in the future if the truck rate were to rise. How, should such a shipper respond to the question about alternatives?

4.1.1.2 Results Based on Actual Rates and Shipping Characteristics

The primary weakness of this report is the failure to report results on shipper choices based on reported rates and shipping characteristics. The report notes that there are only 64 observations with complete data on a single alternative and only 35 observations containing data on more than one non-chosen alternative. According to the authors, "the results indicated that the data do not support meaningful parameter estimates."

One can only speculate at what the authors attempted in their estimations. My guess is that they tried to estimate a logit or probit model using the limited number of observations available and found either illogical or statistically insignificant parameter estimates. I have two concerns about this procedure.

First, any suppression of results introduces the possibility of publication bias. Publication bias occurs when only statistically significant results are reported, thus skewing published results towards higher sensitivities of the dependent variables (shipping choices in this case) with respect to independent variables (rates and shipping characteristics.) Publication bias is inevitable in academic journals, but it is not necessary to have such bias in a report of this kind. I believe that the authors would have provided a more useful product if they had reported the results of their unsatisfactory estimations, along with comments on why they considered these results to be not useful.

Second, in attempting to estimate these models only from data on which prices and shipping characteristics of non-chosen alternatives are chosen, the authors are discarding useful information. A shipper who reports no shipping alternatives *is* giving useful information that efficiently *should* be made use of in estimating the price sensitivity of shipping situations. This problem reflects my earlier concern about the sampling frame that the authors see their survey as representing. Imagine that three quarters of the relevant universe of shippers genuinely has no alternatives and that one quarter does. For three quarters of the shippers, the price elasticity of demand in the relevant range of price changes is zero. One quarter does have shipping alternatives and thus has an elasticity of demand different from zero. By attempting to estimate the elasticity of demand only for those who report alternatives, the authors are skewing their estimates towards representing the most price sensitive parts of the population. I believe that a more accurate procedure would be to have assigned values for non-chosen alternatives that guaranteed that the non-chosen alternatives were not selected. This would have increased the sample size and perhaps have given useable results.

The suppression of results in this potentially central part of the report is particularly problematic since it allows the authors to skip the section on defending their choice of an estimating structure. I would have liked to have seen the spatial logic that supported their choice of an estimating form. Since this section of the report was skipped, a reader cannot evaluate whether their estimating form that gave unsatisfactory results was logically sound or not.

4.1.1.3 Results Based on Hypothetical Changes in Rates and Shipping Characteristics

The results using the data on hypothetical changes in rates and shipping characteristics are derived from a binary logit form. This is a standard form and is consistent with standard practice.

One of the questions in the survey, Question 25b, is "if you would continue to use your original mode, what percentage increase in the transportation rate would be necessary to cause you to switch to the alternative transportation mode?" This is the key piece of information that one is looking for in estimating the price sensitivity of shippers' mode selection. However, the authors do not use it and instead base their estimations on random rate prompts of Question 25. This reader wishes that the authors had chosen to confirm their findings by using the answers to Question 25b, but the information seems not to have been used. Rate prompts guarantee that the rate information on the right hand side can be treated as a fixed variable, thus apparently obviating the need for endogenous variables methods.

While the estimating form is standard, the implementation is unusual. Instead of separately estimating the price sensitivity of modal splits between rail and water, for example, the authors attempt to fit answers to the questions "would you switch" for different price prompts, with current mode and commodity treated as independent category variables. The results demonstrate that, for equal percentage price changes in the current mode and for identical commodity classes, rail shippers are much more likely to switch modes than truck or barge shippers. This is an interesting finding. I assume that it reflects the fact that rail rates tend to be closer to the relevant tipping point than truck or barge rates—presumably a reflection of rail market power compared with barge lines and trucking companies.

While the authors do not state it, I assume that this unusual implementation of the logit method is an attempt to increase the number of observations on which the estimations can be made. It clearly is successful in allowing the estimation of statistically significant coefficients on the variables. However, this reader wishes that the authors had also provided the more traditional modal split estimations as well.

This reader also wishes that a theoretical justification had been offered for the unusual attempt to predict switching rather than modal choice. The well-understood (albeit non-spatial) justification for estimating logits of mode-choice is that shippers receive predictable and random utility from choosing, say, rail or water. The coefficients estimated in a logit model can then be interpreted as measuring an inherent attractiveness of continuing to use the existing mode rather than switching to another for an average shipper. If the same logic were used to justify the current form, one would say that barge and truck shippers are more satisfied with their current choices than rail shippers and that shippers of the base commodity are far less satisfied with their current choices than those shipping in commodity classes A, B or C. I am not sure that this is a sensible way to approach the problem. I wish that the authors had chosen to provide results of other estimating techniques in addition to the switching model presented here. In particular, I wish that a model with a spatial motivation had been offered in addition to one based on random utility.

The authors then take the results of their estimation and make rate elasticity calculations based on the logit estimations. These are found in Tables 17 and 19. The pattern reflects the ogival shape of the estimated logit with relatively flat sections both for very high rates and very low rates. To my tastes, the interesting calculations are for a marginal change in rates. Thus in my listing of elasticity findings at the beginning of this review are for the top row of each table. Other calculated elasticities tend to be lower, but that is an assumption of the estimating form rather than a finding of this study.

The key finding of this study is that rail shippers' mode choice is far more price sensitive than truck and barge. This is because the utility of rail shippers tends to be clustered at the steep section of the estimated modal switching curve, assumed to be common to all shippers. I assume that this reflects the fact that railroads will set rates just below the reservation price for rail service while the other two modes have prices set by intramodal competition. The authors may disagree with this interpretation. Unfortunately, they do not give the reader an explanation for this striking result.

Another key finding of this report is that the elasticity of switching with respect to changes in transit time is roughly of the same magnitude as the price elasticity of switching, with the same pattern of values found across modes and commodities. Again the very high rail elasticity is consistent with setting service quality just above the reservation level, while the lower values for the other two modes reflects intra-modal competition.

I assume that Table 27 is mislabeled and in fact refers to the elasticity of switching with respect to transit time reliability. What is perhaps most interesting here is that the elasticities of switching with respect to reliability are much higher for barge and truck than the corresponding price elasticities of demand, at least for commodity group A. However, the same comments as made above on the sampling frame and the non-spatial motivation for the functional form are relevant here.

Much of transportation economics is based on the concept of a "full price" in which the monetized value of trip characteristics is combined with the money price for a voyage. The authors have chosen not to estimate a full price elasticity, but I believe that the information is available in the survey responses to do such a calculation. Given the closeness of the elasticities of price and the two service characteristics (time and reliability) I doubt that such an estimate would give very different results.

The data set on which the calculations of volume adjustments were made is much smaller than for the choice elasticities reviewed above. The authors were correct to use a Tobit model and were correct to use bootstrapping techniques to effectively increase the size of the data set to the maximum plausible level.

The survey quite correctly asks about changes in volume both for price change common for all shippers or for a single shipper only. The former is the more interesting question for evaluating infrastructure needs, with the latter question effectively acting as a reliability check on the first. Unfortunately, the responses are not consistently rational. Logically, if a rate increase applies to a single shipper only, there is a likelihood that it will lose some customers to a competitor. The elasticity of shipping volume with respect to the change in rate charged to a single shipper must be higher than if the rate change is applied to all shippers. The results in Table 29 and 31 do not show this pattern, however, and in many cases there is a much higher elasticity associated with price changes that apply generally instead of to a particular shipper. Without a clarifying discussion by the authors about what sense to make of these results, this reader is left to conclude that the results do not appear to validly reflect market conditions.

Unlike the previous estimates of the elasticity of mode choice with respect to price and service characteristics, in which the elasticity of mode choice was at roughly comparable levels to price elasticities, in the case of volume adjustments, the study concludes that service characteristics are far less sensitive to service characteristics than to price. There is nothing in the setup of the model that leads me to believe that this conclusion is biased in one direction or another.

4.2 Reviewer 2

A comprehensive editing to the report including writing, table references and table titles will make this a better report to read and as such relate greater acceptance by the reader. The report is so poorly written and presented now, that it diminishes its overall value. For example, on page 4, there is a reference to Table 2 in the last sentence that is probably a reference to Table 3. The same is true in the first sentence on page 5. In another example, Table 5 on page 8 includes cryptic row names and heading titles that leave the reader guessing what they mean. Numerous tables throughout the report need to be reviewed with this in mind.

For other tables it is not clear what is being presented. Table 6, Modal Choices and Alternatives, first introduced on page 8, presented on page 9, lacks sufficient discussion and presentation in order to interpret the results.

As referenced earlier, there are several tables that do not stand alone as presented, including Table 8 on page 10 (what do the 3 rows mean for each variable), Table 12 on page 14 (the discussion leading into the table does not correspond with the results of the table), same thing for Table 13 (a number agreement is the issue), Tables 16, 20 and 24, need to have the "Explanatory Variable" changed given the response for rates, transit times and reliability respectively (see "Log of percent increase rates" for each table).

The phrase "last shipment" is first introduced on page 5 and needs to be defined.

Finally, the authors used a flawed database to generate numerous statistics to draw conclusions that make "common sense." Unfortunately, given the data flaws, the presentation of logical results and quantified response parameters (i.e., model coefficients) could be more spurious than statistically inferred.

APPENDIX C

REVIEW COMMENTS AND RESPONSES OF THE AUTHORS

Technical reviews of this research have multiple sections. Section 1 provides a summary of the objectives of the research, while section 2 provides a summary of findings. These are provided in Appendix B, which contains the full technical review. Section 3 of the technical reviews provides a summary review statement on the validity and quality of findings, while section 4 provides individual comments and issues for resolution. In this appendix, we reproduce only sections 3 and 4 of the technical reviews. The comments of the reviewers are provided, and the responses of the authors are provided in *italics.*

Appendix C

Responses to Comments

Section 2 Summary of Study Conclusions

2.1 Reviewer 1

No responses are necessary

2.2 Reviewer 2 (reproduced here)

To prepare the report, the authors surveyed shippers of non-agricultural commodities and products, stratifying by commodity and distance to the waterway. A survey instrument was prepared and sent to 3,012 potential respondents (using two separate lists). The response rate was about 8 percent or 232 firms. The authors contend that the non-response rate was low because those non-responsive firms did not ship or were not relevant to the survey. In this review, there were additional issues regarding the sample's validity as well as its "correspondence to reality" for modeling purposes as described in more detail in Section 4 of this review; mainly related to geographic concerns.

The universe of shippers from which the sample was drawn consists of shippers who ship selected commodities that commonly travel on the Upper Mississippi and Illinois Waterway. These consist of shippers located "near" the waterway and others further away. When potential respondents were contacted, the WSU interviewers determined whether the shipper met the criteria necessary to be part of the survey (i.e., was part of the relevant universe of shippers) and, if so, attempted to recruit the shipper into the survey. The 3012 contacts included many shippers who did not meet the criteria for inclusion. The response rate is usually defined as the share of eligible respondents (i.e, those in the relevant universe) who are contacted that completed the survey. This is the definition that is used in the text, i.e., 19% of the contacted shippers who met the criteria for inclusion completed the survey.

The survey list was developed through an exhaustive use of a Dun and Bradstreet database delineated on select NAICS codes. The survey effort moved through a series of steps including a mailed pre-contact letter and a survey form, a mailed reminder card, followed by a second mailed survey and finally with telephone calls.

The authors summarized their key findings of the report in the "Executive Summary and Introduction." In essence, through the use of a survey of shippers and elaborate statistical models, the authors concluded (what is logically and intuitively accepted in business), that freight rates, transit times and reliability matter and influence shipper transportation and logistics decisions. Quite frankly, the elaborate data work and statistical modeling were deemed “overkill” relative to the conclusions reached and as described above subject to “data” limitations. In short, the data limitations bring the coefficients that were generated in the models into question, thus defeating the purpose of the study to quantify and establish a predictive model for shipments relative to select economic and business drivers.

We agree that the number of observations generated from the survey is smaller than what hoped for and that other features of the data limit the application. These limitations were discussed in the original and are highlighted at greater length in the revised text However, we feel that the data, despite the limitations, warrant and support statistical analysis. As we point out in the revised text, the small number of observations limited the kinds of analysis we could do, and is also reflected, in some cases, by large standard errors.

A final general comment relates to the quality of the writing and the numerous typographical errors as well as incomprehensible tables and charts. This paper requires a thorough editing effort before public release as these factors prevent the reader from understanding the process, results and conclusions for the study.

The revised text has been thoroughly edited.

Section 3 Summary Review Statement on Validity and Quality of Findings

3.1 Reviewer 1

1. This study uses generally accepted econometric techniques to understand the results of an interesting survey with a low response rate.

2. The sampling frame for the study is unclear and thus it is unclear what the population is for which the results are assumed to be valid.

The revised text describes the population and sampling frame in more detail.

3. Revealed preference estimates were suppressed, leading to the possibility of publication bias; since the estimates were suppressed, it is impossible to tell whether the implementation of the technique is valid.

The attempt to estimate revealed preference parameters is discussed in the revised report.

4. Stated preference estimates of modal choice are based on the somewhat unusual concept of a switching sensitivity rather than a modal split sensitivity.

The choice of the shipper is both a mode and a destination. The parameters of the utility function for mode/destination choice are the same as those of a switching model. In the *revisions, we highlighted this point to a greater degree.*

5. The motivation for an analysis of switching vs staying is not presented; it is unclear whether there is a spatial motivation for this model.

The purpose of the current report is to uncover the demand parameters that relate to how shippers respond to changes in rates, transit times and reliability. In another publication entitled "Spatially Generated Transportation Demands,"[15] *we show how this information is used within a spatial framework to generate spatially differentiated demands.*

6. The techniques used to evaluate volume adjustments appear to be appropriate given the very small number of observations available. However, the results of this estimation appear to be somewhat illogical.

The results indicate that volumes adjust to changes in rates, shipment times, and reliability. The signs are as expected and are statistically significant. In the revised draft, we reestimate the volume models using simpler specifications that address the "illogical" comment. This is discussed in greater detail in response to the related comment below.

7. Except for the limitations noted in points 2-6 above, the results appear to be correctly estimated and well presented.

3.2 Reviewer 2

The report addresses the U.S. Army Corps of Engineers need to model non-agricultural shipper responses to changes in rates, transit time and reliability. A detailed survey effort was developed while a series of statistical models were used to parse the results.
The quality of the writing distracts the overall effectiveness of the report conclusions. The report is in need of a solid editorial review to correct grammatical and spelling errors (for example, the title page has errors, Mississippi is spelled incorrectly and the date should probably be January 2007). Moreover, there are incorrect references to tables from the text. Also, table titles, column and row headings do not allow tables to stand-alone. In some instances it seems the authors simply copied tables and replaced the values without making necessary changes to row headings. For example, it appears that the model descriptions and statistical results tables are misstated. Moreover, one must work hard to decipher what each variable used in the model actually represents and in some cases, it is not something the reader can determine.

The revised draft has been thoroughly edited. We have attempted throughout the revision to more clearly represent the variables and the tables.

The title of the report, "Upper Mississippi and Illinois Transportation Demands for Non-Agricultural Products" does little to truly define the geographic coverage of the study.

---

[15] Train, Kenneth and Wesley W. Wilson, 2007, in Scott Dennis and Wayne K. Talley, eds., *Research in Transport Economics: Railroad Economics*.

From the title, a reader could interpret the scope of the report to mean the upper portion of the State of Mississippi and the State of Illinois. A sense of the geography is presented in the "Executive Summary and Introduction" on page 1, the second paragraph. But, it is not until page 3 under the "Data Sources and Description" section that a more specific geography is presented; even then, the geographic attention seems counter-productive given the nature and scope of this study.

We have renamed the report to "Transportation Demands for the Movement of Non-Agricultural Commodities Pertinent to the Upper Mississippi and Illinois River Basin" and have expanded the discussion in the Executive Summary and Introduction.

Shippers were surveyed from nine states, including Arkansas, Illinois, Indiana, Kentucky, Louisiana, Mississippi, Ohio, Tennessee and Texas. Through stratification, the respondents were stratified by location vis-à-vis the Mississippi River. A concern is that respondents from Texas were included, but they are not directly tributary to the Mississippi River. Yet, other states that are directly tributary to the Mississippi River such as Iowa, Missouri, Minnesota and Wisconsin are not included in the survey. The states of Ohio and Indiana were included, but they are directly tributary to the Ohio River not the Mississippi River. For practical purposes, many government agencies, such as the U.S. Army Corps of Engineers, often refer to the Mississippi River System as including its tributaries and connecting waterways, such as the Arkansas, Illinois, Missouri, Ohio, Tennessee and Cumberland Rivers, and the Gulf Intracoastal Waterway. By extending the definition to the broader sense, the list of states then expands to Alabama, Florida, Nebraska, Oklahoma, Pennsylvania and West Virginia for a total of 15.
The more appropriate title for this report should be the "Upper Mississippi River and Illinois Waterway Transportation Demand for Non-Agricultural Products," that includes the section of the Mississippi River from St. Louis north for example.

We have changed the title as noted above. We note that for non-ag commodities, the traffic tends to be upriver and tend to originate from a variety of locations south of St. Louis. From the waterborne commerce statistics (2003 data), the lower Mississippi is the primary origination point for shipments that terminate in the Upper Mississippi and Illinois.

While an extensive survey methodology was employed using a detailed survey instrument to capture as high a response rate as possible, a number of problems are apparent that might have mitigated the non-responsiveness. As mentioned above, the issue with the state coverage is important. If other states that are tributary to the "Mississippi River System" were included then more respondents likely would have been expected.

As discussed above, the primary limitation encountered in the implementation was identification of potential shippers from the Dun and Bradstreet list. Once the ineligible contacts are removed, the response rate is nearly 20 percent (see above and Table 1 in the text). The sampling frame and state coverage is discussed in the revised text. Further, the goal in this research is to estimate the responsiveness of non-ag *commodities. Much of this originates from points south of the Saint Louis or from tributaries.*

With respect to commodity groupings, the use of the NAICS (North American Industry Classification System, not referenced in the report) is an appropriate tool to use with the Dun and Bradstreet database. But, there was no discussion on how these commodities vary in form, such as liquid or dry. This is an important distinction because different types of barges are used to move commodities. For practical purposes, there are three types of barges: covered dry, open dry and tank or liquid barges. On page 17, the authors conveniently placed commodities into three groupings, Commodity Group A (oil and gas extraction, mining and aggregates), Commodity Group B (wood, paper, petroleum, coal, chemicals, plastics and fuel) and Commodity Group C (mineral and metals). The problem with this approach is that commodity form types are commingled into broad categories, ignoring the type of movement that is a dry or liquid movement. For example, aggregates and coal compete with each other for cargo carrying transportation assets while aggregates and oil do not have any relationship to each other for cargo carrying transportation assets.

Apart from the commodity, we do not have information on barge type. We attempted to enter a dummy variable to differentiate liquid commodities from dry, in addition to the commodity dummies in the model. The variable was not significant, obtaining a t-statitic below 1. For the commodity dummies that enter the model, the NAICS acronym has been spelled out in the revisions.

While the authors did mention that the U.S. Army Corps of Engineers (ACE, as specified by the authors on page 1) uses models that require estimates at a "pool" level of demands for each commodity, there was no reference or discussion of key commodity movements in the pools or river segments. A review of river segment movement data from the U.S. Army Corps of Engineers is readily available with specific detail by date, commodity, volume and direction of move (up river or down river). This would have helped to clarify the commodity groupings while allowing the authors to better appreciate the type of responses received.

Our purpose was to estimate the responsiveness of shippers to changes factors that affect their mode and destination choices. The river segment movement data are not differentiated by shipper, which makes analysis of shipper decisions difficult. However, it could nevertheless be useful to examine these data to determine the extent to which they reveal demand responses. We have added some discussion in the revised text.

The first question of the survey ("Q1. What commodity was shipped in your very last freight shipment?") is somewhat misleading. That is, the survey firm may in fact ship numerous commodities and products, but the last shipment could have been a small or unimportant shipment (i.e., business-wise to the respondent). A better approach would have been to ask the respondent to use the last shipment of the largest volume of a commodity they shipped during the year to complete the survey or some other question that would have generated data related to important shipments.

Our purpose is to identify the parameters of the decision process for shipments in general, both large and small. Asking about the last shipment provides a sample of shipments that is representative of the distribution of shipment sizes. Aggregating shippers responses over these shipments gives an unbiased estimate of the average response. If we had asked about the last large shipment, the sample would have been biased toward large shipments, making it less representative of shipments in general.

The authors focused on shippers owning export facilities while ignoring the possibility, and perhaps more importantly, shippers that own import facilities as referenced on page 7 for Table 5. However, in the survey instrument, under the "Shipper Characteristics" section, Q38, respondents were asked, "Does your firm, (or parent firm) own export or import facilities," "Yes" or "No?" The authors assumed the respondents meant export facilities based on the discussion on page 7 and as presented in the descriptive statistics in Table 5 on page 8.

This has been clarified in the revisions.

Section 4 Individual Comments and Issues for Resolution

4.1 Reviewer 1

4.1.1 Individual Comments From Project Report

4.1.1.1 The Survey

The 2006 Survey of Transportation Needs, on which this research is based, was an ambitious attempt to develop data to provide answers to the questions about the needs for transportation infrastructure to support freight shipping in the Midwest. The survey instrument correctly is not directed solely to barge shippers since there is an assumed fluidity of modal choices across shippers. However, from the description of the firms to be surveyed it is not clear to this reader what the sampling frame was intended to be or what tests were done to guarantee that the sample was representative of a broader class. Moreover, since the contacted firm was not asked about shipping volumes, it is impossible to tell what fraction of existing tons are represented by the survey.
The authors note that the response rate to the survey is extremely low and thus there is a concern about the representativeness of the responses.

We have rewritten this part of the report to reflect this comment and to clarify the designed and executed sampling frame.

The survey instrument asks, "Consider your last shipment from this or your major facility." All of the survey information is then about this shipment. It is not clear to this reader that this was the ideal way to ask about bulk shipments. Truck shipments make up the vast majority of all shipments, while the aggregate tons will be skewed towards rail or water shipments. It seems to me that this question should cause truck shipments to be over-represented in the sample. As noted by the authors, this method caused shipments to Boston, Phoenix and San Diego to be captured in addition to those that are related to river transport. This reader is unsure how the authors intended these off-river shipments to be taken into account. Is the sampling frame intended to include these destinations as well? It appears that the authors used a rule to decide on whom to receive surveys that is based on distance of an establishment from the river. But while this may be good for deciding which firms to include, it will also include many firms whose shipping decisions are unrelated to river transportation. In estimating elasticities, it is important that the authors clarify what the sampling frame is that they believe that they are operating with.

Truck shipments make up a large share of the responses in our survey, as they do in the market. As represented in Table 4 and in other studies, shippers with only truck access dominate transportation. The sampling frame was designed to capture commodities that appear on the river and to capture shippers that may consider water as an option, of which truck shipments constitute an important component.

The critical questions in the survey are numbered 8, 9 and 10 in which the respondent is asked if there are shipping alternatives and then asked two clarifying questions. The modal response is that there are no alternatives. This is, of course, technically untrue and therefore the respondent must have had a different question in mind—presumably something like, is there another combination of mode and destinations that at current rates would be approximately as profitable as my current choice. The same idea appears to repeat in Question 25, with the clarification that the establishment would "go out of business." This seems to be unnecessarily extreme for an establishment that ships to multiple destinations. For example, I can imagine that an establishment whose last shipment was a coil of specialty steel to a customer in Phoenix who is served from this location only three times a year would not go out of business if the truck rate to Phoenix were to rise by 50 percent; that customer would not be served from that location in the future if the truck rate were to rise. How, should such a shipper respond to the question about alternatives?

One of the most consistent and prominent finding over all the surveys that we have conducted in this line of research is that a sizable share of shippers report they have no alternatives. Theoretically, other modes and destinations are perhaps "technically" possible, but the result of this study and others is that these are not considered by the shippers themselves. One explanation is that they are not economically feasible, in that they would result in negative profits such that they are necessarily worse than shutting down. We include the alternative of shutting down, and not the alternatives that the respondent does not consider available and can, therefore, be interpreted as less desirable than shutting down.

4.1.1.2 Results Based on Actual Rates and Shipping Characteristics

The primary weakness of this report is the failure to report results on shipper choices based on reported rates and shipping characteristics. The report notes that there are only 64 observations with complete data on a single alternative and only 35 observations containing data on more than one non-chosen alternative. According to the authors, "the results indicated that the data do not support meaningful parameter estimates."
One can only speculate at what the authors attempted in their estimations. My guess is that they tried to estimate a logit or probit model using the limited number of observations available and found either illogical or statistically insignificant parameter estimates. I have two concerns about this procedure.

We have expanded the related discussion. By "do not support meaningful parameter estimates", we mean that the estimates had illogical signs and/or were not statistically significant. In particular, transit time entered with the wrong sign, and the rate and price coefficients were highly insignificant. These results were obtained using the rp data alone as well as in combination with the sp-off-rp data. We also attempted to generate rate, time, and reliability data for observations with missing data; however, the same results were obtained with the generated variables. Because of these issues, we opted for the much simpler approach described in the report that nevertheless allows relevant estimates to be obtained.

First, any suppression of results introduces the possibility of publication bias. Publication bias occurs when only statistically significant results are reported, thus skewing published results towards higher sensitivities of the dependent variables (shipping choices in this case) with respect to independent variables (rates and shipping characteristics.) Publication bias is inevitable in academic journals, but it is not necessary to have such bias in a report of this kind. I believe that the authors would have provided a more useful product if they had reported the results of their unsatisfactory estimations, along with comments on why they considered these results to be not useful.

Some of this has been captured in the revised report.

Second, in attempting to estimate these models only from data on which prices and shipping characteristics of non-chosen alternatives are chosen, the authors are discarding useful information. A shipper who reports no shipping alternatives *is* giving useful information that efficiently *should* be made use of in estimating the price sensitivity of shipping situations. This problem reflects my earlier concern about the sampling frame that the authors see their survey as representing. Imagine that three quarters of the relevant universe of shippers genuinely has no alternatives and that one quarter does. For three quarters of the shippers, the price elasticity of demand in the relevant range of price changes is zero. One quarter does have shipping alternatives and thus has an elasticity of demand different from zero. By attempting to estimate the elasticity of demand only for those who report alternatives, the authors are skewing their estimates towards representing the most price sensitive parts of the population. I believe that a more accurate procedure would be to have assigned values for non-chosen alternatives that guaranteed that the non-chosen alternatives were not selected. This would have increased the sample size and perhaps have given useable results.

We agree that the no alternatives provide useful information, and, in other studies we have incorporated the information. In our analysis we included shippers who listed no alternatives, since the alternative of shutting down was always considered to be available. So the potential bias that the reviewer mentions does not arise.

The suppression of results in this potentially central part of the report is particularly problematic since it allows the authors to skip the section on defending their choice of an estimating structure. I would have liked to have seen the spatial logic that supported their choice of an estimating form. Since this section of the report was skipped, a reader cannot evaluate whether their estimating form that gave unsatisfactory results was logically sound or not.

We have included in the revisions a discussion of the approach we used. As mentioned above, we have a related paper that illustrates how spatial contexts enter into, and are derived from, the shipper level demand functions.

4.1.1.3 Results Based on Hypothetical Changes in Rates and Shipping Characteristics

The results using the data on hypothetical changes in rates and shipping characteristics are derived from a binary logit form. This is a standard form and is consistent with standard practice.

One of the questions in the survey, Question 25b, is "if you would continue to use your original mode, what percentage increase in the transportation rate would be necessary to cause you to switch to the alternative transportation mode?" This is the key piece of information that one is looking for in estimating the price sensitivity of shippers' mode selection. However, the authors do not use it and instead base their estimations on random rate prompts of Question 25. This reader wishes that the authors had chosen to confirm their findings by using the answers to Question 25b, but the information seems not to have been used. Rate prompts guarantee that the rate information on the right hand side can be treated as a fixed variable, thus apparently obviating the need for endogenous variables methods.

Only a few respondents provided this information. For example, of the 123 shippers who said they would not switch in response to the prompted rate increase, only 36 gave a rate increase at which they would switch. Also, of those shippers who gave a number, the most frequent response was a 100% increase (e.g., a doubling of rates.) We did not feel that the data were sufficiently meaningful to be used.

While the estimating form is standard, the implementation is unusual. Instead of separately estimating the price sensitivity of modal splits between rail and water, for example, the authors attempt to fit answers to the questions "would you switch" for different price prompts, with current mode and commodity treated as independent category variables. The results demonstrate that, for equal percentage price changes in the current mode and for identical commodity classes, rail shippers are much more likely to switch modes than truck or barge shippers. This is an interesting finding. I assume that it reflects the fact that rail rates tend to be closer to the relevant tipping point than truck or barge rates—presumably a reflection of rail market power compared with barge lines and trucking companies.

While the authors do not state it, I assume that this unusual implementation of the logit method is an attempt to increase the number of observations on which the estimations can be made. It clearly is successful in allowing the estimation of statistically significant coefficients on the variables. However, this reader wishes that the authors had also provided the more traditional modal split estimations as well.

We discuss above and in the revised report our attempts to estimate the type of model that we used in previous reports. The simpler models that we estimated still embed modal split as well as destination changes. This is further addressed in previous responses.

This reader also wishes that a theoretical justification had been offered for the unusual attempt to predict switching rather than modal choice. The well-understood (albeit non-spatial) justification for estimating logits of mode-choice is that shippers receive predictable and random utility from choosing, say, rail or water. The coefficients estimated in a logit model can then be interpreted as measuring an inherent attractiveness of continuing to use the existing mode rather than switching to another for an average shipper. If the same logic were used to justify the current form, one would say that barge and truck shippers are more satisfied with their current choices than rail shippers and that shippers of the base commodity are far less satisfied with their current choices than those shipping in commodity classes A, B or C. I am not sure that this is a sensible way to approach the problem. I wish that the authors had chosen to provide results of other estimating techniques in addition to the switching model presented here. In particular, I wish that a model with a spatial motivation had been offered in addition to one based on random utility.

In the revision, we have added more theoretical justification and discussion of other approaches.

The authors then take the results of their estimation and make rate elasticity calculations based on the logit estimations. These are found in Tables 17 and 19. The pattern reflects the ogival shape of the estimated logit with relatively flat sections both for very high rates and very low rates. To my tastes, the interesting calculations are for a marginal change in rates. Thus in my listing of elasticity findings at the beginning of this review are for the top row of each table. Other calculated elasticities tend to be lower, but that is an assumption of the estimating form rather than a finding of this study.

Of course, many different shapes can easily be generated. The particular pattern depends centrally on the parameter estimates not the logit form per se.

The key finding of this study is that rail shippers' mode choice is far more price sensitive than truck and barge. This is because the utility of rail shippers tends to be clustered at the steep section of the estimated modal switching curve, assumed to be common to all shippers. I assume that this reflects the fact that railroads will set rates just below the reservation price for rail service while the other two modes have prices set by intramodal competition. The authors may disagree with this interpretation. Unfortunately, they do not give the reader an explanation for this striking result.

We agree that this offers an explanation and have added some discussion of the text.

Another key finding of this report is that the elasticity of switching with respect to changes in transit time is roughly of the same magnitude as the price elasticity of switching, with the same pattern of values found across modes and commodities. Again the very high rail elasticity is consistent with setting service quality just above the reservation level, while the lower values for the other two modes reflects intra-modal competition.

As with rates, this makes theoretical sense, and we have so noted in the revisions. Indeed, for time sensitive non-captive shippers, railroads may have an incentive to improve service.

I assume that Table 27 is mislabeled and in fact refers to the elasticity of switching with respect to transit time reliability. What is perhaps most interesting here is that the elasticities of switching with respect to reliability are much higher for barge and truck than the corresponding price elasticities of demand, at least for commodity group A. However, the same comments as made above on the sampling frame and the non-spatial motivation for the functional form are relevant here.

This mislabel has been corrected.

Much of transportation economics is based on the concept of a "full price" in which the monetized value of trip characteristics is combined with the money price for a voyage. The authors have chosen not to estimate a full price elasticity, but I believe that the information is available in the survey responses to do such a calculation. Given the closeness of the elasticities of price and the two service characteristics (time and reliability) I doubt that such an estimate would give very different results.

The data set on which the calculations of volume adjustments were made is much smaller than for the choice elasticities reviewed above. The authors were correct to use a Tobit model and were correct to use bootstrapping techniques to effectively increase the size of the data set to the maximum plausible level.

The survey quite correctly asks about changes in volume both for price change common for all shippers or for a single shipper only. The former is the more interesting question for evaluating infrastructure needs, with the latter question effectively acting as a reliability check on the first. Unfortunately, the responses are not consistently rational. Logically, if a rate increase applies to a single shipper only, there is a likelihood that it will lose some customers to a competitor. The elasticity of shipping volume with respect to the change in rate charged to a single shipper must be higher than if the rate change is applied to all shippers. The results in Table 29 and 31 do not show this pattern, however, and in many cases there is a much higher elasticity associated with price changes that apply generally instead of to a particular shipper. Without a clarifying discussion by the authors about what sense to make of these results, this reader is left to conclude that the results do not appear to validly reflect market conditions.

We agree with the referee. The odd pattern arose from low numbers of observations. We chose to estimate a simpler model (for all) and have presented elasticities for the simpler model. We also estimated a version of the model that has commodity and mode dummies, but there are no significant differences. The related discussion has addressed this point and is now generally consistent with prior expectations.

Unlike the previous estimates of the elasticity of mode choice with respect to price and service characteristics, in which the elasticity of mode choice was at roughly comparable levels to price elasticities, in the case of volume adjustments, the study concludes that service characteristics are far less sensitive to service characteristics than to price. There is nothing in the setup of the model that leads me to believe that this conclusion is biased in one direction or another.

4.2 Reviewer 2

A comprehensive editing to the report including writing, table references and table titles will make this a better report to read and as such relate greater acceptance by the reader. The report is so poorly written and presented now, that it diminishes its overall value. For example, on page 4, there is a reference to Table 2 in the last sentence that is probably a reference to Table 3. The same is true in the first sentence on page 5. In another example, Table 5 on page 8 includes cryptic row names and heading titles that leave the reader guessing what they mean. Numerous tables throughout the report need to be reviewed with this in mind.

The revised document has been carefully edited.

For other tables it is not clear what is being presented. Table 6, Modal Choices and Alternatives, first introduced on page 8, presented on page 9, lacks sufficient discussion and presentation in order to interpret the results.

Discussion has been added in the revised document.

As referenced earlier, there are several tables that do not stand alone as presented, including Table 8 on page 10 (what do the 3 rows mean for each variable), Table 12 on page 14 (the discussion leading into the table does not correspond with the results of the table), same thing for Table 13 (a number agreement is the issue), Tables 16, 20 and 24, need to have the “Explanatory Variable” changed given the response for rates, transit times and reliability respectively (see “Log of percent increase rates” for each table). The phrase “last shipment” is first introduced on page 5 and needs to be defined. Finally, the authors used a flawed database to generate numerous statistics to draw conclusions that make “common sense.” Unfortunately, given the data flaws, the presentation of logical results and quantified response parameters (i.e., model coefficients) could be more spurious than statistically inferred.

Where appropriate, each of these has been reflected in the revised draft.

navigation · economics · technologies

The NETS research program is developing a series of practical tools and techniques that can be used by Corps navigation planners across the country to develop consistent, accurate, useful and comparable information regarding the likely impact of proposed changes to navigation infrastructure or systems.

The centerpiece of these efforts will be a suite of simulation models. This suite will include:

- A model for forecasting international and domestic traffic flows and how they may be affected by project improvements.
- A regional traffic routing model that will identify the annual quantities of commodities coming from various origin points and the routes used to satisfy forecasted demand at each destination.
- A microscopic event model that will generate routes for individual shipments from commodity origin to destination in order to evaluate non-structural and reliability measures.

As these models and other tools are finalized they will be available on the NETS web site:

http://www.corpsnets.us/toolbox.cfm

The NETS bookshelf contains the NETS body of knowledge in the form of final reports, models, and policy guidance. Documents are posted as they become available and can be accessed here:

http://www.corpsnets.us/bookshelf.cfm

NETS

navigation · economics · technologies