The Navigation Economic Technologies Program

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NETS

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Transportation Demand for Agricultural Products in the Upper Mississippi and Illinois River Basin

US Army Corps of Engineers®

IWR Report 07-NETS-R-2

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.

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TRANSPORTATION DEMAND FOR AGRICULTURAL PRODUCTS IN THE UPPER MISSISSIPPI AND ILLINOIS RIVER BASIN

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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. Over the past three years, a series of demand studies has been conducted under the NETS program. These studies include a survey of the existing literature on transportation demand modeling (Clark et al. (2005)).[1] This review along with various National Research Council reports pointed to a need to develop models that reflect the alternatives that individual shippers face and the responsiveness of the choices they make to changes in not only rates but also the time it takes to make shipments and the reliability of the various alternatives. Most previous models of freight demand in the literature are based on aggregate data either in a cross section or in time. However, the Army Corps of Engineers' planning models require relatively disaggregate demand information i.e., demands delineated by commodity, origin, and destination. There is a general lack of demand studies that fit the needs for Army Corps of Engineer 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 (2006a)), and the Ohio River (Sitchinava, et. al (2005; 2007)).[2] 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.

The present report continues this line of research by examining decisions of agricultural shippers in the Upper Mississippi and Illinois Waterway basins. A sample of 480 shippers located in a 10 state area is used to examine shippers' choice of mode and destination (i.e., discrete decisions of where and how to ship) and their decisions regarding the volume of shipments (i.e. the continuous decision of how much to ship.) Choices of mode and destination are examined using both revealed and stated preference data collected in the survey. The survey was conducted by the Washington State University Social and Economic Sciences Research Center and was overseen by Kenneth

[1] There are a variety of review articles on transportation demand that appear in the academic literature. These include Winston (1983; 1985), Oum et. al (1992), and Oum (1989).

[2] 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 primary studies include: Train and Wilson (2007a), Train and Wilson (2007b), Train and Wilson (2006b), and Sitchinava, Wilson and Burton (2005; 2007). The citations enumerated in the text contain the primary reports for each of the surveys conducted.

Casavant of Washington State University. The population was identified as agricultural shippers located in Iowa, Illinois, Indiana, Wisconsin, Kansas, Missouri, Nebraska, North Dakota, South Dakota, Ohio, and Minnesota. A list of shippers was developed from a wide variety of sources. From this list, 2000 potential shippers were sampled in August, September and October of 2006. The sample was stratified by distance from the waterway. There were a total of 900 shippers located within 100 miles of the waterway and each was sent a survey form. There were 1100 randomly selected firms located more than 100 miles from the waterway.

A total of 480 responses were received. Of the original 2000, this represents a 24 percent response rate, and corrected for ineligible shippers, the response rate was 27.5. Corn shipments dominate the sample and represent 295 of 480 responses. The remaining commodities include wheat, soybeans, beans, barley, grain etc. There are a wide variety of characteristics reported. These relate to the access shippers have to modes, the size of shippers, and shipment characteristics. Almost all shippers have access to truck modes, about 43 percent have access to rail, and very few, about 5 percent have access (direct) to barge. There is a wide range of elevator sizes represented in the data, but many of these (about 50 percent) have capacities less than 30,000 tons. Further, the majority of elevators responding reflect the only facility in the organization.

There were a total of 471 responses available on the revealed choices of firms. Of these 471, there were 15 barge, 108 rail, 335 truck, 4 truck-barge, and 9 truck-rail shipments. The choice models estimated rest on alternatives. There were 294 that reported options. These shipments include two by barge, 39 by rail, 246 by truck, and 1 truck-rail-barge. It is noted that while truck shipments dominate, they are often the front-end shipment of a truck-barge movement in that 101 of the shipments are to river terminals. The primary destination, however, are to ethanol and processing plants with 211 shipments.

The choice model estimated is framed around shipment attributes and shipper attributes. The shipment attributes are the price received, the rate paid, the shipment time, and the reliability. The shipper attributes include both rail car siding capacity and elevator storage capacity. By mode, the average price received for the product transported is $109 per ton for barge, $130 per ton by rail, and $107 by truck. Rates per ton are, as expected, quite different by mode. The average rate per ton is $26.5, $20, and $7.2 for barge, rail, and truck. The rate levels by mode reflect considerable differences in shipment distances. The average distances are 1032, 67, and 76 for barge, rail and truck. These allow rates per mile (tonmile) to be calculated. These rates average 3.4, 5.7, and 15.6 cents per tonmile. Miles per hour are also as expected. These are 5.19, 7.14, and 15.45 miles per hour for barge, rail and truck. Miles per hour includes not just the transit time but also the time to schedule shipments and to wait for equipment. Finally, reliability is measured by the shipper perceptions on the percentage of time that similar shipments arrive on time. Barge and truck shipments arrive on-time, an average of 86 and 87 percent, respectively, while rail arrives on time only about 60 percent of the time.

The survey also solicits stated preference responses to changes in shipment attributes. In particular, respondents provided information on the next best alternative to the shipment made to a destination by a mode. These alternatives may represent the use of a different mode, shipment to an alternative destination, with the same or a different mode, or shutdown (no alternative exists). As in previous surveys of this nature, there were a number of shippers that stated that they have no alternatives (154 of 461 responses). In response to increases in rates of 10 to 60 percent, there were 425 responses, with 246 that stated they would not switch, with 122 that stated they would switch to an alternative, and 57 that stated they would shutdown. In response to increases in times of 10 to 60 percent, there were 417 responses with 264 that stated they would not switch, 108 that stated they would switch and 45 that stated they would shutdown. Finally, in response to *reductions* in reliability, there were 412 responses with 253 that stated they would not switch, 108 that stated they would switch, and 51 that stated they would shutdown.

Stated preference questions were also framed to solicit information on the responsiveness of annual volumes to changes in shipment characteristics. In all cases, there are large numbers of shippers that state that their annual volumes would not be affected by a change in rates that applies to all shippers and only to the surveyed shipper. Similar findings hold for shipment times and reliability. Nevertheless, there are still significant numbers of shippers that state that their annual volumes would be affected.

As in previous studies, both revealed data and stated preference data are used to analyze choice and the responsiveness of choices to attributes and, in particular, to changes in rates, shipment times, and reliability. Revealed decisions reflect what the shipper actually does, while stated preference data reflect what the shipper states it would do if confronted with a hypothetical situation. Revealed data often exhibit only modest variation in the attributes causing the choice, and the range of responsiveness needed for policy analysis often runs beyond the range of data observed. This shortcoming of revealed data can be overcome by the use of stated preference data. Stated preference data, however, are commonly criticized because the respondent's stated behavior may not mirror its revealed behavior. As a result, stated preference data may not accurately reveal the parameters of interest (e.g., the parameters of the demand function). Under NETS, Train and Wilson (2007a) developed a technique which mitigates both difficulties. The key idea is that the stated preference questions can be based on the shipper's revealed decision. In this way, the criticism that stated preference question constitute hypothetical situations that are not known to respondents is overcome. Further, stated preference questions were framed over a wide range of changes in the attributes e.g., up to a 60 percent change in rates, shipment times, and reliability. This overcomes the problem of revealed data often not providing enough range in the data. Since, however, the stated preference data are constructed from the revealed decision, an econometric technique had to be developed to recognize that the stated preference data generated are endogenously determined. Finally, as noted later in this report, we also have the ability to gauge the consistency of revealed with stated preference data. We find that the use of this technique provides reliable variation in the data and that estimates using revealed data can be improved upon by incorporating stated preference data.

Two other features are captured in this study. Over the last 25 years or so, ethanol plants have become very prevalent in the Midwest, with the growth accelerating during the last decade. This phenomenon is important since corn is a primary agricultural commodity on the Upper Mississippi and is also a primary input into the production of ethanol. In econometric modeling, the development of ethanol provides more choices for shippers. As growth in the industry occurs, there are more market outlets for corn, and as more plants are located within the waterway catchment area, the potential for traffic diversion becomes more prevalent. To our knowledge, there are few transportation demand studies that have captured the destination choices of agricultural shippers. Rather, most studies focus on mode choices. The research presented below offers a novel approach to examining the choices of shippers. In particular, the model rests on a definition of a shipment as containing both the mode and destination choice. This feature is important since agricultural markets are replete with different market outlets for shippers. We find that the prices of different markets outlets are an important causal variable and that the inclusion of prices in the models allows the presence of different markets outlets to be reflected.

A second feature of the analysis is the use of a mixed logit. In freight market demand studies, this is not a common feature. A mixed logit model is based on the same principles as the standard logit model. That is, decision-maker payoff functions (e.g., utility, profit) drive the choice that is made. Traditionally, the payoff function for different alternatives from which a choice is made has two components, a deterministic equation (with fixed parameters to be estimated using observed explanatory variables) and an unobserved component (the error term). In this specification, the parameters are commonly treated as fixed. That is, it is assumed that shippers share the same set of parameters, and a single set of parameters is estimated. The mixed logit differs in that some or all of the parameters are treated as varying randomly over shippers. Instead of estimating fixed parameters, researchers estimate the distribution of the parameters. In transportation markets, there is considerable heterogeneity in shippers, some of which is observed and some of which is not observed. In our previous studies under NETS, we found that there is considerable variation across shippers in the responsiveness of payoffs to observed variables. And, in the current report we have the same result.

The findings of this report are summarized as follows:

1. The choice models indicate statistically important responses of shippers to changes in the prices received, rate, time, reliability, and distance. These responses also differ by shipper attributes that include rail car loading capacity and storage capacity.
2. There are statistically important differences in the responses between truck, rail and barge shipments.
3. Many firms report limited alternatives in their choice of mode and destination, and many report that they would shutdown in the presence of rate increases or if the chosen alternative was taken away. Unlike previous studies conducted under NETS, the effect of a shutdown alternative is reflected in the choices and explicitly captured in the models of switching behavior.

4. Arc elasticities are calculated for each mode and shipment attribute. Demand is found to be inelastic; that is, the arc-elasticities are all less than 1 in magnitude.
5. The rate demand elasticities are all inelastic. Barge elasticities range from -.42 to -.59; rail elasticities range from -.54 to -.87, and truck elasticities range from -.21 to -.26.
6. The time demand elasticities are all inelastic, and smaller than rate elasticities. Barge time elasticities are about .025; rail elasticities range from -.047 to -0.050; and truck elasticities range from -.009 to -.008.
7. The reliability elasticities are all inelastic and rest between those of rate and time elasticities. Barge reliability elasticities range from .15 to .19; rail elasticities range from .21 to .26; and truck elasticities rage from .28 to .42.
8. Annual volume demand elasticities were also estimated for rate, time and reliability. The responses of shippers often pointed to no change in annual volumes from a change in an attribute. A Heckman model was, therefore, used to estimate the model. The results suggest that shippers with large storage capacities and little rail car loading facilities were not likely to adjust volumes in response to rate changes. Given a change does occur, the change is driven largely by the level of the change in the attribute. That is, the elasticities conditioned on a change occurring did not vary with shipper attributes or commodity. But, whether or not a change occurs depends on shipper attributes.
9. The Heckman procedure allows the calculation of two different elasticities. These are a conditional elasticity (given a shippers volume changes) and an unconditional elasticity (where shippers volumes may or may not change). The former is larger in magnitude than the latter for each attribute, by definition. In some cases, annual volumes, given a change in volume, are quite responsive to changes in attributes. However, in most cases, the unconditional elasticities are less than one in magnitude, pointing to relatively inelastic demands.
10. Two different rate elasticities are presented – one where the shipper and its competitors face the same rate change, and one where the shipper but not its competitors face a rate change. The elasticities calculated from the former are much smaller in magnitude than those calculated from the latter. In both cases, the unconditional elasticities are less than one in magnitude for the median shipper. For some rate change levels, the conditional elasticities are greater than one in magnitude. This suggests that if there is a rate change that induces a volume change, the change is relatively responsive.
11. Both time in transit and reliability elasticities are nonzero; a finding that suggests shippers do adjust annual volumes to these shipment attributes. As with rates, the unconditional elasticities are less than one in magnitude.
12. There is considerable variation across shippers. Over the sample, unconditional rate elasticities (for rate changes applying to both the shipper and its competitors) averaged -.36 with a range of -1.36 to -.02; shipper specific elasticities averaged -.86 with a range from -1.66 to -.37; time

elasticities averaged -.31 with a range from -.09 to -.49, and reliability averaged .33 with a range from .16 to .50.

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 DESCRIPTIVE CHARACTERISTICS

2.1 Survey Description

All data used in this analysis were obtained and constructed from a survey of agricultural shippers. The survey was conducted by the Social and Economic Sciences Research Center located at Washington State University and was coordinated by Dr. Kenneth Casavant of Washington State University. The goal of the research was to gather data that pertain to shippers that could conceivably ship down the Upper Mississippi and Illinois waterways. To that end, the mail list was constructed from grain companies, including co-ops in Iowa, Illinois, Indiana, Wisconsin, Kansas, Missouri, Nebraska, North Dakota, South Dakota, Ohio, and Minnesota. The final list of elevators came from three primary sources: 1) a list from Dunn and Bradstreet for companies with relevant 3-digit NAICS commodity listings (111, 115, 311, 493); FarmNet services[3]; and an existing list of warehouses/grain elevator locations compiled by North Dakota State University for elevator firms in the area.[4]

A sample of 2000 potential shippers was drawn from this list and sampled in August, September and October of 2006. The sample was stratified by distance from the waterway. Specifically, approximately 900 locations within 100 miles of the waterways were identified, and all were sent a survey form. From locations further than 100 miles, 1100 locations were randomly drawn. The total sample size was 2000.

The survey was initiated by first sending a letter introducing the survey. This letter was followed by a survey instrument (Appendix A). A postcard reminder was sent within a week, deleting any responses at that point. If no response was received within the next week or so, a second form was sent. From this methodology there were a total of 480 responses, representing a response rate of 27.4 percent.[5]

The overall goal of the survey is to estimate transportation demand functions by mode. The survey instrument contains a variety of information relating to the attributes of

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[3] See http://65.109.0.18/fn/index.html.

[4] The ND Public Service Commission maintains on on-line list of elevators (see http://www.psc.state.nd.us/jurisdiction/grain/location-list-of-nd-elevators.pdf). The resulting list contained duplicate listing, and the list of elevators was inspected to remove duplicates. In addition, a list available from the Farm Service Agency of USDA was also used to supplement and/or verify the list.

[5] There were 1999 forms mailed. Of these, there were 480 with partial or complete answers returned, 7 refusals, 30 that were ineligible, 23 that were out-of-business, and 188 that were returned to sender. The remaining 1262 are considered non-respondents. This yields a response rate of 480/(1262+7+480)*100 = 27.4%.

shippers, their last shipment and alternatives to the last shipment, as well as the relationship of annual volumes to transportation service attributes. Each is discussed in turn. We begin with a short description of the spatial locations of shippers and shipments, followed by a summary of shipper attributes. We then describe revealed and stated preference data related to individual shipments and stated preference data related to annual volumes.

2.2 Locations of Shippers and Shipments

The locations of shippers and the destinations of shipments are presented in Figures 1 and 2. The locations of the 480 respondents are presented in Figure 2, this indicates a clustering of shippers along the waterways, although there are shippers located throughout the target states. These locations form the possible origins of shipments. The destinations, as reported by the shippers, are presented in Figure 2. It is noted that these are the destinations reported by the respondent shipper which may or may not reflect the ultimate destination of the product shipped, but does reflect the decision of the initial shipper. The number of destinations reported by shippers reflects a large number of points in the Upper Mississippi basin, but also a number of locations on the West and Gulf coast.

Figure 1. Shipper Locations

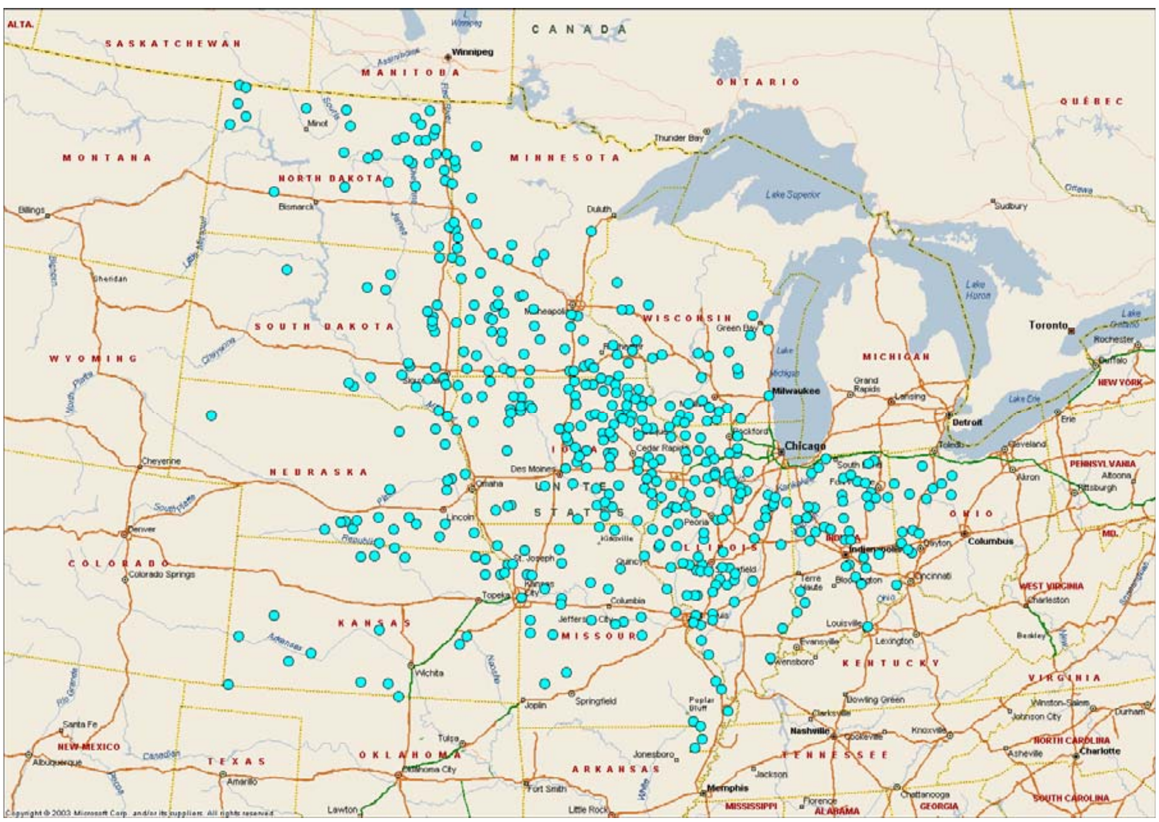

Figure 2. Shipment Destinations

Note: This figure represents the destinations (if available) of shipments that actually occurred. In addition, there are similar mappings that can be made for alternative shipments i.e., shipments that were not made under the current set of prices and shipment attributes, but may be made if the current set changed.

2.3 Shipper Characteristics

In addition to the geographic locations of shippers and market outlets, there are a number of shipper attributes that affect their transportation decisions. First and foremost among these attributes is the access shippers have to modes. It is well understood in the industry that if a shipper is located on the waterway and has direct access to barge, the shipment will likely occur by barge. In addition, a shipper located a long distance from the waterway with direct access to rail will more likely ship by rail to market than by a combination of truck-barge. This is especially so if the shipper has substantial rail car loading capacity, and can therefore, access lower rates associated with volume shipments.

The survey included questions related to the access that shippers have to each mode, and, if they didn't have access, the distance to the nearest access point (table 1). Nearly all shippers have loading capabilities for truck (479/480) but far fewer have loading capacity for rail (201/471) and barge (23/458).[6] Given that a shipper does not have direct access, it could still ship to a rail or barge terminal. When this happens, the average distance is 25 miles to rail access and about 137 miles to barge access. The median values are 20 for rail access and 90 for barge access. This is important in that multimodal options are always a possibility for shippers. That is, they can in most cases ship by truck which is usually a mode with a higher rate relative to rail or barge access points which typically reflect modes with lower rates. As a final point, those shippers that have rail access, tend to have substantial rail car loading capacities (average cars loading capacity is 45 with a median value of 25).

Table 1. Direct Access to Modes and Distance to Mode if no Direct Access.

Mode	Yes	No	Mean Distance to Mode if No Direct Access (miles)	Median Distance to Mode if No Direct Access (miles)	N
Truck	479	1	N.A.	N.A	
Rail	201	270	25	20	248
Barge	23	435	137	90	390

Note: Distance to truck access point was not asked. The N is the number of observations for which the distance data was available.

In addition to mode access, there are a number of other shipper attributes of interest, including its longevity, size, storage capacity, ownership of export facilities, and the number of facilities that are operated by the firm. It appears that the points of origin and location have a long history at those points (table 2). On average, elevators have been in business about 57 years with a median value of 50 years. Further, fewer than four percent of the locations are newer than 10 years, and only 7.25 percent of the locations are new in the last 20 years, strongly indicating that the location of elevators tends to be relatively fixed.

[6] The numerator is the number with access and the denominator is the total number that responded.

Table 2. Longevity of Facility Locations

Years	Frequency	%	Cumulative %
10	17	3.74	3.74
20	33	7.25	10.99
30	59	12.97	23.96
40	61	13.41	37.36
50	66	14.51	51.87
60	39	8.57	60.44
70	27	5.93	66.37
80	30	6.59	72.97
90	45	9.89	82.86
100	56	12.31	95.16
110	15	3.3	98.46
120	2	0.44	98.9
130	3	0.66	99.56
140	1	0.22	99.78
150	1	0.22	100
Total	455	100	

The sizes of elevators in terms of annual volumes shipped and storage capacity is summarized by table 3.[7] Very significant differences exist in the size of elevators in the sample. The average and median values of annual volumes shipped are 140,000 and 56,000 tons, respectively. About 70 percent of the sample ships less than 100,000 tons annually, but there several very large shippers with annual quantities in excess of 500,000 tons (table 3). In terms of storage capacity, the average and median values are 50,645 and 24,000 tons. As with volume, the capacity distribution is also heavily skewed with the sample being dominated by relatively small shippers. Over 30 percent of the sample has storage facilities of less than 15,000 tons, and 70 percent of the sample has storage of less than 50,000 tons. Again, however, there are some very large storage facilities in the data, with, about 12 percent (58 facilities) of the observations reporting storage capacity in excess of 100,000 tons (58 observations).[8]

[7] A number of missing values on total volume shipped initially existed and the range in responses suggests that some miss-recorded values were in the data set. Storage capacity had some of the same issues. However, the use of a number of different web pages and contact with various organizations (state agricultural, Farm Service Agency, Railroad and company websites) allowed most of the figures that were questionable or missing to be either confirmed, replaced or added.

[8] In terms of bushels (using 56 pounds per bushel), a 50,000 ton storage capacity translates into 1.78 million bushels. In the data, there are a number of facilities in excess of 10 million bushels.

Table 3. Elevator Size Distribution

Tons Shipped	N	Percent %	Cum. %	Storage Capacity (tons)	N	Percent %	Cum. %
0-20000	91	21.16	21.16	0-15000	151	32.06	32.06
20000-50000	112	26.05	47.21	15000-30000	113	23.99	56.05
50000-100000	95	22.09	69.3	30000-50000	68	14.4	70.49
100000-250000	65	15.12	84.42	50000-75000	53	11.25	81.74
250000-500000	41	9.53	93.95	75000-100000	28	5.94	87.69
500000-750000	14	3.26	97.21	100000-200000	42	8.92	96.60
750000-1000000	2	0.47	97.67	200000-300000	6	1.27	97.88
1000000-1250000	5	1.16	98.84	300000-400000	3	0.64	98.51
1250000-1500000	1	0.23	99.07	400000-500000	3	0.64	99.15
Larger	4	0.93	100	Larger	4	0.85	100
Total	430	100		Total	471	100	

Generally, the firms do not typically own import or export facilities; only 36 of 461 responses (about 8 percent) indicated ownership. The number of facilities operated by firms averaged 5.7. However, as presented in table 4, the sample was dominated by relatively small firms, with nearly 50 percent of the sample operating only one facility and almost 85 percent operating five facilities or less. Larger companies are represented with about 10 percent operating more than 10 facilities and a few in excess of 100 facilities.

Table 4. Number of Facilities Operated by Firm

Number of Facilities	N	%	Cumulative %
1	214	49.88	49.88
2-5	147	34.27	84.15
6-10	32	7.46	91.61
11-75	30	6.99	98.6
>75	6	1.4	100
Total	429	100	100

2.4 Shipment Characteristics

A major purpose of the survey was to develop a database that allows the discrete decisions of shippers (choice models) to be analyzed. In this regard, the instrument was designed to focus on the last shipment and up to three different alternatives to the shipment choice actually made. A shipment was defined as a mode and a destination choice. Alternative shipments are shipments that could have been made if the chosen shipment was not available. Four hundred seventy one surveyed shippers responded to the initial mode used question (table 5). Of those, trucks were chosen by over 70 percent of the sample (335 choices). Railroads were chosen by about 23 percent of the sample with the remaining a mix of barge, and multimodal shipments. As in previous studies conducted by these authors, the number of shippers who report they have no alternatives is significant. In particular, 154 of 461 observations (33 percent) report that if the chosen alternative were taken away, they would shutdown. Two hundred and ninety-four respondents listed at least one alternative, 132 listed two alternatives and 73 listed the maximum of three alternatives. As with the chosen alternative, truck movements dominated with over 80 percent of the responses. Rail represents the second largest frequency in all cases, with barge and multimodal movement making up the rest.

Table 5. Modal Choices and Alternatives

Mode	Chosen	%	Alter. 1	%	Alter. 2	%	Alter. 3	%
B	15	3.18	2	0.68	1	0.76		
R	108	22.93	39	13.27	16	12.12	5	6.85
T	335	71.13	246	83.67	112	84.85	67	91.78
T-B	4	0.85	0	0	0	0	0	0
T-R	9	1.91	6	2.04	2	1.52	1	1.37
T-R-B	0		1	0.34	1	0.76		
Total	471	100	294	100	132	100	73	100

A number of different destinations may be available to shippers. Geographically, the destinations observed in the data are portrayed in Figure 2. Table 6 details the type of destinations, broken into seven different categories. The bulk of chosen alternatives are relatively short-hauled movements to processing (and/or ethanol) plants. For the chosen and for each of the alternative movements, these movements represent the most frequent category. For the chosen destination, almost one-half of the shipments flow to processing (and/or ethanol) plants. The second largest destination is that of river terminals, followed by rail terminals. There are also a number of movements to export terminals.

Table 6. Destination Alternatives

Destination Type	Chosen	%	Alter. 1	%	Alter. 2	%	Alter. 3	%
River Terminal	101	21.26	75	25.42	40	30.53	29	37.66
Another Terminal	43	9.05	43	14.58	11	8.4	3	3.9
Railroad Terminal	58	12.21	29	9.83	19	14.5	8	10.39
Processing/Ethanol Plant	211	44.42	130	44.07	51	38.93	31	40.26
Other	2	0.42	4	1.36	1	0.76	1	1.3
Export Terminal	34	7.16	5	1.69	3	2.29	3	3.9
Feed lot	26	5.47	9	3.05	6	4.58	2	2.6
Total	475	100	295	100	131	100	77	100

Note: Chosen represents the destination of the shipment made, alternative 1 represents the destination type if the original shipment could not be made, and alternative 2 and 3 represent the destination type for still other alternative mode/destinations.

One of the reasons for the dominance of processing/ethanol is that the primary commodity shipped in the data is corn. Firms were asked to report both the primary commodity handled by their facility and the commodity for which the shipments pertain. In table 7, the number of shipments in grouped categories is provided along with the average price per ton received. Corn shipments dominate the sample with over 60 percent of all shipments (295/480). Corn, of course, is a primary ingredient of ethanol, and there has been tremendous growth in this industry, particularly over the last 10 years or so. In addition to corn shipments, there are a number of shipments of soybeans and beans (49/480 and 33/480, respectively). This was an "open-ended" question, and the term "beans" groups different types together. On inspection of the data, some of the beans shipped are not soybeans. That is, in the open-ended responses, beans were described by pinto, extruded, edible and kidney. Generally, the prices observed for these later tended to be considerably higher than those of "beans" (not designated). In addition to corn and beans, there are also a number of wheat shipments (69/480). The final category "other" has 34/480 shipments and represents variety of different commodities that include barley (2), canola (1), cotton (1), feed (3), fertilizer (2), flour (1), lentils (1), grain (6), oats (2), sorghum (5), soymeal (4), sunflower (2) and otherwise unspecified (4). Generally, inspection of table 7 suggests that the higher valued commodities are beans and soybeans, wheat, and other, while corn receives an average price per ton of about $80.

Table 7. Commodity Shipped and Prices per ton Received by Commodity

Commodity	Number	Price/ton	Std Dev
Corn	295	$79.9 (242)	$11
Soybeans	49	181.9 (43)	16.5
Beans	33	215 (28)	104.1
Wheat	69	148.6 (55)	21.5
Other	34	161.1 (18)	67
Total	480	114.6 (386)	58.4

Note: The numbers in () reflect the number of observations for which price is available. If specialty beans are excluded from the "beans" category, the average is $174 per ton. Specialty beans receive much higher prices with an average of $401.

Each of the choices made by shippers has different attributes attached to it. These data are presented by mode first, and then by chosen and next best alternative. Table 8 presents prices received at the destination, rates, transit times, reliability and distances by mode. By and large, most of these statistics are within the realm of prior expectations in experience and in the literature. On average, commodities shipped receive a price per ton of about $110 per ton (more detailed statistics by commodities are discussed below). The price received for products shipped by rail is somewhat higher than for the other modes. This arises because shipments of commodities exist are higher in value than the prevalent commodity (corn), including soybeans, other beans (pinto, extruded, kidney), and soybean meal which pull the average up.

Table 8. Shipment Attributes-Descriptive Statistics by Mode

Variable\Mode	Barge Average	Std. Dev.	Rail Average	Std. Dev.	Truck Average	Std. Dev	Overall Average	Std. Dev
Price/Ton ($)	109.0 (10)	33.6	130.1 (121)	67.2	106.9 (591)	52.1	111.5 (737)	56.0
Rate/Ton ($)	26.5 (17)	7.1	20.0 (127)	12.5	7.2 (727)	5.9	9.62 (886)	9.6
Time (hours)	256.9 (17)	126.1	219.3 (148)	212.3	59.0 (699)	258.6	93.2 (881)	257.6
Reliability (%)	86.2 (17)	12.2	60.2 (149)	27.8	87.4 (693)	16.5	82.5 (876)	21.6
Distance (miles)	1032.4 (17)	441.9	678.2 (159)	624.3	75.9 (738)	106.5	210.9 (934)	405.9
Rate/tonmile (cents)	3.4 (17)	2.8	5.7 (127)	5.2	15.6 (726)	20.21	13.8 (885)	18.8
Miles per hour	5.19 (17)	5.24	5.36 (145)	7.14	17.7 (697)	15.45	15.3 (873)	15.07

Note: There were 18 barge observations, 165 rail observations, and 751 truck observations. The number in () under each average value is the number of respondents providing enough information to specify the variable.

Barge movements tend to be of longer hauls than rail and truck; barge, rail and truck shipment distances average 1032, 678, and 76 miles, respectively) and tend to cost less per mile (3.4, 5.7 and 15.6 cents per tonmile, respectively). Barge movements also tend to travel slower than rail and truck, with miles per hour of 5.19, 5.36 and 17.7. Time in transit for this questionnaire included not only the travel time but also the time to schedule and wait for equipment. Finally, shippers report that barge and truck shipments are more reliable than rail service with over 85 percent of shipments considered arriving on time, while rail reliability is lower with about 60 percent of shipments arriving on time.

Table 9 compares the shippers' chosen alternative with the alternative that they identify as their next-best alternative. The chosen alternative dominates the next best alternative in terms of price received with a difference of about $3.4 per ton. Rates, however, are also higher for the chosen alternative. Specifically, the rates are about $2.3 per ton higher. The difference in the margin (Price-rate) is $2.75 per ton and is statistically different from zero and is of a sizable economic difference. The primary driver of the difference in rates is that the distances traveled for the chosen alternative tends to be markedly higher than for the alternative shipments. Indeed, the average distance for the chosen alternative is 340 miles, while for the alternative is only about 135. This suggests a tradeoff from relatively distant high value market to relatively local markets with lower returns. Once controlling for distance both in rates and transit times (rate per tonmile and miles per hour), the rate (cents per tonmile) and miles per hour each suggest that the chosen alternative has better attributes i.e., costs less and gets to the destination at a higher rate of speed: though, the differences are not statistically important.

The results reported in table 9 relate the differences between the chosen and the next best alternative, and are generally as expected. Of course, the differences are likely to be mode and destination specific. Also provided in table 9, are the differences by mode originally chosen. From this information, it is noted that the number of barge observations is relatively small (there are small numbers of barge shippers and even fewer with alternatives as demonstrated in table 5). From the limited available information, however, barge shippers report substantial differences in prices, rates, time which occur due to the fact that the distance of the next best tends to be much less. The statistics for railroad are similar to that of barge, prices of the alternative tended to be less as do rates, time, and these differences are likely due to the fact that the distance of the next best tends to be less than that chosen. Unlike barge and rail, shippers that chose truck substitute to alternatives with about the same price, higher rates, longer shipment times, less reliability, and longer distances. Direct calculation of the margins (Price/ton-rate/ton) in the case of all modes points to positive values, and the margin of the chosen shipment exceeds that of the alternative.

Table 9. Shipment Attributes-Average values by Chosen and Next Best Alternative

Variable	Chosen	Next Best	Difference	Paired t-test	N
Price (dollars per ton)	115	110.6	4.4	3.4	213
Rate dollars per ton	11.4	9.1	2.3	3.13	248
Time in hours	88.3	95	-6.7	-0.49	246
Reliability (%)	80.8	81.3	-0.5	-0.26	253
Rate/Tonmile	14	16	-2	-0.97	247
Mph	14.2	14	0.19	0.2	241
Distance (Miles)	340	135	205	6.1	276
Barge Choice					
Price (dollars per ton)	116.6	102.3	14.3	2.3	7
Rate dollars per ton	26.5	18.5	8	1.8	7
Time in hours	236	109	127	1.65	6
Reliability (%)	87.1	84.2	2.9	0.4	6
Rate/Tonmile	2.7	10.2	-7.5	-2.99	7
Mph	7.4	11.6	-4.1	-0.05	6
Distance (Miles)	1061	405	666	3.3	7
Rail Choice					
Price (dollars per ton)	130.3	117.9	12.4	6.6	62
Rate dollars per ton	22.6	11.1	11.4	6.9	68
Time in hours	188.9	163.3	25.6	0.73	77
Reliability (%)	61	79.5	-18.5	-4.5	82
Rate/Tonmile	4.4	13.3	-8.9	-6.6	67
Mph	5.6	8.3	-2.8	-2	74
Distance (Miles)	782	159	623	8.7	87
Truck Choice					
Price (dollars per ton)	106.6	105.9	0.6	0.5	137
Rate dollars per ton	5.8	8	-2.2	-4.11	168
Time in hours	21.7	60.3	-38.6	-3.7	155
Reliability (%)	92	82.5	9.5	5.9	155
Rate/Tonmile	18.6	17.4	1.1	0.38	168
Mph	18.8	16.6	2.3	1.9	154
Distance (Miles)	68	95	-27	-3.2	173

Note: The information in the table applies only to the observations for which there was a chosen and a non-chosen alternative. This allows for the paired t-test presented.

2.5 Stated Preference Responses to Shipment Attributes

Revealed data reflect actual decisions made by shippers and form the basis for many studies. However, it is commonly recognized that a problem with revealed data is that often the attributes do not have a large enough range of data to identify the parameters of interest. Indeed, in table 9, rates per tonmile, times-in-transit, and reliability each have statistically insignificant differences between the chosen and next-best alternative. Because of the limited variation in such statistics, there is a growing literature on stated preference modeling. A stated preference survey confronts survey respondents with a set of hypothetical states, and solicits a preference. This approach considerably simplifies analysis and the difficulty of collecting survey responses to confidential information. However, it is criticized in being based on hypothetical situations instead of real world decision-making. Our approach differs from the standard approach in that the stated preference questions are grounded in the revealed decisions made. In particular, survey recipients are asked what they did and what they would do if the chosen alternative were not available. This is taken as their next best alternative. The stated preference questions perturb each of the attributes of the original choice (For the last shipment, if the attribute changed x percent, would you continue with the original mode and destination or switch to your best alternative choice?). This framing of the question grounds the decision-making not to hypothetical alternatives, but rather to alternatives commonly confronted by the individual making the decision.

In the survey, three such questions related to rate, time and reliability. The percentage change was randomly offered to each and ranged from 10 to 60 percent. This generates a very large range of values over which to identify the parameters of the profit-function on which decisions are made. In addition, if the shipper did not switch, they were asked what level of the attribute would induce a switch with outcomes presented in tables 10, 11, and 12.

Six rate changes, from a 10 to 60 percent increase in rates, were used in the survey. A total of 425 responses are observed. At low values of rate changes, seventy-six percent of responses indicate they would not switch to the alternative. As the rate change increases, this proportion falls. However, even for large rate increases, 38 (28 of 73) percent of respondents report they would still not switch. If they do switch, there are two alternatives utilized. First, they can switch to their next best mode/destination. At various rate changes, there are a total of 122 such switches. Second, they can switch to "shutdown". Shutdown is and has been a major factor in all of the surveys conducted by these and other authors. In this sample, 57 of 425 (13.4 percent) report that they would shutdown at the rate increase prompt. As expected, both the switch to an alternative and the shutdown proportions tend to increase with the level of the rate change.

Table 10. Shipment Stated Preference – Rate Responses

(%)Rate Change	No Switch	Switch	Shutdown	Total	% NO	% Switch	% Shutdown
10	64	13	7	84	76	15	8
20	38	16	6	60	63	26	10
30	42	17	10	69	60	24	14
40	38	22	9	69	55	31	13
50	36	25	9	70	51	35	12
60	28	29	16	73	38	39	21
Total	246	122	57	425	57	29	13

The same information with respect to increases in transit time was examined, with transit times defined, again, as including the setup and waiting times as well as the time once loaded to reach the final destination. There were 417 responses. If time changes, shippers report that a total of 264 (63 percent) shipments would not change regardless of the time change. At small changes in time, the switch rate is higher than for rates, but at large changes in time, the switch rate is lower. As with rates, switch rates generally increase with progressively higher changes in transit times.

Table 11. Shipment Stated Preference – Time Responses

%Time Change	No Switch	Switch	Shutdown	Total	% NO	% Switch	%Shutdown
10	44	11	8	63	69	17	12
20	71	12	3	86	82	13	3
30	44	12	9	65	67	18	13
40	38	15	9	62	61	24	14
50	29	27	5	61	47	44	8
60	38	31	11	80	47	38	13
Total	264	108	45	417	63	26	11

The same information as in tables 10 and 11 with respect to reliability is presented in table 12 with a total of 412 responses. The same general pattern as with rate and time is indicated (as expected). For decreases in reliability, the switch rate increases with the percentage change in reliability. Generally, tables 10, 11, and 12 each follow expectations. Further, shippers appear to be more responsive to rates than to time and reliability, particularly for large rate changes.

Table 12. Shipment Stated Preference – Reliability Responses

%Reliability Change	No Switch	Switch	Shutdown	Total	% No	% Switch	% Shutdown
10	53	8	7	68	77	11	10
20	52	19	2	73	71	26	2
30	46	16	11	73	63	21	15
40	39	22	7	68	57	32	10
50	32	20	11	63	50	31	17
60	31	23	13	67	46	34	19
Total	253	108	51	412	61	26	12

2.6 Stated Preference and Annual Volume Responses

In addition to shipment choices, investment in transportation infrastructure which affects shipment characteristics may also affect the *volumes* shipped, both at the shipment level and annually. However, by and large, the shipment sizes tend to be mode specific and do not vary much across shippers. For example, the median value of shipment size for truck is about 27 tons (the approximate payload of a truck) and for barge 1600 tons (the approximate payload of a barge).[9] If logistics costs do change, it is unlikely to affect shipment volumes. However, if logistics costs change, they can affect the annual volumes shipped. Logistics costs can change due to changes in rates, time in transit and reliability.

In agricultural markets, the responsiveness of the annual volumes of a specific shipper to changes in rates depends critically on whether they apply only to the shipper or if they apply to its competitor as well. Specifically, the sample is dominated by firms that compete locally for the procurement of the commodity shipped. If a shipper experiences a rate increase/decrease that is not experienced by its competitors, annual volumes may respond quite differently than if the shipper and its competitors experience the same rate increase/decrease. The former might be expected if a railroad prices shippers differently or makes an investment that is shipper specific, while the later might be expected from improvements in the major corridors (rail lines to terminal markets or investments in the waterway whose benefits are experienced shared by all shippers in the study region).

[9] Railroads seem to be quite different with shipment sizes taking a wide range. This may be due to the fact that different shippers have different car siding capacities. Indeed, shipment sizes increase an average of 90 tons per unit of rail car siding capacity. The 90 tons rate of increase is the approximate payload capacity of a hopper car. This figure was generated from a regression of shipment sizes on car siding capacity. The parameter of interest was 90.7 with t-statistic of 12.7 and an R-square of 62. There were 102 observations, and a few egregious outliers were excluded. These results, along with the truck and barge results, are consistent with the hypothesis that shipment sizes are capacity driven and not endogenously determined. Hence, we do not make them part of the mode/destination choice model.

In the survey, four questions were asked to evaluate this situation. First, shippers were asked how their annual volumes would change if rates were increased to them as well as their competitors. Second, shippers were asked the same question but with the rate change applying only to them. The last two questions asked their responsiveness of annual volumes if time and reliability changed. The results for each of the four questions are presented in tables 13, 14, 15, and 16.

Generally, the pattern is the same for each. First, small changes in attributes often do not result in any impact on annual volumes. Specifically, there are large proportions of shippers who report their annual volumes are not affected by a 10 percent change in rates, time or reliability. Second, the proportion of shippers reporting a change in their annual volume increases as the level of the attribute change increases. Third, rate changes tend to impact volumes more than the time or reliabilities. This is both in terms of the proportion of shippers whose annual volumes are affected, but also in the magnitude of the change given a change occurs.

In summary, in table 13, the questions are framed around rate changes that accrue to all shippers, while in table 14 the rate changes apply only to the shipper responding. There are striking differences in the two tables, with the former indicating that responses to rate changes are much more muted when all shippers face the same rate change than when the rate change applies to a single shipper. This result, of course, is a direct consequence, likely, of agricultural shippers. As noted above, they compete over space in the procurement of grain; a rate change (or a change in time or reliability) is a mechanism through which more grain may be procured. If a change applies to shippers symmetrically i.e., the benefits of improvements in transportation infrastructure is shares by all shippers, it stands to reason that the change in volume for a given shipper is less than if the improvement applied only to that single shipper. To illustrate, for a rate change of 50 percent that applies to the shipper and its competitors, 46 percent of shippers indicated volumes would adjust and the level of change is an average of a 38 percent change (table 13). For a rate change of 50 percent that applies to a shipper *but not its competitors*, 79 percent stated volumes would change and the level of change is an average of 55%.

Table 13. Annual Stated Preference – Rate Responses (change in rates applies to all)

Rate Change	Change	No Change	% Change given a Change Occurs	Implied Elasticity given a Change Occurs
10	8	48	15.8	1.58
20	23	56	23.3	1.17
30	17	48	32.8	1.09
40	37	38	30.6	0.77
50	38	44	38	0.76
60	39	33	42.6	0.71
Total	162	267	41.8	0.88

Table 14. Annual Stated Preference – Rate Responses (change in rates applies to single shipper)

%Rate Change	Change	No Change	% Change given Change Occurs	Implied Elasticity given a Change Occurs
10	29	49	31.25	3.13
20	42	28	35.46	1.77
30	41	39	35.18	1.17
40	49	26	52.08	1.30
50	56	15	55.02	1.10
60	34	12	61.85	1.03
Total	251	169	46.44	1.48

As stated earlier, both shipment times and reliability questions yielded similar responses. For small changes in shipment times, there is little switching, but as the level of the change increases so does the switching rate. The responses are much smaller than those of rates, but are still substantial (table 13). For small changes in reliability there is again only a small amount in switching which again tends to increase with the level of the prompt. Nevertheless, even for large changes (60 percent), the level of switching is relatively small (43 percent).

Table 15. Annual Stated Preference – Time Responses

%Time Change	Change	No Change	% Change Occurs	Implied Elasticity given a Change Occurs
10	14	66	15.25	1.53
20	15	61	19.14	0.96
30	21	35	31.06	1.04
40	28	40	29.91	0.75
50	27	32	37.25	0.75
60	39	41	39.73	0.66
Total	144	275	31.57	0.86

Table 16. Annual Stated Preference – Reliability Responses

%Reliability Change	Change	No Change	% Change given a Change Occurs	Implied Elasticity given a Change Occurs
10	12	57	16.25	1.63
20	21	46	21.92	1.10
30	26	44	27.13	0.90
40	26	37	29.25	0.73
50	29	45	33.46	0.67
60	28	35	32.57	0.54
Total	142	264	28.19	0.84

In the following sections, we describe our analysis of shippers' choice of mode and destination (section 2) and shippers' changes in volume of shipments in response to rate increases (section 3.)

3. SHIPPERS' CHOICE OF MODES AND DESTINATIONS

3.1 Data

In this section, we examine shippers' choice of mode and destination for their shipments. The model we use rests on the use of a switching model. While unique, this approach does, indeed, allow mode specific demand elasticities to be calculated, and, as we have demonstrated elsewhere, the results can be aggregated over shippers and space to provide demand models relevant to the Army Corps models (Train and Wilson (2007)). Specifically, we examine the extent to which shippers would change modes and/or destinations, or even choose to shut down, in response to changes in rates, time, and reliability. The analysis constitutes one aspect of shippers' overall responses. The other way that shippers can respond is to change their volume of shipping, by, for example, reducing total volume in response to rate increases. This second component of response is examined in section 4.

The data that are used for the analysis of mode and destination choice are described in section 2 above. To summarize: Shippers were asked the mode(s) and destination of their last shipment, as well as alternative mode(s) and destinations, if any, that were available to the shipper for this shipment. For each available alternative, they were asked to provide rates, transit times and reliability measures. Transit times were to include the scheduling, waiting time for equipment, and travel time. Reliability was measured by asking the shippers to estimate the percentage of time that shipments like the one chosen or is an option to that chosen arrive "on-time" at the final destination. Tables 5-9 above provide statistics for shippers' responses. Note from table 5 that that 177 (471-294) of 471 respondents (over 35%) reported no shipping alternatives, such that their only other option was to shut down. A similarly large share of reportedly "captive" shippers (i.e., with no shipping alternatives from their chosen mode and destination) was obtained in the previous surveys of shippers in the Columbia/Snake area (Train and Wilson, 2005) and the Upper Mississippi region (Train and Wilson, 2004). However, unlike the previous studies, we ask respondents in the current survey about conditions that would induce them to shut down, and we explicitly include the "shut down" option in our modeling.

As described in section 1, the standard form of stated-preference questions was not used and an alternative, more realistic form was used instead. The usual procedure for stated-preference question is to present each shipper with a set of hypothetical options from which they choose one. The rate, transit time, and reliability of each hypothetical option are described, and the respondent's choice among the hypothetical options is used to infer the relative value placed on rates, time and reliability. In the current study, we implemented a procedure that we call "sp-off-rp," because the stated-preference (sp) questions are based on the revealed-preference setting and choice of the shipper. Recall that each shipper was asked about their last shipment and the alternative modes and destinations that they could have used, but didn't, for this shipment. For the sp-off-rp questions, the shipper was asked whether they would have remained with the mode and destination if its rate were x% higher, or would they switch to an alternative. For example, the shipper was asked "Suppose that the rates for your last shipment were 40% higher than currently. Would you still use that mode and destination, or would you choose a different alternative?" If the shipper said they would choose a different alternative, they were asked what they would do instead. Shutting down was included as an option, and some shippers chose this option in the face of sufficiently large rate increases. The percent increase in rates was varied over shippers, chosen randomly from 10, 20, 30, 40, 50 and 60 percent changes. Similar questions were also asked for an increase in transit time and decrease in reliability.

Note that these "sp-off-rp" questions relate to the shippers real-world choice situation, unlike standard sp questions that present the shipper with a set of hypothetical options. In answering the sp-off-rp question, the shipper is facing the same options, with all the same factors affecting their decision, as they actually faced when making their last shipment. The only change from the actual situation is in one of the attributes of their chosen option (rate, time or reliability); all other factors remain the same. This similarity to the real-world setting that the shipper faces gives them a greater realism, relative to standard sp choices, which can be expected to translate into more accurate and generalizable estimates of shipper response to changes in rates, transit times, and reliability.

Tables 10-12 above summarize shippers' responses to the "sp-off-rp" questions. A considerable degree of switching is evidenced overall, and the rate changes tend to induce slightly more reported switching than the time and reliability changes. Specifically, 42 percent of the surveyed shippers said they would switch in response to a rate increase (13 percent would shut down and 29 percent would switch to a different mode/destination); 37 percent of shippers would switch in response to a transit time increase, and 38 percent would change in response to a reliability decrease. Finally, as expected, the rates of switching increase with the level of the change. For example, for those that have rate increases of 50 percent, 47 percent report that they would switch, while those with rate increases of 10 percent, 23 percent report switching. In our econometric analysis of these data, we combine the shippers' responses to these hypothetical changes in rates, times and reliability with data on their actual choices. The analysis finds, as discussed below, that actual switch rates are estimated to be lower than those reported by shippers in these hypothetical situations, since shippers' real-world choices imply less response to rates, time, and reliability than their reported responses in these hypothetical situations.

3.2 Choice Model and Estimation

In this section, we describe the econometric method that is used to estimate choice models on the revealed-preference (rp) data and the shippers' responses to the "sp-off-rp" questions. As stated above, the sp-off-rp questions provide greater realism than standard sp questions, since the sp-off-rp questions relate specifically to the situation that the shipper faced for their last shipment. However, this realism has implications for the econometric techniques that are used to analyze the data. The sp-off-rp questions ask the shipper which option they would choose in the rp setting if the rate, time, or reliability of the option they actually chose were changed. These questions have two features that need to be addressed in the estimation. First, when answering the sp-off-rp questions, the shipper is choosing among options in the rp setting. This implies that the attributes of the options in the rp setting, including, importantly, the attributes that are not observed by the researcher, affect the shipper's answer to the sp-off-rp questions. Stated in econometric terms, the unobserved factors associated with each option in the rp setting can be expected to enter the shipper's evaluation of these options when answering the sp-off-rp questions. Second, the sp-off-rp questions ask the respondent about a change in the rate, time or reliability of the option that was chosen in the rp setting. In econometric terms: The sp-off-rp questions are conditional on the outcome of the rp choice. This conditionality implies that the distribution of unobserved attributes that enter the shipper's responses to the sp-off-rp responses is not the unconditional distribution, as in standard choice models, but rather the distribution conditional on the shippers' rp choice.

The econometric method that we develop and apply incorporates both of these implications, building upon the earlier work reported in Train and Wilson (2005; 2007a). The unobserved factors in the rp setting enter the model of the shipper's response to the sp-off-rp questions, and the probability of each possible response is derived based on the distribution of these unobserved factors, conditional on the shipper's choice in the rp setting. We provide below the specification of the model. We first describe a version with fixed coefficients for rate, time and reliability. We then generalize the model to allow for random coefficients, reflecting the fact that the relative value of rates, time, and reliability differs over shippers. The next subsections present the alternative estimation strategies in more detail and outline the "choice framework." Essentially, shippers choose from the alternatives available to them in a manner that maximizes their payoffs, which are taken as a function of rates, times of transit and reliability. The specific form of the payoffs varies according to the treatment of the unknown parameters that are estimated. For readers interested primarily in the results may choose to skip to section 3.3.

3.2.1 Fixed coefficients

With fixed coefficients, the shipper's choice in the rp setting is a standard logit model. The shipper faces J alternatives for its last shipment, which are the alternatives that the shipper reports are available. The utility of each alternative depends on observed variables, namely, rate, transit time, and reliability, as well as unobserved factors.[10] The observed variables are denoted x_j for alternative j (with the subscript for the shipper omitted for simplicity), and the unobserved random factors are denoted collectively ε_j as for alternative j. Utility of alternative j is denoted $U_j=\beta x_j+\varepsilon_j$. Under the assumption that each ε_j is distributed iid extreme value, the probability that the shipper chooses alternative i is the logit formula:[11]

$$P_i = \frac{e^{\beta x_i}}{\sum_j e^{\beta x_j}}$$

The researcher presents the shipper with a series of sp-off-rp questions that are constructed on the basis of the shipper's rp choice. We provide more general notation than is necessary for our particular sp-off-rp questions, to facilitate the use of the method in other settings that might use different types of sp-off-rp questions. (For example, our questions ask the shipper about a change that makes the option they chose worse; an alternative would be to ask the shipper about a change that improves an option that they did not choose.) The researcher asks T sp-off-rp questions, with attributes $\tilde{x}^i_{jt}$ for alternative j in question t based on alternative i having been chosen in the rp setting. For our questions, $\tilde{x}^i_{it} \neq x_i$ for the alternative that was chosen in the rp setting, while $\tilde{x}^i_{jt} = x_j \, \forall j \neq i$ for the non-chosen alternatives; however, more general specifications of $\tilde{x}^i_{jt}$ possible. The shipper is asked to choose among the alternatives in response to each sp-off-rp question.

The shipper's choice in the sp-off-rp setting can be affected by factors that did not arise in the rp setting. We allow for both systematic and random effects. First, respondents might have a tendency to stay with, or switch away, from their chosen rp alternative for reasons that are unrelated to the prompt. To account for this possibility, we include a constant for the chosen rp alternative in the sp-off-rp choices. This constant is defined as $c^i_j = 1$ if $j=i$ and 0 otherwise. If respondents tend to say that they will stay with their rp alternative, independent of the prompt and the values of their other alternatives, then the constant will be positive. If, on the other hand, respondents tend to say that they will switch away from their chosen alternative, perhaps as a protest against the implications of the prompt or as a strategic response intended to induce the ACE to invest in infrastructure, then the constant will be negative. The inclusion of the constant prevents the strategic responses

[10] The model is framed in a utility context although the term profit maximization can be employed so long as there are no agency issues i.e., the shipper makes decisions consistent with the firm's objective of maximizing profit.

[11] This formula can be interpreted as follows as an example. Suppose the shipper faces two alternatives with the observed portion of utility being $\beta x_1=3$ for the first alternative and $\beta x_2=4$ for the second alternative. Even though the observed portion of utility is lower for the first alternative, the shipper might still choose the first alternative because of unobserved factors. The formula states that the probability that the shipper chooses the first alternative is $exp(3)/(exp(3)+exp(4))=0.27$ and the probability that the shipper chooses the second alternative is $exp(4)/(exp(3)+exp(4))=0.73$.

from influencing the estimates of the coefficients of rates, times, and reliability.[12] Second, the responses might be affected by inattention by the agent to the task, pure randomness in the agent's responses, or other quixotic aspects of the sp choices. We consider these effects to be random factors, taking the value of random term η_j for alternative *j*. The relative importance of these factors will be estimated, as described below. The shipper obtains utility $W_{jt} = \beta \tilde{x}^i_{jt} + \varepsilon_j + c^i_j + \eta_{jt}$ from alternative *j* in sp-off-rp question *t*. That is, the shipper evaluates each shipping alternative using the same utility coefficients and with the same unobserved attributes as in the rp setting, with the addition of new errors that reflect quixotic aspects of the shippers' responses to the sp-off-rp questions.

In the "sp-off-rp" questions, one alternative for the shipper is to shut down. This option has no associated rates, time, and other shipment attributes. The utility, or more precisely, the disutility of shutting down, differs over shippers. The average disutility (relative to shipping alternatives) is denoted λ and the deviation of a given shipper's disutility from this average is denoted $\sigma \cdot \mu_s$, where μ_s is assumed to be distributed extreme value and σ is a parameter to be estimated that is proportional to the standard deviation over shippers of the disutility of shutting down. The shipper's disutility of shutting down is the same in each of the "sp-off-rp" questions. However, a second error component, labeled η_{st}, is also included to capture the quixotic aspects of responses to these question, similar to the η_{jt}'s above. Combining these concepts, the disutility of shutting down is specified as: $W_{st} = \lambda + \sigma \cdot \mu_s + \eta_{st}$ where subscript *s* denotes shutting down. As discussed below in connection to the empirical results, we estimate a different λ for shippers with large storage capacity than others, reflecting the fact that these shippers are less likely to shut down than those with smaller storage capacity.

In response to each sp-off-rp question, the shipper chooses the alternative with the greatest utility. To complete the model, we specify each η_{jt} to be iid extreme value with scale *1/α*, which is proportional to the standard deviation of these errors. A large value of parameter *α* indicates that there are few purely random aspects to the sp-off-rp responses. The sp-off-rp responses are, under this specification, standard logits with ε_j as an extra explanatory variable. Since the ε_j 's are not observed, these logits must be integrated over their conditional distribution, as follows. The chosen alternative in response to question *t* is denoted k_t and vector $k = \langle k_1, \ldots, k_T \rangle$ collects the sequence of responses to the sp-off-rp questions.

For notation convenience, denote $V_{jt} \equiv \beta \tilde{x}^i_{jt} + \varepsilon_j$ for each $j \neq s$, that is, for each alternative other than shutting down, and denote $V_{st} = \lambda + \sigma \cdot \mu_s$ for the shut-down option.

[12] In models of standard SP and RP data (as opposed to our SP-off-RP data), it is common practice to include separate constants for the SP data, analogous to the constant we add for the Sp-off-RP responses. See Train, 2003, pages 156-60 and its references for a discussion of this practice.

The probability of choosing alternative k_t in response to sp-off-rp question t, conditional on i being chosen in the rp choice is:

$$P_{k_t|i} = \Pr ob\left[V_{k_t t} + \eta_{k_t t} > V_{jt} + \eta_{jt} \forall j \neq k_t \mid \beta x_i + \varepsilon_i > \beta x_j + \varepsilon_j \forall j \neq i, s\right]$$

$$= \int \frac{e^{\alpha V_{k_t t}}}{\sum e^{\alpha V_{jt}}} f(\varepsilon \mid \beta x_i + \varepsilon_i > \beta x_j + \varepsilon_j \forall j \neq i, s) d\varepsilon.$$

This probability is a mixed logit (Train, 2003), mixed over the conditional distribution of the ε's that enter the V's. It can be simulated by taking draws from the distribution of ε, calculating the logit formula for each draw, and averaging the results. The procedure for taking such draws is given in Train and Wilson (2005; 2007a).

Combining these results, and using the independence of η_{jt} over t, the probability of the agent's rp choice and the sequence of responses to the sp-off-rp questions is:

$$P_{ki} = \int \left[L_{1|i}(\varepsilon) \ldots L_{T|i}(\varepsilon)\right] f(\varepsilon \mid \beta x_i + \varepsilon_i > \beta x_j + \varepsilon_j \forall j \neq i, s) d\varepsilon \frac{e^{\beta x_i}}{\sum e^{\beta x_j}}$$

where

$$L_{t|i}(\varepsilon) = \frac{e^{\alpha V_{k_t t}}}{\sum e^{\alpha V_{jt}}}.$$

This probability is simulated by taking draws of ε from its conditional distribution as described above, calculating the product of logits within brackets for each draw, averaging the results, and then multiplying by the logit probability of the rp choice.

3.2.2 Random coefficients

Utility is as above except that β is now random with density $h(\beta)$ that depends on parameters (not given in the notation) that represent, e.g., the mean and standard deviation of β over shippers. The probability for the rp choice is the logit formula integrated over the density of β:

$$P_i = \int L_i(\beta) h(\beta) d\beta$$

where

$$L_i(\beta) = \frac{e^{\beta x_i}}{\sum_j e^{\beta x_j}}$$

This is a standard mixed logit. By Bayes' rule, the density of β conditional on i being chosen is $L_i(\beta)h(\beta)/P_i$.

For the responses to the sp-off-rp questions, let $L_{t|i}(\varepsilon,\beta)$ be the same as $L_{t|i}(\varepsilon)$ defined above but with β treated as an argument. The probability of the sequence of responses to the sp-off-rp questions is

$$P_{k|i} = \iint L_{1|i}(\varepsilon,\beta)\ldots L_{T|i}(\varepsilon,\beta) f(\varepsilon \mid \beta, \beta x_i + \varepsilon_i > \beta x_j + \varepsilon_j) h(\beta \mid \beta x_i + \varepsilon_i > \beta x_j + \varepsilon_j) d\beta d\varepsilon$$
$$= \iint L_{1|i}(\varepsilon,\beta)\ldots L_{T|i}(\varepsilon,\beta) f(\varepsilon \mid \beta, \beta x_i + \varepsilon_i > \beta x_j + \varepsilon_j) L_i(\beta) h(\beta) d\beta d\varepsilon / P_i .$$

The probability of the rp choice and the sequence of responses to the sp-off-rp questions is P_i times the above formula, which is:

$$P_{ki} = \iint L_{1|i}(\varepsilon,\beta)\ldots L_{T|i}(\varepsilon,\beta) f(\varepsilon \mid \beta, \beta x_i + \varepsilon_i > \beta x_j + \varepsilon_j) L_i(\beta) h(\beta) d\beta d\varepsilon .$$

This probability is simulated as follows: (1) Draw a value of β from its unconditional density; (2) Calculate the logit probability for the rp choice using this β; (3) Draw a value of ε from its conditional density given β using the method described above. Calculate the product of logit formulas for the responses to the sp-off-rp questions for this draw; (4) Multiply the result from step 3 by the result from step 2; and (5) Repeat steps 1-4 numerous times and average the results.

3.3 Estimation Results

Table 17 gives the estimated parameters of a standard logit model that was estimated on the rp data alone. The model has mode specific alternatives, the price received at the point of sale, rate (in tons), shipment times, reliability, and distance. In addition, we also include a select number of shipper characteristics. These include the rail car and storage capacities of the shipper. The specific definitions of each of these latter are discussed below.

The estimated coefficients of rate, time, and reliability all take the expected signs. The ratios of coefficients imply that a day of extra transit time is considered equivalent to about 19 cents per ton in higher rates[13] and that decreasing reliability by 1 percentage point is considered equivalent to 34 cents per ton in higher rates. These two estimated values are similar to those obtained on the rp data in the Columbia/Snake study (27 and 26 cents, respectively; Train and Wilson, 2005.) The rail constant enters by itself and also interacted with a measure of the loading capacity at the firm's premises. This measure was found in previous work to influence shippers' choice of mode (Train and Wilson (2007b). The interaction terms enters significantly and with a positive sign, as expected, indicating greater loading capacity increases the chance that the shipper will use rail, all else equal.

[13] Calculated as: 0.000818 / 0.103, times 24 hours per day.

Table 17: Fixed Coefficients Model on Revealed-Preference Data

Explanatory Variable	Estimated parameter	Standard error	T-statistic
Rate, in dollars per ton	-0.103	0.0325	3.17
Time, in hours	-0.000818	0.000583	1.40
Reliability	0.0346	0.00930	3.72
Price at destination, in $/ton	0.0165	0.0102	1.62
Distance, in miles	0.00329	0.00103	3.20
Rail constant	-2.17	0.963	2.25
Rail cnst*log(1+rail load capacity)	1.51	0.338	4.47
Barge constant	4.31	1.38	3.13
Number of observations	261		
Log-likelihood	-0.677503		

Table 18 gives the estimated parameters of a fixed-coefficients logit model estimated on the rp data combined with the responses to the sp-off-rp questions. Simulation was performed with 200 pseudo-random draws of the conditional extreme value terms, with different draws for each observation. Recall that a possible response to the sp-off-rp questions is for the shipper to say that it would shutdown. As described above, we specified the utility of the shutdown alternative to vary randomly over shippers, with a mean that depends on the storage capacity of the shipper and a standard deviation that is estimated.

As expected, the level of significance for the coefficients of rate, time, and reliability rise considerably when the sp-off-rp data are utilized. The values of time and reliability both drop relative to those estimated on the rp data alone. In particular, the value of time drops from 19 to 12 cents per ton, and the value of reliability drops from 34 to 10 cents per ton. Stated equivalently, the importance of rates relative to time and reliability rises when the responses to the sp-off-rp questions are utilized. A value of time of 12 cents per ton is lower than found in previous analysis of shippers in the Upper Mississippi region (Train and Wilson, 2004). It is important to note, however, that time is defined differently in the current study than in the previous one. In particular, in the previous study of Upper Mississippi shippers, time was defined as time spent in transit only, while in the current study time is defined as the time required for all aspects of making the shipment including wait and scheduling time in addition to time actually in transit. Time is considerably larger under this more inclusive definition, such that the value of marginal changes in time can be expected to be smaller.

Table 18: Fixed Coefficients Model on RP and SP-off-RP Data

Explanatory Variable	Estimated parameter	Standard error	T-statistic
Rate, in dollars per ton	-0.0885	0.0116	7.64
Time, in hours	-0.000426	0.000157	2.71
Reliability	0.00877	0.00170	5.17
Price at destination, in $/ton	0.00773	0.00306	2.52
Distance, in miles	0.00163	0.000315	5.19
Rail constant	-0.899	0.378	2.38
Rail cnst*log(1+rail load capacity)	0.719	0.123	5.85
Barge constant	2.11	0.575	3.67
Shut down constant	-1.35	0.356	3.79
Shut down standard deviation	1.27	0.150	8.46
Sht dn cnst*Storage capacity>median	-0.484	0.326	1.48
Scale of sp error (α)	3.71	0.540	6.86
SP constant for chosen RP alt c_j^i	-0.261	0.0482	5.40
Number of observations	415		
Mean log-likelihood	-2.44106		

The average disutility of shutting down is estimated to be large in magnitude and highly significant. The standard deviation is also large, indicating considerable variation across shippers in how they view the option of shutting down. An interaction term is included between the shut-down constant and an indicator of whether the shipper has greater than median storage capacity.[14] This variable enters with a negative coefficient, indicating, as expected, that shippers with large storage capacity are less likely to shut down than those with less capacity, all else equal.

The inclusion of the shut-down option in the model constitutes an important feature that was not included in previous analyses. In particular, numerous shippers stated that they had no shipping alternatives, other than the one they used. For these shippers, their only alternative in the face of rising rates or time was to shut down. Even shippers who had shipping alternatives might choose to shut down in response to potential changes in rates, time, and reliability for their chosen shipment, rather than switch to their next-best shipping alternative. In fact, many shippers responded in this way to the hypothetical changes in rates, times, and reliability. The model explicitly accounts for these responses. As the estimates indicate, the shut-down option is considered onerous (as captured by the large negative coefficient), and the threshold for deciding to shut down varies considerably over shippers (as captured by the large standard deviation parameter.)

[14] We attempted models with the level and also with the log of storage capacity. The median entered "most significantly", with the significance levels of the other specifications being considerably lower.

The scale parameter α is estimated to be 3.71, which implies that the standard deviation of the additional unobserved portion of utility that affects the responses to the sp-off-rp questions is a little more than a fourth as large as the standard deviation of unobserved utility in the rp choices. As discussed above, if there were no purely random aspects to the responses to the sp-off-rp questions, then the standard deviation would be zero (α unbounded high.) The relatively small estimated standard deviation implies that there is relatively little pure randomness in the shippers' responses to the rp-off-sp questions.

The constant for the chosen rp alternative in the sp-off-rp responses, c^i_j, is estimated to be negative. This result implies that respondents had a tendency to say that they would switch away from their chosen rp alternative independent of the prompt. Respondents were apparently registering a protest, by saying that they would switch regardless of the prompt -- as a way of conveying to the interviewer and perhaps ACE that they do not want to experience the rate, time and reliability degradations that they were presented with. The magnitude of this effect is fairly large. The estimated coefficient is -0.261, which is exponentiated when it enters the probability formula, exp(-0.261)= 0.77. This estimate implies that the probability of staying with the rp alternative in response to the sp-off-rp questions is 0.77 *independent* of the prompt. Stated equivalently, on average, 23 percent (=1-0.77) of the switching that was recorded for the sp-off-rp questions can be considered to be a protest response, in that it is independent of the prompt. This large share explains the difference between the respondents' stated switch rates, as reported in Tables 10-12 above, and the switch rates that are implied by the estimated model, given in tables 20-25 below. In particular, the forecasted switch rates are lower than the rates from respondents' answers, since the forecasts remove the part of the response that was independent of the prompt and, hence, unrelated to the actual change in rates, times, and reliability.

We next examine a random coefficients specification. The rate coefficient is specified to be truncated normal, with truncation at two standard deviations above and below the mean. A truncated normal is specified because the rate coefficient cannot logically be negative; also, in order to calculate values of time and reliability (which are the coefficients of these variables divided by the rate coefficient), the rate coefficient cannot be arbitrarily close to zero (otherwise, values close to zero produce unbounded large values of time and reliability due to division by a number close to zero.) The truncated normal prevents these occurrences provided the mean is more than twice the standard deviation, as we find it to be. The reliability coefficient is specified to be distributed normally with censoring at zero.[15] That is, the coefficient of reliability is specified as the maximum of 0 and β_{rel}, where β_{rel} is normally distributed with mean and standard deviation that are estimated. This specification assures that the reliability coefficient is positive, as required, for all shippers. Also, by having a mass at zero, the specification allows for the possibility that some shippers do not care about reliability (at least within the ranges that are relevant.) The time coefficient is held fixed, primarily for pragmatic reasons. In particular, preliminary models that were estimated with a random coefficient

[15] See Train and Sonnier (2005) for a discussion and application of censored normals and other distributions with bounded support within mixed logit models.

for time obtained a very small and highly insignificant standard deviation for this coefficient. Also, as discussed by Ruud (1996), a choice model with all random coefficients is nearly unidentified empirically, especially with only one or a few observed choices per agent, since only ratios of coefficients are behaviorally meaningful. Holding at least one coefficient fixed assists with empirical identification. In our application, the time coefficient was insignificant and hence the most logical one to hold fixed. It is important to note, however, that a fixed coefficient for time does not imply that all shippers have the same value of time. Rather, variation in the rate coefficient creates variation in the value of time, since the value of time is the ratio of the time coefficient to the rate coefficient.

Table 19 gives the estimated parameters for the random coefficients model. Simulation was performed with 1000 draws of the random coefficients and extreme value terms. The estimated mean value of time is 12 cents per ton with a standard deviation of 7.8, and the estimated mean value of reliability is 13 cents with a standard deviation of 14. The mean values of time and reliability are similar to those obtained with fixed coefficients, discussed above. Approximately 14 percent of shippers are estimated not to care about reliability (i.e., the mass at zero is 0.138).

Table 19: Random Coefficients Model on RP and SP-off-RP Data

Explanatory Variable	**Estimated parameter**	**Standard error**	**T-statistic**
Rate, in dollars per ton: mean	-0.0971	0.0126	7.69
Rate, in dollars per ton: stdev	0.0418	0.0128	3.25
Time, in hours	0.000404	0.000269	1.51
Reliability: mean	0.00934	0.00216	4.33
Reliability: stdev	0.00859	0.00493	1.74
Price at destination, in $/ton	0.00632	0.00247	2.56
Distance, in miles	0.00188	0.000386	4.86
Rail constant	-1.21	0.463	2.62
Rail cnst*log(1+rail load capacity)	0.817	0.153	5.33
Barge constant	2.16	0.568	3.80
Shut down constant	-1.42	0.391	3.64
Shut down stdev	0.980	0.223	4.39
SP constant in chosen RP alt	-0.278	0.0428	6.50
Scale of sp error (α)	4.09	0.640	6.38
Number of observations	415		
Mean log-likelihood	-2.42535		

3.4 Switching Rates and Elasticities for Each Alternative

The estimated model in table 19 is used to forecast the impact of changes in rates, times, and reliability. We consider first the forecasted impact of rate increases. To forecast this impact, the rate for each of the shippers' last shipment was increased by a given percentage, and the estimated model was used to calculate the share of shippers who switch, either to another mode/destination or to shut down. Table 20 gives the percent of shippers who are predicted to switch when the rate for their chosen alternative is raised. Separate estimates are given for shippers who currently ship by barge, by rail, and by truck (where barge is considered to be any combination of modes that includes barge, rail is either rail alone or truck and rail, and truck is truck alone.) Consider, for example, the value of 5.86 that is given for a 10 percent rate increase for barge shippers. This number is interpreted as follows: if the rate for shippers' current mode and destination rose by 10 percent, and the rates for other modes and destinations remained the same, then the model predicts that 5.86 percent of the shippers who currently use barge would switch, either by choosing a different mode/destination or by shutting down.

Table 20: Percent of shippers who are predicted to switch in response to rate increases

% Increase	Barge	Rail	Truck
10	5.86	8.70	2.58
20	11.18	16.12	5.05
30	15.90	22.60	7.41
40	20.22	28.40	9.66
50	24.28	33.62	11.80
60	28.17	38.36	13.83
70	31.94	42.70	15.78
80	35.55	46.67	17.65
90	39.00	50.30	19.44
100	42.27	53.63	21.17

As expected, larger increases in rates induce greater switching. For barge shippers, a 10 percent increase in rates induces 5.86 percent of shippers to switch, while a 50 percent increase in rates induces 24.28 percent of the shippers to switch. Note, however, that some shippers do not switch even when rates are raised quite considerably. For example, over half of barge shippers would stay with their current mode and destination even if the rates for that alternative were doubled.

Switching rates are estimated to be greatest for rail shippers, and larger for barge shippers than for truck shippers. For example, a 10 percent increase in rates induces 8.70 percent of rail shippers to switch, 5.86 percent of barge shippers to switch, and only 2.58 percent of truck shippers to switch.

Table 21 gives the arc elasticities that are implied by the switching rates given in table 20. For example, consider the elasticity of 0.59 for barge shippers in response to a 10 percent increase in the rates. As shown in table 20, the model predicts that 5.86 percent of barge shippers will switch to a different mode/destination or shut down if the rates for their current shipping option rose by 10 percent. Since there is a 5.86 percent reduction in response to a 10 percent increase in rates, the arc elasticity is 0.59 (=5.86/10 rounded to nearest decimal).

The elasticities decrease somewhat as rates increase. For example, the arc elasticity for a 50 percent increase in rates is lower than that for a 10 percent increase in rates. This relation does not imply, of course, that larger rate increases induce less switching than smaller rate increases. Rather, it implies that the number of shippers who switch in response to the rate increases rises less than proportionally with the size of the rate increase.

Table 21: Arc Elasticities with respect to Rates

% Increase	Barge	Rail	Truck
10	0.59	0.87	0.26
20	0.56	0.81	0.25
30	0.53	0.75	0.25
40	0.51	0.71	0.24
50	0.49	0.67	0.24
60	0.47	0.64	0.23
70	0.46	0.61	0.23
80	0.44	0.58	0.22
90	0.43	0.56	0.22
100	0.42	0.54	0.21

Tables 22 and 23 give switch rates and arc elasticities for increases in transit times. These switch rates and elasticities are lower than those for rates, which suggests that shippers are more responsive to changes in rates than changes in transit time. This comparative result has been found in previous analyses (Train and Wilson (2005), (2004)). However, the magnitudes of the response to time are quite low in magnitude, lower than found in previous analysis for the Upper Mississippi. This small response to time is, at least partly, due to the definition of time that is utilized in the current study, as discussed above. Time includes all aspects of the shipment, such that marginal changes in this total time have less impact on shippers' behavior than would changes in transit time alone.

Table 22: Percent of shippers who are predicted to switch in response to Transit Time increases

% Increase	Barge	Rail	Truck
10	0.25	0.50	0.09
20	0.50	1.00	0.18
30	0.76	1.49	0.27
40	1.01	1.97	0.35
50	1.26	2.43	0.43
60	1.51	2.89	0.51
70	1.75	3.34	0.58
80	2.00	3.79	0.65
90	2.25	4.23	0.72
100	2.49	4.66	0.79

Table 23: Arc Elasticities with respect to Transit Times

% Increase	Barge	Rail	Truck
10	0.025	0.050	0.009
20	0.025	0.050	0.009
30	0.025	0.050	0.009
40	0.025	0.049	0.009
50	0.025	0.049	0.009
60	0.025	0.048	0.009
70	0.025	0.048	0.008
80	0.025	0.047	0.008
90	0.025	0.047	0.008
100	0.025	0.047	0.008

Tables 24 and 25 give switching rates and arc elasticities for decreases in the reliability of shipments, where reliability is represented as the chance that the shipment will arrive on time. The switch rates and elasticities are higher than those for transit time. This finding that reliability elasticities are larger than transit time elasticities suggests that shippers are more concerned that the shipment arrives when scheduled than in the amount of scheduled shipment time. Previous analyses have also obtained this result of reliability being more important than time (Train and Wilson, 2005). For barge and rail shippers, switch rates and elasticities are lower for changes in reliability than for changes rates. Interestingly, the relation is reversed for truck shippers, who are modestly more responsive to reliability than rates.

Table 24: Percent of shippers who are predicted to switch in response to Reliability decreases

% Increase	Barge	Rail	Truck
10	1.91	2.63	4.20
20	3.74	5.18	7.97
30	5.43	7.60	11.31
40	7.00	9.89	14.27
50	8.47	12.06	16.94
60	9.87	14.11	19.38
70	11.21	16.05	21.65
80	12.50	17.91	23.79
90	13.74	19.68	25.84
100	14.94	21.37	27.84

Table 25: Arc Elasticities with respect to Reliability

% Increase	Barge	Rail	Truck
10	0.19	0.26	0.42
20	0.19	0.26	0.40
30	0.18	0.25	0.38
40	0.18	0.25	0.36
50	0.17	0.24	0.34
60	0.16	0.24	0.32
70	0.16	0.23	0.31
80	0.16	0.22	0.30
90	0.15	0.22	0.29
100	0.15	0.21	0.28

3.5 Summary and Conclusions for Mode and Destination Choice

The demand for transportation by mode and destination is an essential part of planning infrastructure. For planning infrastructure, there is a need not only for demand functions by mode, but also for a wide variety of different shipment attributes such as rates and transit times. Often, revealed data do not provide significant variation in the attributes. This means that the demand functions are more difficult to estimate precisely and the range of attributes (rates) over which the estimation occurs does not coincide with the range of attributes (rates) needed for planning. While stated preference methods overcome both difficulties, they are often criticized for presenting the decision-maker with hypothetical, and perhaps, irrelevant alternatives. In this study, we use a methodology that employs both types of data. Specifically, we "ground" the stated preference information in the revealed choice made by the shipper. The stated preference information is directly tied to the revealed choices made by the shipper, circumventing the irrelevance issue and, yet, providing sufficient variation in the attributes which allow for precise estimation of demand parameters and provides estimates over a wide range of attribute values necessary for planning.

In this report, the methods are applied to the shipment of agricultural commodities in the Upper Mississippi region. We framed the choice of which alternative to use in terms of rates, transit times and reliability of each option and calculated elasticities with respect to each attribute. We found that elasticities vary by mode (with rail largest and truck smallest), the attribute (with rates largest and time smallest) and the level of the rate change (with arc elasticities falling slightly as the size of the change rises.)

These findings are of direct relevance to the Army Planning Models, since they provide a direct connection between choice modeling and the elasticity of barge transportation. The results imply that barge shippers have low elasticities with respect to rates and exceedingly low elasticities with respect to shipment time including waiting and scheduling time. The elasticities, while low, are nevertheless higher than those used in the Army Corps Modeling, which assumes a perfectly inelastic demand up to a threshold.

4. ANNUAL VOLUME ADJUSTMENTS TO CHANGES IN ATTRIBUTES

In this section, we develop and estimate a model of changes in annual volumes with respect to changes in rates, time in transit, and reliability. In the survey, each respondent is confronted with a percentage change in rates, time, and reliability. They were asked to state whether their annual volumes would change and, given they change, the level of the change.

We analyze the responses with a Heckman model that contains two equations. First, there is a model of whether or not the respondent changes their quantity; this is a discrete binary choice. Second is a model of the level of the change given a change occurs. This second model is a regression on the subset of respondents who stated that they would change their volumes. As pointed out by Heckman, the second model is a selected sample (namely, those shippers who make a change), and estimation by OLS may introduce bias due to a possible correlation between the errors of the model that selects the sample and that of the level of the change. Stated equivalently, the unobserved factors that induce change may also impact the level of the change. Whether this correlation is actually present can be tested, and if it is found to exist, the analysis can incorporate it appropriately.

An equation that determines whether a change is made, and an equation that determines the level if a change is made, must both be specified. Let z represent a set of variables that determine whether change occurs or not, and let x represent a set of variables that determine the level of the change. To illustrate, we begin with a simple model in which both *z* and *x* are functions only of the size of the attribute change. This serves as a "base" model to which more complicated models are assessed. The levels modeled are all based on a log specification of quantities after the attribute change relative to that before the attribute change i.e., $log(q_1/q_0) = log(1\text{-}\%\ change\ \ in\ q)$. The right-hand side consists of the $log(a_1/a_0)=log(1+\%\ change\ in\ attribute)$ where a_1 and a_0 represent the attribute after and before the change. In all cases, elasticities are calculated by predicting the % change in *q* from a % change in the attribute and are calculated as % change in *q* divided by a % change in the attribute. Whether a firm chooses to adjust its quantity is basis for the selection equation. With a two-step estimation procedure, this equation is a probit model. In our specifications, we let the log of the change in the attribute be one of the explanatory variables[16] and assess empirically whether to include other variables in each equation.

4.1 Rate Changes that apply to the shipper and its competitors

As noted in table 2, two different rate prompts were given to the respondent. Both questions are of the form: if rates increased by a given percentage, would annual volumes change, and if so how much. The first question adds the caveat that the rate increase applies not only to the respondent but also its competitors. The second question differs in that the rate increase applies only to the respondent, but not its competitors. The motivating concept for this distinction is that, in agricultural markets, the shippers (elevators) compete locally for the procurement of grain to ship. Rate changes affect the bids that these elevators make to sellers of the commodities e.g., farmers. If all shippers are confronted with the same rate change, due, e.g., to congestion or improvements in the transportation infrastructure, then the response is expected to be different than if the rate change applies only to a single shipper. The latter is expected to induce a larger response to the rate change.

Table 26 contains the results for the case of a rate increase applying to the shipper and its competitors. This table contains results for the base model and for a limited set of more complicated models. In each column, there are two sets of results. These include the level equation (given a change, the size of the change) and the selection equation (does a change occur).

The base model (column (1)) contains a single explanatory variable, $\log(r_1/r_0)$, which is the log of the rate after the increase and the rate before the increase, or, stated equivalently, the log of the percent increase in rates. A binary probit model of whether the shippers change their quantity (the column labeled "Selection") predicts that as the level of the rate change increases, the probability of a change in annual volumes increases. (The positive coefficient on the variable indicates that a larger rate increase is associated with a higher probability of changing volumes.) The levels equation predicts that, given a change, a larger rate increase causes a greater reduction in volume. (The

[16] Rather than using $\log(r_1/r_0)$ as in the level equation, we used log(%□ in the attribute) instead. This has the advantage of requiring that there is no change in levels if there is no change in the attribute. That is, if the attribute does not change, then the natural log has a limiting value of minus infinity which produces a zero value for the probability of a change.

negative coefficient indicates that a larger rate increase is associated with a smaller volume, or equivalently, with a larger reduction in volume.)

Two types of elasticities are relevant with these models. First is a conditional elasticity i.e., the elasticity given a change occurs. Second is an unconditional elasticity that accounts for the probability of making a change as well as the change in volume given that a change is made. The conditional elasticity is larger in magnitude than the unconditional elasticity, since the conditional elasticity is calculated only on those shippers who make a change while the unconditional elasticity is calculated for all shippers even though who do not make any change. In this simple model, the conditional elasticity ranges from -3.14 to -.69 (depending on the rate change level).[17] The unconditional elasticity ranges from -.56 to -.36 (depending on the rate change level).[18]

As noted above, our approach allows testing of whether or not unobserved factors are correlated across the two equations. In the present case, there was not much statistical support for the correlation.[19]

The remaining columns of table 26 include additional explanatory variables. Virtually all shippers have access to truck; some have access to rail; to barge, or to both. Dummy variables were introduced for both types of access, initially included in both the level the selection equation. There was no evidence from this preliminary specification that the access variables affect the level of annual volumes, and so they were excluded from the levels equation.[20] The results are reported in column (2).

The results suggest, as before, that if a larger rate increase occurs, then (i) a change in annual volumes is more likely and (ii) the amount of reduction in volume (given a change occurs) is greater. In addition, however, the results also suggest that a change is more likely for elevators with both rail and barge loading capabilities. As before, there is no evidence of correlation in unobserved factors across the two equations.

We next considered the impact, if any, of the storage capacity, the car-loading capacity, the distance to the nearest rail and barge loading facilities, primary commodity shipped, and the number of options held by a shipper. After preliminary estimation with various combinations of variables, we determined the specification in Column 3. None of the variables omitted from the levels equation is statistically significant in explaining levels, and the one variable omitted from the selection equation (namely, number of options) is not statistically significant in explaining whether a change is made. Distance to barge has

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[17] The estimates are -3.14, -1.48, -1.05, -.87, -.76, and -.69 for a rate change of 10, 20, 30, 40, 50, and 60, respectively.
[18] The estimates are -.56, -.42, -.38, -.37, -.36 and -.36 for a rate change of 10, 20, 30, 40, 50 and 60, respectively.
[19] This means that the levels equation can be estimated on the basis of an OLS regression using only the observations for which a change occurs.
[20] In the Heckman model where the sample selection and the level equation are posited with the same variables, identification occurs through the non-linearity of the inverse mills ratio. By excluding irrelevant variables, identification is much stronger.

Table 26. Coefficient Estimates for Annual Volumes and Rate Changes (to respondent and competitor).

	(1)		(2)		(3)	
Variable	**Level**	**Selection**	**Level**	**Selection**	**Level**	**Selection**
Log(r1/r0)=log(1+□)	-1.380		-0.864		-0.901	
	(5.41)***		(2.71)***		(2.82)***	
Log(r1/r0-1)=log(□)		0.502		0.616		0.706
		(4.93)***		(4.89)***		(5.31)***
Access Barge				0.305		0.067
				(0.54)		(0.12)
Access Rail				0.162		0.077
				(1.14)		(0.25)
Access Barge and Rail				1.245		0.902
				(3.10)***		(1.70)*
Log(Storage Capacity)						-0.149
						(2.15)**
Log(Rail Car Loading Capacity)						0.211
						(2.50)**
Log(Distance to Rail)						0.169
						(2.11)**
Number of Options					0.064	
					(2.09)**	
Constant	0.579	0.131	-0.202	0.173	-0.306	1.290
	(6.16)***	(0.99)	(1.12)	(1.05)	(1.66)*	(1.80)*
Observations	404	404	404	404	370	370

Note: Absolute value of z statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

an important effect on predicting whether change occurs, but only when distance to rail is excluded.[21]

The results in Column 3 suggest that the probability of a volume change is larger for shippers that have barge and rail access, a large rail-car loading capacity, and a large distance to a rail car facility. In addition, the results suggest that firms with greater storage capacity are less likely to switch.

As discussed earlier, the models provide both conditional (given a change occurs) and an unconditional (factoring in the probability of a change) elasticities. The estimated

[21] Inclusion of both rail and barge distances resulted in a loss of significance on barge distance. While this often points to multicollinearity between the two, the correlation is small. Inspection suggests that a number of observations are lost due to missing values on distance to nearest waterway which may explain the inability to separately identify the effects.

elasticities are presented in table 27 for the parameter estimates given in column 3 and median values of the continuous variables and zero values for the binary variables (truck only access shippers). As expected, the conditional elasticities are larger in magnitude than the unconditional. Generally, the latter estimates are small, indicating relatively inelastic demands. A key factor in the difference is the probability of a change in annual volumes which is also provided in the table. As is clear, the probability of a volume change is small for small changes in rates, but rises progressively with the level of the rate change. Nevertheless, even with very large changes in rates, the probability of making a change in volume is only .35 for the median firm.

Table 27. Elasticity Estimates for Annual Volumes in Response to a Rate Change for the median shipper.

Percentage Change in Rates	Conditional Elasticity	Unconditional Elasticity	Probability of a Volume Change
10	-1.407	-0.075	0.050
20	-1.116	-0.153	0.123
30	-0.954	-0.208	0.191
40	-0.845	-0.246	0.251
50	-0.764	-0.272	0.304
60	-0.700	-0.289	0.350

To assess the range of response over shippers, we calculate the probability of a volume change for each surveyed shipper, as well as their conditional and unconditional elasticities. The average probability of changing volume is .36 with a minimum value of .04 and a maximum value of .88. Even, however, for the shipper with the largest probability of a volume change, the conditional and unconditional elasticity estimates are only -.74 and -.68, respectively.

4.2 Rate Changes that apply to the shipper but not its competitors

The models described above were also applied to shippers responses to rate changes that apply to the shipper but not its competitors. The results are in tables 28 and 29. The estimated coefficient of the rate change, and the resultant elasticities, are larger in magnitude than those discussed above. This result is consistent with the theoretical argument that changes should be more frequent and larger when rate changes apply only to the responding shipper than when rate changes apply to both the responding shipper and its competitors.

Table 28. Coefficient Estimates for Annual Volumes and Rate Changes (to respondent, but not competitors).

	(1)		(3)		(5)	
Variable	**Level**	**Selection**	**Level**	**Selection**	**Level**	**Selection**
Log(r1/r0)=log(1+□)	-1.995		-2.275		-1.760	
	(5.21)***		(6.31)***		(3.70)***	
Log(r1/r0-1)=log(□)		0.493		0.530		0.573
		(4.91)***		(5.55)***		(4.47)***
Access Barge				-0.031		1.026
				(0.15)		(1.52)
Access Rail				0.097		-0.134
				(1.50)		(0.45)
Access Barge and Rail				0.205		0.207
				(1.38)		(0.35)
Log(Storage Capacity)						-0.141
						(1.99)**
Log(Rail Car Loading Capacity)						0.191
						(2.36)**
Log(Distance to Rail)						-0.009
						(0.12)
Number of Options					-0.037	
					(0.92)	
Constant	0.493	0.604	0.564	0.607	-0.027	1.962
	(4.03)***	(4.04)***	(4.77)***	(4.27)***	(0.09)	(2.62)***
Observations	340	340	340	340	309	309

Note: Absolute value of z statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Modal access is not found to be statistically significant. However, storage capacity and rail car loading capacity do appear to have a statistically important effect.
As before and as required, the unconditional elasticities are larger in magnitude than the conditional elasticities. The unconditional elasticities range in value from -.66 for small rate changes to -.76 for other rate changes. The conditional elasticities range from -2.7 for small rate changes to -1.0 for larger rate changes.

Table 29. Elasticity Estimates for Annual Volumes in Response to a Rate Change for the median shipper but not its competitors.

Percentage Change in Rates	Conditional Elasticity	Unconditional Elasticity	Probability of a Volume Change
10	-2.709	-0.657	0.215
20	-1.840	-0.737	0.347
30	-1.493	-0.761	0.436
40	-1.284	-0.759	0.502
50	-1.136	-0.742	0.553
60	-1.023	-0.719	0.594

Also as before, there is considerable heterogeneity in the predicted elasticities of different shippers. The average conditional elasticity is -1.6 and the unconditional is -.86. The conditional elasticity ranges from -.99 to -3.3, while the unconditional elasticity ranges from -.37 to -1.66. The probability of a volume change averages .51 with a range from .09 to .95. Shippers with large rail-car capacity and little storage capacity are more likely to react to rate changes than shippers with no rail access and a large storage capacity.

4.3 Transit Time Responses

The transit time models are presented in table 30 with elasticity and probabilities in table 31. As with all previous models, the prompting variable has a statistically important effect. And, as before, it is positive in the selection equation and negative in the levels equation. Unlike the rate models, storage and rail car loading capacity are not statistically significant. However, shippers with greater access, i.e., access to barge and rail, are less likely to adjust volumes in response to transit time changes.

Table 30. Coefficient Estimates for Annual Volumes and Transit Time Changes

	(1)		(3)		(5)	
Variable	**Level**	**Selection**	**Level**	**Selection**	**Level**	**Selection**
Log(t1/t0)=log(1+□)	-0.955		-0.937		-1.082	
	(2.41)**		(2.54)**		(2.31)**	
Log(t1/t0-1)=log(□)		0.483		0.494		0.479
		(4.20)***		(4.27)***		(3.96)***
Access Barge				-0.558		-0.480
				(0.88)		(0.75)
Access Rail				0.009		-0.378
				(0.06)		(1.28)
Access Barge and Rail				-0.443		-1.103
				(0.96)		(1.74)*
Log(Storage Capacity)						0.049
						(0.71)
Log(Rail Car Loading Capacity)						0.085
						(1.06)
Log(Distance to Rail)						-0.034
						(0.45)
Number of Options					0.016	
					(0.56)	
Constant	-0.161	0.007	-0.180	0.036	0.038	-0.376
	(0.50)	(0.05)	(0.63)	(0.21)	(0.09)	(0.53)
Observations	383	383	383	383	352	352

Note: Absolute value of z statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

The elasticity estimates for the median firm are presented in table 31. The conditional estimates range from -1.84 for a 10 percent increase in transit times to -.694 percent for a 60 percent change in transit times. The unconditional elasticities (which include zero change in volumes) are much lower and range from -.31 to -.35. This is due to a relatively low probability of the median shipper adjusting volumes due to a change in transit times. This probability is about .16 for a 10 percent change in transit times to .437 for a 60 percent change in transit times.

Table 31. Elasticity Estimates for Annual Volumes in Response to a Time in Transit Change.

Percentage Change in Rates	Conditional Elasticity	Unconditional Elasticity	Probability of a Volume Change
10	-1.841	-0.310	0.155
20	-1.179	-0.321	0.247
30	-0.960	-0.335	0.312
40	-0.839	-0.344	0.362
50	-0.756	-0.348	0.403
60	-0.694	-0.349	0.437

For the sample, the average conditional and unconditional elasticities are -1.06 and -.31, respectively. The range in the conditional elasticity is -2.6 to -.64, and the range in the unconditional probability is -.09 to -.49. The unconditional elasticities are associated with probabilities of adjustment that are, on average, .29 with a range of .03 to .61.

4.4 Reliability Responses

The final set of results reported is with respect to reliability. Each shipper was asked about their changes in annual volumes due to a given percentage *decrease* in reliability. Thus, a large value of the prompt (i.e., a large decrease in reliability) represents a worsening of the shippers' situation, the same as in the case of increases in rates and transit times. The coefficient estimates for the models are presented in table 32 with elasticities in table 33. The basic result of the models is that, as expected, larger declines in reliability increase the likelihood that firms adjust their annual volumes. And, consistent with the other attributes, a greater reduction (less volume) is associated with a larger decrease in reliability.

Generally, there is little, if any, statistical support for the inclusion of other variables. There is modest support in the second model for the hypothesis that shippers with rail access are more likely to adjust volumes than those without, but in model 3 the effect becomes insignificant.

Table 32. Coefficient Estimates for Annual Volumes and Reliability

	(1)		(3)		(5)	
Variable	**Level**	**Selection**	**Level**	**Selection**	**Level**	**Selection**
Log(rel1/rel0)=log(1+□)	-0.526		-0.719		-0.644	
	(2.26)**		(3.58)***		(3.00)***	
Log(rel1/rel0-1)=log(□)		0.391		0.285		0.215
		(3.35)***		(2.68)***		(1.91)*
Access Barge				-0.119		-0.038
				(0.54)		(0.17)
Access Rail				0.135		-0.189
				(2.01)**		(1.18)
Access Barge and Rail				-0.000		-0.435
				(0.00)		(1.71)*
Log(Storage Capacity)						0.030
						(0.75)
Log(Rail Car Loading Capacity)						0.054
						(1.53)
Log(Distance to Rail)						-0.048
						(1.07)
Number of Options	-0.229	-0.063	0.310	-0.234	0.292	-0.493
	(1.14)	(0.42)	(4.28)***	(1.59)	(3.52)***	(1.15)
Constant					-0.004	
					(0.32)	
Observations	377	377	377	377	348	348

Note: Absolute value of z statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

As with the other attributes, the unconditional elasticities are smaller in magnitude than the conditional elasticities. In addition, as with the other attributes, the elasticities tend to decrease in magnitude with the size of the prompt for the median shipper. The conditional elasticity ranges from .56 to 2.4 for large and small decreases in reliability. The unconditional elasticity ranges from .23 to .62 for large and small decreases in reliability. Finally, the probability of a volume change ranges from .23 for small reliability decreases to .36 for large decreases.

Calculation of these same statistics over the sample gives a sense of the range of values. The conditional elasticity averages 1.10 with a range from .46 to 2.9. The unconditional or expected elasticity averages .33 with a range from .21 to .65. Finally, the probability of the shipper adjusting volumes averages .30 with a range of .16 to .50.

Table 33. Elasticity Estimates for Annual Volumes in Response to a Reliability Change.

Percentage Change in Rates	Conditional Elasticity	Unconditional Elasticity	Probability of a Volume Change
10	2.417	0.619	0.231
20	1.259	0.388	0.279
30	0.906	0.311	0.309
40	0.735	0.272	0.331
50	0.632	0.248	0.348
60	0.561	0.231	0.363

Note: The figures presented are in response to a decrease in reliability. Hence, the elasticities should be positively valued unlike the previous attributes.

5. CONCLUDING REMARKS

This report continues a series of demand studies aimed at providing shipper level information that can be used by the Army Corps of Engineers to evaluate the benefits of waterway improvements. The shipper based surveys that have been developed and modified over the last three and one-half years are designed to collect information on shipper and shipments. These data, in turn, are used to estimate the responsiveness of mode and destination choices and annual volumes to changes in rates, time in transit and reliability.

The choice models were estimated with a mixed logit methodology applied to both revealed and stated preference data. The results suggest that while demands are responsive to changes in rates, time in transit and reliability, the response is somewhat small and point to relatively inelastic demands i.e., demand elasticities less than one in magnitude. The annual volume models were estimated with a Heckman selection model using stated preference data. Generally, the results suggest that shippers respond to rates, time in transit and reliability; but as with the choice models, the response is somewhat small with most elasticities less than one in magnitude.

The demand functions appear to be reasonably steep and point to a large degree of captive shippers i.e., shippers that do not switch to alternatives even for large changes in the attributes. While this result points to relatively large benefits to infrastructure investments, there are limits. A novelty of this research is the incorporation of the option of no longer shipping i.e., shutting down. Indeed, about 33% of the shippers reported that if the mode/destination they chose was not available, they would need to shutdown (they have no alternatives). This finding has been a consistent theme throughout this line of research. In the present case, shutdown is explicitly represented in the choice model. Hence, attributes, and, in particular, rates, cannot increase without bound, since eventually shippers will opt out of the market. This reaction places limits on the benefit calculations necessary for the ACE planning models.

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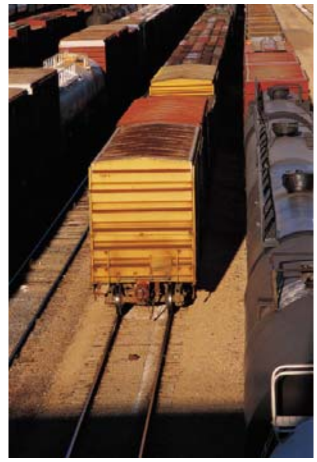
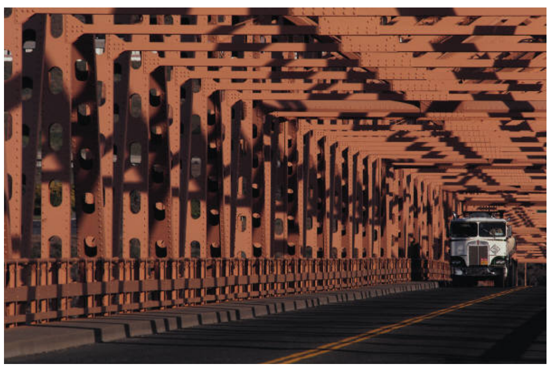
APPENDIX A
SURVEY FORM

2006 Survey of Agricultural Shipping Needs in the Midwest





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and
Washington State University

Your responses to this survey will help us determine the need for transportation investments in your region. This information will be used by Federal and State Transportation agencies to evaluate and support public provision of transportation infrastructure improvements. 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 elevator: ***«NAME»***
«ADDRESS1»
«CITY», «STATE» «ZIP»

Q1. What is the primary commodity you ship from this elevator? ___________ commodity

Q2. At this location, do you have loading capabilities for…

	Yes	No
a. Trucks	☐1	☐2
b. Rail Cars	☐1	☐2
c. Barges	☐1	☐2

Q2b. If YES to Rail loading capability, what is your rail car loading capacity?

______ # of cars

Q2c. If NO to Rail loading capability, how close is the nearest rail loading facility to this elevator?

_______ miles

Q2d. If NO to Barge loading capability, how close is the nearest barge loading facility to this elevator?

_______ miles

YOUR LAST FREIGHT SHIPMENT

Q3. What commodity was shipped in your last shipment? ___________ commodity

Q4. Where was this commodity shipped to: _________________________ city __________ state

Q4b. What type of destination is this?

☐1 River terminal ☐2 Another Elevator ☐3 Railroad terminal ☐4 Processing Plant
☐5 Other (please specify): _____________________

Q5. How large was this shipment (payload weight)?

______________________________ payload weight, in

☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Bushels ☐5 Other (specify): _______________

Q6. What type of transportation was used for this shipment, approximately what distance did each travel (in miles), and what was the approximate transportation rate?

Mode (check if used)	Distance traveled	Transportation rate	Per Unit type for commodity: Tons	Cwt	Gallons	Bushels	Shipment	Other	(Specify)
☐ Truck	________ miles	________ rate	☐1	☐2	☐3	☐4	☐5	☐6	________
☐ Rail	________ miles	________ rate	☐1	☐2	☐3	☐4	☐5	☐6	________
☐ Barge	________ miles	________ rate	☐1	☐2	☐3	☐4	☐5	☐6	________
What were the *total* transport costs? ________			☐1	☐2	☐3	☐4	☐5	☐6	________

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

Q7. What do you estimate was the shipment time (include scheduling time, wait for equipment and transit time)

________ days + ________ hours.

Q8. 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

Q9. What price did you receive for your commodity at the destination terminal?

________ dollars per

☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Bushels ☐5 Shipment ☐6 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.

Q10. If the mode and destination you used for my last shipment had not been available and would never be available, then you would …

☐1 Shut down and go out of business → **skip to Q25**
☐2 Continue your operations but in a different, perhaps more costly way

FIRST SHIPPING ALTERNATIVE

Q11. Where would this commodity be shipped to? __________________ city _______ state

Q11b. What type of destination is this?

☐1 River terminal ☐2 Another Elevator ☐3 Railroad terminal ☐4 Processing Plant
☐5 Other (please specify): ________________________

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

Mode (check if used)		Distance traveled		Transportation rate		Per Unit type for commodity: Tons	Cwt	Gallons	Bushels	Shipment	Other (Specify)	
☐	Truck	__________	miles	__________	rate	☐1	☐2	☐3	☐4	☐5	☐6	_______
☐	Rail	__________	miles	__________	rate	☐1	☐2	☐3	☐4	☐5	☐6	_______
☐	Barge	__________	miles	__________	rate	☐1	☐2	☐3	☐4	☐5	☐6	_______

What would be the *total* transport costs? ________ ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 _______

What would be the approximate *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 would you expect them to arrive on time?

__________ percent on-time arrivals

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

______________________________ payload weight, in

☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Bushels ☐5 Other (specify): ___________________

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

__________ dollars per

☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Bushels ☐5 Shipment ☐6 Other (specify): ___________________

OTHER SHIPPING ALTERNATIVES

Please complete the table below for your other shipping alternatives. <u>If you have no other alternatives, skip to Q24</u>

	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 Another Elevator ☐3 Rail terminal ☐4 Processing Plant ☐5 Other (specify): ________________	☐1 River terminal ☐2 Another Elevator ☐3 Rail terminal ☐4 Processing Plant ☐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 Bushels ☐5 Shipment ☐6 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 Bushels ☐5 Shipment ☐6 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 Bushels ☐5 Other (specify):	__________ payload weight ☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Bushels ☐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 Bushels ☐5 Shipment ☐6 Other (specify):	__________ dollars ☐1 Tons ☐2 Cwt. ☐3 Gallons ☐4 Bushels ☐5 Shipment ☐6 Other (specify):

BEST ALTERNATIVE CHOICE

Q24. Of the alternative shipments, if any, what is your "preferred alternative"? That is, if you could 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 RATES

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 Q10, 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 percentage increase in the transportation rate 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 percentage increase in the transit time 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 percentage decrease in the reliability would be necessary to cause you to switch to the Alternative transportation mode?

______ % increase

VOLUME

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 elevator been at its current location?

_____ years

Q33. How large is your elevator?

___________________ **Total Amount of Annual Units Shipped**

please check the type of unit for this elevator

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

________________ **Total Amount of Storage Capacity**

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

Q34. Does your firm (or parent firm) own export or import facilities?

☐1 Yes
☐2 No

Q35. How many facilities such as this one does your firm own and/or operate?

_______________ number of elevators.

Q36. Finally, if we have any questions and wish to follow up, may we contact you?

☐1 Yes
☐2 No → **Skip to Q37**

Q36b. Name: ______________________ Telephone: ______________________

Email: ______________________

Q37. Would you like a copy of the survey results?

☐1 Yes
☐2 No → **Skip to Q38**

Q37b. Yes, please email the website for the report. Email: ______________________
Yes, please send a hard copy to:
Name: ______________________

Address: ______________________

City, State Zip: ______________________

Q38. 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» - 1

APPENDIX B
TECHNICAL REVIEW

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

By

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under

Task Order #67
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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 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 with an independent technical review of the report *Upper Mississippi and Illinois Transportation Demands for 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 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

The primary conclusions of the report are that shippers, in general, are likely to change modes, destinations and annual shipping volumes in response to changes in shipping rates, transit time and transit time variability.

The changes in modes and destinations in response to proposed changes vary across attributes, mode chosen and the percent change in attributes of the chosen mode[1]. Barge and rail usage are most sensitive to changes in rates, next to changes in transit time reliability and least to changes in average transit time with the scale of the ratios on the order of 15:7:1. Contrarily, truck usage is most sensitive to travel time reliability, next to rates and least to travel time with ratios on the order of 40:20:1. For all three modes, these ratios vary (generally decrease) with increases in the percent attribute change. These differences may be a function of the expectations of shippers concerning the values of these attributes for each mode (truck is expected to be highly reliable, rail and barge are expected to be low cost), differences in the magnitude of changes (which are tested as a percent of the base values) and/or other behavioral differences. However, shippers appear to be very insensitive to changes in travel time independent of mode or the percent change considered (from 10 to 100 percent).

Shippers changes in total annual volume in response to changes applied to all shippers are greatest for reliability, next for travel time and finally to rate. These results are distinctly different than those for choice of shipment mode and destination. However, if the rate change is applied uniquely to the shipper in question, the sensitivity to rate change increases by a factor of ten and is higher than for reliability or time.

2.2 Reviewer 2

This report continues a line of research introduced by the Navigation and Economics Technologies (NETS) program designed to examine the nature of transportation demands for use in U.S. Army Corps of Engineers inland navigation planning models. Under the NETS program, freight transportation demands have been addressed through a series of surveys of shippers located in the Upper Mississippi and Illinois Waterway, the Columbia-Snake Waterway and the Ohio River. In each study, methods were employed to identify and survey shippers that could plausibly use the relevant segment of the inland transportation system. To this end, the surveys focused on shippers of commodities that have a historical presence on the waterway and on shippers of varying distance from the waterway that might use 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 changes in transportation rates, time in transit and reliability of service. This study reinforces those earlier conclusions.

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[1] All changes are reported in terms of elasticity; the ratio of the percent of shippers making changes to the percent change in the attribute.

The shippers' responsiveness is two-fold. Shippers' discrete decisions (where and how to ship a product) and continuous decisions (the volume of total shipments) are both affected by changes in shipment attributes. In all cases, the analyses support the notion that shippers do respond to changes in transportation attributes that can be affected by the U.S. Army Corps of Engineers infrastructure decisions.

The major findings regarding shippers' discrete decisions in this study can be summarized as:

1. The choice models indicate statistically important responses of shippers to changes in rate, time, reliability price and distance.

2. There are statistically important differences in the responses between truck, rail and barge shipments.

3. Many firms report limited alternatives in their choice of mode and destination, and many report that they would shutdown in the presence of rate increases or if the chosen alternative was taken away. Unlike previous studies conducted under NETS, the effect of a shutdown alternative is reflected in the choices and explicitly captured in the models of switching behavior.

4. Arc-elasticities are calculated for each mode and shipment attribute. Demand is found to be inelastic; that is, the arc-elasticities are all less than 1 in magnitude.

The major findings regarding shippers' continuous decisions can be summarized as:

1. The responses of shippers often pointed to no change in annual volumes from a change in an attribute.

2. The analysis allows the calculation of two different but related volume elasticities. These are a conditional elasticity (given a shipper's volume does change) and an unconditional elasticity (where shippers volumes may or may not change). The former, by definition, is larger in magnitude than the latter for each attribute. In some cases, annual volumes, given that there is a change in volume, are quite responsive to changes in attributes. However, in most cases, the unconditional elasticities are less than one in magnitude, pointing to relatively inelastic annual volume demands.

3. The results suggest that shippers with large storage capacities and little rail car loading facilities were not likely to adjust volumes in response to transportation rate changes. But if a volume change does occur, the change is driven largely by the level of the change in the attribute. That is, the elasticities conditioned on a change occurring did not vary with shipper attributes or commodity. But, whether or not a change occurs depends on shipper attributes.

4. Two different rate elasticities are presented – one where the shipper and its competitors face the same rate change, and one where the shipper but not its competitors face a rate change. The elasticities calculated from the former are much smaller in magnitude than those calculated from the latter. In both cases, the unconditional elasticities are less than one in magnitude for the median shipper. For some rate change levels, the conditional elasticities

are greater than one in magnitude. This suggests that if there is a rate change that induces a volume change, the change is relatively responsive.

5. Both time in transit and reliability elasticities are nonzero; a finding that suggests shippers do adjust annual volumes to these shipment attributes. As with rates, the unconditional elasticities are less than one in magnitude.

6. There is considerable variation across shippers.

Section 3
Summary Review Statement on Validity and Quality of Findings

3.1 Reviewer 1

The approach adopted by Train and Wilson for shippers' mode and destination choice is based on advanced econometric procedures including an approach recently developed by them[2] which increases the usefulness and the efficiency of stated response data. This approach limits the selection of stated response cases to those which make the chosen alternative less desirable than it was when chosen which results in two important advantages over previous approaches. First, the stated response experiments are more realistic because they are closely tied to the real situation under which the shipment was made. Second, fewer stated response experiments are required to get the same level of precision as experiments which improve the relative value of the chosen alternative (and are therefore unlikely to be chosen) are eliminated. The authors introduce an econometric correction to eliminate bias resulting from limiting the range of offered experiments.

The approach used for assessing annual volume shipped is based on changes in the rate, time or reliability of the chosen mode for the most recent shipment and considers two distinct cases for rate changes; when the rate increase applies to all shippers and when the rate increase applies to the surveyed shipper only. The decision process is presented in two stages; the decision of whether to reduce annual shipping volume and, if so, the percent reduction. The methodology is not unique to Train and Wilson but is econometrically sophisticated.

The model results, as interpreted, provide strong evidence that changes in the attributes considered result in changes in shipment choices and annual shipping volume which differs from the assumption used by the U.S. Army Corps of Engineers that there is no change in shipping behavior up to a threshold. However, some of these elasticities (for mode and destination choice in response to changes in shipment time and for total volume in response to a general rate increase) are very small.

Further, there is some ambiguity in the interpretation of changes in annual volume as the survey, up to this point, is focused on the most recent shipment and the chosen mode and destination. It is unclear whether the respondents are thinking about an average rate, time or reliability change across all modes and destinations or only the mode and destination actually chosen. Also, it is not clear whether they are responding in terms of volume changes for that mode or summed over all modes.

3.2 Reviewer 2

I am unable to offer an unconditional endorsement of the validity and quality of the findings in the report because it appears that the discrete choice models estimated from the sp-off-rp data

[2] "SP-off-RP: Econometric Analysis of Stated Preference Questions Constructed from Revealed Preference Choices" by Kenneth Train and Wesley Wilson, Working Paper, University of California at Berkeley and University of Washington, November 2006.

do not do a good job of forecasting the survey respondents' answers to the stated preference questions posed in the survey which serve as the basis for the sp-off-rp data. This indicates a problem in the formulation of the models, interpretation of the survey data or even possible strategic behavior of survey respondents and is particularly troubling because the inclusion of the sp-off-rp data in estimating the choice models appears to fulfill its intended purpose of adding precision to parameter estimates by increasing the range of attribute variations while adding only a relatively small quixotic contribution to the unobservable error components in choice determination. Exactly why the discrete choice models fail to reasonably approximate stated preferences is not at all clear.

I can state that accounting for the shut-down option in the discrete shipper choice models in situations where surveyed shippers indicate that they have no shipping alternative is an important improvement to previous methodologies used to estimate Upper Mississippi River and Illinois Waterway transportation demands. However, exactly how to treat the shut-down option in the choice models given the data available in the survey is also not clear and different treatments may greatly affect model parameter estimates. I can further state that including reliability as a shipment attribute in the discrete choice models is an improvement to previous methodologies used to estimate Upper Mississippi River and Illinois Waterway transportation demands.

The modeling of shippers' continuous decisions regarding adjustments to their annual volumes in response to changes in attributes appears to be a reasonable approach employing a two equation Heckman model.

Section 4
Individual Comments and Issues for Resolution

4.1 Reviewer 1

4.1.1 Individual Comments From Project Report

1. Section 1, Page 3, Paragraph 2. The list of findings in the Executive Summary is based exclusively on the modeling results. No information is reported from the description from the data including the range of characteristics of different shippers, the selection of shippers surveyed, the availability of mode and destination alternatives, differences between chosen and next best alternatives or stated changes in response to hypothetical alternatives. Some of this information should be reported to provide a context for the findings and for their insight into how shippers respond to changes in service. This can be readily addressed.

2. Section 1, Page 14, Paragraph 2 and 15, Table9. The information presented on rates, time and reliability are independent of mode making it difficult to interpret these data. Further, no information is given as to whether the next best alternative is a different mode, a different destination or both. It would appear that this information is available and can be readily summarized.

3. Section 3.3, Page 26, Paragraph 1 and Table 17. The model specification does not include some variables that might be useful in describing shipper behavior. These include characteristics of the shipper (annual shipment volume, storage facilities, etc. represented by categorical variables)[3] and the commodity shipped as alternative specific variables or in interaction with attribute variables. Further, it may be useful to include dummy variables representing the destination type. These may explain some important differences in behavior and/or provide a basis for assessing the relative importance of changes to different shippers. Finally, it would be desirable to provide specific information on the number and type of alternatives included in the model. For example, if only the chosen and the second best alternative are included; it would be useful to know how many cases include different modes, different destinations or both.

4. Section 3.3 (1st), Page 26, Table 17. It is interesting to note that the parameter for rate is approximately six times the parameter for price both measured in dollars per ton[4]. One would expect that a rational decision maker would apply the same value (with opposite signs) to these variables. This large difference in magnitude may be due to the fact that rate sensitivity is primarily due to differences in mode while price is exclusively associated with different destinations.

5. Section 3.4 (1st, there are two Sections 3.4), Page 27, Paragraph 2 and Table 18. The standard deviation of the shutdown constant indicates "considerable variation across shippers in how they view the option of shutting down." It is possible that including categorical variables describing the shipper size (in terms of annual shipment volume or size of storage facilities) might explain some of this variation structurally providing better insight into the impacts of

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[3] Note that other characteristics of shippers in the section on volume change are not significant.
[4] The corresponding ratio in Table 18 for both RP and SP-off-RP data is approximately sixteen.

changes on different shippers. I suggest that the authors include one or more such variables to test this possibility.

6. Section 3.4 (1st), Page 30, Table 20. The differences in response rates and elasticities (Table 21) suggest that it might be useful to estimate distinct parameters for shipping rates in the model reported in Table 19. Similar exploration would be appropriate for the travel time and reliability parameters.

7. Section 3.4 (1st), Page 30, Paragraph 2. The first sentence "Switching rates are estimated to be greatest for rail shippers and larger for barge shippers than for truck shippers." is correct for shipping rates, which are discussed in the example, and for travel time but not for reliability.

8. Section 3.4 (1st), Page 32, Paragraph 1. The second sentence "The switch rates and elasticities … (for reliability) … are lower than those for rates but higher than those for transit time." is correct for barge and rail but not for truck where the response to reliability changes is larger than for both rates and travel time.

9. Section 4. Interpretation of volume changes is somewhat ambiguous as it is unclear whether the changes reported represent changes in total annual volume by all modes or annual volume by the chosen mode. Even though the questions in the survey "If the average … increased by …percent, would your annual volume shipped decrease?" and "If yes, by how much would the volume decrease?" are designed to elicit a response in terms of total volume; they might be misinterpreted by some respondents as relevant only to cost, time or reliability for the most recently chosen mode and destination as the entire survey up to this point is focused on the most recent shipment.[5] This might explain the statement (on Page 37, Paragraph 4) that "Shippers with a high (low) probability of a changing volumes are those with both rail and barge access (which by definition means distance to rail is zero), little storage capacity, and large car-loading capacity." There does not seem to be any reason why shippers with both rail and barge access would be more or less sensitive than others to cost, time or reliability changes across all modes; however, it does seem likely that they would reduce their volume on rail or barge (whichever one was chosen and is assumed to change) because of the ready availability of the other alternative.

4.2 Reviewer 2

4.2.1 Editorial Comments

1. Section 1 (Executive Summary and Introduction) Page 1, Paragraph 3

   "A sample of 480 shippers located in a 10 state area are" should read "A sample of 480 shippers located in a 10 state area is"

5 Also, it is difficult to imagine a respondent assuming that rates, time or reliability across all modes and destinations would change in the same proportion.

2. Section 1 (Executive Summary and Introduction) Page 2, Paragraph 1

   The following sentence needs to be rewritten: "Further, the nature of stated preference questions is the ability to control the experiment and, under our approach, to specify the range of the stated preference data."

3. Section 1 (Executive Summary and Introduction) Page 2, Paragraph 1

   "we also have the ability to gage the" should read "we also have the ability to gauge the"

4. Section 1 (Executive Summary and Introduction) Page 3, Finding 1

   Need to insert a comma after reliability – "rate, time, reliability, price, distance"

5. Section 1 (Executive Summary and Introduction) Page 3, Finding 6

   "-0.54" should read "-.054"

6. Section 2 (Data Sources and Descriptive Characteristics) Page 4, Paragraph 1

   "conceivable" should read "conceivably"

   "a existing list" should read "an existing list"

7. Section 2 (Data Sources and Descriptive Characteristics) Page 4, Paragraph 2

   The description of how the sample is stratified is awkward and should be revised.

8. Section 2 (Data Sources and Descriptive Characteristics) Page 5, Paragraph 1

   "The sample was implemented" should read "The survey was initiated"

9. Section 2 (Data Sources and Descriptive Characteristics) Page 5, Paragraph 3 (Locations of Shippers and Shipments)

   "The locations of the 480 respondents are presented in Figure 2" should read "The locations of the 480 respondents are presented in Figure 1"

10. Section 2 (Data Sources and Descriptive Characteristics) Page 7, Note to Figure 2

    there are similar mappings can be made" should read "there are similar mappings that can be made"

11. Section 2 (Data Sources and Descriptive Characteristics) Page 7, Paragraph 2 (Shipper Characteristics)

    "the distance to the nearest point Table1." should read "the distance to the nearest access point (Table 1)"

"(479/480" should read (479/480)"

12. Section 2 (Data Sources and Descriptive Characteristics) Page 8, Footnote 5

    "The numbers in the numerator is the number with access and in the denominator is the total number that responded." should read "The numerator is the number with access and in the denominator is the total number that responded."

13. Section 2 (Data Sources and Descriptive Characteristics) Page 9, Footnote 6

    "However, the use of a number of different web pages and contact with various organizations (state agricultural, Farm Service Agency, Railroad and company websites) allowed most of the figures that were questionable or missing were either confirmed, replaced or added." should read "However, the use of a number of different web pages and contact with various organizations (state agricultural, Farm Service Agency, Railroad and company websites) allowed most of the figures that were questionable or missing to be either confirmed, replaced or added."

14. Section 2 (Data Sources and Descriptive Characteristics) Page 10, Table 3

    "100000-25000" should read "100000-250000"

15. Section 2 (Data Sources and Descriptive Characteristics) Page 10, Paragraph 1

    "Generally, the firms do not typically own export facilities (Table 4)." Table 4 does not display export facilities owned by survey respondents.

16. Section 2 (Data Sources and Descriptive Characteristics) Page 10, Paragraph 2 (Shipper Characteristics)

    "A major purpose of the survey was to develop a database from which choice models can be used." suggest revising to something like: "…for use in developing choice models."

17. Section 2 (Data Sources and Descriptive Characteristics) Page 11, Paragraph 2

    Suggest replacing the word "largest" with "most frequent"

18. Section 2 (Data Sources and Descriptive Characteristics) Page 14, Paragraph 1 (1st sentence under table)

    "1032 versus 624" should read "1032 versus 678"

19. Section 3 (Shippers' Choice of Modes and Destinations) Page 20, Section Heading

    "Shippers' Choice of Modes and Destinations" should read "SHIPPERS' CHOICE OF MODES AND DESTINATIONS"

20. Section 3.1 (Data) Page 20

Paragraphs in this section should be reformatted without indentation and with a blank line between paragraphs to match the rest of the paper.

21. Section 3.1 (Data) Page 20, Paragraph 2

    "To summarized" should read "To summarize"

    "Tables 5-9 above provides" should read "Tables 5-9 above provide"

22. Section 3.2.2 (Random Coefficients) Page 25, Bottom of Page

    "logit probabiliuty" should read "logit probability"

23. Section 3.3 (Estimation Results) Page 27, Paragraph 2

    "This inclusion of the option of shutting down constitutes important aspect" should read "This inclusion of the option of shutting down constitutes an important aspect"

24. Section 3.3 (Estimation Results) Page 28, Paragraph 2

    "Approximately than 9 percent of shippers are estimated not to care about reliability (i.e., the mass at zero is 0.091)." should read "Approximately 9 percent of shippers are estimated not to care about reliability (i.e., the mass at zero is 0.091)."

25. Section 3.4 (Summary and Conclusions for Mode and Destination Choice) Page 33, Title

    "Desatination" should read "Destination"

26. Section 3.4 (Summary and Conclusions for Mode and Destination Choice) Page 33, Bottom of Page

    "occurs does not coincide with the rate of attributes…" should read "occurs does not coincide with the range of attributes"

27. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 35, Paragraph 1

    The following sentence needs to be revised: "Whether a firm chooses to adjust its quantity may or not is the selection equation."

28. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 36, Paragraph 3

    "In the present case, the hypothesis of no correlation cannot be rejected, suggesting that selection bias need not be present." is awkward

29. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 37, Paragraph 1

    "not statistically significant in explaining whether a change in made" should read "not statistically significant in explaining whether a change is made"

30. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 37, Paragraph 3

    "As discussed earlier, the models provider both conditional (given a change occurs) and an unconditional (factoring in the probability of a change) elasticities" should read "As discussed earlier, the models provide both conditional (given a change occurs) and unconditional (factoring in the probability of a change) elasticities"

31. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 37, Footnote 17

    "While often points to multicollinearity between the two, the correlation is small" should read "While this often points to multicollinearity between the two, the correlation is small"

32. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 38, Paragraph 2

    "Modal access is not found to be a statistically significant" should read "Modal access is not found to be statistically significant"

33. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 38, Paragraph 5

    "The elasticity estimates for the median firm are presented in table 31 for the median firm" should read "The elasticity estimates for the median firm are presented in Table 31"

34. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 39, Paragraph 2

    "Generally, the other variables do not significantly influence changes annual volumes with respect to changes in reliability." -- should be rewritten

35. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 39, Paragraph 5

    "As with the other attributes, the expected elasticities are smaller in magnitude than the conditional elasticities." should read "As with the other attributes, the unconditional elasticities are smaller in magnitude than the conditional elasticities."

4.2.2 Comments Regarding Content in Specific Sections of the Report

1. Section 1. (Executive Summary and Introduction) Page 2, Paragraph 2

   This paragraph states that prices received are an important explanatory variable. I agree. By the same token, is it not the price that shippers pay to procure the shipped commodity important in determining alternatives, especially with regard to the shut-down alternative as firms with greater profit margins are probably less likely to shut-down in the face of degraded shipment attributes? I suggest that this information be obtained in future surveys.

2. Table 8 (Shipment Attributes-Descriptive Statistics by Mode) Page 14

   Why is the sample size for the "overall average" in each row greater than the sum of the sample sizes for each of the three modes?

How are the mode specific rate per ton-mile and the miles per hour calculated? Are multi-modal alternatives excluded from these calculations or is some other method employed to account for multi-modal alternatives?

The units of measure for all variable/modes should be displayed in the first column of the table.

It should be noted that the miles per hour computations reflect scheduling time and wait for equipment, not just transit time.

Each cell in an individual column of the table should display the same number of significant decimal places to facilitate comparing the cell values. This problem is exhibited by many tables in the report and should be corrected for all tables in the final report.

3. Table 8 (Shipment Attributes-Descriptive Statistics by Mode) Page 14

   Data appears to be available for only 17 alternatives that involve barge movement. Further, apparently only 10 of the 17 barge shipments include a Price/Ton. Is this a sufficient number for developing meaningful elasticity conclusions for this mode?

4. Table 9 (Shipment Attributes-Average values by Chosen and Next Best Alternative) Page 15

   Why are both rate and distance averages for the chosen and next best alternatives so inconsistent with the corresponding rate/ton-mile averages?

5. Tables 10, 11, 12 (Shipment Stated Preference) Pages 16 and 17

   These tables indicate that the stated preference responses to the random perturbations in the three explanatory variables are very similar as evidenced by the percentage of respondents stating that they would not switch, switch or shutdown at the selected percentage prompts in particular and with respect to the percentages displayed over all the prompt levels in general.

6. Tables 13 – 16 (Annual Stated Preference) Pages 18 - 20

   Table 14 does not include a total row.

7. Section 3.2 (Choice Model and Estimation) Pages 22-25

   I suggest removing references to utility functions in the report. The authors are not estimating utility functions, but rather, coefficients of scaled payoff functions to elevators where the elevators select a best alternative with respect to the scaled payoff function from a discrete set of self-reported alternatives differentiated by transportation modes and destinations. The scaled payoff function to each elevator takes the general form given

   by $U_j = \beta x_j + \varepsilon_j$, where β denotes a column vector of unknown coefficients that may or may not vary across elevators, x_j denotes a row vector of observable factors contributing to the payoff from alternative j and ε_j denotes the net additive contribution to the payoff of unobservable factors associated with alternative j. The ε_j are presumed to be iid extreme value distributions over alternatives which is why the payoff functions are scaled by a factor related to the assumed common variance of the ε_j. If the random payoff functions are taken to represent scaled profits as mentioned in footnote 9 and profits are defined as revenues net of costs from alternative shipment choices then there are important implications for the form of the random payoff functions. For example, the coefficient of price received at the destination and the coefficient of transportation costs incurred to reach that destination ought to be of opposite sign and nearly equal in absolute value for each elevator. This limits the joint distribution of the potentially randomly distributed coefficients of these variables. Further, at least one important profit determining variable, the cost to the elevator to acquire the product to be shipped, is not available from the current survey. This cost most certainly affects profits and shut-down probabilities (more profitable elevators are less likely to shut down for a given perturbation of their revealed choice) and is omitted from the payoff function. Consequently, the full functional form employed for the payoff functions of each fitted model needs to be explicitly stated in the paper along with its basis in theory in determining elevator payoffs.

8. Section 3.2 (Choice Model and Estimation) Pages 23-24

   The derivation of choice probabilities and likelihood functions are described in the text for a more general specification of the choice model than the specification actually employed in the estimations reported in the paper. While this is very useful for academic economists it impairs the understanding of the choice models actually fitted in this paper to the U.S. Army Corps of Engineers audience not fully versed in discrete choice theory. I suggest an example be provided that describes the sp-off-rp choice sets and associated choice probabilities used in the sp-off-rp estimations in this survey for a representative elevator that reported at least one shipping alternative and a representative elevator that reported no shipment alternatives.

4.2.3 General Comments

1. This report contained many typographical errors which greatly diminished the clarity of the exposition. This lack of clarity made reviewing the report very difficult and time consuming. The report would benefit from a thorough proof reading, explicit presentation of equations of all fitted models and reformatting and cleaning the data presented in the many tables.

2. The target of the survey in the report is Midwestern grain elevators. Elevators are neither the beginning nor the end of the grain supply chain and elevators are not the only participants in the agricultural supply chain with shipment choices. Producers at the beginning of the supply chain have choices regarding what and how much product to produce and whether and when to sell product into one supply chain or another. In fact, many agricultural producers bypass elevators in the supply chain and ship their own

product directly to terminals and end users. Consumers at the end of the supply chain have choices regarding purchase quantities and sources of supply. Consequently, some origin, destination and modal decisions as well as shipment attributes from the perspective of the overall supply chain have already been determined by the time grain reaches a surveyed elevator. This fact limits some of the possible variation in origins, destinations, modes and attributes of the flow of grain incorporated in a choice model fit only to elevators. This could result in lower elasticity values estimated for elevators than those that may exist from the larger perspective of the total agricultural supply chain.

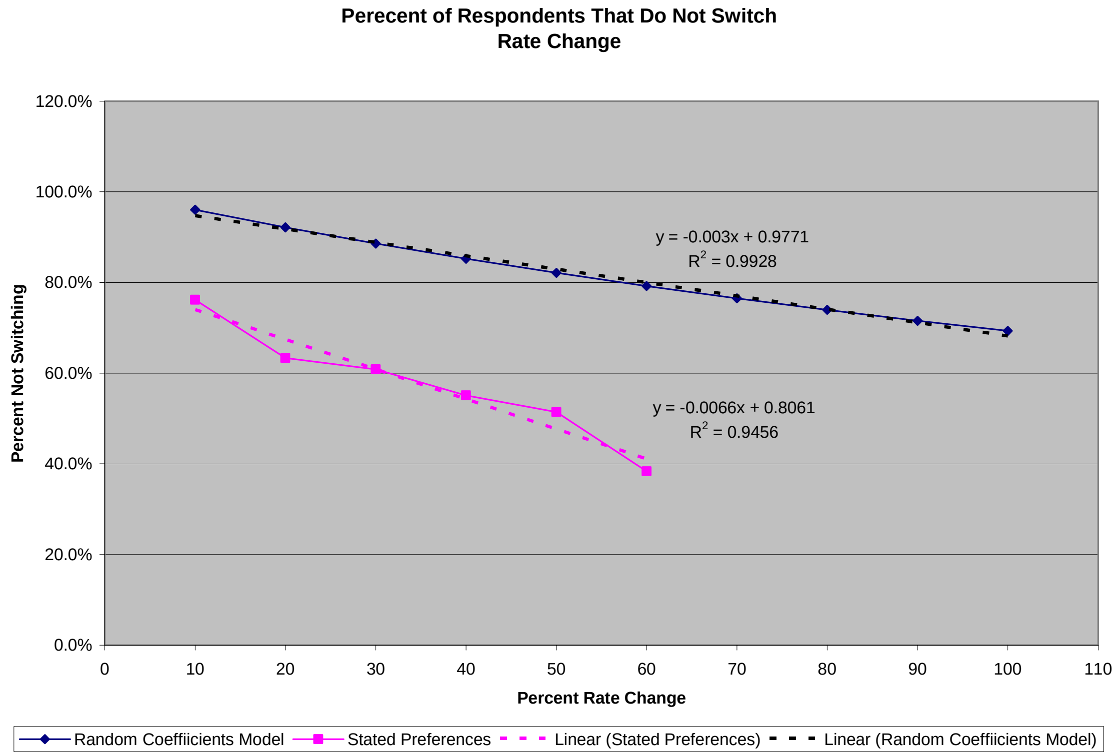
3. The paper describes revealed preferences as what elevators actually did. In this self-reporting context it is probably more accurate to describe revealed preferences as what the elevators reported they did.

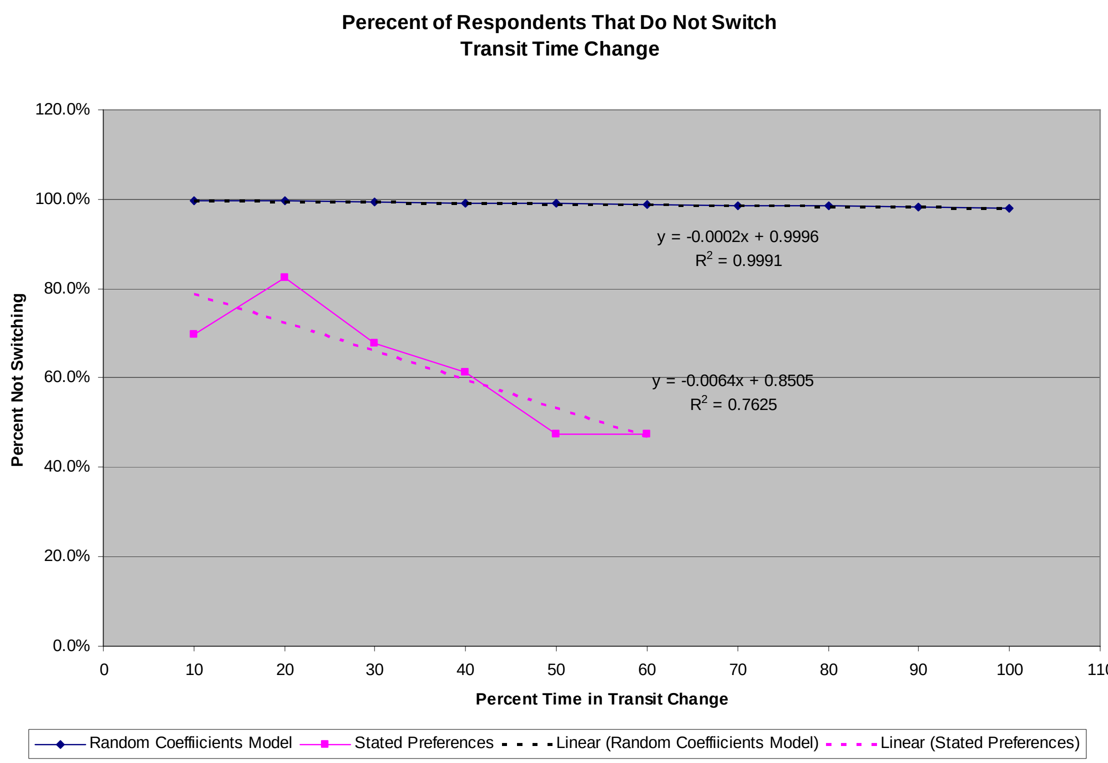
4. There may be a significant difference in the behavior of shippers organized as cooperative enterprises versus the behavior of other grain shippers. A variable differentiating between these types of elevators can be used to test for significant differences in behavior.

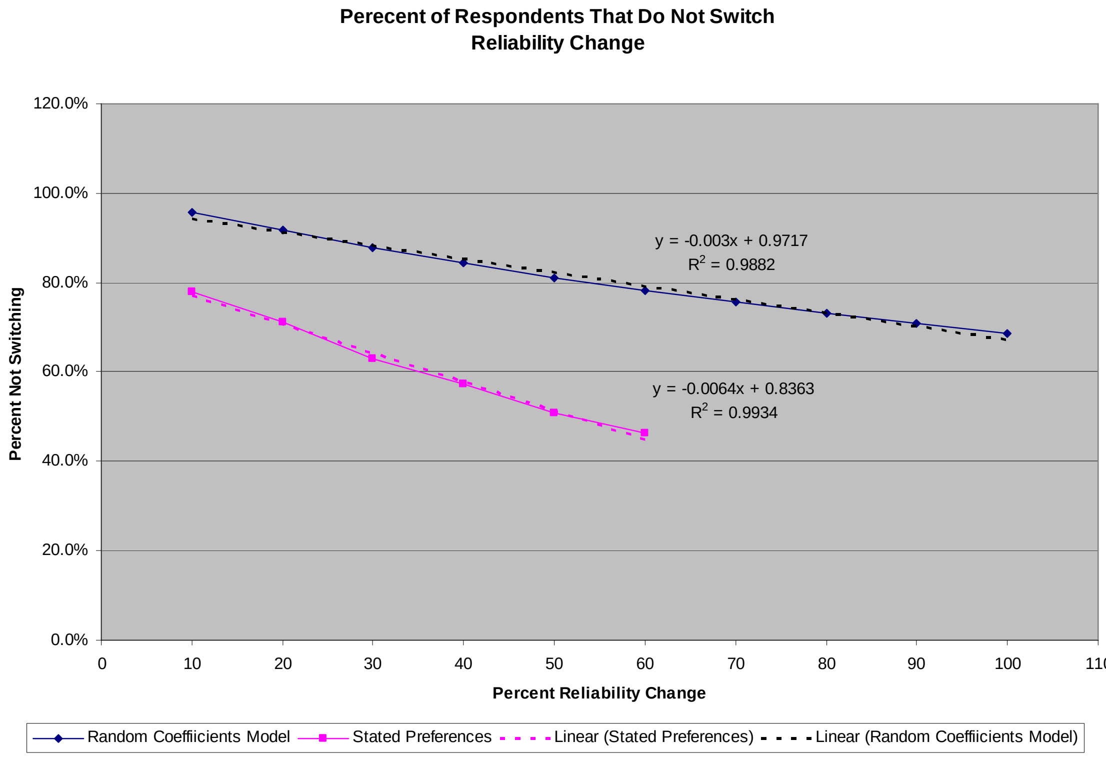
5. It would be helpful to the reader to provide several examples calculating both the estimated observable component of utility of the chosen and alternative shipments and the probabilities associated with the chosen movement and its alternatives.

6. The survey was conducted during the time period from August through October of 2006. The transportation rates for agricultural products, especially barge rates, are quite seasonal peaking annually during this time period. How might this have impacted the survey results and choice model parameter estimations?

7. The authors' findings regarding the model estimated switch rates and implied arc-elasticities of demand reported in Tables 20-25 appear to be greatly inconsistent with the stated preferences reported by the elevators summarized in Tables 10-12. The following figures demonstrate the inconsistencies for rate changes, time in transit changes and reliability changes, respectively.


Perecent of Respondents That Do Not Switch
Rate Change
Percent Not Switching
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
0
10
20
30
40
50
60
70
80
90
100
110
Percent Rate Change
y = -0.003x + 0.9771
R2 = 0.9928
y = -0.0066x + 0.8061
R2 = 0.9456
Random Coeffiicients Model
Stated Preferences
Linear (Stated Preferences)
Linear (Random Coeffiicients Model)


Perecent of Respondents That Do Not Switch
Transit Time Change
Percent Not Switching
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
0
10
20
30
40
50
60
70
80
90
100
110
Percent Time in Transit Change
y = -0.0002x + 0.9996
R2 = 0.9991
y = -0.0064x + 0.8505
R2 = 0.7625
Random Coeffiicients Model
Stated Preferences
Linear (Random Coeffiicients Model)
Linear (Stated Preferences)



The figures are constructed from the information contained in Tables 5, 10-12, 20, 22 and 24 in the report assuming that the original mode selected by survey respondents is distributed independently with respect to percent perturbation prompts. The figures also include linear regressions of the "no switch" percentages of stated preferences and forecasted model predictions. These figures illustrate two important points. First, a linear probability model fit to the survey data would predict that a significant percentage of survey respondents would switch transportation alternatives with no change in shipment attributes. Second, the random coefficients model does a poor job of forecasting stated responses to hypothetical perturbations in shipment attributes, both with respect to absolute "no switch" rates and changes in "no switch rates" associated with changes in the levels of shipment attributes.

On page 26 the authors report that, "…respondents were apparently paying careful attention to the sp-off-rp questions and answering similarly to how they would behave in the rp setting." If this is the case, then why are the model's forecasts of the responses to the hypothetical attribute level changes presented in the sp questions so different from the respondents own self-reported responses?

8. As noted by the authors, the demand for grain transportation is a derived demand. The elevators generally (except for cooperatives) are profit maximizers who generate revenue by purchasing grain at a time and/or place where it has relatively low value and selling grain at a time and/or place where it has relatively high value. Their operating margin must be sufficient to cover the variable handling, transportation and other costs and all elevators can shut-down if revenues do not cover variable costs. Can the payoff functions developed in the paper be reconciled with this conceptual framework of all elevators having a shut-down option if revenues do not cover variable costs?

9. The survey would have benefited by a question asking about the procurement price of the commodity as this variable helps determine profit margins for all shipment alternatives and particularly impacts on how changes in shipment attribute levels affect the probability of the shut-down alternative. The omitting of this variable through possible misspecification of the shut-down probabilities might bias model coefficient estimates.

10. It is possible that the survey respondents may not have interpreted the questions in the survey in the same manner that the authors interpreted the responses. For example survey question Q10 asks, "If the mode and destination you used for my last shipment had not been available and would never be available, then you would …." The authors are interpreting the survey responses as either the mode is unavailable, the destination is unavailable, or both are unavailable, however some survey respondents may have interpreted the question as meaning specifically both the destination and the mode are unavailable leading to a shut-down response by the respondent to the question when in fact the elevator had an alternative destination involving the same mode. This could explain the very large proportion of respondents that reported that they had no alternative. Of course, strategic respondent behavior might also explain the large proportion of no shipping alternative responses.

11. It would be nice in future surveys to have information on the interpretation of the survey questions by the shippers and the process they employed to formulate their responses. Hensher, Rose and Green (2005) describe the importance of incorporating respondents processing strategies into choice models and that the employment of certain processing strategies by respondents may introduce bias in the estimation of model coefficients if the processing strategies are not incorporated in the choice models. For example, if an elevator responded that a given percentage rate increase would not cause them to switch to an alternative it would be informative to know if the response was because:

    a. The elevator could absorb the higher transportation rate and still have the originally revealed preferred alternative the most profitable shipment alternative;

    b. The elevator believed that they could pass the increased cost forward to their end customer;

    c. The elevator believed that it could obtain the shipped commodity for a lower cost in the face of higher outbound transportation rates;

    d. Some combination of a, b and c; or

    e. Some other reason.

    The process employed to answer the questions has important implications for model specification and estimation. For example, if the respondents used b. above as their response strategy then the choice model should incorporate that both the price received and the transportation rate attributes simultaneously change by the same amount when estimating the model parameters rather than just presuming that the only variable to change is the rate attribute.

12. Since some elevator movements may be pre-scheduled well in advance of when they are actually needed the survey question defining shipment time as including scheduling time may be ambiguous. For future survey efforts the time question should be better clarified so that a definitive start and end time can be identified by the respondent and interpreted by the analyst.

13. The related issues of self-selection bias in the sample and possible strategic responses to the survey questions should be addressed by the authors in the face of the survey response rate of approximately 27 percent. Essentially, survey recipients have a range of possible actions when receiving the survey. They can:

    a. Respond to the survey

       Truthfully

       Non-truthfully by providing strategic responses

    b. Not Respond to the survey

    There is some literature suggesting that in a consequential (as perceived by the survey recipient) survey attempting to elicit willingness to pay for private goods (such as water transportation) of potential consumers of the goods that the dominant strategic response is to respond to the survey and then over represent the willingness to pay.

    Information on who actually responded to the survey (by the sample stratification variable of proximity to barge transportation) may yield some insight into possible sample self-selection sample bias and strategic response strategies employed by respondents.

14. Survey design issues

    a. The survey is what I will term an unbalanced SP-off-RP design because the survey questions only degrade the attractiveness of the already stated best alternative and never improve the attractiveness of the stated second best alternative. Hess, Rose and Hensher (2007) offer evidence of asymmetrical responses to increases or decreases in attribute levels when compared to the corresponding values of a reference alternative. They suggest that survey respondents can and do attach differing values to increases or decrease in the attractiveness of a reference alternative.

    b. The sequence of the rate, time and reliability attribute perturbation questions should be randomly determined in the design of the next survey instrument. In the current survey, the transportation rate perturbation is always the first survey question asked which may place an undue emphasis in the respondent's mind on transportation rates when addressing the subsequent survey questions.

    c. The next survey should include questions regarding perturbation of the price received for the revealed preference.

d. The next survey design should include questions regarding an important omitted variable: the cost of acquiring grain products for shipments at the elevators.

15. It is possible given the nature of the payoff functions in these surveys that random coefficients are non-independent jointly distributed random coefficients which might be modeled as approximately linear models with interaction effects (Cherchi and Ortuzar, 2002). This should be considered in the design of the next survey and formulation of the next generation of discrete choice models.

16. Does a new survey have to be completed for every U.S. Army Corps of Engineers inland navigation feasibility study on given waterway? In other words what is the shelf-life of the estimated coefficients?

17. The U.S. Army Corps of Engineers inland navigation analyses must forecast traffic for periods of over 50 years. How might survey results be applied to determine future modal demand curves as a result of exogenous or endogenous growth?

4.2.4 References for Reviewer 2

Cherchi, Elisabetta and Ortuzar, Juan De Dios (2002), Mixed RP/SP Models Incorporating Interaction Effects, Transportation: 29, 4: 371-395, Springer.

Hensher, David A. (2006A), Towards a Practical Method to Establish Comparable Values of Travel Time Savings from Stated Choice Experiments with Differing Design Dimensions, Transportation Research: Part A: Policy and Practice: 40, 10: 829.

Hensher, David A. (2006B), How Do Respondents Process Stated Choice Experiments? Attribute Consideration under Varying Information Load, Journal of Applied Econometrics: 21, 6 Page: 861-878, Chichester, England.

Hensher, David A., Rose, John M. and Greene, William H. (2005), The Implications on Willingness to Pay of Respondents Ignoring Specific Attributes, Transportation 32: 203–222, Springer.

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Louviere, Jordan J. (2006), What You Don't Know Might Hurt You: Some

Unresolved Issues in the Design and Analysis of Discrete Choice Experiments, Environmental and Resource Economics 34: 173–188, Springer.

Train, Kenneth and Weeks, Melvyn (2005), Discrete Choice Models in Preference Space and Willingness-to-Pay-Space, in A. Alberini and R. Scarpa, eds., Applications of Simulation

Methods in Environmental Resource Economics, Chapter 1; pp. 1–17, Dordrecht, The Netherlands: Springer.

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.

Train, Kenneth and Wesley W. Wilson (2005), "Analysis of Stated-Preference

Experiments Constructed from Revealed-Preference Choices. IWR Report 05-NETS-P-08.

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.*

Section 3 Summary Review Statement on Validity and Quality of Findings

3.1 Reviewer 1

The approach adopted by Train and Wilson for shippers' mode and destination choice is based on advanced econometric procedures including an approach recently developed by them which increases the usefulness and the efficiency of stated response data. This approach limits the selection of stated response cases to those which make the chosen alternative less desirable than it was when chosen which results in two important advantages over previous approaches. First, the stated response experiments are more realistic because they are closely tied to the real situation under which the shipment was made. Second, fewer stated response experiments are required to get the same level of precision as experiments which improve the relative value of the chosen alternative (and are therefore unlikely to be chosen) are eliminated. The authors introduce an econometric correction to eliminate bias resulting from limiting the range of offered experiments.

The approach used for assessing annual volume shipped is based on changes in the rate, time or reliability of the chosen mode for the most recent shipment and considers two distinct cases for rate changes; when the rate increase applies to all shippers and when the rate increase applies to the surveyed shipper only. The decision process is presented in two stages; the decision of whether to reduce annual shipping volume and, if so, the percent reduction. The methodology is not unique to Train and Wilson but is econometrically sophisticated.

The model results, as interpreted, provide strong evidence that changes in the attributes considered result in changes in shipment choices and annual shipping volume which differs from the assumption used by the U.S. Army Corps of Engineers that there is no change in shipping behavior up to a threshold. However, some of these elasticities (for mode and destination choice in response to changes in shipment time and for total volume in response to a general rate increase) are very small.

Further, there is some ambiguity in the interpretation of changes in annual volume as the survey, up to this point, is focused on the most recent shipment and the chosen mode and destination. It is unclear whether the respondents are thinking about an average rate, time or reliability change across all modes and destinations or only the mode and destination actually chosen. Also, it is not clear whether they are responding in terms of volume changes for that mode or summed over all modes.

We were concerned about this possibility also. The survey uses the term "average rates" and "average transit time" when asking about changes in annual volume. Our intent in specifying "average" was to assure that the respondent was thinking about rates and times for all shipments, rather than the last one. In the pretest of the survey instrument, we did not see any evidence of respondents misinterpreting the term "average" and thinking of the last shipment. In contrast, earlier versions of the instrument did not differentiate rate increases to the shipper alone from rate increases to all shippers, and comments from respondents indicated that this differentiation was needed (and was therefore made.) This suggests that if there was confusion about the term "average", it is likely that respondents would have noted their confusion to us, which they didn't.

3.2 Reviewer 2

I am unable to offer an unconditional endorsement of the validity and quality of the findings in the report because it appears that the discrete choice models estimated from the sp-off-rp data do not do a good job of forecasting the survey respondents' answers to the stated preference questions posed in the survey which serve as the basis for the sp-off-rp data. This indicates a problem in the formulation of the models, interpretation of the survey data or even possible strategic behavior of survey respondents and is particularly troubling because the inclusion of the sp-off-rp data in estimating the choice models appears to fulfill its intended purpose of adding precision to parameter estimates by increasing the range of attribute variations while adding only a relatively small quixotic contribution to the unobservable error components in choice determination. Exactly why the discrete choice models fail to reasonably approximate stated preferences is not at all clear.

Based on the reviewer's comments, we reestimated the model with an additional parameter that reflects the extent to which respondents said they would switch or not switch independent of the level of the prompt. This parameter captures the systematic bias that can arise in sp-off-rp responses. In particular, a positive coefficient indicates that respondents tend to say they would stay with their existing alternative, independent of the prompt, perhaps as a way of not having to think about the situation. A negative coefficient indicates that respondents have a tendency to say they would switch independent of the prompt, as perhaps a protest against the notion of a rise in rates and times, or in hopes of affecting the governmental decision-process regarding the upgrading of infrastructure. The parameter was estimated to be negative, indicating a tendency for respondents to say they would switch independent of the prompt. The predicted switch rates do not incorporate this term, since the predictions are intended to reflect actual response to actual changes in rates and times. The difference between the predicted switch rates and those based on the reported responses to the sp-off-rp data – i.e., the difference that the reviewer noted -- is due to this term, which is now explicitly incorporated into the model. The revised report includes the new model, describing this new term and its estimation in greater detail.

I can state that accounting for the shut-down option in the discrete shipper choice models in situations where surveyed shippers indicate that they have no shipping alternative is an important improvement to previous methodologies used to estimate Upper Mississippi River and Illinois Waterway transportation demands. However, exactly how to treat the shut-down option in the choice models given the data available in the survey is also not clear and different treatments may greatly affect model parameter estimates. I can further state that including reliability as a shipment attribute in the discrete choice models is an improvement to previous methodologies used to estimate Upper Mississippi River and Illinois Waterway transportation demands.

*In response to the reviewer's comments about the shut-down option, we re-estimated the model with greater structure to the shutdown random parameter. That is, instead of b*shutdown, where b is a random coefficient, as in our earlier model, we specified b=ax+e where b remains a random coefficient but the mean varies according observed variables x. We attempted several explanatory variables and found that storage capacity* *enters with moderate significance. In particular, the probability of shutting down in response to an increase in rates or times is lower for shippers with large storage capacity than for those with less storage capacity. The new model with this variable has been incorporated into the text in Section 3.*

The modeling of shippers' continuous decisions regarding adjustments to their annual volumes in response to changes in attributes appears to be a reasonable approach employing a two equation Heckman model.

Section 4 Individual Comments and Issues for Resolution

4.1 Reviewer 1

4.1.1 Individual Comments from Project Report

1. Section 1, Page 3, Paragraph 2. The list of findings in the Executive Summary is based exclusively on the modeling results. No information is reported from the description from the data including the range of characteristics of different shippers, the selection of shippers surveyed, the availability of mode and destination alternatives, differences between chosen and next best alternatives or stated changes in response to hypothetical alternatives. Some of this information should be reported to provide a context for the findings and for their insight into how shippers respond to changes in service. This can be readily addressed.

   These have been added to the Executive Summary

2. Section 1, Page 14, Paragraph 2 and 15, Table9. The information presented on rates, time and reliability are independent of mode making it difficult to interpret these data. Further, no information is given as to whether the next best alternative is a different mode, a different destination or both. It would appear that this information is available and can be readily summarized.

   These have been added. The mode choices and alternatives are summarized in Table 5, but there are too many cells to present all of the information in Table 9. We did, however, augment Table 9 and the related discussion with the descriptive statistics conditions on the original choice.

3. Section 3.3, Page 26, Paragraph 1 and Table 17. The model specification does not include some variables that might be useful in describing shipper behavior. These include characteristics of the shipper (annual shipment volume, storage facilities, etc. represented by categorical variables) and the commodity shipped as alternative specific variables or in interaction with attribute variables. Further, it may be useful to include dummy variables representing the destination type. These may explain some important differences in behavior and/or provide a basis for assessing the relative importance of changes to different shippers. Finally, it would be desirable to provide specific information on the number and type of alternatives included in the model.

For example, if only the chosen and the second best alternative are included; it would be useful to know how many cases include different modes, different destinations or both.

We reestimated the model and allowed some of the parameters to vary with observed variables. Indeed, we did find some evidence of the random coefficients depending on observables, and incorporated the changes into the text and discussion. The changes include: 1. Allowing the responses of rail shippers to vary with rail car loading capacity; and 2. Allowing the shutdown coefficient to vary with elevator storage capacity. The discussion is now in the revised section 3.

4. Section 3.3 (1st), Page 26, Table 17. It is interesting to note that the parameter for rate is approximately six times the parameter for price both measured in dollars per ton. One would expect that a rational decision maker would apply the same value (with opposite signs) to these variables. This large difference in magnitude may be due to the fact that rate sensitivity is primarily due to differences in mode while price is exclusively associated with different destinations.

   We agree with the comment and were concerned about the difference between the price and rate coefficients. In a stylized model with fully rational decision makers and no measurement error in the variables, the coefficients are expected to be the same. However, given the choice of constraining the coefficients to be the same when the data indicated that they are not, or allowing them to differ, we consider the latter approach to be more reasonable. Our practice is similar to that of, e.g., Baumol and Vinod (1970), who estimated a model with a(price received-rate) + b*rate, which is equivalent to entering rate and price separately.*

5. Section 3.4 (1st, there are two Sections 3.4), Page 27, Paragraph 2 and Table 18. The standard deviation of the shutdown constant indicates "considerable variation across shippers in how they view the option of shutting down." It is possible that including categorical variables describing the shipper size (in terms of annual shipment volume or size of storage facilities) might explain some of this variation structurally providing better insight into the impacts of changes on different shippers. I suggest that the authors include one or more such variables to test this possibility.

   We explored such a possibility and found modest evidence that some of the variation is indeed caused by storage facilities and have modified the associated tables and related discussion in section 3.

6. Section 3.4 (1st), Page 30, Table 20. The differences in response rates and elasticities (Table 21) suggest that it might be useful to estimate distinct parameters for shipping rates in the model reported in Table 19. Similar exploration would be appropriate for the travel time and reliability parameters.

   The issue of mode-specific coefficients of rate, time, and reliability is complicated. In an ideal model, the coefficients would be the same over modes, reflecting the *shippers' value of the attributes. Our model conforms to this ideal. However, for reasons analogous to those by which rate and price can have different coefficients, the coefficients of rates, time, and reliability can in reality vary by mode. In our analysis, we found that the data did not support meaningful estimation of mode-specific coefficients for rate, time, and reliability – a specification that entails three times as many parameters.*

7. Section 3.4 (1st), Page 30, Paragraph 2. The first sentence "Switching rates are estimated to be greatest for rail shippers and larger for barge shippers than for truck shippers." is correct for shipping rates, which are discussed in the example, and for travel time but not for reliability.

   We have made the change in the text.

8. Section 3.4 (1st), Page 32, Paragraph 1. The second sentence "The switch rates and elasticities … (for reliability) … are lower than those for rates but higher than those for transit time." is correct for barge and rail but not for truck where the response to reliability changes is larger than for both rates and travel time.

   We have made the change.

9. Section 4. Interpretation of volume changes is somewhat ambiguous as it is unclear whether the changes reported represent changes in total annual volume by all modes or annual volume by the chosen mode. Even though the questions in the survey "If the average … increased by …percent, would your annual volume shipped decrease?" and "If yes, by how much would the volume decrease?" are designed to elicit a response in terms of total volume; they might be misinterpreted by some respondents as relevant only to cost, time or reliability for the most recently chosen mode and destination as the entire survey up to this point is focused on the most recent shipment. This might explain the statement (on Page 37, Paragraph 4) that "Shippers with a high (low) probability of a changing volumes are those with both rail and barge access (which by definition means distance to rail is zero), little storage capacity, and large car-loading capacity." There does not seem to be any reason why shippers with both rail and barge access would be more or less sensitive than others to cost, time or reliability changes across all modes; however, it does seem likely that they would reduce their volume on rail or barge (whichever one was chosen and is assumed to change) because of the ready availability of the other alternative.

   Some of this was discussed above in the response to 3.1. The statement referred to on the former page 37, paragraph 4, was removed in the present draft. The sensitivity might be due to the notion that with greater access, they have more options and it is, in some sense, easier to adjust.

4.2 Reviewer 2

4.2.1 Editorial Comments

Each of the suggested changes that are listed below have been made. Section 3 has been substantially revised in response to other comments and has been completely rewritten.

1. Section 1 (Executive Summary and Introduction) Page 1, Paragraph 3

   "A sample of 480 shippers located in a 10 state area are" should read "A sample of 480 shippers located in a 10 state area is"

2. Section 1 (Executive Summary and Introduction) Page 2, Paragraph 1

   The following sentence needs to be rewritten: "Further, the nature of stated preference questions is the ability to control the experiment and, under our approach, to specify the range of the stated preference data."

3. Section 1 (Executive Summary and Introduction) Page 2, Paragraph 1

   "we also have the ability to gage the" should read "we also have the ability to gauge the"

4. Section 1 (Executive Summary and Introduction) Page 3, Finding 1

   Need to insert a comma after reliability – "rate, time, reliability, price, distance"

5. Section 1 (Executive Summary and Introduction) Page 3, Finding 6

   "-0.54" should read "-.054"

6. Section 2 (Data Sources and Descriptive Characteristics) Page 4, Paragraph 1

   "conceivable" should read "conceivably"

   "a existing list" should read "an existing list"

7. Section 2 (Data Sources and Descriptive Characteristics) Page 4, Paragraph 2

   The description of how the sample is stratified is awkward and should be revised.

8. Section 2 (Data Sources and Descriptive Characteristics) Page 5, Paragraph 1

   "The sample was implemented" should read "The survey was initiated"

9. Section 2 (Data Sources and Descriptive Characteristics) Page 5, Paragraph 3 (Locations of Shippers and Shipments)

   "The locations of the 480 respondents are presented in Figure 2" should read "The locations of the 480 respondents are presented in Figure 1"

10. Section 2 (Data Sources and Descriptive Characteristics) Page 7, Note to Figure 2

    there are similar mappings can be made" should read "there are similar mappings that can be made"

11. Section 2 (Data Sources and Descriptive Characteristics) Page 7, Paragraph 2 (Shipper Characteristics)

    "the distance to the nearest point Table1." should read "the distance to the nearest access point (Table 1)" "(479/480" should read (479/480)"

12. Section 2 (Data Sources and Descriptive Characteristics) Page 8, Footnote 5

    "The numbers in the numerator is the number with access and in the denominator is the total number that responded." should read "The numerator is the number with access and in the denominator is the total number that responded."

13. Section 2 (Data Sources and Descriptive Characteristics) Page 9, Footnote 6

    "However, the use of a number of different web pages and contact with various organizations (state agricultural, Farm Service Agency, Railroad and company websites) allowed most of the figures that were questionable or missing were either confirmed, replaced or added." should read "However, the use of a number of different web pages and contact with various organizations (state agricultural, Farm Service Agency, Railroad and company websites) allowed most of the figures that were questionable or missing to be either confirmed, replaced or added."

14. Section 2 (Data Sources and Descriptive Characteristics) Page 10, Table 3

    "100000-25000" should read "100000-250000"

15. Section 2 (Data Sources and Descriptive Characteristics) Page 10, Paragraph 1

    "Generally, the firms do not typically own export facilities (Table 4)." Table 4 does not display export facilities owned by survey respondents.

16. Section 2 (Data Sources and Descriptive Characteristics) Page 10, Paragraph 2 (Shipper Characteristics)

    "A major purpose of the survey was to develop a database from which choice models can be used." suggest revising to something like: "…for use in developing choice models."

17. Section 2 (Data Sources and Descriptive Characteristics) Page 11, Paragraph 2

    Suggest replacing the word "largest" with "most frequent"

18. Section 2 (Data Sources and Descriptive Characteristics) Page 14, Paragraph 1 (1st sentence under table)

"1032 versus 624" should read "1032 versus 678"

19. Section 3 (Shippers' Choice of Modes and Destinations) Page 20, Section Heading

    "Shippers' Choice of Modes and Destinations" should read "SHIPPERS' CHOICE OF MODES AND DESTINATIONS"

20. Section 3.1 (Data) Page 20

    Paragraphs in this section should be reformatted without indentation and with a blank line between paragraphs to match the rest of the paper.

21. Section 3.1 (Data) Page 20, Paragraph 2

    "To summarized" should read "To summarize"

    "Tables 5-9 above provides" should read "Tables 5-9 above provide"

22. Section 3.2.2 (Random Coefficients) Page 25, Bottom of Page

    "logit probabiliuty" should read "logit probability"

23. Section 3.3 (Estimation Results) Page 27, Paragraph 2

    "This inclusion of the option of shutting down constitutes important aspect" should read "This inclusion of the option of shutting down constitutes an important aspect"

24. Section 3.3 (Estimation Results) Page 28, Paragraph 2

    "Approximately than 9 percent of shippers are estimated not to care about reliability (i.e., the mass at zero is 0.091)." should read "Approximately 9 percent of shippers are estimated not to care about reliability (i.e., the mass at zero is 0.091)."

25. Section 3.4 (Summary and Conclusions for Mode and Destination Choice) Page 33, Title

    "Desatination" should read "Destination"

26. Section 3.4 (Summary and Conclusions for Mode and Destination Choice) Page 33, Bottom of Page

    "occurs does not coincide with the rate of attributes…" should read "occurs does not coincide with the range of attributes"

27. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 35, Paragraph 1

    The following sentence needs to be revised: "Whether a firm chooses to adjust its quantity may or not is the selection equation."

28. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 36, Paragraph 3

    "In the present case, the hypothesis of no correlation cannot be rejected, suggesting that selection bias need not be present." is awkward

29. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 37, Paragraph 1

    "not statistically significant in explaining whether a change in made" should read

    "not statistically significant in explaining whether a change is made"

30. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 37, Paragraph 3

    "As discussed earlier, the models provider both conditional (given a change occurs) and an unconditional (factoring in the probability of a change) elasticities" should read "As discussed earlier, the models provide both conditional (given a change occurs) and unconditional (factoring in the probability of a change) elasticities"

31. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 37, Footnote 17

    "While often points to multicollinearity between the two, the correlation is small" should read "While this often points to multicollinearity between the two, the correlation is small"

32. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 38, Paragraph 2

    "Modal access is not found to be a statistically significant" should read "Modal access is not found to be statistically significant"

33. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 38, Paragraph 5

    "The elasticity estimates for the median firm are presented in table 31 for the median firm" should read

    "The elasticity estimates for the median firm are presented in Table 31"

34. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 39, Paragraph 2

    "Generally, the other variables do not significantly influence changes annual volumes with respect to changes in reliability." -- should be rewritten

35. Section 3.4 (Annual Volume Adjustments to Changes in Attributes) Page 39, Paragraph 5

"As with the other attributes, the expected elasticities are smaller in magnitude than the conditional elasticities." should read "As with the other attributes, the unconditional elasticities are smaller in magnitude than the conditional elasticities."

4.2.2 Comments Regarding Content in Specific Sections of the Report

1. Section 1. (Executive Summary and Introduction) Page 2, Paragraph 2

This paragraph states that prices received are an important explanatory variable. I agree. By the same token, is it not the price that shippers pay to procure the shipped commodity important in determining alternatives, especially with regard to the shut-down alternative as firms with greater profit margins are probably less likely to shut-down in the face of degraded shipment attributes? I suggest that this information be obtained in future surveys.

We agree with the comment and plan to do so. We do note that the price paid to procure the product is likely endogenous and a function of the other variables present in the model. As such, its influence operates through the variables that cause it. In the revised draft, we have attempted with modest success to reflect a tenet of this comment with the inclusion of shutdown and its interaction with storage capacity.

2. Table 8 (Shipment Attributes-Descriptive Statistics by Mode) Page 14

Why is the sample size for the "overall average" in each row greater than the sum of the sample sizes for each of the three modes?

In some cases, there are multiple modes involved in the shipment and individual mode attributes were not observed.

How are the mode specific rate per ton-mile and the miles per hour calculated? Are multi-modal alternatives excluded from these calculations or is some other method employed to account for multi-modal alternatives?

Rate per unit was observed in the data (converted to tons where necessary) and rate per ton was divided by distance. Miles per hour were inferred from the data (shipment distance/time in hours). Only rates were available by mode, and when available for each mode in the calculation they are reflected. Time-in-transit and reliability apply only to the total shipment and are suppressed.

The units of measure for all variable/modes should be displayed in the first column of the table.

This has been done.

It should be noted that the miles per hour computations reflect scheduling time and wait for equipment, not just transit time.

This has been added.

Each cell in an individual column of the table should display the same number of significant decimal places to facilitate comparing the cell values. This problem is exhibited by many tables in the report and should be corrected for all tables in the final report.

This modification has been made throughout where applicable. It was not done for tables that include variables, distance, tons, capacity and variables such as rate per tonmile. The decimal places for the former are not necessary, but for the latter are.

3. Table 8 (Shipment Attributes-Descriptive Statistics by Mode) Page 14

Data appears to be available for only 17 alternatives that involve barge movement. Further, apparently only 10 of the 17 barge shipments include a Price/Ton. Is this a sufficient number for developing meaningful elasticity conclusions for this mode?

This is true. Indeed, across all possible alternatives (up to four for each individual), there are a total of 18 movements reported that use barge and only 23 observations that report they have "barge" access. This is simply a matter of fact from sampling and low numbers of elevators on the river. The low cell count may make it difficult to obtain statistical significance; indeed, the t-statistic in Table 19 indicate marginal significance, and in the volume models identification rests on "barge" access. In this case, again, elevators with barge but not rail access, do not seem to be different from the others, while elevators with both barge and rail seem to be different from the others. That said, most of the observations are "off-river". However, of the 475 shippers that provide the information, 101 shipments flow to a river terminal whereupon, presumably, the shipment changes ownership and flows down the river by barge.

4. Table 9 (Shipment Attributes-Average values by Chosen and Next Best Alternative) Page 15

Why are both rate and distance averages for the chosen and next best alternatives so inconsistent with the corresponding rate/ton-mile averages?

The ratio of average rate/average distance is not mathematically the same as average(rate/distance). The difference is particularly large when the distribution of the denominator, in the case distance, is highly skewed.

5. Tables 10, 11, 12 (Shipment Stated Preference) Pages 16 and 17

These tables indicate that the stated preference responses to the random perturbations in the three explanatory variables are very similar as evidenced by the percentage of respondents stating that they would not switch, switch or shutdown at the selected percentage prompts in particular and with respect to the percentages displayed over all the prompt levels in general.

Section 3 has been substantially revised and there is considerable discussion of just this issue in the revised text.

6. Tables 13 – 16 (Annual Stated Preference) Pages 18 - 20

Table 14 does not include a total row.

This has been added.

7. Section 3.2 (Choice Model and Estimation) Pages 22-25

I suggest removing references to utility functions in the report. The authors are not estimating utility functions, but rather, coefficients of scaled payoff functions to elevators where the elevators select a best alternative with respect to the scaled payoff function from a discrete set of self-reported alternatives differentiated by transportation modes and destinations. The scaled payoff function to each elevator takes the general form given by, where denotes a column vector of unknown coefficients that may or may not vary across elevators, denotes a row vector of observable factors contributing to the payoff from alternative j and denotes the net additive contribution to the payoff of unobservable factors associated with alternative j. The are presumed to be iid extreme value distributions over alternatives which is why the payoff functions are scaled by a factor related to the assumed common variance of the. If the random payoff functions are taken to represent scaled profits as mentioned in footnote 9 and profits are defined as revenues net of costs from alternative shipment choices then there are important implications for the form of the random payoff functions. For example, the coefficient of price received at the destination and the coefficient of transportation costs incurred to reach that destination ought to be of opposite sign and nearly equal in absolute value for each elevator. This limits the joint distribution of the potentially randomly distributed coefficients of these variables. Further, at least one important profit determining variable, the cost to the elevator to acquire the product to be shipped, is not available from the current survey. This cost most certainly affects profits and shut-down probabilities (more profitable elevators are less likely to shut down for a given perturbation of their revealed choice) and is omitted from the payoff function. Consequently, the full functional form employed for the payoff functions of each fitted model needs to be explicitly stated in the paper along with its basis in theory in determining elevator payoffs.

We discuss these implications of the use of a payoff function above, at 4.1.1 (4) in reference to the rate and price coefficients and at 4.2.2 (1) in reference to the cost to acquire the product.

8. Section 3.2 (Choice Model and Estimation) Pages 23-24

The derivation of choice probabilities and likelihood functions are described in the text for a more general specification of the choice model than the specification actually employed in the estimations reported in the paper. While this is very useful for academic economists it impairs the understanding of the choice models actually fitted in this paper to the U.S. Army Corps of Engineers audience not fully versed in discrete choice theory. I suggest an example be provided that describes the sp-off-rp choice sets and associated choice probabilities used in the sp-off-rp estimations in this survey for a representative elevator that reported at least one shipping alternative and a representative elevator that reported no shipment alternatives.

Some of this has been added in the revised section and hopefully there is greater clarity particularly in the descriptive part of section 3.

4.2.3 General Comments

1. This report contained many typographical errors which greatly diminished the clarity of the exposition. This lack of clarity made reviewing the report very difficult and time consuming. The report would benefit from a thorough proof reading, explicit presentation of equations of all fitted models and reformatting and cleaning the data presented in the many tables.

All editorial comments have been incorporated and then the report modified for other comments. The report was then proofed for typos, diction and grammar.

2. The target of the survey in the report is Midwestern grain elevators. Elevators are neither the beginning nor the end of the grain supply chain and elevators are not the only participants in the agricultural supply chain with shipment choices. Producers at the beginning of the supply chain have choices regarding what and how much product to produce and whether and when to sell product into one supply chain or another. In fact, many agricultural producers bypass elevators in the supply chain and ship their own product directly to terminals and end users. Consumers at the end of the supply chain have choices regarding purchase quantities and sources of supply. Consequently, some origin, destination and modal decisions as well as shipment attributes from the perspective of the overall supply chain have already been determined by the time grain reaches a surveyed elevator. This fact limits some of the possible variation in origins, destinations, modes and attributes of the flow of grain incorporated in a choice model fit only to elevators. This could result in lower elasticity values estimated for elevators than those that may exist from the larger perspective of the total agricultural supply chain.

We agree. Our analysis of mode/destination choice takes the shipment of the elevator as given. In a more general model, the shipment itself is endogenous. This endogneity can be incorporated into a spatial demand/supply equilibrium model, using the model in this report in the way described by Train and Wilson (2007).

3. The paper describes revealed preferences as what elevators actually did. In this self-reporting context it is probably more accurate to describe revealed preferences as what the elevators reported they did.

4. There may be a significant difference in the behavior of shippers organized as cooperative enterprises versus the behavior of other grain shippers. A variable differentiating between these types of elevators can be used to test for significant differences in behavior.

   It is certainly plausible that coops behave differently than other grain shippers and with data is a testable hypothesis. These data were not collected in the survey, and so the test cannot be performed. However, it is not clear that the objective of maximizing the utility of members differs from maximizing the returns of the entity

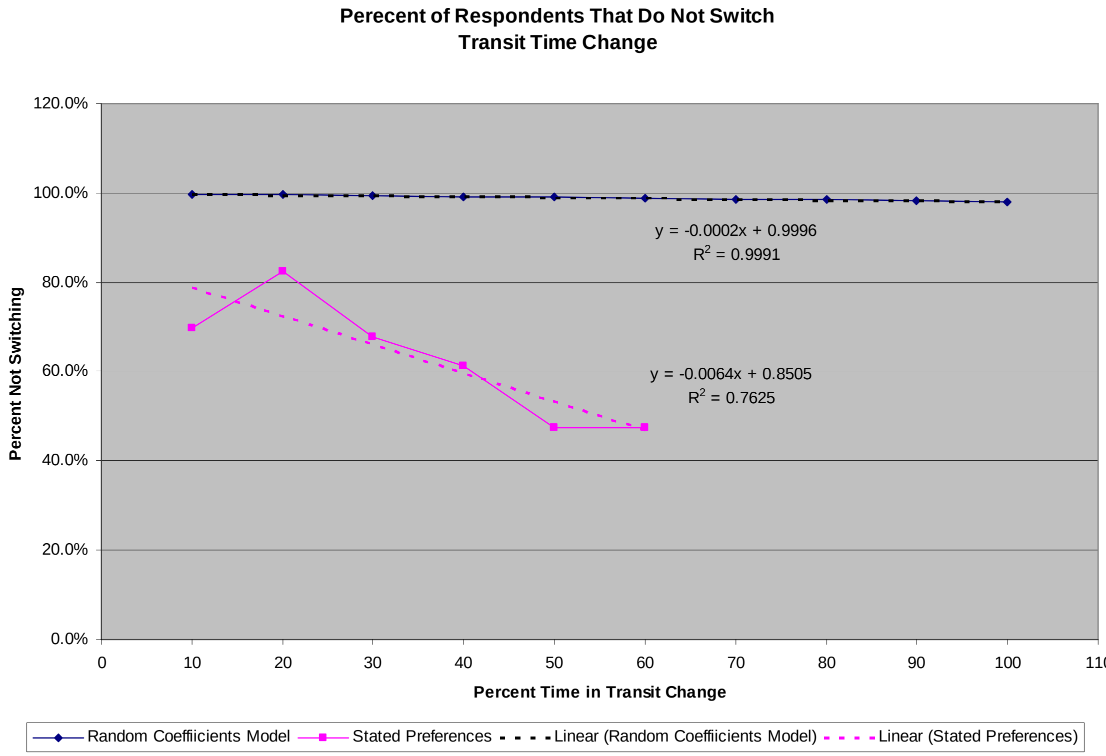
5. It would be helpful to the reader to provide several examples calculating both the observable component of utility of the chosen and alternative shipments and the probabilities associated with the chosen movement and its alternatives.

   An example is now given in the report.

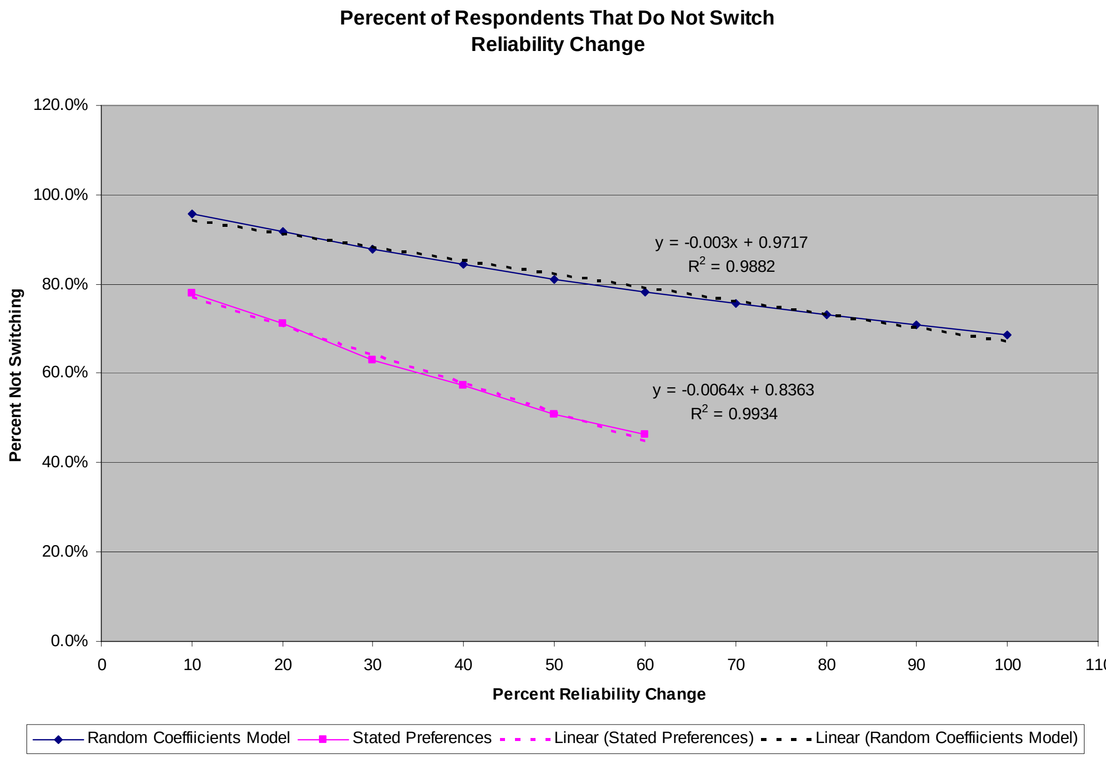
6. The survey was conducted during the time period from August through October of 2006. The transportation rates for agricultural products, especially barge rates, are quite seasonal peaking annually during this time period. How might this have impacted the survey results and choice model parameters?

   There are plausible reasons for elasticities being higher, or lower, during the peak season than during off-peak. We do not know the net effect, and consider this an interesting topic for future investigation.

7. The authors' findings regarding the model estimated switch rates and implied arc-elasticities of demand reported in Tables 20-25 appear to be greatly inconsistent with the stated preferences reported by the elevators summarized in Tables 10-12. The following figures demonstrate the inconsistencies for rate changes, time in transit changes and reliability changes, respectively.



Perecent of Respondents That Do Not Switch
Transit Time Change
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Percent Not Switching
0
10
20
30
40
50
60
70
80
90
100
110
Percent Time in Transit Change
y = -0.0002x + 0.9996
R2 = 0.9991
y = -0.0064x + 0.8505
R2 = 0.7625
Random Coeffiicients Model
Stated Preferences
Linear (Random Coeffiicients Model)
Linear (Stated Preferences)



Perecent of Respondents That Do Not Switch
Reliability Change
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Percent Not Switching
0
10
20
30
40
50
60
70
80
90
100
110
Percent Reliability Change
y = -0.003x + 0.9717
R2 = 0.9882
y = -0.0064x + 0.8363
R2 = 0.9934
Random Coeffiicients Model
Stated Preferences
Linear (Stated Preferences)
Linear (Random Coeffiicients Model)

The figures are constructed from the information contained in Tables 5, 10-12, 20, 22 and 24 in the report assuming that the original mode selected by survey respondents is distributed independently with respect to percent perturbation prompts. The figures also include linear regressions of the "no switch" percentages of stated preferences and forecasted model predictions. These figures illustrate two important points. First, a linear probability model fit to the survey data would predict that a significant percentage of survey respondents would switch transportation alternatives with no change in shipment attributes. Second, the random coefficients model does a poor job of forecasting stated responses to hypothetical perturbations in shipment attributes, both with respect to absolute "no switch" rates and changes in "no switch rates" associated with changes in the levels of shipment attributes.

On page 26 the authors report that, "…respondents were apparently paying careful attention to the sp-off-rp questions and answering similarly to how they would behave in the rp setting." If this is the case, then why are the model's forecasts of the responses to the hypothetical attribute level changes presented in the sp questions so different from the respondents own self-reported responses?

As discussed in relation to 4.1.1 (4), we reestimated the model to investigate and resolve the issue that the reviewer raises. The revised report now discusses the new model and reconciliation of predicted switch rates with those reported as responses to the sp-off-rp questions.

As noted by the authors, the demand for grain transportation is a derived demand. The elevators generally (except for cooperatives) are profit maximizers who generate revenue by purchasing grain at a time and/or place where it has relatively low value and selling grain at a time and/or place where it has relatively high value. Their operating margin must be sufficient to cover the variable handling, transportation and other costs and all elevators can shut-down if revenues do not cover variable costs. Can the payoff functions developed in the paper be reconciled with this conceptual framework of all elevators having a shut-down option if revenues do not cover variable costs?

This issue is related to that discussed at 4.2.2 (1) and the next point below. With data on the acquisition price for the shipment, a more complete model of the decision to shut-down could be developed.

9. The survey would have benefited by a question asking about the procurement price of the commodity as this variable helps determine profit margins for all shipment alternatives and particularly impacts on how changes in shipment attribute levels affect the probability of the shut-down alternative. The omitting of this variable through possible misspecification of the shut-down probabilities might bias model coefficient estimates.

We agree that this information would be useful and may be useful in modeling. However, we also note that in these markets the bid price is typically an endogenous variable, and therefore, its presence is embedded in the current model. On the shutdown point, we did examine the possibility of variables impacting the random response. We found *some support for storage capacity. These changes are discussed in section 3 and the results reflect this effort.*

10. It is possible that the survey respondents may not have interpreted the questions in the survey in the same manner that the authors interpreted the responses. For example survey question Q10 asks, "If the mode and destination you used for my last shipment had not been available and would never be available, then you would …." The authors are interpreting the survey responses as either the mode is unavailable, the destination is unavailable, or both are unavailable, however some survey respondents may have interpreted the question as meaning specifically both the destination and the mode are unavailable leading to a shut-down response by the respondent to the question when in fact the elevator had an alternative destination involving the same mode. This could explain the very large proportion of respondents that reported that they had no alternative. Of course, strategic respondent behavior might also explain the large proportion of no shipping alternative responses.

    It is certainly possible. Yet, various forms of this question have been used in other surveys, and these results are very comparable to the other studies. This, in particular, includes the Columbia-Snake survey wherein we were able to document the entire choice set. In this survey, the number of responses with "no-alternatives" was about 25%.which compares favorably with the 33% in the present study.

11. It would be nice in future surveys to have information on the interpretation of the survey questions by the shippers and the process they employed to formulate their responses. Hensher, Rose and Green (2005) describe the importance of incorporating respondents processing strategies into choice models and that the employment of certain processing strategies by respondents may introduce bias in the estimation of model coefficients if the processing strategies are not incorporated in the choice models. For example, if an elevator responded that a given percentage rate increase would not cause them to switch to an alternative it would be informative to know if the response was because:

    a. The elevator could absorb the higher transportation rate and still have the originally revealed preferred alternative the most profitable shipment alternative;

    b. The elevator believed that they could pass the increased cost forward to their end customer;

    c. The elevator believed that it could obtain the shipped commodity for a lower cost in the face of higher outbound transportation rates;

    d. Some combination of a, b and c; or

    e. Some other reason.

    The process employed to answer the questions has important implications for model specification and estimation. For example, if the respondents used b. above as their response strategy then the choice model should incorporate that both the price received and the transportation rate attributes simultaneously change by the same amount when estimating the model parameters rather than just presuming that the only variable to change is the rate attribute.

We certainly agree that such information would be useful, but also point out that the collection of such data would dramatically increase sample costs and may require personal interviews.

12. Since some elevator movements may be pre-scheduled well in advance of when they are actually needed the survey question defining shipment time as including scheduling time may be ambiguous. For future survey efforts the time question should be better clarified so that a definitive start and end time can be identified by the respondent and interpreted by the analyst.

    We agree and in future research, we plan to add such information.

13. The related issues of self-selection bias in the sample and possible strategic responses to the survey questions should be addressed by the authors in the face of the survey response rate of approximately 27 percent. Essentially, survey recipients have a range of possible actions when receiving the survey. They can:

    a. Respond to the survey

    Truthfully

    Non-truthfully by providing strategic responses

    In the revised section 3, we discuss strategic responses. Generally, we find that respondents were indeed providing, at least partially, "strategic"responses. This effect has now been explicitly incorporated into the model.

    b. Not Respond to the survey

    There is some literature suggesting that in a consequential (as perceived by the survey recipient) survey attempting to elicit willingness to pay for private goods (such as water transportation) of potential consumers of the goods that the dominant strategic response is to respond to the survey and then over represent the willingness to pay.

    Information on who actually responded to the survey (by the sample stratification variable of proximity to barge transportation) may yield some insight into possible sample self-selection sample bias and strategic response strategies employed by respondents.

    This is an important issue. In a sense the issue is unknowable, since the nonrespondents do not, by definition, provide the relevant information that is needed for comparisons. More work is needed on how to design surveys that are consequential and incentive compatible for all potential respondents.

14. Survey design issues

We agree with each of the following comments and, to the extent future surveys are conducted, such information should be included.

a. The survey is what I will term an unbalanced SP-off-RP design because the survey questions only degrade the attractiveness of the already stated best alternative and never improve the attractiveness of the stated second best alternative. Hess, Rose and Hensher (2007) offer evidence of asymmetrical responses to increases or decreases in attribute levels when compared to the corresponding values of a reference alternative. They suggest that survey respondents can and do attach differing values to increases or decrease in the attractiveness of a reference alternative.

This possibility of asymmetric response can be investigated by adding sp-off-rp questions that improve a non-chosen alternative.

b. The sequence of the rate, time and reliability attribute perturbation questions should be randomly determined in the design of the next survey instrument. In the current survey, the transportation rate perturbation is always the first survey question asked which may place an undue emphasis in the respondent's mind on transportation rates when addressing the subsequent survey questions.

c. The next survey should include questions regarding perturbation of the price received for the revealed preference.

d. The next survey design should include questions regarding an important omitted variable: the cost of acquiring grain products for shipments at the elevators.

15. It is possible given the nature of the payoff functions in these surveys that random coefficients are non-independent jointly distributed random coefficients which might be modeled as approximately linear models with interaction effects (Cherchi and Ortuzar, 2002). This should be considered in the design of the next survey and formulation of the next generation of discrete choice models.

    We agree.

16. Does a new survey have to be completed for every U.S. Army Corps of Engineers inland navigation feasibility study on given waterway? In other words what is the shelf-life of the estimated coefficients?

    Hopefully, the decision process is somewhat stable, such that the shelf life of the estimates is long enough to make the analysis useable for forecasting. Of course, this can only be known by conducting surveys over a considerable time span and comparing results.

17. The U.S. Army Corps of Engineers inland navigation analyses must forecast traffic for periods of over 50 years. How might survey results be applied to determine future modal demand curves as a result of exogenous or endogenous growth?

    The models take the location of firms as given. This location decision can be endogenized in the forecasting model, while still using the mode/destination choice model from this report for each location. This procedure would require a model of firm location, in addition to the models in this report.

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

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