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TRANSPORTATION DEMAND FOR GRAIN SHIPMENTS

A Revealed and Stated Preference Approach

US Army Corps of Engineers®

IWR Report 04-NETS-P-07

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 Grain Shipments:A Revealed and Stated Preference Approach

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Abstract. A survey of grain shippers was conducted to obtain information about the mode and origin/destination (O/D) of their shipments, the next-best alternative mode and O/D, as well as factors that might induce the shipper to switch to the next-best alternative. An econometric model was estimated on the combined revealed-preference data (the shippers' observed choices in the market) and stated-preference data (the choices that shippers said they would make if transportation rates or times rose for their current mode and O/D.) The estimated model is used to forecast the share of shippers that would change mode and/or O/D in response to specified changes in transportation rates and time. The analysis indicates that many shippers would switch to an alternative mode and/or O/D in response to a relatively small rate increase for their current mode and O/D. The share who would switch rises with the magnitude of the rate increase, though less than proportionately. Shippers are found to respond to transit times in addition to rates, with the response to transit times being smaller than the rate response. While many shippers are found to respond to fairly small changes in rates or transit times, a large share of shippers are found to be essentially insensitive to large changes in rates and times.

INTRODUCTION

This paper examines grain shippers' choice of mode and origin/destination (O/D), with particular emphasis on the response of these choices to changes in transportation rates and times. The analysis is based on a survey of 369 shippers who were interviewed between December 2003 and February 2004. The surveyed shippers are grain elevators sampled from a list of elevators obtained from the USDA and supplemented by trade association lists. Information was obtained on the shippers' current modes and O/D's (called "revealed preference data") and on how the shippers report they would change the mode and/or O/D of their shipments in response to changes in transportation rates and times ("stated preference data.") Econometric models of shippers' decisions were estimated on these combined revealed and stated preference data.

The findings can be summarized as follow:

- A large share of shippers do not have viable alternatives available to them. 26% of the surveyed shippers reported that they would have to shut down if the mode and O/D that they currently use were not viable.
- Of the shippers who have alternatives available to them, a considerable number would switch to their next-best alternative if the rate for their current mode and O/D choices rose. A ten percent increase in transportation rates for the mode and O/D of a shipment is predicted to induce 14% of shippers to switch to the next-best alternative.
- As implied by the previous point, the arc elasticity of mode and OD choice with respect to rates is 1.4 for a 10% increase in rates.
- Though some shippers are very responsive to rates, other shippers would continue using their current mode and O/D choices in the face of large rate increases. A doubling of rates for their current mode and O/D is predicted to induce 62% of shippers to switch to their next-best alternative. The remaining 38% would not switch even when their rates doubled.
- As implied by the previous point, the arc elasticity of mode and O/D choice with respect to rates is 0.6 for a 100% increase in rates.
- The arc elasticity decreases as the magnitude of the rate increase rises, from 1.4 for a 10% rate increase to 0.6 for a 100% rate increase. This difference reflects the fact that small rate increases induce the shippers who are readily able to switch to do so, leaving only the shippers who are captive or nearly so to respond, as possible, to larger rate increases.

- Shippers respond to transit times in addition to rates in their choice of mode and O/D. That is, transit time has an impact in itself, independent of the fact that longer times usually translate into greater rates.
- While transit time matters, it matters less than rates. Stated precisely, shippers respond less to a percent increase in transit time than they do to the same percent increase in transit rates.
- The arc elasticity of mode and O/D choice with respect to a 10% change in transit times is 0.8. This elasticity is considerably smaller than the equivalent rate elasticity, which, as given above, is 1.4.
- As with the rate elasticity, the arc elasticity of mode and O/D choice with respect to transit time decreases as the percent increase in times rises. The arc elasticity for a doubling of transit times is 0.4, which is lower than the elasticity of 0.8 for a 10% rise in times.

For interested readers, details about the survey and analysis are provided in (1), which also presents analyses of shippers' annual volumes and facility locations that are not described in this paper.

SURVEY

The Center for Business and Economic Research (CBER) at Marshall University implemented the survey between December 1, 2003 and February 25, 2004. The sample was drawn from a list of elevators that was provided by the United States Department of Agriculture (USDA) and supplemented by CBER with contact information from trade associations. The sampling procedure was designed to provide a representative sample without re-weighting while assuring that a proportionate share of sampled shippers are relatively close to the waterway system. In particular, two stata were defined on the basis of whether or not the elevator was located within ninety miles of the Midwestern inland navigation system, and the same sampling proportion was applied in each stratum. A total of 369 completed surveys were obtained, with the sample shares in each statum being within 5 percent of the population shares.

The USDA file contains information on the shipment options at each elevator. We assumed that all elevators have the ability to load and unload trucks. The USDA data identify whether the elevator can ship by barge and/or rail directly from their facility. The percent of elevators that have each shipment option at their facility are given in Table 1, for the USDA list and the sample. Almost one-half of the USDA-listed elevators have only truck as a shipment alternative at the facility. These elevators can use rail or barge only by trucking to the rail/barge loading facilities. The sample contains a smaller share of elevators that have only truck available than is contained in the USDA list, and a larger share of elevators with rail and/or barge available. This difference reflects the fact that one purpose of the study, as described to the respondent when soliciting participation, was to examine mode choice, and a smaller portion of the contacted elevators that have only truck as an option were interested in participating.

Shippers were asked about their annual volumes, revenues, modes used, and other relevant factors about their shipping practices and operations as a whole. The shippers were also asked specific information about one shipment; in order to avoid bias in respondents' choice of which shipment to describe, we asked the shipper to provide information about the last shipment that they made. The commodity, origin, destination, size, modes used, rate on each mode, and transit time for the last shipment were determined. Most of the shipments were corn (219), with soybeans (26), and wheat (54) and a host of other commodities (70) accounting for the rest. The shipments take place from origins throughout in the Midwest and terminate in a wide array of different states.

Table 2 provides statistics on the rates, speed, distance, and size of the sampled shipments, by mode. The differences across modes are generally as expected. Barge movements typically cost less per ton-mile but take longer to travel. Rail shipments costs more than barge but less than truck, on a ton-mile basis. Rail shipments are also faster than barge but slower than truck. Finally, as is well recognized, barge shipments are longer than rail, but both are quite long (over 750 miles on average). Truck shipments, in contrast, are more expensive, faster, and of shorter lengths. Shipment sizes are much larger for rail and barge than for truck.

Of considerable importance to modeling transportation is the identification of shippers' alternatives. The survey instrument was designed to obtain information on the "next-best" alternative that was available to the shipper for its last shipment. After the shipper described its last shipment, the shipper was asked what it would have done if the choice it made for its last shipment were not available. For example, if the last shipment was by barge, the shipper was asked what it would have done if sending the shipment by barge were not an option. The majority of shippers (58%) said that they would use a different mode, without changing origin or destination. About 16% said that they would choose a different origin or destination. More than a quarter of the shippers said that they have no alternatives and would have to shut down. These statistics are consistent with the general observation that switching is more by mode than location, and that many shippers are essentially captive with no viable alternatives. For the shippers who had an alternative (that is, did not say that they would have to shut down), detailed information was obtained regarding the rates, travel time, modes, origin, destination, and size of the shipment for this alternative.

Next, a series of questions was asked regarding conditions that might induce a shipper to switch from its chosen mode and O/D to its next-best alternative. A hypothetical rate increase was randomly selected from the numbers 10%, 20%, and so on up to 60%. For the sake of this explanation, suppose that 40% is selected. The shipper was then asked, "If the rate for your original choice was 40% higher than what you paid, would you make the original choice or the alternative?" The shipper's response was recorded. The same type of question was then asked for a randomly selected increase in transit time. This information provided the data to estimate models of shippers' choice between the chosen and next-best alternative and the importance of rates and time in this choice. The specification of these models is described in the next section.

MODEL SPECIFICATION

The origin, destination, modes, rates, transit time, etc. of the last shipment collectively describe the "chosen alternative." We denote this alternative as 1, with the rates, time, and other attributes of the alternative denoted c_1, t_1, and vector x_1, respectively. The "next best" alternative is denoted as 2, with rates c_2, time t_2, and other attributes x_2. For notational simplicity, we do not denote the shipper, since the same specification is applicable to each surveyed shipper.

The utility that the shipper obtains from the last shipment is U_1, which can be decomposed into a part that depends on observed variables and an unobserved part: $U_1 = V_1 + \varepsilon_1$. The first portion of utility depends on the rates, time, and other attributes of the shipment: $V_1 = V(c_1, t_1, x_1 \mid \beta)$ where β represents the shipper's decision parameters. The decision parameters vary over shippers, reflecting the fact that different shippers place different levels of importance on rates, time, and other factors. The density of these parameters in the population of shippers is denoted $f(\beta \mid \theta)$ where θ represents the parameters of this density, such as the mean and variance of β among shippers. The unobserved component of utility ε_1 also varies over shippers. We assume that it is distributed iid extreme value.

The utility that the shipper would obtain from the alternative shipment is decomposed analogously as $U_2 = V_2 + \varepsilon_2$, where $V_2 = V(c_2, t_2, x_2 \mid \beta)$. Since the shipper did not chose this alternative, we know that $U_1 > U_2$.

Consider now the changes in rates and time about which the shipper was asked. As stated in the previous section, a rate increase was randomly selected from the numbers 10%, 20%, etc. The rate increase that was selected for the shipper is denoted *cp* and called the "rate prompt." The shipper was asked whether it would switch to the alternative if the rates for the last shipment rose by *cp*. The rate for the shipment under this scenario becomes the original rate c_1 times $(1+ cp/100)$. The utility of the last shipment under this new, higher rate is therefore $U_{1,CP} = V_{1,CP} + \varepsilon_1$, where $V_{1,CP} = V(c_1(1+cp/100), t_1, x_1 \mid \beta)$ and the subscript "*1, CP*" refers to alternative 1 with rates higher by the rate prompt. Note that the unobserved component of utility is the same, since all factors other than rates remain the same. Since the higher rates translate into lower utility, $U_{1,CP} < U_1$. In deciding whether to switch in response to the higher rates, the shipper compares $U_{1,CP}$ with U_2. The shipper would switch if $U_{1,CP} < U_2$ and would not switch if $U_{1,CP} > U_2$.

Similar notation and comparisons apply to the increase in transit time. The time increase that was randomly selected is denoted *tp* and called the "time prompt." The utility of the last shipment under this higher time is $U_{1,TP} = V_{1,TP} + \varepsilon_1$, where $V_{1,TP} = V(c_1, t_1(1+tp/100), x_1 \mid \beta)$. The shipper would switch if $U_{1,TP} < U_2$ and would not switch if $U_{1,TP} > U_2$.

We can derive the formula for the probability of each possible outcome to the shipper's choices between these two alternatives, in the original choice and in response to the rate and time prompts. Consider a shipper who is observed to choose alternative 1 over alternative 2 and, in response to the prompts, chooses alternative 2 when the rates for alternative 1 are raised by the rate prompt (i.e., says "I would switch to the alternative" in response to the rate prompt), and chooses alternative 1 when its time is raised by the time prompt (i.e., says "I would not switch to the alternative" in response to the time prompt.) The probability of this event is

$$\text{Prob}(\, U_1 > U_2 \text{ and } U_{1,CP} < U_2 \text{ and } U_{1,TP} > U_2 \,)$$

$$= \text{Prob}(\, V_1 + \varepsilon_1 > V_2 + \varepsilon_2 \text{ and } V_{1,CP} + \varepsilon_1 < V_2 + \varepsilon_2 \text{ and } V_{1,TP} + \varepsilon_1 > V_2 + \varepsilon_2 \,) .$$

Since ε_1 and ε_2 are iid extreme value, the probability conditional on β is

$$p(\beta) = MAX\left[0, \frac{e^{V_{1,TP}}}{e^{V_{1,TP}} + e^{V_2}} - \frac{e^{V_{1,CP}}}{e^{V_{1,CP}} + e^{V_2}}\right]$$

where the 0 in brackets accounts for the possibility that the second term is negative for a given value of β. See (1) for a more exhaustive derivation and discussion of this conditional probability. The unconditional probability is the integral of the conditional probability over all values of β:

$$P = \int MAX\left[0, \frac{e^{V_{1,TP}}}{e^{V_{1,TP}} + e^{V_2}} - \frac{e^{V_{1,CP}}}{e^{V_{1,CP}} + e^{V_2}}\right] f(\beta \mid \theta)\, d\beta \, .$$

Note that even though $p(\beta)$ can be zero for some values of β, it is nonzero for other values, such that P is strictly positive.

The probabilities of other sets of responses are determined similarly. The probabilities are simulated by taking draws of β from its density, calculating the conditional probability $p(\beta)$ for each draw, and averaging the results. See (2), especially section 7.6 on general mixed models. The simulated probability is then used within a maximum likelihood estimator.

In estimation, the portion of utility that depends on observed variables is specified to be:

$$V(c\,,t\,,x \mid \beta) = -\ \beta_c\, ln(c)\ -\ \beta_t\ ln(t)\ +\ \beta_x\, x\, .$$

The negative of the rate and time coefficients, i.e., β_c and β_t, are assumed to be lognormally distributed over shippers. Since the lognormal distribution has support only on positive numbers, this distribution assures that, for all shippers, utility decreases when time or rates increase. The mean and median of the lognormal distributions are estimated. The standard deviation is a function of the difference between the mean and median: a larger standard deviation is associated with a larger difference between the mean and median. The other coefficients in utility, β_x are assumed to be fixed.

Two notes are useful for clarification. First, it is not possible for alternative 2 to be chosen over 1 given our notation. This is not a restriction and does not imply that the shipper is not free to choose either of the two best alternatives. The distinction is simply notational. Consider two shippers who face the same two alternatives as their best two. Label these alternatives *J* and *K*. Suppose one shipper chooses alternative *J* and the other chooses alternative *K*. In our notation, alternative *J* is 1 and alternative *K* is 2 for the first shipper and vice versa for the second shipper. Each shipper chooses alternative “1”. But alternative 1 is different for the two shippers. The probability of choosing alternative “1” incorporates in the numerator of the logit formula the attributes of alternative *J* for the first shipper and of alternative *K* for the second shipper. The rate and time prompts are then applied to whichever alternative is chosen.

The second note relates to the density of the random terms β, ε_1, and ε_2. The probabilities are conditional on the attributes of only the best two alternatives rather than the attributes of all the alternatives that are available to the shipper. This conditioning is consistent with the data: we (the researchers) observe the attributes of the best two alternatives but not the attributes of the other alternatives. However, this conditioning implies that the density of the random terms that is used to calculate the probabilities is similarly conditional. When the attributes of *all* alternatives are observed, the distribution of random terms conditional on the chosen alternative (or in our case, the best two alternatives) can be derived and depends, in general, on the attributes of all the alternatives (see, e.g., (2) Ch. 11.) In the present analysis, however, this derivation is not appropriate since the attributes of all alternatives are not observed, only the attributes of the two best alternatives. An appropriate derivation of the densities under this type of conditioning has not been developed. We treat the density as being the same for all shippers, and we point out that this issue is an important topic for future work.

ESTIMATION RESULTS

Table 3 gives the estimation results. This model was obtained after extensive testing of specifications and variables. We discuss the estimated model first and then briefly describe the other specifications and variables that were tried.

Rates are measured in dollars per ton, and time is measured in hours. Since rates and time enter in log form, their coefficients represent the change in utility for a percent change in rates and time, respectively. The estimated parameters of the distribution of the rate coefficient are highly significant, which indicates, as expected, that rates are an important factor in shippers’ decision-making. The estimated parameters relating to the time coefficient are also highly significant. This result indicates that shippers make their decisions on the basis of transit times in addition to rates. That is, transit time matters in itself, not simply because greater transit times usually translate into higher rates.

The average rate coefficient is about twice that of time (-3.96 compared to -1.92). The median rate coefficient is also about twice as large as the median time coefficient (-3.24 compared to -1.79.) This difference indicates, loosely speaking, that rates are more important than time. Stated more precisely, a percent change in rates has more impact on utility than the same percent change in time.

The standard deviation of a log-normal distribution is equal to $m\sqrt{\left(m/d\right)^2 - 1}$ where *m* is the mean and *d* is the median. The estimated means and medians imply standard deviations of 2.78 for the rate coefficient and 0.74 for the time coefficient. The distribution of time coefficients is “tighter” than that for rate coefficients.

The dummy variables for rail and barge indicate whether the shipment used either of these two modes (either alone or in combination with other modes.) The third mode, truck, is taken as the base, with its dummy normalized to zero. The coefficients of the rail and barge dummies are therefore interpreted as being relative to truck. Both are positive, which indicates that rail and barge would be preferred to truck if the rates and times were the same. The coefficient of the barge dummy exceeds that for rail, which indicates that barge would be preferred to rail if rates and times were the same. Of course, rates and times are not the same on the different modes, such that the coefficient of the dummies do not indicate that, all things considered, barge is preferred to rail and rail is preferred to truck. Rather, the dummies seem to be reflecting a scale effect, namely, that barges hold more than rail cars, and rail cars hold more than trucks. If the modes all somehow had the same rate per ton and transit time, then using the mode that carries more tons is preferable.

Most of the shipments in the survey were corn, wheat or soybeans, but some were for other products. The next parameter in Table 3 is a factor that adjusts the time coefficient for shippers of these other products relative to corn/wheat/soybean shippers. For these shippers, the rates coefficient is multiplied by the exponential of this factor. The value of *exp*(.7972) is 2.22. This estimate implies that shippers of products other than corn, wheat, and soybeans place about twice as much importance on time as shippers of corn, wheat, and soybeans. Since the mean and median time coefficients without this adjustment are about half as large as the mean and median rate coefficients (as described above), the combined results indicate that the mean and median time coefficients for these shippers are about the same as their mean and median rate coefficients.

The last parameter is the coefficient of shipment distance. If the shipper’s last shipment and the next best alternative shipment have the same origin and destination, this variable does not affect the probabilities, since it enters each *V* and thereby cancels out in the logit formula. It only affects the probabilities when the last shipment and the next best alternative have different origins or destinations. The positive coefficient indicates that, if time and rates are the same, shipping a greater distance is preferred. Of course, shipping a greater distance usually entails higher rates and more time. This coefficient indicates that a given rate and time become more attractive as the distance that the rate and time apply to increases. The coefficient is also perhaps reflecting a differential in delivered price. The delivered price of a product is usually higher when the product is shipped further. Therefore, for a given shipment rate and time, the profit that the shipper makes is greater at a distant destination than a closer one.

As stated above, other specifications and variables were tested. In particular, we found none of the following to be significant: (1) differences over commodities in the distribution of the rate coefficient, (2) difference over commodities in the distribution of the time coefficient, other than the differences for non-corn/wheat/soybean shippers that was incorporated into the model, (3) whether the shipper had rail or barge loading facilities (the differences attributable to these facilities are apparently captured directly in the rate and time variables), and (4) shipment size (presumably because size only entered the choice if the best alternative was a different size than the last shipment, which seldom occurred in the survey.)

FORECASTED SWITCH RATES

The estimated model can be used to forecast the response of shippers to changes in rates and time. Suppose, for example, that the rates for each shipper’s last shipment rose by 40%. The model can be used to forecast the share of shippers who would switch to their next-best alternative in response to this rate increase, and the share that would make the same shipment without switching. Table 4 gives the share of shippers in our survey who would switch to their next-best alternative if the rates for their last shipment rose, along with the arc elasticities that are implied by the forecasted level of switching.

If rates for the last shipment were 10% higher, the model indicates that nearly 14% of surveyed shippers would switch to their next-best alternative. This relatively high switch rate is consistent with the fact that many shippers are highly sensitive to rates and will change shipment modes and destinations in response to small changes in rates. The arc elasticity is 1.4 for this magnitude of rate change; for a 20% rise in rates, the arc elasticity is about 1.2.

With larger rate increases, more shippers switch of course. However, even very large rate increases do not induce all shippers to switch. For example, a doubling of rates induces 62% of shippers to switch, leaving 38% that do not switch. This result is consistent with the fact that some shippers are essentially captive, with only very unattractive alternatives. This diversity of shipper response, with some shippers highly responsive to small price changes and others nearly captive, is one of the distinguishing characteristics of the industry.

Table 5 presents switch rates in response to increases in transit times. As expected, fewer shippers switch in response to an increase in transit time than to the same percent increase in rates. For example, a 10% increase in transit time for the last shipment would induce 8% of shippers to switch to their next-best alternative. This switch rate is not at all trivial, and its not being zero indicates that shippers do response to time as well as rates. However, it is less than the 14% switch rate that arises from the same percent increase in rates. The arc elasticity for a 10% increase is time is .8 and for a 20% increase is .7. A doubling of transit time is forecast to induce slightly fewer than half of the shippers to switch.

The above forecasts are for increases in time holding transit rates constant. Usually, an increase in transit times translates into a increase in transit rates, due to the extra labor, fuel, and other factors whose use rises when time increases. Table 6 presents forecasts for increases in times and rates together, with rates raised by an amount that represents the impact of the time increase on rates. For each percent increase in time, rates were raised .5 percent for truck shipments and .3 percent for rail and barge shipments. These proportions were obtained through regression analysis of the rates and times for the surveyed shippers (where the dependent variable was log of transit rates and the explanatory variables were log of transit times differentiated by mode.) The proportion is smaller for rail and barge than for trucks, since fixed costs constitute a larger share of rates for rail and barge than for trucks. Stated alternatively, time-dependent costs constitute a smaller share of total rates for barge and rail than for trucks. Even though we present forecasts based on these proportions, the model can be used to forecast the combined impact of changes in times and any associated changes in rates.

We call the estimated impacts “congestion effects” since congestion causes transit times to rise which in turn causes rates to rise. The first row of Table 6 gives the impact of a 10% increase in transit time for each surveyed shippers’ last shipment. The time increase translates into a 4.4% rise in rates, on average (5% for trucks and 3% for rail and barge, averaged over the survey shipments.) This combined change in time and rates is forecast to induce 14.5% of shippers to switch to their next-best alternative. The arc “congestion” elasticity, given in the last column, is defined as the percent of shipments that switch due to the total effect (on rates and time) of a percent increase in transit times. The arc elasticity for a 10% increase in congestion (i.e., transit times) is 1.45. This is larger, of course, than the arc elasticity in Table 5, which represents the impact of higher transit times holding rates constant.

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REFERENCES

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LIST OF TABLES

TABLE 1 Elevators with Each Shipping Option at Their Facility (percents)

Options	USDA list	Survey sample
Truck only	48.28	41.50
Truck & Barge	1.31	3.46
Truck & Rail	49.12	48.70
Truck & Rail & Barge	1.29	5.96

TABLE 2 Rates, Speed, Distance, and Size of Sampled Shipments by Mode

Choice	Rate per ton-mile (cents)	Miles per hour	Miles	Shipment Size (tons)
Barge	1.19	4.26	863	1740
Rail	3.16	8.64	775	2752
Truck	12.90	34.78	123	25.2
Multi-mode	18.48	28.92	644	27.3

Note: Rates, miles per hour, and miles are averages. Shipment sizes are medians.

TABLE 3 Model of Shippers' Choice between Two Best Alternatives

Parameters	Estimates	Std. err.	T-statistic
Median rate coefficient	-3.2436	0.3750	8.649
Mean rate coefficient	-3.9629	0.5061	7.830
Median time coefficient	-1.7942	0.1649	10.882
Mean time coefficient	-1.9232	0.1841	10.446
Rail dummy	3.7036	0.3313	11.179
Barge dummy	4.7048	1.0167	4.627
Time coefficient factor if not corn/wheat/soy	0.7972	0.1774	4.494
Shipment distance	3.3566	0.5213	6.439

Number of observations: 208
Mean log-likelihood at convergence: -2.40314

TABLE 4 Share of Surveyed Shippers Forecasted to Switch to Their Best Alternative if Their Transportation Rates Rise

Percent rate increase	Percent switching	Arc elasticity
10	13.79	1.38
20	24.53	1.23
30	32.95	1.10
40	39.69	0.99
50	45.18	0.90
60	49.73	0.83
70	53.56	0.77
80	56.81	0.71
90	59.59	0.66
100	62.01	0.62

TABLE 5 Share of Surveyed Shippers Forecasted to Switch to Their Best Alternative if Their Transportation Times Rise

Percent time increase	Percent switching	Arc elasticity
10	8.02	0.80
20	14.86	0.74
30	20.70	0.69
40	25.72	0.64
50	30.05	0.60
60	33.84	0.56
70	37.16	0.53
80	40.11	0.50
90	42.73	0.47
100	45.08	0.45

TABLE 6 Share of Surveyed Shippers Forecasted to Switch to Their Best Alternative if Their Transportation Times Rise and Their Rates Rise Due to the Increased Transit Time

Percent time increase	Percent rate increase, avg	Percent switching	Arc congestion elasticity
10	4.40	14.54	1.45
20	8.81	26.37	1.32
30	13.2	35.85	1.19
40	17.6	43.45	1.09
50	22.0	49.59	0.99
60	26.4	54.61	0.91
70	30.8	58.76	0.84
80	35.2	62.24	0.78
90	39.6	65.19	0.72
100	44.0	67.71	0.68

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

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

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

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

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

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

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

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