SPATIAL DEMAND DECISIONS IN THE PACIFIC NORTHWEST: MODE CHOICES AND MARKET AREAS

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Submission date: July 31, 2005
Resubmitted: November 14, 2005
Word count: 4192 plus 8 tables and figures at 250 each = 6192 words

forthcoming
Transportation Research Record: Journal of the Transportation Research Board
2006

Abstract

Individual transportation demand decisions form the basis for aggregated demand models that the Army Corps of Engineers (ACE) use to evaluate infrastructure improvements. The treatment by ACE planning models has been criticized on the grounds that the demand expressions used are inappropriate. Specifically, the demand models used are perfectly inelastic (to a threshold point) and ignore the spatial market setting in which transportation decisions are made. This paper reports the results of a survey of shippers located on and off the Columbia-Snake waterway in the Pacific Northwest to estimate shipper level demand decisions. The model addresses the concerns about the current ACE planning models by estimating elasticities rather than assuming them and by allowing the probability of using the river to be explained in terms of the spatial setting of the demander. The survey provides choices made in both revealed and stated preference settings. The choice attributes are rate, transit times, and reliability. The revealed and stated preference data are combined to estimate demand functions. The choice model is then used to simulate the likelihood of using the river as a function of shipment distances. To perform these simulations, rates and transit times are fit to distances. These fitted relations are used with the choice model to explain decisions to use truck-barge as a function of distance to the waterway. The choice model provides statistically significant effects of rate, time and reliability on mode choice, and the simulation suggests that as distance from the waterway increases, the likelihood of using the waterway falls.

INTRODUCTION

Transportation demand forms a central feature in the assessment of the welfare effects of transportation infrastructure improvements. The demand functions commonly involve aggregation of the demand functions of individuals located over space. For example, the Army Corps of Engineers (ACE) uses demands that are aggregated to a "pool" level. A pool is a body of water between two identifiable points on the river e.g., a lock, another river tributary, mouth of the river. The ACE planning models define an individual demand by the movement of a commodity from an originating pool to a terminating pool (An "ODC" triple). The welfare benefit from a lock improvement is taken as the cost savings in an equilibrated system over large numbers of these ODC triples. The specific demand quantities at the ODC level are, at least in some models, taken as exogenous and fixed up to the least cost alternative (usually taken as the rail rate). At barge costs above the threshold, all traffic reverts to the alternative.

The demand assumptions have been heavily scrutinized and criticized by Berry et al. *(1)* and the National Research Council *(2) (3)*. The primary criticism lies in the fact that transportation demanders have both modal and market alternatives and that transportation demands should be considered in a spatial setting. Anderson and Wilson [*(4), (5), (6)*] have developed a full spatial model that describes barge market equilibrium in a spatial setting with congestion *(4)*, the effects of modal competition wherein the railroad has pricing power *(5)*, and the measurement of welfare *(6)*. A key feature of the models developed is that ODC level demands are a function of the responsiveness of shippers to distances traveled. In particular, in *(6)* they find that one source of welfare not present in ACE planning models, is the effect of reductions in barge rates on the "extensive" margin for river transport. Simply stated, as barge rates fall on the river, shippers located greater distances from the river who shipped by rail now revert to truck-barge shipments.

The focus of this paper is on the behavior of shippers over a geographical setting and relates directly to the decisions of transportation demanders as distance to market and, in particular, to the river changes. A choice model is developed and applied to agricultural shippers in the Pacific Northwest. As is common in freight transportation demand modeling, demand is framed in terms of rate, but the choices also incorporate transit times and reliability. Unlike most freight demand models, which commonly use time series methods, modal shares, and/or neoclassical production relations (see, Oum *(7)* and Clark et al. *(8)*), the model estimated is choice model that incorporates both revealed and stated preference data. The results find strong evidence that rates, transit times and reliability have an expected and statistically important effect on mode choices. However, underlying rates and transit times, and possibly, reliability are distances from the market. These variables are fit to distance and other variables with auxiliary regressions to evaluate the effects of distance and to estimate the effects of distance to the river on the likelihood of using the river.

Section 2 provides a description of the institutional setting and data used in the analysis. Section 3 describes the empirical model, while Section 4 describes the results. Section 5 describes the likelihood of mode choice and distance, and Section 6 provides closing comments.

AGRICULTURAL SHPMENTS IN THE PACIFIC NORTHWEST

The study applies to agricultural shipments in the Pacific Northwest. As presented by Jessup and Casavant (*9)*, Eastern Washington is one of the primary wheat producing regions in the U.S. and has the largest wheat-producing county (Whitman Country) in the United States. Further, within Eastern Washington, there are 17 grain producing counties of which five account for over 75 percent of the state's production *(9)*.

The region has an interconnected transportation system that consists of a series of rail lines and the Columbia-Snake river basin. Most of the wheat (over 90 percent) produced travels to ocean terminals located in or near Portland *(*9*)* by rail or barge. While wheat can flow to other locations, this is not a prominent tendency. This makes the statistical methods employed much simpler in that it allows a focus on mode choice rather than both modes and location choices.

The data employed in the analysis were collected through a survey conducted by the Social and Economic Sciences Research Center at Washington State University. The survey instrument and methodology is provided and fully described by Jessup and Casavant *(10)*. The survey was pre-tested and reviewed both by academics and target survey recipients. It was conducted in October of 2004. There was a first mailing, a follow-up postcard, and a second mailing. Non-responders were also contacted after the second mailing. The survey was sent to both grain and non-grain shippers. Grain shippers represent the bulk of the population (over 80 percent) and the bulk of the respondents (over 85 percent). There were only two refusals of the 78 firms contacted, and a total of 29 firms that completed the questionnaires, representing a total of 181 of an approximate 391 eligible warehouses. This gives nearly a 50 percent response rate.

Shippers were asked a set of questions that relate to revealed and stated preference demand modeling. In addition, a set of questions provided characteristics of the shipper. Revealed choice information pertains to the last shipment choice made and to the alternatives confronted by the respondent. In this regard, there were six possible choices. These include: 1. Truck to Pasco and Barge to Portland; 2. Truck to another barge port and barge to Portland; 3. Rail to Portland; 4. Truck to a rail terminal and rail to Portland; 5. Barge to Portland; and 6. Other. Shippers were asked what options were available and what choice was made. For each available option, 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 this arrive "on-time" at the final destination. Table 1 describes the responses by option. It is noted that, as expected, the rate per ton-mile by barge is the lowest of all options. It is somewhat unexpected that the transit-times are also lowest. However, it is noted that transit times include scheduling and waiting for equipment. Further, multi-modal shipments require added scheduling, waiting for equipment etc. Finally, movements that involve barge-only or a truck-barge combination yield the most reliable service, while railroad-alone and truck-rail involve the lowest reliability measures.

Insert Table 1

The stated preference questions proceeded as follows. Each shipper was asked what they would have done if the option they choose were unavailable for six months. Table 2 provides a summary of these data. While there are some potential difficulties, e.g., switching to the same alternative chosen, most of these are explained by different truck options, different Ports to the river, etc. A surprising result that was also experienced in an analysis of Upper Mississippi river shippers *(11)* was that 51 of 200 (25%) respondents report they have no alternatives. Of those reporting no alternatives, most of these involve some form of barge shipments (34 of 51) or shipments to other locations (17 of 51).

Insert Table 2

A somewhat different approach from the usual stated preference methodology was used. The usual procedure is that each shipper is confronted with a set of hypothetical choices from which they choose one. In the current study, each shipper was confronted with a randomly drawn increase in rates, transit times, and reliability on their original choice, and asked if they would switch to their next best alternative. The changes in these variables were random and reflected 10, 20, 30, 40, 50 and 60 percent changes. As shown in Table 3, there is considerable switching observed in the data overall, and the rate changes tend to accrue slightly more switching than the time and reliability changes. Specifically, 107 of 140 would switch in response to a rate increase, 98 of 146 would switch in response to a transit time increase, and 93 of 146 would change in response to a reliability decrease. Finally, as is standard, the rates of switching increase with the level of the change. For example, for those that have rate increases of 50 or 60 percent, 68 percent would switch, while those with rate increases of 10 or 20 percent, 51 percent would switch.

Insert Table 3

In addition to the revealed and stated preference information, the survey also provided a set of elevator characteristics. These included the length of time in business, whether they had access to rail and barge loading facilities along with distances to each if they did not have access, number of rail cars that can be loaded, etc. Generally, these organizations have been in business a long time. The average number of years in business was 46 years with about 90 percent in business 10 years or more. In terms of loading facilities, 205 of 206 reported they could load trucks, 91 had direct access to rail, and 25 had direct to barge. It is notable that 11 of 211 had access to all modes, and 106 of 211 had access only to truck. Access to modes is, of course, necessary for some options, and this causes the choice set to vary across the shippers. For example, a shipper with access only to trucking must truck to a river terminal, to rail, or, in one case, to the Portland area terminals. Of the 91 carriers with direct access to rail, the average number of rail cars that can be loaded at a given time is slightly more than eight. More importantly, about 40 percent had rail car capacities of 25 cars or more. This is important in that there are serious decreases in rail rates with increases in shipment sizes e.g., unit car rates are substantially lower than single car rates.

CHOICE MODELING

The data described above follow the tradition of Baumol and Vinod *(12*) and the transportation choice literature formulated by McFadden *(13)* and parallels earlier work of Train and Wilson *(11)*. Baumol and Vinod *(12)* frame transportation decisions as an "inventory" demand decisions. Demand decisions depend on not only rates but also service characteristics such as time in transit and reliability. McFadden *(13)* developed conditional logit modeling in the context of passenger transportation. In this modeling framework, demanders compare random utilities of choice options with different characteristics. Train and Wilson *(11)* employ the choice modeling techniques in a model with rates and service characteristics to estimate freight demands in the Upper Mississippi River Valley. Their model integrated revealed and stated preference survey data to estimate switching behavior across modes and locations. The present study has one primary terminal market, but a number of modes and modal combinations to reach the terminal market and allows a more detailed description of the mode choices and behavior over geographic space.

Following the choice literature, shippers are assumed to pick from a set of options to maximize utility. The utility of a specific option (*j*) is written as U_j where *j* denotes option ($j=1, 2, \dots, J_i$) where *i* indexes the shipper. Note that the choice set depends on *i*. This is because different shippers have different options depending on the availability of loading equipment. U_j is formed with two components i.e., $U_j = V(rate_j, time_j, reliability_j|\beta) + \varepsilon_j$. The first component, $V(rate_j, time_j, reliability_j|\beta)$, is a function of observed factors which represents the deterministic component with an unknown set of parameters (β) to be estimated. The second component, ε_j is the error term which captures all other *unobserved* factors. The shipper is taken to compare utilities across the set of options available and selects that option with the highest utility. Under the assumption that differences in errors are logistic, the probability that option "c" is chosen can be written as:

$$\text{Prb}(c) = \frac{\exp(\beta_c + \beta_r r_c + \beta_t t_c + \beta_{rel} rel_c)}{\sum_j^{J_i} \exp(\beta_j + \beta_r r_j + \beta_t t_j + \beta_{rel} rel_j)} \qquad (1)$$

where *r*, *t*, and *rel* stand for rate, time and reliability attached to each option, and β_r, β_t, and β_{rel}, represent the parameters of *V* to be estimated. In this application, the parameters are fixed across individuals, and rates, time and reliability are different across options and shippers. Finally, not all shippers may have the same set of alternatives so that the choice set it indexed by the individual (J_i).

This is the standard setup to estimate a random utility model. It can be applied directly to the revealed preference data described earlier. However, in the survey there are three different stated preference questions that can and should be used in the estimation. Specifically, each respondent that had an alternative was confronted with three additional choices that relate to a randomly drawn increase in rates and transit times and a decrease in reliability. Given the changed setting, the respondent would then be given a chance to switch or not to another alternative. The result then provides four choices for each respondent-the revealed choice, and each of the stated preference responses. Attached to each of these choices are different sets of rate, time and reliability. The resulting data set can be estimated in the same manner as a standard conditional logit.

EMPIRICAL RESULTS

The results of the logit model are provided in Table 4. Five different sets of estimates are presented. These include results based on only revealed data, one for each of the three different stated preference data, and one for all data. As one might expect, the pseudo-R^2 is greatest for the revealed preference model. All attribute coefficients are of the correct sign and of roughly the same magnitude across specifications. The coefficients reflect the effect of the associated variable on utility. A positive (negative) coefficient means that utility is increased (decreased) by an increase in the variable. For example, for a given alternative, if the rate increases and the coefficient is negative, then that option will give less utility and, therefore, be less likely to be chosen. The estimated coefficient of rates is negative in all models and is statistically significant in three of the five models. The estimated time coefficient is also negative as expected, but the results appear to be relatively noisy in that it is only significant in the combined data. Finally, the estimated coefficients for reliability are positive, as expected in all models and are statistically significant in four of the five specifications.

Insert table 4

The results are relatively stable across data subsets, and the combined data give strong statistical results. Thus, the remainder of the paper is based on these results with one modification. Specifically, the first four columns Table 4 represent the results on four subsets data delineated by revealed versus stated preference data. Column five is a restricted version of these first four models wherein the coefficients are restricted to have common values. That is, the revealed and each of the stated preference models have the same values. This restriction can be tested by estimating each of the first four models separately and then testing whether the models estimating separately (the unrestricted model) are different from the pooled model (the restricted model). The test can be performed with a likelihood ratio test. The unrestricted log-likelihood value is simply the sum of the values for the first four columns. The restricted model is in column 5. The result leads to a chi-square statistic of 43.66 that suggests that there are statistical differences across the two models. A key differentiating factor in the models is the use of revealed and stated preference data. To reflect the differences, a model was estimated in which the alternative specific constants were allowed to be different in the revealed and stated-preference choices. The results are in the final column of the table (where the stated-preference constants are omitted to save space.) The same pool test between the unrestricted model (the first four columns) and the restricted model (column 6) yields a chi-square statistic of 10.6 which is less than the critical value of 36.42 with a five percent level and 24 degrees of freedom.

As discussed above, the coefficient estimates can be regarded as scaled effects of the variables on utility. In this case, utility is a direct function of profit. As such, the findings suggest that increases in rates and transit times reduce profits of shippers, while improvements in reliability increase profits. In these models, alternative specific dummies are measured relative to a base option. In this case, the base option is relative to option 2 (truck to a river port other than Pasco and barge to the Portland area). That is, a positive value means higher profits than option 2 *given all else is identical* i.e., rates, transit times, and reliabilities are exactly the same. In this regard, all options except for rail to Portland yield lower profits than truck to a river port and barge to Portland. This means that the unobserved factors associated with rail to Portland yield higher profits than the other options.

The elasticity of demand with respect to rates is of central interest to planners. To this end, elasticities were calculated at each point in the sample for each option and are reported in Table 5. The elasticities do vary and vary substantially across the options and through the sample. The most “elastic” is option 1 (Truck to Pasco and Barge to Portland). A one percent increase in the rate, reduces the probability of shipping via this option an average of 1.27 percent in the sample. However, there is a significant range in elastcities (-2.15 to -.63). In contrast, the “least” elastic option is that of barge traffic. The average elastiticity is only -.24 and the range is quite small (-.37 to -.05). It seems clear from the results that barge demands for shippers on the river are relatively inelastic. Shippers that use truck to access rivers are relatively more elastic, and the nature of this finding is described in the next section.

Insert Table 5

AUXILLARY REGRESSIONS – RATES, TIME, AND RELIABILITY

In this section, a simple model of rates and transit times is estimated with the express purpose of integrating the logit results into a model of transportation infrastructure. The result can then be used to examine the likelihood of using the river as a function of distance to river.

To frame the calculations, two shipment options are considered. Both shipment options terminate at the same location (a terminal point). Each shipper in the space has two options. They can ship either by truck-barge or by rail to the terminal point. However, shippers are located off-river, and if they use truck-barge, they must use truck to get to the river port and then barge to terminal market. They are assumed to have direct access to rail shipments. The geography of this exercise is in Figure 1. There is one river port located *d* miles from the terminal point. Shippers are considered as located on a vertical line from the river port such as Shippers A and B in Figure 1. The basic idea is that Shipper A is located closer to the barge access and should, therefore, be more willing to use Truck-Barge relative to Shipper B. Rail distances are calculated using the Pythagorean Theorem i.e., rail distance = $(d^2\text{+distance to port}^2)^{1/2}$.

Insert Figure 1

There are a total of four regressions that provide estimated rates and transit times for each option and for each shipper located in the space. These regressions were conducted with the data described in the previous section. A double log specification of rates and transit times to distance and the percentage of truck miles in the total movement were fit from the survey data for truck-barge rates and times and to distance for rail rates and times. The results are in Table 6. Generally, the regressions are as expected. The one exception is for rail rates. The coefficients are of the correct sign, but the regression is not statistically significant. This may be due to the fact that there is not enough variation in rail distances and/or distance is not a good predictor of rail rates in this market. In other cases, the signs are correct, and for the most part statistically significant. Using the parameter estimates, rates and times are calculated for each option (Truck-Barge to the Terminal Port and Rail to the Terminal Port). Reliabilities were used at sample averages of 90 percent for Truck-Barge and 63 for Rail.

Insert Table 6

Probabilities were then calculated using the model and coefficients of the last section. In this experiment, the only source of change is the location of shippers. As shipper locations move north, shipment distance and truck distances both increase. From the Truck-Barge regressions, this puts upward pressure on rates and transit times. Rail distances also increase but only modestly in comparison to Truck-Barge. Relative small increases in distance coupled with a relative small “coefficient” that relates rates to distance, causes only small increases in rates. Nevertheless, the rates for both modes do rise.

The modal mode choice probabilities as a function of the distance to river are provided in Figure 2. As expected, shippers located near the river tend to prefer Truck-Barge movements. The high cost truck movement is relatively short and offset by the savings of going by barge rather than rail. Further, transit times and reliability each favor shipments by Truck-Barge than by Rail. The intercept is somewhat low, but is explained by the fact that, given all else is the same, shippers have a preference for rail. This preference is reflected by the positive sign on the rail coefficient in Table 2. This means that utility *given all else* is higher for rail to Portland than for truck to other and barge to Portland. It is noted that this coefficient is not precisely measured and is not statistically different from zero. Nevertheless, the preference is offset for shippers close to the river due to lower rates (a greater proportion of barge miles instead of truck miles). Thus, near the river, shippers prefer barge, and continue to prefer barge, out to about 100 miles. In this example then the estimated market area or gathering area, defined as the area in which truck-barge is preferred to rail, is about 100 miles.

Insert Figure 2

FINAL COMMENTS

ACE planning models have traditionally and often used demand functions that hold quantities constant up to the least cost alternative (most typically rail). Anecdotally and theoretically, however, if barge rates fall, say due to a lock improvement, it may induce shipments from off river. In this paper, a choice model is estimated and used with a set of auxiliary regressions that allow the decisions of off-river shippers to use truck and barge as opposed to rail.

The choice model is based on McFadden's *(13)* random utility model wherein shippers choose from a set of options with different characteristics to maximize utility. The characteristics used include rate, transit times, and reliability. The model estimated combines both revealed and stated preference data from a survey of Pacific Northwest shippers. The estimates suggest some flexibility in demand decisions and that all three characteristics (rates, transit times, and reliability) all have statistically significant effects on choices. The results also suggest there are a number of unobserved characteristics that have important effects in that these characteristics may require non trivial changes in the observed variables to induce shippers to make different choices.

A simple transportation network was employed to illustrate how shipper demand decisions vary with distance from the river. The results suggest that shippers located close to the river are more likely to use the river as opposed to rail, and that as distance from the river increases, shippers do switch to rail.

The results of the study provide strong evidence that there is flexibility in demand decisions and that there is a spatial component to the flexibility. The specific form of space considered in this paper relates to inducing movements from the hinterland. While the results suggest that there may be some substitution, the simulated results provided in Section 5 suggest that there are important unobserved factors at work. Uncovering these factors is the next stage in this line of research. In addition, as noted by Anderson and Wilson *(4)*, there may also be substitution within the waterway. To the authors' knowledge, there has been no empirical research examining this form of substitution. Finally, the paper focused entirely on choices amongst discrete options. However, individual shippers may also adjust production plans in response to transportation cost changes. Train and Wilson *(11)* examined this area in the Upper Midwest and found small but still significant effects.

Currently, there are a variety of efforts to evaluate the effects of incorporating such structures into the planning models. However, ACE models are currently operated at a system-wide basis. That is, an improvement to one lock theoretically affects the entire system. The definition of equilibrium in such settings has been theoretically examined in a series of papers by Anderson and Wilson *(4), (5),* and *(6)*.   There has also been considerable empirical research, e.g., Train and Wilson *(11)* designed to improve and/or assess demand modeling in the markets. This latter is necessary to numerically assess welfare effects in the equilibrium and planning models.

ACKNOWLEDGEMENTS

This research was conducted under the Navigation Technologies Research (NETS) program. The authors gratefully acknowledge a number of discussions with Kenneth Casavant, Eric Jessup, and Keith Hofseth.

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List of Tables and Figures

Table 1 Revealed Choice Data Summary

Option	N	Available (% yes)	Choice (% of total)	Rate (per tonmile)	Time (days)	Reliability (%)
Truck to Pasco-Barge to Portland	120	61.3	7.3	5.05	11.2	77.3
Truck to Port-Barge to Portland	107	54.7	32.7	4.2	4.1	90.5
Rail to Portland	65	33.4	16.1	3.7	10.4	63.2
Truck to Rail-Rail to Portand	95	50.9	13.7	4.2	11.3	73.0
Barge to Portland	22	12.3	8.3	2.6	1.09	88.1
Other	12	11.8	21.9	13.1	4.4	90.1

Table 2 Revealed Choices and Next Best Alternative

Alternative	Original Choice						
	1	2	3	4	5	6	Total
1	1	4	13	13	1	0	32
2	0	14	10	5	1	3	33
3	0	5	0	1	2	3	11
4	7	9	4	0	1	4	25
6	4	11	6	9	2	16	48
7	3	21	0	0	10	17	51
Total	15	64	33	28	17	43	200

Option	Description
1	Truck to Pasco-Barge to Portland
2	Truck to Port-Barge to Portland
3	Rail to Portland
4	Truck to Rail-Rail to Portland
5	Barge to Portland
6	Other
7	No Alternatives available

Table 3 Switching Behavior

% Change	N	Rate	Time	Reliability
10	23	10	11	11
20	22	13	11	9
30	35	28	28	24
40	24	17	17	15
50	38	25	29	23
60	19	14	11	11
Total Switches/ Total Responses	161	107/140	98/146	93/146

Table 4 Coefficient Estimates

Parameter	Revealed	SP-Rate	SP-Time	SP-Reliability	Combined	Combined/Dummy
a_1	-1.742*	-0.353	-0.327	-0.268	-0.494*	-1.711*
	(0.55)	(0.39)	(0.39)	(0.39)	(0.19)	(0.467)
a_3	1.075*	-1.049**	-0.550	-0.654	-0.275	0.593
	(0.51)	(0.61)	(0.56)	(0.50)	(0.25)	(0.42)
a_4	-0.674**	-0.624**	-0.775*	-0.752*	-0.680*	-0.765*
	(0.40)	(0.38)	(0.37)	(0.37)	(0.19)	(0.37)
a_5	-0.456	-0.726	0.134	0.183	-0.273	-0.174
	(0.78)	(0.79)	(0.88)	(0.87)	(0.40)	(0.67)
a_6	-0.596	-0.556	-0.501	-0.535	-0.564	-0.599
	(1.06)	(1.21)	(1.27)	(1.30)	(0.57)	(0.93)
Rate	-0.125*	-0.079*	-0.075	-0.065	-0.085*	-0.082*
	(0.06)	(0.04)	(0.07)	(0.06)	(0.03)	(0.026)
Time	-0.034	-0.024	-0.010	-0.026	-0.034*	-0.264**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)	(0.015)
reliability	0.032*	0.018**	0.018**	0.005	0.011*	0.013*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Log-Likelihood	-62.8	-70.6	-73.8	-75.9	-304.93	-288.4
Pseudo-R	35	14	12	10	12	17

Note: A * and a ** indicates statistical significance at the 5% and 10% level, respectively
Stated preference dummies are not reported to conserve space.
The parameters labeled a_1, a_3, a_4, a_5, and a_6 are the alternative specific dummies. They apply as follows:

1=Truck to Pasco-Barge to Portland
2=(base) Truck to Other River Port-Barge to Portland
3=Rail to Portland
4=Truck to Rail Terminal-Rail to Portland
5=Barge to Portland
6=Other

Table 5 Elasticity Estimates by Option

Variable	N	Mean	Std. Dev	Min	Max
Truck to Pasco - Barge to Portland	77	-1.27	0.34	-2.15	-0.63
Truck to Other River Port-Barge to Portland	58	-0.50	0.35	-1.47	-0.03
Rail to Portland	44	-0.49	0.47	-2.89	-0.02
Truck to Rail Terminal - Rail to Portland	76	-0.86	0.40	-3.02	-0.14
Barge to Portland	12	-0.24	0.12	-0.37	-0.05
Other	8	-1.05	0.84	-2.25	-0.07

Table 6 Auxiliary Regressions

Model	Rate-Trk/Brg	Rate-Rail	Time-Trk/Barge	Time-Rail
Constant	-0.161	2.30*	-7.152*	1.33**
	(0.532)	(0.275)	(1.5)	(0.797)
Distance	0.505*	0.054	1.41*	0.138
	(0.090)	(0.047)	(0.250)	(.137)
% Truck Distance	0.089*	NA	-0.090	NA
	(.030)		(0.085)	
R-Square	32	2	23	32
N	106	61	108	63

Figure 1 Simulation Geography

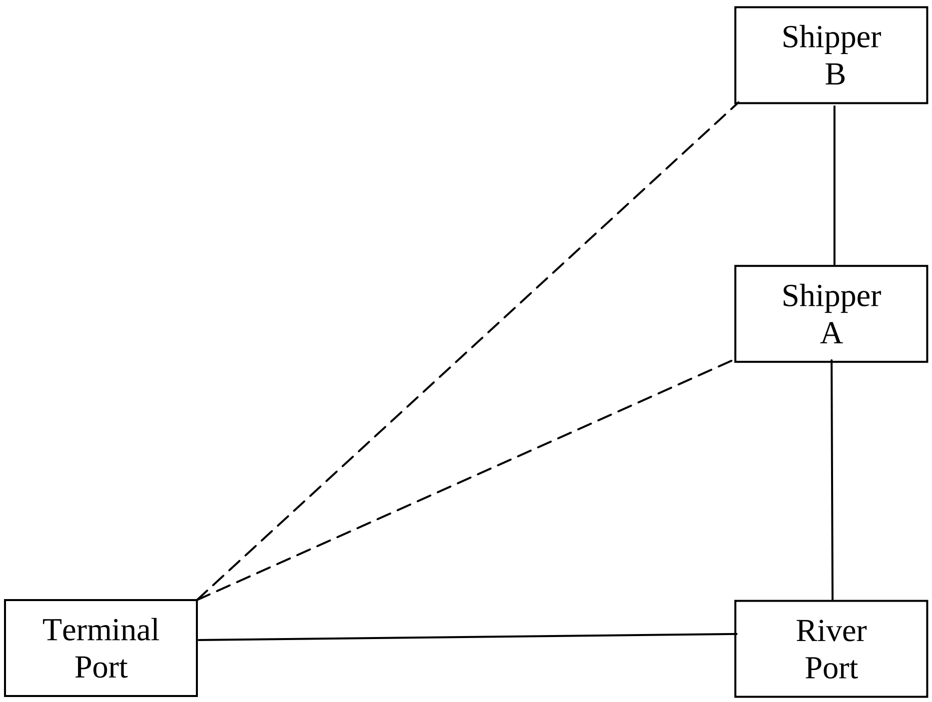

Figure 2 Distance to River and Mode Choice