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Title: Measuring the Non-Pecuniary Costs of Triple Trailer Operation in Oregon: A Contingent Valuation Approach

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The purpose of this study is to measure the costs of the perceived safety threat from triple trailer operation in Oregon. This is done using the political referendum model of a common non-market valuation technique, contingent valuation. Specifically, the average cost of allowing triples will be found so that comparison with previously estimated benefits will provide a measure of net social welfare associated with triple trailer use.

The data were collected through in-person interviews conducted in five regions in Oregon. Questions relating to the respondents' attitudes toward triple trailer trucks, driving experience, education and other demographics were asked. The empirical model estimates the probability that respondents will vote to ban triple trailers.

The results of this study suggest that there are concerns about the safety of triple trailer operation.

However, there seem to be still greater benefits; a result which is consistent with the recent ballot measure.

Measuring the Non-Pecuniary Costs of Triple Trailer Operation in Oregon: A Contingent Valuation Approach

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INTRODUCTION

The State of Oregon is one of sixteen states that currently allows the operation of triple trailer trucks for freight transportation. An initiative to ban triples from Oregon highways was proposed to voters in November 1992. This suggests that there are perceived costs to triple trailer use, the magnitude of which is unknown. One reason is that these costs tend to be non-pecuniary. The purpose of this study is to quantify the largest of these, the perceived safety threat from triple trailers, using the political referendum model of the contingent valuation method. There is evidence that there are considerable benefits to triple trailer operation (EAI, 1977). If estimated costs are less than benefits an argument may be made for allowing triples in all states, thus improving transportation efficiency.

BACKGROUND

A triple is generally described as a tractor pulling three semi-trailers of approximately equal length. The maximum size allowed in Oregon is 95 feet overall length and 105,500 pounds. Most of the triple trailer traffic in Oregon runs between Portland and Salt Lake City along Interstate 84. Traffic flows fairly smoothly here as states along this route (Idaho, Nevada and Utah) also allow triple trailer use. However, since neither Washington nor California allows triple trailer operation freight transportation along the I5 corridor is less efficient.

There two major issues to triple trailer use; safety and cost. Several states have studied safety issues but the consensus in the literature is that these have been based on poor quality data and results are undefensible. It has been suggested that longer combination vehicles (LCV's) as a group have higher accident involvement than traditional tractor semi-trailers, (McCarthy, 1993) but triple trailers have not been separated from the larger category.

Triple trailer use clearly allows more freight to be hauled. However, there have been no systematic comparisons of costs of operation between triples and other configurations. Triple trailers may incur more

system costs than doubles, but it depends on the exact configuration. Damage to the highways increases with weight per axle. However, current laws tax truck transportation by the axle; a regulation which encourages trucks to configure with as few axles as possible. Some of the single trailer, few axle configurations carry more weight per axle than triples. Therefore, if current taxing regulations were changed to an equivalent single axle load (esal), triple trailers may be no more damaging to the roads than other configurations. (Winston, et al, 1989)

THEORY

Many things deemed valuable by individuals are never traded in the marketplace. Dams, flood control projects and interstate highways, for example, are rarely produced by private producers. Because of the nonrivalness or nonexcludability of these goods private producers are unable to capture all benefits associated with their production and so choose not to produce them. Usually the government intervenes to produce these goods. In other cases goods that are privately produced have additional costs or benefits associated with their production which are not reflected in the market price. Again the government then regulates the production of these goods.

Market failures such as these help explain why government policy exists. Under these circumstances the good is either over- or under-produced. Society's resources are being misallocated. The government, as society's representative, intervenes to assure that social welfare is maximized, i.e. that society as a whole is as well off as possible.

The ideal way to measure social welfare gains is by the rule of Pareto optimality. This rule states that society is better off if a project or regulation makes at least one person better off and no one worse off.

However, increasing social welfare generally occurs at someone's expense. Therefore Pareto optimality has been refined to the Kaldor-Hicks compensation principle. If gainers from a particular project or policy could, in theory, compensate losers and still come out ahead, there is a net benefit to society of proceeding with the project. This is the reason for measuring non-market valued costs; to compare with measured benefits to assess social welfare changes. While this analysis can measure net social welfare changes, it cannot compare changes in individuals' utility. Who pays the costs or which groups receive the benefits is not considered, though often such information is precisely what is desired by policy makers. This is, therefore, analysis based only on efficiency criteria which offers no assistance for equity or distributional questions associated with this issue.

There are measurable benefits associated with operating triple trailers. There are fewer trucks on the road. Triples are more fuel efficient than other configurations as more goods are shipped using a single tractor. These lower costs per unit translate into lower prices, for consumers of transportation services and of the final transported goods. Another benefit of triple trailer operation is the reduction in pollution emissions, although this is not market valued. Economic Applications International (1977) estimates the total benefits of

triple trailer operation in Oregon to range from $84 million to $398 million per year.

There are also costs associated with triple trailers. There are efficiency losses in the transportation system from differing regulations between states. The biggest cost is the perception that triple trailers are unsafe. Many drivers are fearful of driving near or passing triple trailer rigs at highway speeds. This fear costs drivers their peace of mind. If, when weighing all the costs and benefits together, there are net benefits to society of allowing triple trailers in Oregon then there is an argument for extending their operation into other states. Even Oregon benefits might rise if Washington and California also allowed triples. This result would seem to depend, though, on the value people place on the perceived decline in safety caused by triples. The next section of this paper will present one way to value this perceived safety threat by soliciting preferences from a sample of the general public.

CONTINGENT VALUATION

Contingent valuation (CV) is a method frequently used to estimate the value of something which is not traded in markets. This technique involves creating a hypothetical market (a contingent market) through which survey respondents can reveal their value for a good through "purchase" decisions. Though most often used to estimate values for natural resources or other environmental amenities, this technique can also be used to measure the value of a policy change.

The traditional measure of benefits in economic theory is consumer surplus. Measured using the Marshallian (ordinary) demand curve, consumer surplus represents the difference between what consumers were willing to pay and the market price for a particular good. When public goods are the goods in question, the price is assumed to be zero. Hence the consumer surplus for public goods is the area under the ordinary demand curve. However, Marshallian demand holds income constant but allows changes in consumers' utility levels as relative prices of goods change or as quantity of public goods provided changes. There are two effects of such price and quantity changes. The income effect measures how much more (or less) purchasing power the consumer has when the

price of the good falls (rises) while the substitution effect measures how the good will be substituted for other goods as relative prices change. These two effects mean that use of Marshallian consumer surplus as a measure of benefits is not completely accurate because it does not allow isolation of the dollar effects of price or quantity changes. The Hicksian measure of demand (compensated demand) nets out the income effect while holding utility constant and is, therefore, the correct demand measure to use in contingent valuation studies. (Mitchell and Carson, 1989)

Hicksian welfare measures fall into one of eight categories depending on the initial property rights endowment. Assuming the consumer currently has the right to the initial utility level, the consumer may be required to pay for, or may be compensated for, a change in the good. Alternatively, if the consumer is entitled to the new utility level that would result from a change in price or quantity he may also be required to pay or receive compensation for not allowing price or quantity to change.

The choices between compensating or equivalence measures, surplus or variation measures and between willingness to pay (WTP) or willingness to accept (WTA) depend upon the property right endowment and the chosen structure of the CV project. This study uses WTP format to assess compensating surplus. It is assumed that

banning triple trailers would lead to a perceived increase in the level of highway safety. Consumers are asked their WTP to acheive this change while maintaining their current utility level. This is consistent with compensating measures which assume that consumers are entitled to their current level of utility. (Mitchell and Carson, 1989) WTP is the amount of money the consumer would be willing to pay to get the change in quantity (to ban triple trailers, thus increasing perceived safety) while remaining at the same level of utility. A survey instrument is used to solicit the values for consumers' willingness to pay for the increase in perceived safety.

SURVEY METHODOLOGY

There are three commonly used techniques for asking the survey questions: iterative bidding, the payment card and dichotomous choice. Each of these has biases associated with it. Iterative bidding offers the respondent an initial dollar amount as a value for the resource. This value is either accepted or rejected. If accepted, the offered value is increased until a maximum bid is reached. If the initial bid is rejected, the offered bid is decreased until one is accepted. The maximum dollar amount accepted is taken as the value of the resource or policy. Iterative bidding, however, is subject to starting bias. The initial bid may serve as a point of reference for the respondent, influencing his responses to increases or decreases without actually being a measure of his preference for the resource.

The payment card method presents the respondent with a range of values from which to choose. These are arranged to begin at zero and increase at fixed intervals. The respondent chooses the range that includes the dollar amount he is willing to pay to have the resource. Because the resource/policy is not valued in markets already, there may be a large number of non-responses as respondents may be unable to assign a value in dollar

terms. In addition, there may be protest responses. If respondents feel that the resource should never be "sold" they may respond with answers like "a million dollars". These answers are not usually true valuations as the respondent is not able to pay a million dollars for the public good.

The most generally accepted technique is dichotomous choice using the political referendum model. This method presents the respondent with a hypothetical ballot question containing the valuation bid. The respondent is asked to vote yes or no on the offered question. This technique was chosen for its realism as it paraphrases the recent Oregon ballot measure. Since this is a take-it-or-leave-it option the proffered bids must vary across the sample. Statistical techniques are then used to estimate the actual valuation. Although this technique is relatively easy for the respondent to answer, there are problems associated with it. To achieve the same statistical accuracy that the other methods achieve, many observations are required. Also, there may be a problem with "yea-saying". This is the tendency for respondents to agree with what the interviewer asks whether or not that reflects their true views. There may also be protest responses arising from the non-market valued nature of the good. Respondents feel unable to answer a question about paying for a good which is not traded currently.

Following the recommendation of the NOAA panel report on contingent valuation (1993), interviews for this project were conducted in person. However, there are limitations to this method. Training interviewers to make interviews identical is time consuming and difficult to monitor. There are interviewer effects on the respondent that may bias the data. In addition, many people refuse to give income information or to take the interview seriously.

Two hundred sixty-two interviews were conducted in five regions in Oregon; Portland, at rest areas along Interstate 5, Corvallis and Albany, Newport and Bend. Interviewers approached people at random in public areas such as parks but this was not a fully random sample due to time and monetary constraints. Two hundred of the surveys were completed, an effective response rate of 76.3%. Most of the incomplete responses were refusals to answer the income question. Fifty-five percent of respondents were men. The average income of the respondents was $40,800 per year and on average they had some education beyond high school. Forty-two percent of the respondents voted to ban triple trailers. (see Table 1) This is slightly higher than the results of the 1992 ballot measure when 39% voted yes. This sample was not designed to repeat the vote. Respondents were not asked if or how they had voted on the ballot measure.

Therefore, differences in the resulting percentages will occur. Other questions asked respondents their feelings about triple trailer safety, their driving experience, whether they were aware of the ballot initiative, and other demographic data. The survey instrument is reproduced in Appendix 2.

Completion of the surveys leaves the researcher with data containing demographic information and preferences. These can be analyzed using econometric models such as maximum likelihood estimation of a logit model, described below.

Table 1: Distribution of Votes by Bid Amount

Bid Value	No Votes	Yes Votes	% Yes Votes
$1.00 - $5	2	4	67
$5.01 - $10	8	12	60
$10.01 - $15	10	8	44
$15.01 - $20	10	6	37.5
$20.01 - $25	9	15	62.5
$25.01 - $30	11	7	39
$30.01 - $35	16	3	16
$35.01 - $40	9	7	44
$40.01 - $45	11	6	35
$45.01 - $50	10	2	16.7
$50.01 - $55	4	4	50
$55.01 - $60	0	3	100
$60.01 - $65	0	0	0
$65.01 - $70	3	1	25
$70.01 - $75	4	1	20
$75.01 - $80	2	1	33

Table 1, cont.

Bid Value	No Votes	Yes Votes	% Yes Votes
$80.01 - $85	2	0	0
$85.01 - $90	3	1	25
$90.01 - $95	0	2	100
$95.01- $100	1	1	50
> $100	1	0	0

THEORETICAL MODEL

Maximum Likelihood Estimation (MLE) is a method for finding the estimators which maximize the probability of observing a particular sample. For example, a random variable, X, has a probability distribution f(X) which is characterized by some vector of parameters, θ. If a random sample of X's is observed then the MLE of θ is the particular vector θ_{MLE} which maximizes the probability of obtaining the sample observed. A likelihood function ($L(\theta)$) of this sample, ie the probability of this sample occuring, is the value of the joint density function of the random variable, X, at the point of the observed sample.

$$L(\theta) = f(X_1, X_2, \ldots, X_n; \theta) \qquad (1)$$

or

$$L(\theta) = \prod_{i=1}^{n} f(X_i; \theta) \qquad (2)$$

Maximizing this likelihood function with respect to the parameters in θ and solving the resulting equations for those parameters will result in maximum likelihood estimates of the parameters of the model. In most cases it is computationally easier to estimate the log of the

likelihood function and then maximize this. The specific form of the log likelihood function depends on the form of the joint probability distribution, f(X). In this case the logistic distribution was chosen and so a logit model was used.

Logit is a model used for estimation of data with qualitative rather than continuous dependent variables. The dependent variable is discrete, taking on values of 0 or 1. In this study the dependent variable is the yes/no response to the referendum question. The model therefore, will analyze the probability that a respondent will vote yes to a triple trailer ban. Beginning with an indirect utility function

$$u(M,q,C)$$

let

M = income

q = the quantity of perceived safety

C = a vector of individual characteristics

T = the offered bid

A respondent will vote yes if the utility associated with the new quantity at the offered bid equals or exceeds that of the old quantity.

$$u(M - T,q^1,C) - u(M,q^0,C) \geq 0$$

The probability of a yes vote is given by

$$P(Y) = P(v(M - T,q^1,C) + \epsilon_1 > v(M,q^0,C) + \epsilon_0)$$

where v(.) is the observable component of utility and ϵ_i,

i=1,0, is the random component. Because this is a logit model this random component of utility is assumed to have a logistic distribution and therefore the probability of a yes vote can be written

$$P(Y) = (1 + e^{-\Delta v})^{-1} \quad (3)$$

where

$$\Delta v = X_i\beta \quad (4)$$

The underlying model can then be defined by

$$Y_i^* = \beta X_i + w_i$$

where w_i is a vector of random errors. Y_i^* is the difference in utility between having triple trailers and banning triples but paying higher prices. Y_i^* is unobservable.

The dummy variable Y is defined as

$$Y=1 \text{ if } Y_i^* > 0, \text{ else } Y=0$$

The probability, then, that a respondent will vote yes is

$$\begin{aligned} P(Y=1) &= P(Y_i^* > 0) \\ &= P(w_i > X_i B) \\ &= F(X_i\beta) \end{aligned}$$

where $F(X_i\beta)$ is the cumulative distribution function for the error, (w_i), evaluated at $X_i\beta$.

Recalling the general format for the likelihood function from equation (2), $f(X_i)$ can be defined for binary choice models such as logit.

$$f(X_i) = P_i^{Y_i} (1 - P_i)^{(1 - Y_i)} \quad (6)$$

Substituting the above definition of P_i the likelihood function becomes:

$$L = \prod_i F(X_i\beta)^{Y_i} [1 - F(X_i\beta)]^{(1 - Y_i)} \quad (7)$$

and the log likelihood function is

$$lnL = \sum [Y_i \ln F(X_i\beta) + (1 - Y_i) \ln [1 - F(X_i\beta)]] \quad (8)$$

The distribution function, $F(X_i\beta)$ in this case is the logistic distribution.

$$F(X_i\beta) = P_i = [1 + e^{-(X\beta)}]^{-1} \quad (9)$$

Equation (9) implies that:

$$[1 - F(X_i\beta)] = [1 - P_i] = (1 + e^{+X\beta})^{-1} \quad (10)$$

Substituting equations (9) and (10) into the log

likelihood function (8) and maximizing this expression will result in parameters which describe the probability that a survey respondent from this sample will vote to ban triple trailers.

In the logit model the goodness of fit measure (R^2) commonly used in linear regression models is not appropriate. An alternative measure is one based on likelihood ratios. This tests the null hypothesis that a model with all slope parameters set equal to zero explains the variation in the dependent variable better than the full model. The test statistic is distributed Chi squared with k degrees of freedom, where k is the number of independent variables in the model. The likelihood ratio test statistic is:

$$D = -2LLR = -2\ln\left(\frac{L0}{L1}\right) = -2(\ln L0 - \ln L1) \qquad (11)$$

where

L1 = maximum value of the likelihood function for the full model

L0 = maximum value of the likelihood function if all slope coefficients are zero

LLR = log likelihood ratio

If D is greater than X^2_c, the null hypothesis is rejected. (Brown, 1991) Results of this test are described in the next section.

Calculating average values for the independent variables is computationally complex but follows statistical theory. It is of particular interest for this study to obtain the average value for the WTP variable. This amount will reflect the average cost of the perceived threat from triple trailers. Comparison of this average to estimated benefits of triples will allow estimation of net social welfare associated with triple trailers.

One method for obtaining the average values follows that of Freeman, (1993). A bid function can be derived from the expenditure function which describes how the respondent responds to the offered bid given the change in quantity and the initial utility level. In other words, the respondent will vote to ban triple trailers if his value for the increased level of safety, at the same utility, exceeds the amount that this increase will cost him. The probability that this respondent will vote yes is then the probability that the observable part of the bid function exceeds the cost which is the cumulative distribution of the bid variable. The expected value of the c.d.f. can be obtained through integration. However, this method is sensitive to extreme values in the distribution of the bid variable. With this data the distribution is not adequately defined and so the method is inaccurate. An alternative method follows Hanemann, (1984), and focuses on the median bid value. This median

value can be obtained by finding the point at which the average respondent is indifferent between voting yes and no. The point where the average respondent is indifferent to voting yes or no is where P(Y) = 0.5. Recalling the probability of a yes vote (equations (3) and (4)), this time the $X_i\beta$ are the average values for each of the independent variables in the original model multiplied by the coefficients derived from the model estimation. Since WTP is the variable of interest, it is left as the unknown and the equation to be solved is

$$0.5 = (1 + e^{X\beta})^{-1} \qquad (12)$$

The resulting value is reported in the Results section and compared with estimated benefits of triple trailer trucks. The next section describes the estimation of the logit model presented as equation (4).

EMPIRICAL MODEL

The logit model (eqn. 4) was estimated with the $X_i\beta$ defined as follows:

b_0 + b_1 STATE + b_2 YEARS +b_3 ACCTYPE + b_4 HOSP +

b_5 CARTYPE + b_6 HMILES +b_7 SEEN + b_8 AWARE +

b_9 SAFETY + b_{10} SAFECOMP + b_{11} WTP + b_{12} WITH +

b_{13} CHILD + b_{14} ED + b_{15} DRIVE + b_{16} INCOME + b_{17} LOC + b_{18} TIME + b_{19} DAY + b_{20} INTERV + b_{21} SEX + b_{22} RAIN

The dependent variable is VOTE. Following is a description of each variable. A table of coding values appears in Appendix 1.

VOTE is a yes or no vote on the political referendum question. Respondents were asked to vote on a triple trailer ban, given the increase in consumer prices that would likely result from such a ban.

STATE is whether or not the respondent's driver's license was from a state which allowed triple trailers. If drivers are familiar with triple trailers they may not be as afraid of them as those drivers who are not.

YEARS is the number of years the respondent has been driving. This is a proxy for age and experience. It is possible that experienced drivers have fewer reservations about triple trailers than less experienced drivers.

ACCTYPE records the type of vehicle accident the respondent has experienced, if any. Drivers who have been in a vehicle accident may experience more fear about large trucks than those who have not. In addition, as the severity of the accident increases that fear may increase.

HOSP is whether or not the respondent has ever been hospitalized as the result of an accident. This may make drivers more afraid of triple trailers if they feel triples are a safety risk.

CARTYPE is the type of car most often driven by the respondent. It is possible that people who drive smaller cars are more afraid of triple trailer trucks.

HMILES is the number of miles driven on highways at 55 mph or higher posted speed in one year. Drivers who drive many highway miles may be more likely to be comfortable with the presence of triple trailer trucks.

SEEN records whether or not the respondent had ever seen a triple trailer truck in Oregon. Those drivers who have never seen a triple trailer truck may not have a perception that triples are unsafe.

AWARE is whether or not the respondent was aware of the Oregon ballot measure to ban triples. Those who are aware of the issue may be more likely to have formed some opinion.

SAFETY asks respondents how they feel about the safety of triple trailer trucks in general. If drivers

feel that triple trailers are not safe, they may be willing to pay to ban them.

SAFECOMP is how respondents feel about the safety of triple trailer trucks compared to double trailers. If there is not much difference in perceived safety of the two types then this may not be an important issue to drivers.

WTP contains the offered bid value in the CV valuation question. This value varied across the sample. Respondents were asked how much they would be willing to pay in higher consumer prices to ban triple trailers.

WITH is a budget reminder added to about half of the surveys. Respondents were reminded that they would have to reduce what they spend on everything else by the bid amount if triple trailers were banned. It is possible that this makes the valuation question more realistic and that it helps respondents to consider their budgets before answering the question.

CHILD is the number of children under the age of 16 in the respondent's household. Parents with more young children may be more sensitive to safety issues than those with older children or none.

ED is the highest level of school that the respondent has attended. It is possible that with more education drivers are more aware of, or will search out, information about triple trailers. This may make them

either more likely to want to ban triple trailers or less concerned about the risk.

DRIVE records whether or not the respondent drives on the job. Those who do may be more comfortable with driving in general and less concerned about triple trailers.

INCOME is the annual household income of the respondent. It is possible that those with higher incomes are less concerned about triple trailers because they are also better educated. It is also possible that those with higher incomes are more concerned about triple trailers because they drive more expensive cars which would be more costly to repair in the event of an accident.

LOC is the survey location. The I-5 corridor and the Portland area have more traffic including trucks so people in those areas may be more familiar with, and hence less concerned about, triple trailers. Alternatively, they may have experienced them enough to be more afraid about their safety. The other regions, Newport, Bend and Central Valley, see fewer triple trailers. People in these regions may be less concerned about the issue because they are unfamiliar with triples, or more concerned because they are more insecure about triples when they do see one.

TIME is the time of the day that the survey was taken. It is possible that as it gets later in the day

people are tired and more likely to vote to ban triples or that they are less interested in the survey and would be more likely to vote no.

DAY is the day of the week when the survey was taken. Respondents who are relaxed on the weekends may be less interested in the issue and/or in the questionaire and may be more likely to not want to ban triples. However, they may be out on a weekend jaunt and may be frustrated with traffic conditions and thus more likely to want a ban.

INTERV is the gender of the interviewer. Respondents may respond differently to one gender than to the other.

SEX is the gender of the respondent. It is possible that men are less concerned about triple trailers than women, or at least that may be what they say.

RAIN records whether or not it was raining when the survey was taken. Spray is one of the problems with triple trailers so on a rainy day respondents may be more likely to want to ban them.

RESULTS

Results of the model estimation are shown in Table 2. Four of the variables were significant at one percent: SAFETY, SAFECOMP, WTP and ED. No additional variables were significant at five percent. As expected, safety seems to be an important issue to respondents. Both safety variables had negative signs indicating that the probability that respondents would vote to ban triples increased as their confidence in the safety of triples decreased. The same was true for the comparison between safety of triple trailers and that of doubles. As respondents felt that triples were less safe than doubles they were more likely to vote to ban triples. Education was also a significant explanatory variable. Those respondents with more education were more likely to vote to ban triples. As expected, WTP was significant. The negative sign indicates that as the offered bid increased respondents were less likely to vote for a ban on triples. This is consistent with theory.

HOSP was significant at 10% and was positive. This may be evidence that if a person had been hospitalized as the result of an accident they were more likely to vote for a ban.

It is surprising that YEARS was not significant in explaining the probability of a yes vote. It was expected that as a person gained driving experience they would be less concerned about triple trailer trucks. Moreover, the sign on this coefficient was positive indicating that increasing years of experience led to an increased probability that respondents would vote to ban triples. In addition, RAIN had no significant explanatory power. One of the biggest reported problems with triple trailer trucks is splash and spray. It was expected that on rainy days people would be more aware of the spray problems and would be more likely to vote for a ban.

WITH was also not significant. This was a budget reminder; a sentence which reminded respondents that in order to pay the offered bid they would have to reduce their spending on everything else by that amount. It was expected that this would cause respondents to think carefully about the bid amount and whether they were willing or able to pay it. It is surprising that this was not important to their decision to vote.

The model correctly predicted 84.5 % of the votes. The joint significance of the regressors was tested with the likelihood ratio test. Distributed as chi-squared with 22 degrees of freedom, the test resulted in rejection of the null hypothesis that the regressors were jointly insignificant.

Table 2: Model Estimation Results

Variable	Coefficient	Std. Error	Prob. Value
STATE	-.078467	0.9255	0.39652
YEARS	0.01332	0.0211	0.52772
ACCTYPE	-0.055845	0.2628	0.83173
HOSP	1.0296	0.6278	0.10101
CARTYPE	-0.072986	0.1541	0.63572
HMILES	-0.034063	0.02321	0.14228
SEEN	-0.67709	1.387	0.62531
AWARE	1.3766	0.8708	0.11391
SAFETY	-3.2627	0.6873	0.00000 **
SAFECOMP	-1.9775	0.5625	0.00044 **
WTP	-0.03084	0.01135	0.00657 **
WITH	-0.40986	0.4873	0.40026
CHILD	-0.27648	0.2450	0.25910
ED	2.1481	0.6669	0.00128 **

* significant at 5 %

** significant at 1 %

Table 2, cont.

Variable	Coefficient	Std. Error	Prob. Value
DRIVE	0.10464	0.5913	0.85953
INCOME	0.00270	0.09418	0.97712
LOC	0.21386	0.2500	0.39228
TIME	-0.00174	0.000998	0.08140
DAY	-0.05614	0.09356	0.54849
INTERV	0.53273	0.4863	0.27327
SEX	0.27401	0.5293	0.60468
RAIN	0.01196	0.6749	0.98587

Economic Applications International (EAI, 1977) estimated the benefits of triple trailer operation to range from $84- to $398 million per year. If the estimated social costs of triple trailer operation are lower than $84 million dollars, the benefits of triple trailers will outweigh the costs and triples should remain in Oregon. In addition, there may be an argument for allowing triples in other states. However, if costs were between $84 and $398 million, the benefits may not outweigh the social costs. At the low end of the range,

with an estimated population of licensed drivers at just less than 3.7 million, (Oregon Blue Book, 1993) estimated benefits are approximately $22.70 per year per citizen. Therefore, net social welfare associated with triples would be zero if costs were $22.70. This study estimates the non-pecuniary costs of triple trailer use to be $35.26 per person per year. This suggests that costs exceed benefits in the lower range of estimated benefits. There may be evidence therefore that triple trailers should not be allowed in Oregon. However, the 1992 referendum to ban triples failed which may indicate that the lower end of the range of estimated benefits was too conservative. It may also be an indication that the voting sample of the population is not the same as the sample which produced this data.[1]

The sample was compared to 1990 Oregon census data. Average education, number of children and income were higher in the sample than in the Oregon data. (see Table 3) Income was significantly higher. It is generally accepted in the literature that there is significant income inflation in survey data, particularly in in-person interviews. It may be that this happens to a higher degree in the sample survey situation than in census surveying. There may be a sense of anonymity associated with the census that reassures respondents. This comparison suggests that while the sample surveyed for

this study does reflect the population of Oregon in some areas, in others there are significant differences.

In the upper range of the estimated benefits these benefits exceed costs. Perhaps further research is necessary both to narrow the range of estimated benefits and to determine whether a net benefit would exist for allowing triple trailers to operate in additional western states.

Table 3: Oregon vs. Sample Data Averages

Variable	Oregon	Sample
CHILD	0.47	0.84
ED	1.478	1.71
YEARS	34.6	35.4
SEX (% of men)	49	55
INC	$34,062	$40,800

CONCLUSIONS

This study used a contingent valuation research technique to quantify the value of triple trailer safety to the general public. Estimates obtained indicate that people would be willing to pay an average of $35.26 annually to remove triple trailers from the road. Compared with previous estimates of benefits ranging from $22.70 to $107.57 however, this suggests that the operation of triple trailers may provide a net benefit to society. These results support those who argue for increased use of triple trailers on efficiency grounds.

There are reservations about the application of the CV methodology to this issue, however. CVM is dependent on setting up a hypothetical market which is believable to the respondents. The interviewers were not confident that this happened with all respondents. Many respondents gave conflicting answers to the valuation question suggesting that they either did not understand the question or did not take it seriously.

Many respondents were distressed by the interviewers questioning. They were not convinced that the surveyors were unaffiliated with any political group. The general public in Oregon is often subjected to surveyors and petition gatherers. Whether this is a result of the

initiative and referendum method of policy making and whether this affects the quality of Oregon survey data might be interesting future studies.

This study rests on perceptions. The respondents were asked their perception of the risks inherent in triple trailer use and of the cost savings from their operation. The difference between this perception of risk and objective risk is information. Many respondents asked the interviewers for statistical information about triple trailers, both cost and safety. Such information is not available. Further research in these areas may be warranted.

NOTES

1. A test of the sample was performed as follows. The median WTP was recalculated using Oregon 1990 census data for the demographic variables CHILD, ED, INC, SEX and YEARS. The other, survey specific variables were omitted. This median value was compared to one calculated with the same five variables from the sample. The median WTP for the Oregon data was -$29.45 while from the sample: -$43.24. This suggests that respondents must be paid to ban triple trailers. However, these results are inconclusive. A number of variables were omitted including SAFETY and SAFECOMP which were significant in the model. Therefore this test may only point out the differences between the sample characteristics and Oregon population characteristics.

BIBLIOGRAPHY

Arrow, K., R. Solow, R. Portney, E. Leamer, R. Radner, and H. Schuman. 1993. "Report of the NOAA Panel on Contingent Valuation." Federal Register 58:4601-4614.

Brown, William S. Introducing Econometrics West Publishing Company, St. Paul, Minnesota, 1991

Cummings, R.G., D.S. Brookshire, and W.D. Schulze. 1986 Valuing Environmental Goods; An Assessment of the Contingent Valuation Method Rowman and Allanheld, Totowa, New Jersey.

Economic Applications International, Inc. 1992. Initiative to Ban Triple-Trailer Combination Trucks from Oregon Highways.

Freeman III, A.M. 1993. The Measurement of Environmental and Resource Values: Theory and Methods. Resources for the Future. Washington, D.C.

Hanemann, M.W. 1984. "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses" American Journal of Agricultural Economics. 66:332-341.

Jones-Lee, M.W., M. Hammerton and P.R. Philips. 1985. "The Value of Safety: Results of a National Sample Survey". The Economic Journal. 95:49-72.

Loomis, John B. 1987. "Expanding Contingent Value Sample Estimates to Aggregate Benefit Estimates: Current Practices and Proposed Solutions" Land Economics. 63:396-402

McCarthy, Patrick S. "Motor Carrier Productivity and Highway Safety: Expanding the Use of Longer Combination Vehicles". Working paper, Purdue University.

Mitchell, R.M. and R.T. Carson. 1989. Using Surveys to Value Public Goods: The Contingent Valuation Method Resources for the Future, Washington, D.C.

Pearce, D.W. and R.K. Turner. 1990. Economics of Natural Resources and the Environment. The Johns Hopkins University Press, Baltimore.

"Truck Size and Weight; Restrictions on Longer Combination Vehicles (LCV's) and Vehicles with Two or More Cargo-Carrying Units." Department of Transportation, Federal Highway Administration, 23 CFR Parts 657 and 658, FHWA Docket #92-15 RIN 2125-AC86

Winston, C., K.A. Small, C.A. Evans. 1989. Road Work: A New Highway Pricing and Investment Policy. The Brookings Institute, Washington D.C.

APPENDICES

APPENDIX 1

Table of Coding Values

STATE		
	0	No
	1	Yes
HOSP		
	0	No
	1	Yes
SEEN		
	0	No
	1	Yes
AWARE		
	0	No
	1	Yes
SAFECOMP		
	0	Less safe
	1	As safe
	2	More safe
WITH		
	0	W/o budget reminder
	1	W/ budget reminder
DRIVE		
	0	No
	1	Yes
INCOME		
	0	< $10,000
	1	$10,000 - $20,000
	2	$20,000 - $30,000
	3	$30,000 - $40,000
	4	$40,000 - $50,000
	5	$50,000 - $60,000
	6	$60,000 - $70,000
	7	$70,000 - $80,000
	8	$80,000 - $90,000
	9	$90,000 - $100,000
	10	> $100,000
INTERV		
	0	Female
	1	Male
RAIN		
	0	No
	1	Yes

ACCTYPE		
	0	None
	1	Single car
	2	Two car
	3	Car and delivery van or truck
CARTYPE		
	0	Compact
	1	Midsize sedan
	2	Large sedan/wagon
	3	Passenger van
	4	Pickup truck
SAFETY		
	0	Not at all safe
	1	Somewhat safe
	2	Very safe
VOTE		
	0	No
	1	Yes
ED		
	0	Grade school
	1	High school
	2	College
LOC		
	0	Bend
	1	Portland
	2	I-5
	3	Central Valley
	4	Newport
DAY		
	1	Sunday
	2	Monday
	3	Tuesday
	4	Wednesday
	5	Thursday
	6	Friday
	7	Saturday
SEX		
	0	Female
	1	Male

APPENDIX 2

Survey Instrument

1. Do you have a valid drivers license?

___ YES (to Q 2)
___ NO (to Q 6)
___ NR

From which state?

2. How many years have you been driving?

3. Have you ever been in a traffic accident?

___ YES (to Q3a)
___ NO (to Q4)
___ NR

3a. Was your accident...:

___ Single car (or other passenger vehicle)
___ Two car (or other passenger vehicles)
___ Car and delivery van or truck

3b. Have you or has anyone in your family ever been hospitalized as the result of a traffic accident?

___ YES
___ NO
___ NR

4. What kind of car do you drive most often?

___ compact
___ midsize sedan/wagon (Accord, Escort wagon)
___ large sedan/station wagon (most US sedans)
___ passenger van (Caravan, Blazer, Explorer)
___ pickup truck

5. How many miles a year do you drive?

5a. How many of these are highway miles? (Any highway at 55 mph or over) (Percent of total miles ok)

(A triple trailer truck is defined as a tractor (cab) pulling 3 -28 foot trailers.)

6. Have you ever seen a triple trailer truck while driving in Oregon?

___ YES
___ NO
___ NR

7. Did you know that a measure to ban triple trailer trucks was on the Oregon ballot last November?

___ YES
___ NO
___ NR

8. Which of the following best describes how you feel about the safety of triple trailer trucks?

___ very safe
___ somewhat safe
___ not at all safe
___ NR

9. Do you feel that triple trailer trucks are less safe, as safe or more safe than double trailer trucks?

___ more safe
___ as safe
___ less safe
___ NR

10. Triple trailer trucks can be operated more cost efficiently than doubles. This means that consumers pay lower prices on most goods they buy in the store. Banning triple trailers would therefore cost consumers money. Although these costs are not known for sure they are estimated to be about $ ____ per person, per year. *To pay these costs therefore, you would have to reduce what you spend on everything else by $ ____ per year.* * Knowing these estimated costs, if you could vote on a measure to ban triple trailers would you vote yes or no?

___ YES (to Q 10b)
___ NO (to Q 10a)
___ NR

* Budget reminder. Included only with version 1 of the survey.

10a. Would you pay anything to ban triple trailers?

___ YES (to Q 10b)
___ NO (Why?)
___ NR

10b. What is the maximum you would be willing to pay per year in higher prices in order to NOT have triple trailers on the highways?

11. How many children under the age of 16 are in your household?

12. What is the highest level of school you have attended?

___ Grade School
___ High school
___ College

13. Does your occupation require that you drive while on the job? Examples: delivery route, taxi or bus driver etc.

___ YES
___ NO
___ NR

14. Is your total household income above or below $40,000 per year?

___ Above (to Q 14a.)
___ Below (to Q 14b.)
___ NR

14a. Into which category does your total household income best fit?

___ 40,000 - 50,000
___ 50,000 - 60,000
___ 60,000 - 70,000
___ 70,000 - 80,000
___ 80,000 - 90,000
___ 90,000 - 100,000
___ > 100,000

14b. Into which category does your total household income best fit?

___ 30,000 - 40,000
___ 20,000 - 30,000
___ 10,000 - 20,000
___ < 10,000

Interviewers please fill out:

15. Location survey taken:

16. Time of day

17. Day of week

18. Interviewer

19. Gender of respondent

20. Weather
rain?

APPENDIX 3

Data Frequency

STATE

29-0 No
171-1 Yes

HOSP

155-0 No
45-1 Yes

SEEN

10-0 No
174-1 Yes

AWARE

26-0 No
174-1 Yes

SAFECOMP

110-0 Less safe
81-1 As safe
9-2 More safe

WITH

101-0 W/o budget reminder
99-1 W/ budget reminder

DRIVE

142-0 No
58-1 Yes

INCOME

21-0 < $10,000
24-1 $10,000 - $20,000
26-2 $20,000 - $30,000
25-3 $30,000 - $40,000
25-4 $40,000 - $50,000
17-5 $50,000 - $60,000
19-6 $60,000 - $70,000
11-7 $70,000 - $80,000
13-8 $80,000 - $90,000
6-9 $90,000 - $100,000
13-10 > $100,000

INTERV

97-0 Female
103-1 Male

RAIN

161-0 No
39-1 Yes

ACCTYPE

84-0 None
36-1 Single car
70-2 Two car
10-3 Car and delivery van or truck

CARTYPE

49-0 Compact
54-1 Midsize sedan
23-2 Large sedan/wagon
36-3 Passenger van
38-4 Pickup truck

SAFETY

60-0 Not at all safe
110-1 Somewhat safe
30-2 Very safe

VOTE

116-0 No
84-1 Yes

ED

4-0 Grade school
51-1 High school
145-2 College

LOC

42-0 Bend
86-1 Portland
26-2 I-5
36-3 Corvallis/Albany
10-4 Newport

DAY

56-1 Sunday
6-2 Monday
6-3 Tuesday
9-4 Wednesday
14-5 Thursday
7-6 Friday
102-7 Saturday

SEX

90-0 Female
110-1 Male