A Forecasting Model For Grain Transportation Planning in Washington State

WA-RD 183.1

Final Report
April1987

Washington State Department of Transportation
Planning, Research and Public Transportation Division

in cooperation with the
United States Department of Transportation
Federal Highway Administration

A FORECASTING MODEL FOR GRAIN TRANSPORTATION PLANNING IN WASHINGTON STATE

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FINAL REPORT
Research Project Y-3400, Task 3
Prepared for
Washington State Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration
April 1987
Revised June 1989

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. WA-RD 183.1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle A Forecasting Model for Grain Transportation Planning in Washington State		5. Report Date April 10, 1987
		6. Performing Organization Code
7. Author(s) Nancy E. Wallace and Frederick S. Inaba		8. Performing Organization Report No.
9. Performing Organization Name and Address Washington State University Pullman, Washington 99164-4860		10. Work Unit No.
		11. Contract or Grant No. Y-3400, Task 3
12. Sponsoring Agency Name and Address Washington State Transportation Center Washington State Department of Transportation Highway Administration Building Olympia, WA 98504		13. Type of Report and Period Covered Final Report 7/10/85-4/10/87
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

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17. Key Words Grain, Transportation, Demand Forecasting		18. Distribution Statement	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

Form DOT F 1700.7 (8-69)
DOT FORM 341-004 6/72

Acknowledgements

The authors would like to thank Murat Gene, John Kuhlman, and Wes Wilson for their assistance on this project. The Social Research Center at Washington State University conducted the survey of grain elevators in the Pacific Northwest. Finally, we would like to thank Erwin Quimio and Richard Heffel for programming the interactive computer forecasting model.

ABSTRACT

This project developed a demand-based forecasting model for rural and highway road transportation planning to assist decision-makers in predicting transportation demand flows of wheat in the Pacific Northwest. In order to be sensitive to policy changes, the model is based upon the disaggregate, individual shipment decisions of wheat elevators. The research found that the mode/market selection process significantly affects the usual regression estimates of mode/market demand flows. Therefore, estimates of the parameters on the major determinants of transportation demand were obtained by weighted least squares that were corrected for selectivity bias. Procedure was developed to aggregate the disaggregate predictions into total regional flows. This procedure retains the policy-sensitivity of the disaggregate model and is computationally practical in applications. Finally, the aggregate forecasting model was developed into an interactive computer program which can be used in a variety of policy-relation applications.

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PROJECT OVERVIEW

PURPOSE

It is well known that grain transportation in the Pacific Northwest is experiencing widespread structural change with significant impacts on Washington State highways and rural roads. The three most important impacts are the development of the Columbia/Snake River system and the introduction of unit train rail service, and abandonment of low density rail lines. Increased truck traffic of Pacific Northwest wheat destined for river and unit train subterminals has created tremendous pressure on the highways and rural roads in the eastern and southeastern regions of the state.

The increase in the number of vehicles and vehicle weights and the shift in traffic patterns has resulted in a number of significant problems for transportation planners. Existing roads require more frequent repair and maintenance. Traffic engineers must determine whether frequently used roads should be upgraded to handle the changing traffic. County commissioners are under pressure to establish new roads and to provide better maintenance of existing ones. These problems make it imperative that transportation planners forecast wheat transportation demand flows in response to proposed changes in the structure of transportation service and costs.

The purpose of this project was to develop a demand-based forecasting model for rural and highway road transportation planning to assist decision-makers in assessing maintenance, construction, budgeting, and taxing strategies. The model was to provide numeric prediction of wheat transportation demand flows originating in the states of Montana, Idaho, Oregon, and Washington. Using this model it was intended that planners would be able to assess traffic responses to such changes as road construction and improvements, transportation rate changes on the various modes, changes in the price of wheat at the major markets, the imposition of user charges and/or taxes, rail abandonment, addition of new rail lines.

OBJECTIVE

There are three major objectives of the demand forecasting model. First, the model must be useful for policy analysis and be able to predict traffic responses to changes in prices, rates and characteristics. In order to accomplish this objective, the model is best estimated at the disaggregate level. This is because changes in demand are the result of individual responses to changes in the underlying parameters. Aggregate data tends to smooth out and mask these responses so that policy-sensitivity of the model is greatly reduced. Hence, for policy analysis, it is best to use disaggregate models with disaggregate data.

The second major objective of forecasting model is to provide a computationally efficient, yet reasonably accurate link between the individual shipper decisions of the disaggregate model and the aggregate demand flows that are of interest to the intended users of the model. This objective is accomplished by the aggregate demand model, which is capable of generating aggregate level demand flows for nine regions of the study area from individual mode/market predictions of demand flows.

The third major objective of the forecasting model is to provide a useful, operationally simple planning tool for the intended users. The user must be able to conduct policy and planning analyses with the model and not be required to provide extensive data input or perform complicated computer programming. This objective is accomplished by the transportation demand forecasting computer package that was developed for this project.

MAJOR FINDINGS

The disaggregate demand model is formulated to account for the simultaneity between the shipper's choice of mode/market alternatives and the shipment quantity. Previous studies have neglected the possible interdependence between these two decisions and have simply estimated single equation models of quantity shipped on the various modes. The results of this project indicate that previous studies are flawed by ignoring the simultaneity between mode/market and quantity shipped, the effect of which is that previous models may very well be biased and inconsistent. The estimation results in this project show that the effect of mode/market selectivity on shipment size is statistically significant, and therefore models that do not account for the simultaneity of mode/market choice and quantity shipped are flawed.

The second major finding of the study is that spatial competition between wheat elevators seems to be an important determinant in the demand for wheat transportation. A market boundary variable, constructed in the spirit of the Hotelling theory of spatial competition, is found to be an important determinant in the wheat elevator's choice of mode and market and shipment size. This finding allows a great deal of realism to be incorporated into the disaggregate demand model.

A third major result of the study is the development of a computationally simple aggregation procedure that permits aggregate demand flows to respond to changes in variables that determine both mode/market choice and shipment quantity. No other study has aggregated individual predictions that account for the simultaneity of discrete and continuous choices of the decision makers. Tests of the aggregation procedure have shown that it is not the most accurate method of aggregation. A better approach is to add up the individual shipper forecasts. However, this involves the greatest complexity in computing the forecasts. Hence, a trade off had to be made between accuracy and computational feasibility.

The final major result is the development of the computer package that enables the user to apply the forecasting model to a variety of policy and planning problems. The computer package is designed for users with limited computing facilities, and will run on any standard IBM PC with 640K memory and 8087 math co-processor. The package permits the user to change key transportation service or cost variables and to add or delete transportation services. It then provides numeric prediction of the mode/market demand flows by region.

RECOMMENDATION

The freight transportation demand forecasting model developed in this project applied several new economic and econometric modeling approaches. Furthermore, the survey and the resulting data set, upon which the estimates of the model parameters are based, are unique. Consequently, it is unlikely that similar studies will be undertaken in the near future on the same population of elevators for the same purposes. This will probably preclude any opportunity to compare the results from this study with any other. For these reasons it is important that transportation planners in the Pacific Northwest use the model whenever the opportunity occasions. Experience by people who have expertise in wheat transportation demand will provide much needed information to further refine the forecasting mode, to make adjustments, and to correct any weaknesses. The most important recommendation is to encourage the implementation of the model and to monitor its performance in applications so that valuable feedback information can be channeled back to the research team.

DISCUSSION

PROBLEM DESCRIPTION

The wheat transportation demand forecasting model generates numeric predictions of demand flows under specified values for the variables that describe the transportation service and cost structures facing wheat elevators in the Pacific Northwest. The predictions are given for the mode/market alternatives that are feasible for each of nine regions in the study area. The model is designed to be policy-sensitive; that is, the policy analyst can make changes in the relevant policy variables or in the transportation service structure and the model will generate the predictions corresponding to these changes.

The development of the forecasting model proceeded in three phases; the disaggregate model, the aggregate model, the computer forecasting and planning model. The disaggregate model attempts to replicate individual shipment decisions with respect to mode/market choice and shipment size. A mail and telephone survey was conducted to study how elevator operators actually make shipment decisions and what variables and factors are important in the decision process. An important determinant in the decision process is the presence of one or more nearby elevators that compete to serve the same group of farmers in the market area. Hotelling's model of spatial competition is applied to derive a variable for a firm's market boundary. The market boundary variable, which depends upon such variables as the price of wheat, the transport rate, the handling fee, and the distance to the firm's nearest competitor, is significant in explaining both the mode/market choice of the firm and the quantity it chooses to ship.

The aggregate model uses a method of aggregating the individual mode/market predictions of demand flows into total forecasts by firms over an entire region. The aggregate model provides the critical link between individual shipper decisions and the aggregate demand flows that are the main interests of planners. This model enables the user to generate aggregate demand flows by region, given the specification of the exogenous variables that govern the mode/market and shipment size decisions of the individual elevators. The aggregation approach that this project uses is computationally tractable, requiring only a modest amount of data and information maintenance by the user. The approach also retains the property of being policy-sensitive, an advantage that is inherited from the disaggregate model.

The third phase of the forecasting model is the interactive computer package that enables the user to access the model to conduct policy and planning analyses. The computer program is embedded with the values for the exogenous variables based upon the survey conducted in the study. The user is allowed to substitute updated values for these variables and to make additions and/or deletions to the set of mode/market alternatives that are accessible within each region. The program then performs the mathematical computations to deliver the model's forecasts of transport demand flows.

PREVIOUS MODELS

One conclusion that can be drawn from previous intercity freight demand models is that disaggregate analyses, where the unit of observation is an actual shipment, are in most instances preferable to aggregate analyses, where the unit of observation is aggregate freight shares. The disaggregate analyses (Daughety and Inaba, 1981; Winston, 1981) are firmly grounded in theories of constrained economic behavior and allow richer empirical specifications. The use of aggregate data to estimate essentially firm specific microeconomic models (Chiang, et al., 1980; Friedlaender and Spandy, 1980; Oum, 1979) greatly obscures the behavioral strategies of firms who face different mode/market choice sets or market share advantages. Market elasticities derived from these studies are also likely to suffer from aggregation bias arising from the use of average values for mode specific characteristics.

There are also several more specific problems with aggregate formulations of freight transport demand. The aggregate logit model has been shown to impose rigid a priori restrictions on elasticities given the choice of a base mode (Oum, 1979). The aggregate neoclassical models of freight demand (Friedlaender and Spady, 1980; Oum, 1979) rely on the unattractive assumption that quantity shipped is a choice variable that is functionally independent from the rate structure. As is well known, the assumption is needed to justify the use of Shephard's lemma to derive the conditional factor demands. The assumption is, however, problematic given considerable empirical evidence that transportation rates taper with shipment size.

The generality of both the aggregate and disaggregate freight demand analyses has frequently been limited by the assumed role of the mode choice decision maker. For example, Winston (1981) focuses his analysis on a subset of highly compartmentalized firms in which the average shipment size is determined by the inventory objectives of the purchasing department and is therefore exogenous to the mode choice decisions of the shipping or receiving departments. Daughety and Inaba (1981) assume that the decision maker maximizes utility associated with mode choice given that individual shipments are made from an inventory predetermined by the firm's profit maximization problem. The most general formulation is provided by Chiang et al. (1980). They explicitly model the joint choice of mode and quantity shipped because their shippers are solving both the distribution and inventory problem of the firm. Unfortunately, shipment size is estimated in this study as a set of discrete choices rather than accounting for discrete mode choice conditioned on a continuous quantity decision. Their results are, therefore, highly sensitive to the a priori decisions concerning the appropriate ranges for shipment sizes.

Another serious limitation with econometric freight demand studies is the failure to integrate the analysis of mode choice with shippers market area decisions. Freight mode choice decisions frequently entail a simultaneous decision of where to ship, how much to ship, and by what mode. These decisions are made by shippers who are competing in geographic space with other shippers who face a similar set of simultaneous decisions. Clearly, a firm's location and market area can directly affect and be affected by its choice of mode, and considerable literature exists to suggest that firms do indeed consider spatially determined market demands in their profit maximization decisions (Greenhut et al., 1975). Including the spatial attributes of the firm's economic decision making is important because it offers an additional dimension of realism and provides the added benefit of bringing the econometric freight demand models closer to the less behaviorally complete spatial price and freight network equilibrium models.

To recapitulate the findings from this review, disaggregate econometric studies of intercity freight demand have typically not accounted for the probable endogeneity of the quantity shipped in the mode/market decision. For this reason, they do not reflect the transportation decisions of a large class of firms in which distribution and inventory objectives are solved simultaneously. Additionally, the relative behavioral realism of microeconomic models of firm mode/market decision making is considerably weakened by not accounting for the market area effects of these decisions. To be policy sensitive, econometric models of transportation demand must reflect a world of delivered pricing in which firms respond to price cues from market destinations, service characteristics of the modes, and pricing strategies of competing shippers.

The linkage between the disaggregate models and aggregate level forecasts of interest to planners and decision makers has been the focus of an increasing number of studies in recent years. However, all of the research in the published literature has concentrated on the problem of aggregating discrete choice models, and has neglected the problem of aggregating joint continuous/discrete choice models. In other words, none of the existing literature deals directly with aggregating individual mode/market shipment sizes where the mode/market decisions are treated as a discrete choice problem. Nevertheless, a number of studies did have results which were useful in formulating the aggregation approach adopted in this project.

Ben-Akiva and Lerman (1985) group discrete choice aggregation procedures into five types. The "average individual" procedure assumes that the individuals in the population can be approximated by an "average" or "representative" shipper. Then aggregation simply becomes replication with respect to identical individuals. While this approach has the advantage of simplicity, Koppelman (1975) has shown that its accuracy decreases rapidly as the variance of the distribution of the exogenous variables increases.

The second approach is an extension of the first approach and simply groups the individuals into homogeneous classifications. Then the "average individual" approach is applied to each classification. Koppelman and Ben-Akiva (1977) found that the classification procedure works very well when a relatively small number of classes is used and when the individuals within a given class have similar choice sets.

The third procedure, statistical differentials, approximates the distribution of the exogenous variables by a second order Taylor's expansion. Koppelman (1975) found this procedure to be generally unsatisfactory.

The fourth procedure, explicit integration, was used by McFadden and Reid (1975) and Westin (1974). This approach starts with an assumed distribution for the exogenous variables and then estimates the probability density function of the exogenous variables. This enables the estimation of the expected choice behavior across all individuals in the population. The major drawbacks of this approach are that complicated computer algorithms must be written to evaluate the values of integrals, and the distribution of the exogenous variables must be assumed a priori.

The final procedure is sample enumeration and merely approximates the choice behavior across all individuals in the population by that of the individuals in the sample. The main drawback of this procedure is that it requires that each individual's exogenous variables be stored and updated within the aggregation model. Therefore, this approach suffers from large data requirements. For large samples, this approach provides fairly good estimates of mode/market choice behavior.

THEORY AND MODELING

A wheat shipment is the result of a contract between the firm and a buyer wherein the firm promises to deliver a given quantity, by a given date, for a given price, to a given market or location. Usually the contract is chosen from among several alternative contracts offered at different markets.

The contract quantity is based upon the firm's assessment of how much wheat it will be able to obtain from the farmers in its market area and upon the quantity in storage. The firm announces a net price, which consists of the contract price for the wheat minus the transport rate and a handling fee. However, at the same time, the firm's competitor announces its net price offer. The farmers in the market area then choose between the two offers, and the offer which yields the greatest profit for the farmer is chosen. In calculating its profit, the farmer must also consider the cost of transporting its wheat to the elevator's loading site. Therefore, the contract quantity depends upon the net price offers of both the firm and its competitor and the transport cost of getting the wheat to the elevator facility. In addition, the expected contract quantity also depends upon the size of the elevator's storage facility.

Using the information summarized in the preceding paragraphs, the firm estimates the quantity of wheat it will be able to deliver under the alternative contracts. It also estimates the shipping costs associated with each alternative. These variables then enter into the firm's choice index which it uses to select the optimal alternative.

The first step in developing the formal model is to specify the determinants of shipment size. We assume that the observed net price offers meet the farmers' reservation prices, so that one offer will always be selected. Thus, we eliminate the need to model the farmer's reservation price. This assumption seems reasonable since the elevator must be reasonably certain that the farmers are willing to sell their wheat at the contract price when the elevator accepts the contract. Next we assume that the farmer will accept the highest net price offer minus the unit transportation cost of moving the wheat to the loading facility. The usual mode used here is truck.

In order to write the quantity model explicitly, we introduce the following notation:

π_{ti} = $p_i - r_i - h_t$ = the net price offer by firm t under the mode/market alternative i.

p_i = the market or contract price of wheat under alternative i.

r_i = the unit transport rate under alternative i.

h_t = firm t's handling fee.

ξ_t = distance from firm t to its nearest competitor.

T = unit transport cost incurred by the farmers.

$x_t =$ distance between a farmer and firm t.

$Y_t =$ size of the firm's storage facility (i.e., elevator capacity).

We shall use the subscript "c" to refer to a variable belonging to the firm's nearest competitor.

In thinking about the model it is useful to view the firm's customers as being located along a road that leads to the firm's facility. The farmers along the road can ship their wheat to firm t or its competitor. A farmer at a distance x_t from firm t and $\xi_t - x_t$ from the firm's competitor will accept the former's bid if

(1) $\pi_{ti} - Tx_t > \pi_{tc} - T(\xi_t - x_t)$.

It follows from (1) that the distance between firm t and the farthest farmer who chooses to ship to firm t is given by

(2) $x_{ti} = (1/2T)(\pi_{ti} - \pi_{tc}) + (1/2)\xi_t$.

Let $f(x)$ be the density function for the quantity of wheat of each farmer at a distance x along the road. Then the quantity of wheat that farmers along the road bring to firm t for shipment under alternative i is

(3) $q_{ti} = \int_0^{x_{ti}} f(x)dx$.

The total quantity of wheat that the firm expects to ship from farmers along the road and from his storage facility under alternative i is

(4) $Q_{ti} = \int_0^{x_{ti}} f(x)dx + \beta_1 Y_t$.

We shall assume the (4) has a linear approximation of the form

(5) $Q_{ti} = \beta_0 x_{ti} + \beta_1 Y_t + u_{ti}$.

Equation (5) is the model of the shipment size for firm t under alternative i.

The next step in developing the model is to specify the mode/market choice decision. We assume that the t-th firm has an unobservable stochastic profit index I^*_{ti}, conditional on quantity Q_{ti} of the form

(6) $I^*_{ti} = \alpha_0 Q_{ti} + \alpha' Z_{ti} + v_{ti}$,

where Z_{ti} is a column vector of characteristics for alternative i observed by firm t, α_0 is a scaler, α is a vector of constants, and v_{ti} is an unobserved random variable. Thus, conditional on the quantities $Q_{t1},\ldots,$ Q_{tN}, and given the characteristics $Z_{t1},\ldots, Z_{tN}$, firm t chooses to ship wheat under alternative i if

$I^*_{ti} > I^*_{tj}$ for all $j \neq i$.

Before we discuss the implications of the form of (6), it will be useful to describe the characteristics in the vector Z_{ti}. Essentially, these characteristics measure the service attributes of the transport modes available to the markets. The first variable in Z_{ti} is the per bushel inventory holding cost implied by the length of time the shipper expects to wait from the date that the carrier promises delivery of the transport equipment to the actual delivery date. The wait variable captures the responsiveness of the mode in providing service when it is ordered. The second variable is the per bushel inventory holding cost of loading time required by the mode. The third variable is the per bushel inventory holding cost of the in-transit time of the mode from origin to destination. The final set of variables are dummy variables that capture the large shipment size requirements of using barge, unit-train, or truck-barge.

Inspection of equation (6) reveals that the parameters of the choice index are characteristic-specific rather than alternative-specific. In view of the construction of the characteristic variables, the essential idea behind the profit index is that an alternative is defined abstractly in terms of its direct and indirect service related costs. In other words, an alternative is defined by a bundle of characteristics in the spirit of Lancaster's approach to utility theory. There is nothing intrinsic about an alternative in our model; only the levels of the service-related costs and the shipment size matter in the choice of an alternative.

This approach is important for policy applications for two reasons. First, the effects of policy changes such as changes in user's fees, taxes, and public investment in highways and structures, can be analyzed by assessing the impacts on the service attributes of the alternatives. Second, one can assess the policy of either adding or eliminating an alternative, such as the abandonment of a rail line. Again, this kind of change can be assessed through the effects on the service variables. If the parameters in the mode were alternative-specific, we could not examine the effect of changing the alternative set.

We note that the data on shipment sizes, the Q_{ti}'s, are conditional on the mode/market choices of firms. Therefore, there is a self-selection problem and the disturbances in (5) and (6) are correlated so that conventional estimation techniques will not provide consistent estimates of the parameters. Lee (1982) has proposed a two stage method for the specification and estimation of such selectivity models. Our procedure draws heavily on his work.

Substitute (5) into (6) to obtain the reduced form equation for the choice index,

(7) $I_{ti} = \gamma_0 x_{ti} + \gamma_1 Y_t + \alpha' Z_{ti} + w_{ti}$.

where $\gamma_0 = \alpha_0 \beta_0$, $\gamma_1 = \alpha_0 \beta_1$, $w_{ti} = \alpha_0 u_{ti} + v_{ti}$. The first stage of Lee's procedure consists of estimating the parameters in (7) under the assumption that the disturbances, w_{ti}, are distributed as independent, identical, Type

I extreme value random variables with a common scale parameter equal to one and a common location parameter equal to zero. The probability that firm t chooses alternative i given the values of x_{ti}, Z_{ti}, can be shown to conform to the Conditional Logit model

$$(8) \quad P_{ti} = \frac{\exp(\delta_0 x_{ti} + \alpha' z_{ti})}{\sum_j \exp(\delta_0 x_{tj} + \alpha' z_{tj})}.$$

Thus, the first stage of Lee's procedure consists of using (8) to obtain Maximum Likelihood estimates a_0, a of the parameters δ_0, α.

The second stage consists of using the estimates a_0, a from the first stage to calculate P_{ti} from (8) and to construct a new variable

$$(9) \quad s_{ti} = \frac{\phi[\Phi^{-1}(P_{ti})]}{P_{ti}}$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the standard normal density and distribution functions, respectively. This new variable, called the selectivity variable, is appended to the quantity equation (5) to obtain

$$(10) \quad Q_{ti} = \beta_0 x_{ti} + \beta_1 Y_t + \beta_2 s_{ti} + \mu_{ti}$$

which is then estimated by weighted least squares, with corrections for heteroscedasticity (see Lee, et al. [1980]).

The theory underlying the appending of the selectivity variable is that the original model (5) suffers from an omitted variable problem. What is omitted is the effect of the mode/market selection process on the quantity of wheat that the firm wants to ship on the observed alternative. In particular, one would expect to observe larger shipment sizes on alternatives that were optimally chosen than if the alternatives were selected randomly. Hence, a positive, significant parameter on the selectivity variable in equation (10) would support the theory that the mode/market selection process tends to increase the expected quantity of wheat that firms want to ship on any mode/market alternative. Equation

(10) is designed to pick up the effects of this omitted variable so that the resulting parameter estimates are consistent.

The theory and estimation of the demand for freight transportation presented up to this point has focused on the individual shipper. The estimated disaggregate model predicts the probabilities and the shipment sizes of each mode/market alternative for each individual shipper, given the exogenous variables that govern the decision-maker's transportation decisions. Thus, the disaggregate model forecasts the expected mode/market demand flows of wheat transportation for an individual shipper, for a given specification of the exogenous variables.

We now extend the disaggregate model in such a way that the expected mode/market flows of transportation demand for all shippers are forecast by region. Since the disaggregate model assigns to each specification of exogenous variables an estimate of the expected demand on each feasible mode/market choice, one can, in principle, forecast aggregate mode/market flows from each region simply adding up the individual predictions. However, there are two major weaknesses to this complete enumeration approach. First, it requires that the vector of exogenous variables be specified for every shipper. This data requirement is clearly infeasible for most potential users of the model. The second weakness is the unwieldy number of mathematical calculations that this approach requires. For large mainframe computers, the problem is not serious, but for small microcomputers, for which the forecasting model is intended, the problem of mathematical complexity renders the complete enumeration approach impractical.

Therefore, the design of the aggregation model seeks to minimize as much as possible data required by the user, to achieve computational practicality, and to forecast with a reasonable level of confidence. As we shall indicate, the aggregation model performs very well with respect to the first two criteria and performs with certain recognized shortcomings with respect to the third criterion.

The study area, the Pacific Northwest, is partitioned into nine regions. Consider one of these regions in which there are N elevators. Now if the relevant exogenous variables x_{ti}, y_t, z_{ti} for each elevator $t = 1, \ldots, N$ and each feasible alternative, $i = 1, \ldots, M$, are known then the disaggregate model generates the mode/market choice probabilities, P_{ti}, and the mode/market shipment sizes, Q_{ti}, from equations (8) and (10), respectively. The aggregate expected mode/market flows could then be forecast by complete enumeration,

$$(11)\quad D_i = \sum_{t=1}^{N} P_{ti}\, Q_{ti}.$$

The weaknesses of adopting (11) as the aggregation model were pointed out, above. An alternative procedure must be found.

For notational convenience, let w denote the (4M + 1)-vector of exogenous variables $(x_1, \ldots, x_M, Y, Z_1, \ldots, Z_M)$ where M is the number of feasible mode/market alternatives in the choice set. If w is regarded as a random vector, then the values w_t of w observed for each elevator t in the region corresponds to the realization of a sample, which in turn generates a sample of choice probabilities and quantities, $P_i(w_t)$ and $Q_i(w_t)$, from equations (8) and (10), respectively. Then, one can state the basic problem of aggregation as follows: find good estimators for the mean of the product of the random variables, $P_i(w) \cdot Q_i(w)$, $i = 1, \ldots, M$.

The approach adopted in this project is to approximate the mean, $E[P_i(w) \cdot Q_i(w)]$, by the product $P_i(Ew) \cdot Q_i(Ew)$, and then to estimate the mean, Ew, by the sample mean,

$$\bar{w} = \frac{1}{T}\sum_{t=1}^{T} w_t$$

where T is the number of observations in the sample. Notice that the aggregation model assumes that each of the N firms in the region can be approximated by the "typical" individual who bases his decisions on the mean, Ew. Given these assumptions, the aggregate expected mode/market forecasts are given by the following model:

(12) $D_i(\bar{w}) = NP_i(\bar{w})\ Q_i(\bar{w})$.

Before considering the data development and estimation results, the strengths and weaknesses of this model should be summarized. The primary strength of the model is its simultaneous equation structure that allows an explicit account of market area and mode/market choices, or shipment size and mode/market choice. Additionally, the correlation between the error structure of these decisions can be tested (a test on the sign and statistical significance of the correction term parameter estimate, Equation 10). A second strength is that the differential effects of rate changes, or rail abandonments, on market area and mode choices can be identified. Similarly, changes in market prices for wheat, or the introduction of new port facilities, can be traced through to responses in market area (or quantity shipped) and mode choices. Final advantages of the disaggregate model are its spatial components which greatly enhance the realism of the model.

One obvious advantage of the aggregation model is its computational simplicity. Given the values of the regional averages, $\bar{w}$, the model easily computes $P_i(\bar{w})$, $Q_i(\bar{w})$, and $D_i(\bar{w})$ from equations (8), (10), and (12). The second advantage is its amenability to policy analysis. Changes in any of the policy variables, such as transport rates, wheat prices, service characteristics, are transmitted through changes in the regional averages, $\bar{w}$. Using the new value of $\bar{w}$, the model computes the corresponding mode/market demand flows, $D_i(\bar{w})$, for each alternative $i = 1, \ldots, M$, in the choice set. Another useful policy application of the model is the assessment of the impacts on mode/market demands of eliminating one or more of the feasible alternatives in the regional choice set. For example, elimination of the first mode/market alternative is handled by removing all the components of the vector $\bar{w}$ corresponding to $i = 1$ and then performing all calculations in (8), (10) and (12) for $i = 2,3,\ldots, M$. The Users' Guide provides detailed instructions on the use and operation of the aggregate forecasting model and suggests some interesting policy applications that can be analyzed with the model.

The obvious weakness of the aggregation procedure is the strong assumption that $E[P_i(w)Q_i(w)]$ can be approximated by $P_i(Ew)Q_i(Ew)$. There is, however, a special case where the approximation is exact. Namely, when the expression $P_i(w)Q_i(w)$ is a linear function of the exogenous variables in w. Thus, if

$$P_i(w)Q_i(w) = w'\beta$$

where β is a vector of constants, then

$$\begin{aligned} E[P_i(w)Q_i(w)] &= (Ew)'\beta \\ &= P_i(Ew)Q_i(Ew) \end{aligned}$$

Consequently, if $P_i(w)Q_i(w)$ cannot be approximated by a linear function of w, then we cannot be very confident in the forecasts from the model.

Another serious weakness is the distributional assumption required to make estimation of the polychotomous choice model computationally tractable. Although there is no obvious theoretical requirement that the errors over choice alternatives (Equation 7) are correlated, it remains a maintained hypothesis in this analysis that the alternative specific error are independently, identically distributed. This implies that the unobservable characteristics over alternatives are not correlated or that elevator managers unobserved attitudes toward risk are not correlated across modes.

Hausman and McFadden's (1984) test for violations of our distributional assumptions, the independence of irrelevant alternative assumptions (IIA), was carried out for a large number of reduced choice sets, including individual elimination of each of the rail/market alternatives. The null hypothesis was accepted in all cases. Nevertheless, to the extent that the IIA assumption is violated, our model will consistently overestimate the probabilities of close substitutes.

DATA AND VARIABLE CONSTRUCTION

The data for this analysis were gathered from a questionnaire survey of all grain elevators with either federal or state licenses in the states of Idaho, Oregon, Montana, and Washington. Each elevator received a mailed questionnaire prior to a phone survey which occurred on the last week of November and the first two weeks of December 1984. Of the universe of 329 firms in the region, 289 shipped wheat in 1984. Of these, 36 refused to respond to the questionnaire, 67 provided such incomplete information that the responses could not be used, and 3 firms had only one mode/market shipment choice available, which left 183 firms. The preponderance of firms in the nonresponse or incomplete response category were red wheat shippers from small country elevators in Southern Idaho and Montana.

Although the sample represents only 63% of all wheat shipping firms in the region, it represents 78% of the export white wheat shipping firms.

The elevator managers in the survey were asked detailed questions about capacity, loading facilities, service and handling charges, and costs. They were also asked to provide information from an actual shipment record on the loading times, service characteristics, market prices, and costs of a shipment made in either the first fifteen days of October 1984, a peak shipment period, or the first fifteen days of February 1984, an off-peak shipment period. Questions were also asked about the costs and service characteristics of alternative modes of transportation available for the shipment. This information was then combined with information about the identity and proximity of competing firms and actual road distances from the firm to available market destinations. Whenever possible, the data obtained from the survey was verified with records kept by the Federal and State licensing agencies.

Seven mode choices appeared in the sample: truck, barge, single car rail, multiple car rail, unit train, truck/barge, and truck/multiple car rail; however, very few firms reported all the modes in their choice set. It should be pointed out that there are important differences among the service characteristics of the rail and multi-modal alternatives listed above. Differences between single, multiple, and unit rail alternatives include not only rate differentials, but also differences in loading times, and waiting times. For example a unit train requires the elevator to have sufficient storage and loading capacity to fully load the train (about 50,000 bushels) in 48 hours. Single car rail are packages of one and three car units that are dropped off at elevator sidings for loading and then later rehitched to line-haul trains. Similar differences exist between the single and multiple mode alternatives above, which is why the formulation of a transportation mode as an abstract bundle of quantity and service characteristics is the strategy used in the theoretical model. New "modes" can then be defined to reflect new pricing and packaging strategies of the carriers.

There were also seven destinations used: Minneapolis, MN, Great Fall, MT, Ogden, UT, the Columbia River System, Portland, OR, Seattle, WA, and Oakland, CA. The potential destinations for red wheat were Minneapolis, Great Falls, and Ogden and those for white wheat were Seattle, Portland, the River, and California. Thus, there are a total of 37 mode/market pairs as choice alternatives. The maximum number of choice alternatives for any firm in the sample was 24 and the minimum was three, the mode for the sample was 12 choices.

As discussed, the service characteristics used in the reduced form choice function (Equation 7) are waiting time, time in transit, loading time and dummy variables. The characteristics were all constructed as inventory costs using the firm's reported storage charge to proxy the firm's perceived costs of working capital. Waiting and loading time costs are measured as dollars per bushel per day. The rate and time cost are measured as dollars per bushel per mile. The net prices that appear in equation (1) were calculated for each mode/market pair using the price of wheat at the time of shipment for each destination, the firm's reported handling charge, and the reported rate for the respective mode. The local truck rate for the firm was used to proxy (T), the unit transport cost incurred by the farmer. In the cases where reported service characteristics were incomplete and yet firms reported a given mode/market pair as an alternative, OLS was used to estimate regionally specific population parameters for rate, wait, transit time, and loading time. Estimates for the missing data were then used. Distance to the nearest competitor was measured as actual road distance.

RESULTS

The disaggregate model was estimated in two stages. In the first stage, the parameters of the Conditional Logit choice probabilities were estimated by maximum likelihood. The index function for the Conditional Logit takes the form

$$\text{(13) PROFIT(i)} = \gamma_0\text{*BOUNDARY(i)} + \gamma_1\text{*WAIT(i)} + \gamma_2\text{*TRANSIT(i)} + \gamma_3\text{*LOAD(i)} + \gamma_4\text{*DUMMY}.$$

The first stage estimates, which are shown in Table 1, were then used to construct the selectivity variables which were appended to the regression equations for shipment size. The regression equations were estimated by weighted least squares, and the results of this second stage are shown in Table 2. The regression equation for the second stage takes the form

$$\text{(14) QUANTITY(i)} = \beta_0\text{*BOUNDARY(i)} + \beta_1\text{*CAPACITY(i)} + \beta_2\text{*SELECTIVITY(i)} + \beta_3\text{*LOAD(i)} + \beta_4\text{*DUMMY}.$$

Table 1 shows that waiting costs and market boundary are all statistically significant at the 5% level and have the expected signs in explaining the firms mode/market decisions. Thus, we find that a mode/market alternative that requires a longer waiting time is less likely to be chosen. Waiting costs reflect the opportunity costs of having to hold grain in storage while waiting for the delivery of transportation equipment. For example, when rail cars are in short supply, elevators may expect to wait longer to receive their equipment order. Therefore, the

Table 1
Maximum Likelihood Estimates for the Joint Choice
of Mode and Market Destination

Variable	Parameter Est.	Std. Error
Waiting Cost	-214.9	70.32
Loading Cost	-224.4	160.50
Time in Transit Cost	-41.1	65.19
Market Boundary	252.9	39.74
Dummy		
Barge/Portland	3.95	.94
Unit/Seattle	1.98	.53
Unit/Portland	3.02	.39
Truck-Barge/Portland	1.39	.31

Auxiliary Statistics	At Convergence	At Zero
Log Likelihood	-305.0	-393.7
Percent Corrected Predicted	46.0	13.97
Likelihood Ratio Statistic		
X^2_8	177.4	
Likelihood Ratio Index	.225	
Sample Size = 183		

costs of using rail increases and reduces the likelihood that rail will be chosen. Our results show that this is an important factor in the elevator's decision process. Recall that the market boundary variable is a linear function of the difference between the net prices of the firm and its competitor and of the distance to the firm's competitor. Net price is defined as the market price of wheat minus the transport rate and a handling charge. If the elevator can get a higher price for its customers or can negotiate lower transportation rates or charges less for handling, then the market boundary increases. Our results show that if a mode/market alternative increases the market boundary, then this will increase the likelihood of choosing that alternative.

The Likelihood Ratio Statistic which tests the null hypothesis that the coefficients of the Logit model are jointly zero is statistically significant at the .001 level. However, the Likelihood Ratio Index, a pseudo R^2, shows that only about 22.5% of the variance is accounted for at convergence. The small percent of variance explained reflects the sample size and the sparse cell frequencies for some of the choice alternatives.

Table 1 shows that the parameter estimates on transit costs and loading costs are statistically insignificant. Discussions with elevator operators suggested that transit time was not very important in deciding mode/market choice, and this fact was clearly supported by the data. Our results are consistent with other studies (Daughety and Inaba, 1981; Winston, 1981). Similarly, loading costs were not very important in deciding mode/market choice.

The last noteworthy results in Table 1 are the effects of the dummy variables. All the coefficients on the dummy variables are statistically significant at the .05 level and positive. These results imply that the large capacity and mechanization embodied in these modes lends to a preference for them if they are feasible. Thus, a shipper located on the Columbia River with a barge terminal would be very likely to choose barge. Similarly for an elevator with unit train facilities.

Presented in Table 2 are the estimation results for equation (13), the quantity shipped as a function of the market boundary and elevator capacity, conditional on mode/market choice. The standard errors are derived from the asymptotic covariance matrices for switching regression models developed by Lee (1980). The most important result shown is the highly significant parameter estimate on the selectivity correction variable. The strong positive sign is consistent with the theory that the choice of mode and market is a fundamental determinant of shipment size. This result implies that standard regression techniques that are applied to estimate shipment size <u>without accounting for mode/market selectivity</u> are highly suspect and are likely to suffer from misspecification. The firm's storage capacity has the anticipated effect on shipment size, but has only a marginal impact at the 11% level of significance. The insignificant parameter estimate on the market boundary variable should be interpreted with some caution. Market boundary is an important determinant of shipment size, not so much directly, but rather through its effect on the mode/market decision. As in the results in Table 1, the dummy variables for barge to Portland and unit train to Portland and Seattle in Table 2 are statistically significant, whereas the dummy variable for truck-barge to Portland is not. The F statistic from the joint test that all parameters are zero shows that the null hypothesis can be rejected at the .0001 level. The R^2 shows that only about 32% of the variance is explained by the model.

Table 2

Weighted Least Squares Estimation
of the Elevator's Shipment Quantity Decision
(Dependent Variable Quantity)

Variable	Parameter Est.	Std. Error
Market Boundary	239.27	590.74
Elevator Capacity	-.0021	.0020
Selectivity Correction	12,946.08	5,143.07
Dummy		
Barge/Portland	77,417.00	32,800.0
Unit/Seattle	77,063.99	33,799.3
Unit/Portland	120,265.74	19,377.4
Truck-Barge/Portland	17,705.22	19,796.8
$F_{7,176}$ Statistics	11.73	
R^2	.32	
N	183	

Again, this is due to the sparse cell frequencies for some of the mode/market alternatives. In general, Table 2 provides strong support for the disaggregate demand model.

FORECASTING EXPERIMENTS

This section reviews a number of forecasting experiments that were conducted with the computer model. These experiments will demonstrate how the model can be used by potential users and will indicate the strengths and weaknesses of the model. All calculations used actual data that were obtained from the 1984 survey of 183 firms in the study area. The forecasts were then compared with the actual traffic flows observed in the sample.

The elevators in each region were partitioned according to the mode-destination choices that were likely to be feasible. Using the average regional values of the relevant variables, e.g., modal rates, wheat prices, storage capacities, waiting costs, etc., the computer model generated the total number of bushels of wheat that the firms in each partition were expected to ship on the mode-destination alternatives that are feasible for each partition. These predictions were summed for each mode-destination alternative relevant to the region to obtain aggregate regional forecasts.

Forecasts for Region 1--Montana:

The Montana elevators in the samples were assumed to belong to three classes of shippers:

1) Thirteen shippers of hard red wheat destined for California, Great Falls, Ogden and Minneapolis by truck, single car rail, multiple car

rail and truck-rail combination. Firms in this class do not have unit train facilities.

2) Twenty-seven shippers of soft white wheat destined for Seattle, Portland and river subterminals. These are small elevators that lack unit train facilities and can use truck, single car rail, multiple car rail, truck-rail and truck-barge.

3) Eleven large shippers of soft white wheat destined for Seattle and Portland. These firms use only rail; single car, multiple car and unit trains.

In Table 3.1, we show all alternatives for which either the forecast or the observed sample flow is positive. Given the variability between the forecast and sample data on each alternative, it is useful to look at the results in a more meaningful summarized form:

	Sample	Forecasts
Total Rail Flows--Portland	1,443,050	590,868
Truck Barge--Portland	40,202	180,109
Hard Red Wheat Flows	61,119	59,748

It should be noted that truck shipments to river terminals are ultimately truck barge shipments to Portland. Hence, in reporting truck barge shipments to Portland, we shall henceforth include truck shipments to the river. Our experiments indicate that the model seriously under-predicts rail traffic to Portland from Montana. Examination of the sample data revealed that unit train shipments from Montana were approximately seventy percent larger than the average unit train shipment for the entire sample.

TABLE 3.1

Region 1--Montana

	Demand Flows (Bushels)	
Mode--Destination	Sample Data	Forecasts
Truck--Portland	6,000	18,236
Truck--Seattle		13,889
Truck--River	29,352	22,600
Truck--California	720	
Truck--Minneapolis	1,200	
Truck--Great Falls	28,156	12,983
Truck--Ogden	2,751	11,576
Single Rail--Portland	12,000	19,365
Single Rail--Seattle		11,743
Single Rail--Great Falls	3,292	8,278
Single Rail--Ogden	25,000	7,510
Multi-Rail--Portland	181,800	11,707
Multi-Rail--Great Falls		10,539
Multi-Rail--Ogden		8,862
Unit Train--Portland	1,184,250	559,796
Unit Train--Seattle	172,000	198,257
Truck Rail--Portland	65,000	
Truck Barge--Portland	10,850	157,509

This can explain much of the discrepancy obtained in our experiments. In contrast, the discrepancy in the truck barge traffic cannot be explained. It is very surprising that the observed volumes on truck barge were so low, given the net prices that Montana elevators were offering for using this mode and the estimated transit-time costs of using truck from Montana to the river. It could be that the net price of $2.89 per bushel for using truck barge reported in our data is simply too high relative to what Montana elevators normally offer.

Our final comment on the Montana forecast concerns the shipment to Seattle. Our forecasts predict a greater volume going to Seattle than were observed in the sample. The reason is that the model's default setting is to treat the Seattle and Portland markets as equal in size. In reality, the demand at Seattle is far lower than at Portland. Therefore, unless we explicitly restrict the volume of demand at Seattle, the model is likely to over-predict traffic to that market. One way to deal with this problem is to explicitly remove Seattle from the destination choice set of a proportion of firms in the region. This procedure essentially presupposes that some of the elevators do not receive bid offers for the delivery of wheat to Seattle. This adjustment to the model is easy to implement by the user, and we suggest that it be made whenever conditions warrant it.

Forecasts for Region 2--Southern Idaho and Eastern Oregon:

Our sample indicated that the elevators in the survey could be partitioned into three classes:

1) Twenty-three shippers of hard red wheat destined for California or Ogden using truck, single car and multiple car rail.
2) Thirteen shippers of soft white wheat to Seattle, Portland and the river using truck, single car rail and truck barge.
3) Ten shippers of soft white wheat to Seattle, Portland and the river using truck, single car rail, multiple car rail, unit train and truck

barge. These shippers were determined to be larger than those of class 2.

The forecasts and observed flows are shown in Table 3.2

For purposes of evaluation, it is again useful to summarize these results as follows:

	Sample	Forecasts
Total Rail Flows--Portland	428,600	598,222
Total Rail Flows--Seattle	85,000	114,402
Truck and Truck Barge--Portland	171,244	148,707
Hard Red Wheat Flows	66,767	73,069

These results suggest that the experiments with the forecasts of demand flows for Region 2 were moderately successful. It appears that the model was able to pick up the important traffic patterns and, except for an over-prediction of unit train flows to Portland, the model was able to predict general traffic flows. The discrepancy between the predicted and observed rail flows to Portland is disturbing. An examination of the data reveals that of the ten elevators that reported the availability of unit train facilities, only five of them shipped by unit train. This utilization rate is lower than average, which explains the flow discrepancy for unit train in Region 2.

TABLE 3.2

Region 2--Southern Idaho and Eastern Oregon

Mode--Destination	Demand Flows (Bushels) Sample Data	Forecasts
Truck--Portland	61,530	5,027
Truck--Seattle		3,813
Truck--California		6,273
Truck--Ogden	27,667	29,178
Single Rail--Portland	20,000	3,975
Single Rail--Seattle		3,209
Single Rail--California	3,300	5,643
Single Rail--Ogden	3,300	16,256
Multi-Rail--Portland	79,100	
Multi-Rail--Seattle		
Multi-Rail--California	32,500	
Multi-Rail--Ogden		15,719
Unit Train--Portland	329,500	594,247
Unit Train--Seattle	85,000	111,193
Truck Barge--Portland	109,714	148,707

Forecasts for Region 3--Northeastern Oregon; Klickitat, Skamania Counties, Washington

For this region, elevators were assumed to fall into four classes:

1) Three river elevators which can use barge and truck. Destinations include Seattle and Portland, the major markets for soft white wheat.

2) Five small elevators that can use only truck or truck-rail to Portland or Seattle.

3) Five medium size elevators that can use truck, single car, multiple car and truck barge modes to Portland or Seattle.

4) Four large elevators that have unit train facilities and can also use truck, single car and multiple car rail.

The following data summarizes the forecast results for Region 3, which are shown in Table 3.3:

	Sample	Forecasts
Total Rail Flow--Portland	191,200	214,135
Truck and Truck Barge--Portland	58,067	58,049
Total Rail Flow--Seattle	--	39,090

As can be seen, the forecasts are quite close to the observed data. The over-prediction of shipments to Seattle by rail again reflects the fact that the experiment did not account for the lower demand for wheat at the Seattle market. Examination of Table 3.3 leads to the conclusion that there are sizeable differences between the forecasts and sample flows when one looks at individual mode-destinations. However, aggregating these into the more general classes of rail, truck and barge, one obtains much more accurate forecasts.

TABLE 3.3

Region 3--Northeastern Oregon; Klickitat, Skamania Counties, Washington

	Demand Flows (Bushels)	
Mode--Destination	Sample Data	Forecasts
Barge--Portland	250,000	211,164
Truck--Portland	37,267	7,139
Truck--Seattle		1,383
Single Rail--Portland	39,600	
Single Rail--Seattle		
Multi-Rail--Portland	39,400	2,421
Multi-Rail--Seattle		
Unit Train--Portland	82,500	210,044
Unit Train--Seattle		39,090
Truck Rail--Portland	29,700	1,669
Truck Rail--Seattle		895
Truck Barge--Portland	20,800	50,910

Forecasts for Region 4--Western Oregon; Clark and Cowlitz Counties, Washington

The eleven firms in Region 4 are small-to-medium size elevators with average capacity of just under one million bushels. Given their close proximity to Portland, they typically ship by truck, even though all of them have direct access to rail facilities. None of the firms in the sample has unit train or barge facilities. While some of them deliver wheat to terminals on the Columbia River, these delivery points are so close to Portland that we have included them as Portland destinations. The only feasible modes assumed for Region 4 firms are truck, single car and multiple car rail, and the only destinations are assumed to be Portland and Seattle.

As shown in Table 3.4, the model predicts a preponderance of traffic by truck to Portland, which is consistent with the data. The model also predicts an occasional rail shipment to Portland. As we noted earlier, the unconstrained model tends to over-predict traffic to Seattle, which is the case for Region 4. To correct this bias, one can simply eliminate Seattle as a feasible destination. This procedure is clearly appropriate since the elevators in this region are located so near to Portland.

TABLE 3.4

Region 4--Western Oregon; Clark and Cowlitz Counties, Washington

	Demand Flows (Bushels)	
Mode--Destination	Sample Data	Forecasts
Truck--Portland	29,735	24,234
Truck--Seattle		4,840
Single Rail--Seattle		2,831
Multi-Rail--Portland		4,718

Forecasts for Region 5--Asotin, Garfield, Columbia, Walla Walla Counties, Washington

While there are only six firms in Region 5 in our sample, they used four different mode-destination alternatives. Given this amount of variation in their actual choices, it was necessary to assume that these firms fell into three classes:

1) Two small shippers that use only truck, single car rail and truck barge modes to either Portland or Seattle.
2) Two large inland shippers that have unit-trail facilities. These firms can also ship by truck, multiple car rail and truck barge to Portland or Seattle.
3) Two large river elevators that rely almost exclusively on barge, although truck is also available.

The model accurately predicts total rail flow to Portland; it predicts 103,653 bushels whereas the observed flow is 102,000 bushels. Again, without any prior constraints on the Seattle market, the model tends to over-predict rail traffic to Seattle. The prediction for barge traffic is within seven percent of the observed. However, the model has significantly under-predicted truck and truck barge flows to Portland. Inspection of the data reveals that there was one truck barge shipment of 100,000 bushels. This is significantly greater than the average shipment size of 26,300 bushels for this mode.

TABLE 3.5

Region 5--Asotin, Garfield, Columbia, Walla Walla Counties, Washington

	Demand Flows (Bushels)	
Mode--Destination	Sample Data	Forecasts
Barge--Portland	230,802	246,423
Multi-Rail--Portland	20,000	
Unit Train--Portland	82,000	103,653
Unit Train--Seattle		23,350
Truck Barge--Portland	115,000	20,824

Forecasts for Region 6--North Idaho; Whitman and Adams Counties, Washington

The thirty firms in the sample were partitioned into three classes:

1) Twenty shippers that use truck, single car rail, truck rail and truck barge to Seattle and Portland.
2) Nine large inland firms that have unit train facilities. They can also ship by truck, multiple car rail and truck barge to Seattle and Portland.
3) One large river terminal with barge facilities. It can also ship by truck as an alternative mode. Destinations include Portland and Seattle.

The results in Table 3.6 are summarized as follows:

	Sample	Forecasts
Total Rail Flow--Portland	418,800	527,319
Total Rail Flow--Seattle	103,600	78,288
Truck and Truck Barge--Portland	430,418	220,927

As indicated in Table 3.6 and the summary above, the model is only moderately successful in predicting rail traffic to Portland and Seattle. But it seriously under-predicted the importance of truck and truck-barge traffic to Portland. Inspection of the data for Region 6 reveals a very large shipment of 120,000 bushels by truck barge. This accounts for a large portion of the forecast error. However, a large forecast error still remains unexplained.

TABLE 3.6

Region 6--North Idaho; Whitman and Adams Counties, Washington

	Demand Flows (Bushels)	
Mode--Destination	Sample Data	Forecasts
Barge--Portland	115,000	126,383
Truck--Portland	15,000	2,365
Single Rail--Portland	128,000	
Multi-Rail--Seattle	10,000	
Unit Train--Portland	353,800	527,319
Unit Train--Seattle	93,600	78,288
Truck Barge--Portland	415,418	218,562

Forecasts for Region 7--Idaho Panhandle; Spokane, Lincoln, Stevens Counties, Washington

Examination of the firms in the survey revealed approximately two classes of shippers:

1) Five smaller elevators with truck, single car rail and truck barge modes available. Destinations include Seattle and Portland.
2) Eight larger firms with facilities for unit train shipments. These firms can also use truck, single car rail, multiple car rail and truck barge to Portland and Seattle.

The results in Table 3.7 indicate moderate forecasting accuracy for rail flows to Portland and Truck, Truck barge flows to Portland. This can be seen in the following summary of Table 3.7:

	Sample	Forecasts
Total Rail Flows--Portland	352,100	344,253
Total Rail Flows--Seattle	256,000	94,970
Truck, Truck Barge--Portland	33,000	38,607

However, the heavy traffic to Seattle by unit train was not predicted by the model. While a sizeable volume of traffic was predicted by the model, only about one-third of the observed volume was predicted. Because Seattle is not a high volume market for wheat, it might be the case that the 256,600 bushels reported in the sample is unusually high.

TABLE 3.7

Region 7--Idaho Panhandle; Spokane, Lincoln, Stevens Counties, Washington

	Demand Flows (Bushels)	
Mode--Destination	Sample Data	Forecasts
Single Rail--Portland	6,600	
Multi-Rail--Portland	55,700	
Unit Train--Portland	289,800	344,253
Unit Train--Seattle	256,600	94,970
Truck Barge--Portland	33,000	38,607

Forecasts for Region 8--Yakima, Benton, Kittitas Counties, Washington

This region contains the fewest firms (three) in the sample. We assume that these firms can ship to Seattle or Portland by truck, single car rail, multiple car rail or truck barge. Table 3.8 compares the predicted traffic flows with the observed data. As can be seen, the predictions hardly resemble the data. To evaluate the reason for the disparity, recall that the predictions are based on the average values of the variables for the region. Furthermore, the model was estimated using the decision outcomes and the variables of all the firms in the sample. Since Region 8 contains only three sampled firms, it might be that their decisions are not like the "typical" firm postulated by the model.

In order to explore this possibility, the model was used to "replicate" the actual data. To do this, we assumed a set of values for the decision variables, which, when fed into the model, generated predications that were reasonably close to the data. The results of this experiment are shown in table 3.8'. Essentially, transit time on truck barge and net prices on the other feasible alternatives were adjusted to obtain probabilities of choosing the alternatives consistent with the observed outcomes. Then the influence of the market boundary variable was adjusted in order to increase expected shipment size. Except for the last adjustment, all changes in the variables are within the ranges observed in the sample. This suggests that the sample data in Region 8 are within the predictive ability of the model.

TABLE 3.8

Region 8--Yakima, Benton, Kittitas Counties, Washington

	Demand Flows (Bushels)	
Mode--Destination	Sample Data	Forecasts
Truck--Portland		1,374
Truck--Seattle		1,515
Single Rail--Seattle	4,000	
Multi-Rail--Portland	9,500	1,305
Multi-Rail--Seattle	10,000	1,337
Truck Barge--Portland		28,375

TABLE 3.8'

Region 8--Replication Experiment of Sample Data

Mode--Destination	Predicted Demand Flows (Bushels)
Single Rail--Seattle	6,600
Multi-Rail--Portland	9,732
Multi-Rail--Seattle	9,740

Assumptions: Choice	Net Price ($)
Truck--Seattle	2.80
Truck--Portland	2.73
Truck--River	2.75
Single Rail--Seattle	3.10
Single Rail--Portland	2.88
Multi-Rail--Seattle	3.25
Multi-Rail--Portland	3.25
Truck Barge--Portland	2.73

Transit time for truck barge--Portland is seven days; transit time for truck--Portland is one day (i.e., 7 : 1). Coefficient on BOUNDARY is 439.274 rather than 239.274.

Forecasts for Region 9--Grant and Douglas Counties, Washington

We assume that the six firms in this region ship to Seattle or Portland by truck, single car rail, multiple car rail or truck barge. The results in Table 3.9 have a similar interpretation as in Table 3.8. However, the predicted pattern of shipments matches favorably with the sample data. The discrepancies are in the volumes of traffic (e.g., 1,427 and 1,794 bushels predicted for multi-rail versus 40,333 and 66,000 bushels observed in the sample).

Inspection of the data revealed that the multi-rail shipments were usually large. In a sense, these elevators behaved as if they possessed unit train facilities. This suggests that we change our forecasting assumptions so that two firms have unit train facilities. The last column of Table 3.9 shows that the predictions under the new assumption come much closer to the observed data, with respect to rail traffic Portland and Seattle. However, the new predications for truck barge are still far below the data. Inspection of the sample data reveals a single, very large shipment by truck barge. Correcting for this large shipment, we note that the model's predictions for truck barge traffic are fairly consistent with the average shipment size on that mode.

TABLE 3.9

Region 9--Grant, Douglas Counties, Washington

Mode--Destination	Sample Data	Forecasts	Revised Forecasts
Truck--Portland		1,562	1,471
Truck--Seattle	1,000	1,739	1,292
Single Rail--Portland		1,341	
Multi-Rail--Portland	66,000	1,427	
Multi-Rail--Seattle	40,333	1,794	
Unit Train--Portland			99,490
Unit Train--Seattle			18,958
Truck Barge--Portland	115,000	57,732	60,727

Applications

The forecasting model can be used to examine a variety of policy issues. Here we illustrate its application to predict the effects of rail abandonment in two regions of Eastern Washington and Idaho; Region 6 (Whitman and Adams Counties, Washington and the Latah County area of Idaho) and Region 7 (Spokane, Lincoln and Stevens Counties, Washington and the Idaho Panhandle).

We assume that rail abandonment will result in the loss of direct rail service to fifty percent of the elevators in each region. Specifically, it is assumed that after rail abandonment the modes that are feasible for the sample elevators in Region 6 are as follows:

a) Fifteen firms with modes truck, truck rail and truck barge.

b) Ten firms with modes truck, single car rail and truck barge.

c) Four firms with modes truck, single car and multiple car rail, unit train and truck barge.

d) One firm with modes truck and barge.

The model is then used to forecast the demand flows for each of the four classes of firms in Region 6. The total demand flow for each mode-destination alternative is shown in Table 4. Comparisons with the pre-abandonment forecasts, also shown in Table 4, reveal the following conclusions:

TABLE 4

Effects of a 50 Percent Rail Abandonment in Region 6

	Demand Flow Forecasts (Bushels)	
Mode--Destinations	Pre-Abandonment	Post-Abandonment
Barge--Portland	126,383	126,383
Truck--Seattle		
Truck--Portland	2,365	2,912
Truck--River	2,595	3,201
Single Rail--Seattle		
Single Rail--Portland		1,124
Multi-Rail--Seattle		
Multi-Rail--Portland		
Unit Train--Seattle	78,288	33,686
Unit Train--Portland	527,319	226,907
Truck Rail--Seattle		
Truck Rail--Portland		
Truck Barge--Portland	215,967	274,663

Abandonment is predicted to reduce rail traffic by 57 percent and to increase truck barge traffic by 27 percent. Overall, abandonment is predicted to reduce transportation flows by 30 percent.

It should be noted that these forecasts are based on the assumption that only rail availability has been changed. Realistically, other variables are likely to change as well. For example, the increased demand for truck and for the existing rail service might cause rates on these modes to increase. Or perhaps, new barge facilities might spring up to accommodate the increased traffic on the waterways. These can be obtained to reflect these secondary effects of rail abandonment.

Given the proximity of many Region 6 elevators to the Snake River, it is not surprising that the model predicts a sizeable shift to truck barge traffic in response to rail abandonment. However, the effects of lost rail availability are not limited to substitutions of one mode for another. The model suggests that lack of rail availability will actually raise costs to such an extent that total regional production will fall in absolute terms. An important policy implication is that to maintain production, something must be done to lower transport costs of truck and barge and to increase accessability of these alternative modes to rail transport.

We have seen in the above application that there is likely to be a significant diversion of abandoned rail traffic to truck barge. However, many points in Region 6 are reasonably close to river terminals. In a region like Region 7, access to truck barge transportation is limited because of the long distances to river loading facilities. Therefore, it is of some interest to compare the effects of rail abandonment in Region 7 with Region 6. Again, assume that fifty percent of the elevators in Region 7 lose direct rail service. This implies that the thirteen firms in our sample will have the following transport availability:

a) Three firms have modes truck, single car rail, truck barge.

b) Six firms have modes truck, truck rail, truck barge.

c) Four firms have modes truck, single car rail, multiple car rail, unit train, truck barge.

Again, in making our forecasts, we have assumed that only rail availability has been changed; all rates, prices and services are unchanged. Table 5 shows the pre- and post-abandonment forecasts for Region 7. Since the model predicted that truck, single car and multiple car rail would not be used under either scenario, Table 5 has omitted these modes.

TABLE 5

Effects of a 50 Percent Rail Abandonment on Region 7

	Demand Flow Forecasts (Bushels)	
Mode--Destinations	Pre-Abandonment	Post-Abandonment
Unit Train--Seattle	94,970	47,485
Unit Train--Portland	344,253	172,127
Truck Rail--Seattle		
Truck Rail--Portland		
Truck Barge--Portland	38,607	56,846

As the table shows, rail traffic is predicted to fall by 50 percent, but truck barge demand is predicted to rise by 47 percent. However, the net effect of abandonment is to reduce total transport demand--and therefore production--in Region 7 by 42 percent. It is important to note that without any changes in rates or service for the truck-rail combination mode, the model does not predict any diversion to this mode. Comparing the effects of rail abandonment in Regions 6 and 7, we conclude that Region 7 will suffer more from abandonment than Region 6. This is due to the fact that Region 6 has greater access to barge and truck barge modes and depends less on rail than does Region 7.

The above applications on the use of the demand forecasting model are only meant to illustrate the ways the model can be used for policy analysis. One interesting application of the model is to examine what would happen to transportation demand flows if river transportation were made more accessible to the wheat elevators. In making this analysis, one could hypothetically add more barge facilities on the rivers, and lower transit and waiting time costs to reflect improved road and highway conditions for trucks heading to these barge facilities.

IMPLEMENTATION PLAN

There are no formal plans for the research team to implement the forecasting model. It is anticipated that the model will be applied by the Rail/Air Transportation Branch and the Economic Branch of Washington State Department of Transportation. In addition, the forecasting model should also be used by county planners and commissioners. The Users Guide and a copy of the computer program diskettes are all that is needed to run the model. One of the strengths of the forecasting model is that it will allow the user to input the values of the variables which are known to prevail in the local region (e.g., prevailing unit train rates in Whitman County). The performance of the model in such application should be relayed to WSDOT.

The research team is planning to use the forecasting model in a number of future research projects. One project is to develop better aggregation procedures than the one adopted in this project. This will be the topic of a Ph.D. dissertation. The second project is to apply the disaggregate choice model in an empirical test of alternative theories of spatial competition. This work will attempt to incorporate a choice probabilities model in the conjectural variations of a firm's reaction function.

Appendix: Regional Distribution of Firms

Region	Est. Population Total	Sample Number	Sampled Firms with Barge	Sampled Firms with Unit Train
1	79	51	0	11
2	77	46	0	11
3	27	17	3	8
4	19	11	0	0
5	9	6	2	2
6	46	30	1	9
7	14	13	0	8
8	5	3	0	0
9	11	6	0	0

Appendix: Survey Instrument

BACKGROUND QUESTIONS

1. WHAT IS YOUR POSITION?

__OWNER __ASSISTANT MANAGER
__MANAGER __OTHER (PLEASE SPECIFY)

____

2. WHO OWNS THIS COMPANY? (CHECK ONE)

__A CORPORATION (PLEASE NAME)______
____

__AN INDIVIDUAL
__OTHER (PLEASE NAME)__________

3. IS THIS COMPANY A MEMBER OF A COOPERATIVE?

__YES __NO

4. WHAT IS THE CAPACITY OF THIS company?
______________(BUSHELS)

5. WHAT TYPE OF ELEVATOR IS THIS?

__TERMINAL ELEVATOR __COUNTRY ELEVATOR
__SUBTERMINAL ELEVATOR __OTHER (PLEASE NAME)________

____

6. HOW FAR ON AVERAGE ARE YOUR ELEVATORS FROM THE NEAREST RIVER LOADING POINT?
________(MILES)

7. HOW FAR ON AVERAGE ARE YOUR ELEVATORS FROM THE NEAREST SINGLE OR MULTIPLE CAR RAILROAD LOADING POINT? ________(MILES)

8. HOW FAR ON AVERAGE ARE YOUR ELEVATORS FROM THE NEAREST UNIT TRAIN LOADING FACILITY?
__________(MILES)

9. PLEASE CHECK MODES YOU CAN USE TO MAKE SHIPMENTS.

__TRUCK __UNIT TRAIN
__BARGE (PLEASE STATE
__SINGLE CAR RAIL NUMBER OF CARS)
__MULTIPLE CAR RAIL

____

10. PLEASE SPECIFY ALL DESTINATIONS TO WHICH SHIPMENTS WERE MADE DURING THE 1984 CROP YEAR.

(A) ALL MAJOR MARKETS

__PORTLAND AREA __DULUTH AREA

__MINNEAPOLIS AREA __LOS ANGELES

__SEATTLE/TACOMA AREA

(B) OTHER (CITY/STATE)

____

____

11. WHAT ARE YOUR PER BUSHEL STORAGE EXPENSES (TOTAL VARIABLE EXPENSES) PER DAY?

____________($/BUSHEL/DAY)

12. WHAT ARE YOUR PER BUSHEL HANDLING EXPENSES (TOTAL VARIABLE EXPENSES) PER HOUR?

____________($/BUSHEL/HOUR)

SHIPMENT CHARACTERISTIC QUESTIONS

WE WOULD NOW LIKE TO ASK SEVERAL QUESTIONS ABOUT A SPECIFIC SHIPMENT DECISION MADE BY THIS ELEVATOR. PLEASE PROVIDE THE FOLLOWING INFORMATION FOR THE FIRST WHEAT SHIPMENT MADE DURING THE FIRST 15 DAYS OF FEB.. IF NO SHIPMENTS WERE MADE IN THAT PERIOD THEN SELECT THE FIRST SHIPMENT FROM THE FOLLOWING WEEK.

13. WHAT TYPE OF GRAIN DID YOU SHIP? (CHECK ONE)

__WHITE WHEAT
__RED WHEAT

14. WHAT WAS THE CONTRACT DATE OF SALE? __________

15. WHAT WAS THE CONTRACT DELIVERY DATE? __________

16. WHAT WAS THE CONTRACT PRICE? (PER BUSHEL)
____

17. DOES THE CONTRACT PRICE INCLUDE THE TRANSPORT RATE?

__YES __NO

18. WHAT WAS THE SHIPMENT SIZE? (IN BUSHELS)
____

19. WHAT WAS THE CAPACITY OF THE ELEVATOR AT THE LOADING ORIGIN? (IN BUSHELS)__________

20. WHAT WAS THE DESTINATION OF THE SHIPMENT?

__PORTLAND AREA __DULUTH

__MINNEAPOLIS __LOS ANGELES

__SEATTLE/TACOMA AREA

__OTHER (CITY/STATE)

____

____

21. WHAT WAS THE SHIPPING DATE? (GIVE ALL DATES IF SHIPMENT SENT ON MORE THAN ONE DAY)________

____

22. WHAT WAS THE UNLOADING DATE AT THE DESTINATION? ____________

23. WHO PAID THE TRANSPORT COST?

___ SHIPPER
___ RECEIVER
___ OTHER (PLEASE NAME) ________

24. WHO OWNS THE TRANSPORT VEHICLES USED FOR THIS SHIPMENT?

___ SHIPPER
___ RECEIVER
___ OTHER (PLEASE NAME) ________

25. WHAT WERE THE PER BUSHEL STORAGE CHARGES PER DAY TO FARMERS FOR THIS SHIPMENT? ____________ ($/BUSHEL/DAY)

26. WHAT WERE THE PER BUSHEL HANDLING CHARGES PER HOUR TO FARMERS FOR THIS SHIPMENT? ____________ ($/BUSHEL/HOUR)

27. WHAT MODE WAS USED?

___ BARGE (PLEASE GO TO QUESTIONS 28-32))

___ TRUCK (PLEASE GO TO QUESTIONS 28-32)

___ SINGLE CAR RAIL (PLEASE GO TO QUESTIONS 28-32)

___ MULTIPLE CAR RAIL (NUMBER OF CARS? ________)(PLEASE GO TO QUESTIONS 28-32)

___ UNIT TRAIN (NUMBER OF CARS? ________) (PLEASE GO TO QUESTIONS 28-32)

___ TRUCK/BARGE (PLEASE GO TO QUESTIONS 33-45)

___ TRUCK/UNIT TRAIN (NUMBER OF CARS? ________)(PLEASE GO TO QUESTIONS 33-45)

___ TRUCK/MULTIPLE CAR RAIL (NUMBER OF CARS? ________)(PLEASE GO TO QUESTIONS 33-45)

___ OTHER (PLEASE NAME ____________)(PLEASE GO TO QUESTIONS 28-32)

SINGLE MODE CHOICE QUESTIONS

28. WHAT WAS THE TRANSPORT RATE ON THE MODE CHOSEN? (PER BUSHEL) ____________

29. HOW MANY DAYS WAS THE MODE CHOSEN DELAYED AFTER THE DUE DATE SPECIFIED IN THE EQUIPMENT ORDER? ____________

30. HOW LONG DO YOU USUALLY EXPECT TO WAIT (IN DAYS) TO BE 95% SURE OF RECEIVING THE MODE CHOSEN AFTER THE DUE DATE SPECIFIED IN THE EQUIPMENT ORDER? ____________

31. WHAT WAS THE DOLLAR AMOUNT OF LOSS AND DAMAGE FOR THIS SHIPMENT ON THE MODE CHOSEN? ____________

32. HOW MANY HOURS WERE REQUIRED TO LOAD THE SHIPMENT? ____________

(PLEASE GO TO QUESTIONS 46 AND 47)

MULTI-MODAL MODE CHOICE QUESTIONS

33. WHAT WAS THE TRANSPORT RATE ON THE TRUCK? (PER BUSHEL) ____________

34. HOW MANY DAYS DID THIS SHIPMENT TAKE TO ARRIVE AT THE FACILITY FOR THE BARGE (OR RAIL) LOADING? ____________

35. HOW MANY DAYS WAS THE TRUCK DELAYED AFTER THE DUE DATE SPECIFIED IN THE EQUIPMENT ORDER? ____________

36. HOW LONG DO YOU USUALLY EXPECT TO WAIT (IN DAYS) TO BE 95% SURE OF RECEIVING TRUCKS AFTER THE DUE DATE SPECIFIED IN THE EQUIPMENT ORDER? ____________

37. WHAT WAS THE DOLLAR AMOUNT OF LOSS AND DAMAGE FOR THIS SHIPMENT ON THE TRUCK? ____________

38. HOW MANY HOURS WERE REQUIRED TO LOAD THIS SHIPMENT ON THE TRUCK (OR TRUCKS)? ____________

39. HOW MANY DAYS WAS THE TRUCK (OR TRUCKS) TRANSSHIPMENT DELAYED DUE TO COUNTRY ROAD CLOSURES OR SPEED LIMIT RESTRICTIONS? ____________

40. WHAT WAS THE TRANSPORT RATE ON THE BARGE (OR RAIL)? (PER BUSHEL) ____________

41. HOW MANY DAYS DID THIS SHIPMENT TAKE ON THE BARGE (OR RAIL) FROM SHIPPING DATE TO UNLOADING DATE? ____________

42. HOW MANY DAYS WAS THE BARGE (OR RAIL) DELAYED AFTER THE DUE DATE SPECIFIED IN THE EQUIPMENT ORDER? ____________

43. HOW LONG DO YOU USUALLY EXPECT TO WAIT (IN DAYS) TO BE 95% SURE OF RECEIVING THE BARGE (OR RAIL) AFTER THE DUE DATE SPECIFIED IN THE EQUIPMENT ORDER? ____________

44. WHAT WAS THE DOLLAR AMOUNT OF LOSS AND DAMAGE FOR THIS SHIPMENT ON THE BARGE (OR RAIL)? ____________

45. HOW MANY HOURS WERE REQUIRED TO LOAD THIS SHIPMENT ON THE BARGE (OR RAIL)? ____________

(PLEASE GO TO QUESTIONS 46 AND 47)

MODE CHOICE ALTERNATIVES QUESTIONS

WE WOULD NOW LIKE TO ASK YOU SOME QUESTIONS ABOUT ALTERNATIVE MODES THAT COULD POSSIBLY HAVE BEEN USED TO MOVE THIS SHIPMENT. PLEASE CONSIDER THE FOLLOWING ALTERNATIVES NO MATTER HOW UNLIKELYSUCH ALTERNATIVE MODE CHOICE DECISIONS MIGHT BE.

46. WHICH MODES WOULD HAVE BEEN AT ALL POSSIBLE TO USE FOR THIS SHIPMENT? (CHECK ALL MODES YOU COULD HAVE USED, NO MATTER HOW UNLIKELY.)

___BARGE ALONE

___TRUCK ALONE

___TRUCK/BARGE

___TRUCK/MULTIPLE CAR RAIL

___TRUCK/UNIT TRAIN

___SINGLE CAR RAIL ALONE

___MULTIPLE CAR RAIL ALONE (PLEASE STATE NUMBER OF CARS____________________)

___UNIT TRAIN (PLEASE STATE NUMBER OF CARS ____________________)

___OTHER (PLEASE NAME ________________)

(PLEASE GO TO QUESTION 47)

MODE CHOICE ALTERNATIVE CHARACTERISTICS

47. PLEASE FILL OUT THE FOLLOWING TABLE FOR POSSIBLE (NO MATTER HOW UNLIKELY) SINGLE AND COMBINATION MODE ALTERNATIVES YOU MIGHT HAVE CHOSEN FOR THE SAME SHIPMENT.

	SINGLE MODE ALTERNATIVES					COMBINATION MODE ALTERNATIVES		
	TRUCK ALONE	BARGE ALONE	SINGLE CAR RAIL ALONE	MULTIPLE CAR RAIL ALONE	UNIT TRAIN ALONE	TRUCK/BARGE COMBINATION	TRUCK/MULTIPLE RAIL COMBINATION	TRUCK/UNIT TRAIN COMBINATION
a. WHAT WAS THE EXPECTED (PER BUSHEL) TRANSPORT RATE?								
b. HOW MANY DAYS WOULD YOU NORMALLY EXPECT THIS SHIPMENT TO TAKE FROM SHIPPING DATE TO UNLOADING DATE?								
c. WHAT WOULD BE THE AVERAGE EXPECTED PERIOD OF DELAY (IN DAYS) IN RECEIVING THE MODE AFTER THE DUE DATE SPECIFIED IN THE EQUIPMENT ORDER?								
d. HOW LONG WOULD YOU EXPECT TO WAIT (IN DAYS) TO BE 95% SURE OF RECEIVING THE MODE AFTER THE DUE DATE SPECIFIED IN THE EQUIPMENT ORDER?								
e. WHAT WOULD BE THE EXPECTED DOLLAR AMOUNT OF LOSS AND DAMAGE FOR THIS SHIPMENT ON THE ALTERNATIVE?								
f. HOW MANY HOURS WOULD BE BE NEEDED TO LOAD THIS SHIPMENT?								

Appendix: Users' Guide

TABLE OF CONTENTS

INTRODUCTION

The WSU Grain Transportation Forecasting Model is referred to henceforth by the name of ECON. ECON is the implementation of the Forecasting Model for Grain Transportation Planning in Washington State by Drs. Nancy E. Wallace and Frederick S. Inaba of the Department of Economics at Washington State University for the Washington State Department of Transportation. ECON is an interactive, user-friendly PASCAL computer program that generates expected mode/market transportation demand flows for wheat in Washington State, Montana, Idaho, and Oregon. The model data and parameter values in ECON were obtained from a study of shipment decisions by wheat elevator operators in the four state region.

SYSTEM CONFIGURATION

Requirements

An IBM PC or close compatible with 192K of memory
A color or monochrome monitor
One floppy disk drive
An installed 8087 Math Coprocessor
MS-DOS or PC-DOS version 2.00 or higher

Recommended

A color monitor
A hard disk
A parallel printer
RAM Disk Software

Environment Managers

When running under topview or DESQview, the following information is needed in order to construct the Program Information File (PIF).

ECON requires 145K of memory.
ECON writes directly to the screen.
ECON runs only in the foreground.
ECON uses its own colors.
ECON can be swapped to disk.
ECON allows Topview calls.
ECON allows keyboard type-ahead.
ECON allows script type-ahead.
ECON should be closed on exit to DOS.

Files on Diskette

ECON.COM
IMODEL.DAT

SET-UP

We assume that you have already turned on your computer and loaded the MicroSoft Disk Operating System, commonly referred to as MS-DOS.

If you have a hard disk, we recommend that you create a new directory, then copy the files found on the diskette. The following sequence of commands should suffice provided the letter of the hard disk is "C".

```
A>C:
C>MD TRANSPOR
C>CD TRANSPOR
C>COPY A:ECON.COM /v
C>COPY A:IMODEL.DAT /v
```

If you do not have a hard disk, place the floppy disk with the appropriate file into drive A:.

To begin to use the transportation model, the current working directory must be TRANSPOR. For people with a floppy system only, type "A:" at the DOS prompt. For hard disk systems, type "C:" at the DOS prompt followed by "CD TRANSPOR" to change to the correct directory.

START-UP

Type "ECON" to invoke the transportation model program. We recommend that rather than reading this documentation (apart from the information found under the title "NOT QUITE SO APPARENT FEATURES") that you actually attempt to use the program. We are confident that the program is so user-friendly that you will have practically no need for this documentation. There are only one or two actions that may not be apparent, and therefore need to be explained. We will explain these features immediately.

NOT QUITE SO APPARENT FEATURES

If the user is advanced, that is, very familiar with IBM PCs and MS-DOS, we suggest that the user place ECON.COM and the associated data files on a RAM DISK. This operation will greatly increase the speed of the program since disk access to a floppy or hard disk is very slow compared to a RAM disk.

The file IMODEL.DAT is the default file used for input of preset values for all nine regions included in this model. If you are familiar with MS-DOS and have your own values stored in a data file, you may rename IMODEL.DAT to some other name and rename your data file to IMODEL.DAT. This tactic would cause your file to become the default file and may reduce the amount of typing you have to do since pressing the RETURN key specifies the program to use the default file in many instances.

The second not so obvious feature is when you desire to make a copy of a file. Quite clearly, this can be done at the Operating System level by typing at the DOS prompt "COPY OLDFILE.DAT NEWFILE.DAT". The sequence required once the program ECON has been invoked is slightly more complicated. Assuming that you have reached the DATA MANAGEMENT MENU, choose the MODIFY DATA SET submenu. Then specify the name of the file you wish to copy. To be consistent with the method we demonstrated at the DOS level, the name of the file we will choose will be "OLDFILE.DAT". Next you will be prompted for the number of a region. Choose any number in the range 1 to 9 inclusive. The checker board should appear. To complete the sequence, simply choose F4 (Save the Changes and Exit). You will then be prompted for the name of the file in which you wish to store the information. If you specify "NEWFILE.DAT", you will have accomplished the equivalent task of copying the file in a manner consistent with the way it was done at the Operating System level.

Another not so obvious feature is creating a file that has no values, i.e., all the values are zero. This can be accomplished by reaching the DATA MANAGEMENT MENU. At this point, choose the MODIFY DATA SET submenu. When you are prompted for a filename, choose a name that you are sure is not used. For example, choose "XXXX". When you are next prompted for a region number, you may specify any number in the range of 1 to 9 inclusive. The checker board should appear. To complete the sequence, simply choose F4 (Save the Changes and Exit). You will then be prompted for the name of the file in which you wish to store the information. Choose a name that you desire. For example, you may choose "EMPTY". Be careful when choosing this second name because the contents of the file by that name will be wiped out if a file by that name does indeed exist.

The last not so obvious feature is described more thoroughly in the section entitled "Errors". If there is not enough room left on the disk (floppy, hard disk, or RAM disk), the program will terminate abnormally if the user attempts to write a new file.

ERRORS

If the program bombs, that is, it finishes in an unusual manner, the program will issue a cryptic error message. If the error message is equal to 90, 99, F0, F1, F2 or FF, we recommend that the user check the directory to make sure there is enough room for a file of size 36027 bytes to be written. If insufficient room is available, the user is urged to delete unnecessary files or run this program and associated files on a floppy disk.

BODY OF DOCUMENTATION

In this section, we will show you the visual output of the program at the various stages of program execution. We provide a QUICK REFERENCE section that allows you to jump to the correct screen whenever more than one choice exists. Please notice that the text before the particular figure explains that screen.

If you typed "ECON" at the DOS prompt, the following screen will appear. This screen is simply the introduction screen. The user is prompted to enter the password "SYSTEM" to continue to use this program.

Figure 1:

```
|------------------------------------------------------------------------|
|                                                                        |
|                                                                        |
|                          Welcome to the                                |
|               WSU Transportation Forecasting Model                     |
|                                                                        |
|                                                                        |
|                Please enter the password to continue.                  |
|     |------------------------------------------------------------------||
|====>|                                                                  ||
|     |                                                                  ||
|     |------------------------------------------------------------------||
|------------------------------------------------------------------------|
```

If you entered the incorrect password in Figure 1, the following screen appears and you are subsequently ejected from the program.

Figure 2:

```
|------------------------------------------------------------------------|
|                                                                        |
|                        ERROR MESSAGE                                   |
|                                                                        |
|                                                                        |
|   Password Incorrect or Unauthorized Access.                           |
|                                                                        |
|                                                                        |
|------------------------------------------------------------------------|
```

If the password was correctly entered in Figure 1, the MAIN MENU section appears. It is shown below. You are offered three choices or actions. In order to invoke your particular action, simply depress the appropriately labeled key on the keyboard.

Quick Reference:
F1 : Go to Figure 4.
F2 : Go to Figure 16.
ESC : Exits irrevocably from ECON.

Figure 3:

```
MAIN MENU

F1   Run the Model
F2   Modify the Data
ESC  To Exit

Enter the key for the desired option
```

To Run the Model

If we choose to run the model, we would simply depress F1. After so doing, the following screen is displayed.

Quick Reference:
F1 : Go to Figure 5.
F2 : Go to Figure 5.
ESC : Go to Figure 3.

Figure 4:

```
RUN MODEL MENU

F1   Run a Particular Region
F2   Run All Regions
ESC  Return to Main Menu

Enter the key for the desired option
```

It is readily apparent that there are three courses of action. We will show you the screens that appear as a result of choosing to perform the calculations only for a particular region. (Please note that running a particular region or all the regions requires that the user follow the same sequence of actions. The only difference is that more information is generated). To accomplish this task, we would depress F1. After doing so, a window pops up asking for the name of the data file we intend to use. If the RETURN key is pressed, the model will compute the values based on the information found in the default file called IMODEL.DAT. You may, however, specify that the information be searched for in another file simply by typing that file's name at the prompt.

Figure 5:

```
|------------------------------------------------------------------------|
|                                                                        |
|            RUN MODEL MENU                                              |
|                                                                        |
|                                                                        |
|       F1    Run a Particular Region                                     |
|       F2    R|-----------------------------------------------|          |
|       ESC   R|                                               |          |
|             |             Filename Request                  |          |
|             |                                               |          |
|       Enter |                                               |          |
|             |        Enter the Filename to be used or       |          |
|             |             RETURN key for default            |          |
|             |                                               |          |
|             |====>                                          |          |
|             |-----------------------------------------------|          |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
|------------------------------------------------------------------------|
```

After either pressing RETURN or entering a filename, a window asking for the number of the region pops up. The only valid values that may be entered are 1 through 9 inclusive.

Figure 6:

```
|------------------------------------------------------------------------|
|                                                                        |
|            RUN MODEL MENU                                              |
|                                                                        |
|                                                                        |
|       F1    Run a Particular Region                                     |
|       F2    Run Al|------------------------------------|               |
|       ESC   Return|                                    |               |
|                   |                                    |               |
|                   | Particular Region/Region Number Menu |             |
|       Enter the k|                                     |               |
|                   |    Enter the Number of the Region  |               |
|                   |                                    |               |
|                   |                                    |               |
|                   |====>                               |               |
|                   |------------------------------------|               |
|                                                                        |
|                                                                        |
|                                                                        |
|                                                                        |
|------------------------------------------------------------------------|
```

The ECON program will search for the file you have indicated. If you specify a file that does not exist, then the following screen will appear. After a couple of seconds, the RUN MODEL screen will reappear. You will return to Figure 4 after the screen shown in Figure 7 is displayed.

Figure 7:

```
ERROR MESSAGE

File not found.
```

If the file with this particular region exists, then the following screen appears.

Quick Reference:

F1	:	Go to Figure 9.
F2	:	Go to Figure 10.
F3	:	Go to Figure 12.
F4	:	Go to Figure 14.
ESC	:	Go to Figure 3.

Figure 8:

```
Method of Output Screen

F1   Output displayed on the Monitor
F2   Output sent to a New File
F3   Output sent to the Monitor and a New File
F4   Output directed to the Printer
ESC  Return to Main Menu

Enter the key for the desired option
```

If you depress F1 while the screen shown in Figure 8 is displayed, the following screen appears. Notice that the name of the data file and the region number that was specified is the very first line of generated information. After pressing the return key, the MAIN MENU screen appears.

Figure 9:

Data file: imodel.dat Region Number: 9

CHOICES		PROBABILITY	SHIPMENT SIZE	EXPECTED SHIPMENT SIZE
Truck	Portland	0.00139990	73774.8092	1136.0520
Truck	Seattle	0.00240780	50521.0465	1338.0880
Truck	River	0.36556014	22831.1508	91807.7458
Truck	Calif	0.00000114	69392282.6000	867.5481
Single-Car	Portland	0.00123778	81043.3316	1103.4496
Single-Car	Seattle	0.00896989	27645.4495	2727.7416
Single-Car	River	0.58296913	23028.7192	147675.3553
Single-Car	Calif	0.00000109	72541677.8123	867.4883
Multi-Car	Portland	0.02258110	23258.9297	5777.3356
Multi-Car	Seattle	0.00140706	73433.0780	1136.5759
Multi-Car	River	0.00000387	20420292.4897	869.3876
Multi-Car	Calif	0.00000732	10811160.7675	870.6524
Unit-Train	Portland	0.00158938	66959.8014	1170.6683
Unit-Train	Seattle	0.00074298	123196.2229	1006.8601
Truck-Barge	Portland	0.01112143	26212.6202	3206.7393

Please press "RETURN" to continue

Now let's suppose that instead of choosing F1, we choose F2 while the screen shown in Figure 8 is displayed. The action of writing to a File causes a window to pop up. The pop-up window asks for the name of a file in which to store the generated information.

Figure 10:

```
RUN MODEL MENU

F1     Run a Particular Region
F2     R
ESC    R
               Filename Request

Enter
          Enter the Filename to be used or
               RETURN key for default

       ====>
```

After a filename has been specified, the following screen will appear briefly. This screen will quickly disappear and yield the MAIN MENU screen, once again.

Figure 11:

```
WRITING THE RESULTS TO A NEW FILE
```

If you depress F3 while the screen shown in Figure 8 is displayed, the following screen appears. Please note that this window that pops up is identical to that found in Figure 10. After the screen in Figure 12 is displayed, the screen shown in Figure 13 will be displayed as well. This screen is identical to that of Figure 9. You will no doubt notice that the name of the data file and the region number that was specified is the very first line of generated information.

Figure 12:

```
          RUN MODEL MENU

   F1    Run a Particular Region
   F2    R|
   ESC   R|
          |            Filename Request
          |
   Enter  |
          |      Enter the Filename to be used or
          |            RETURN key for default
          |
          |====>
```

As mentioned before, the previous screen will be followed by the screen below which displays the results to the monitor. After pressing the RETURN key, the MAIN MENU screen appears.

Figure 13:

Data file: imodel.dat   Region Number: 9

CHOICES		PROBABILITY	SHIPMENT SIZE	EXPECTED SHIPMENT SIZE
Truck	Portland	0.00139990	73774.8092	1136.0520
Truck	Seattle	0.00240780	50521.0465	1338.0880
Truck	River	0.36556014	22831.1508	91807.7458
Truck	Calif	0.00000114	69392282.6000	867.5481
Single-Car	Portland	0.00123778	81043.3316	1103.4496
Single-Car	Seattle	0.00896989	27645.4495	2727.7416
Single-Car	River	0.58296913	23028.7192	147675.3553
Single-Car	Calif	0.00000109	72541677.8123	867.4883
Multi-Car	Portland	0.02258110	23258.9297	5777.3356
Multi-Car	Seattle	0.00140706	73433.0780	1136.5759
Multi-Car	River	0.00000387	20420292.4897	869.3876
Multi-Car	Calif	0.00000732	10811160.7675	870.6524
Unit-Train	Portland	0.00158938	66959.8014	1170.6683
Unit-Train	Seattle	0.00074298	123196.2229	1006.8601
Truck-Barge	Portland	0.01112143	26212.6202	3206.7393

Please press "RETURN" to continue

Choosing F4 as an option when the screen shown in Figure 9 is displayed causes the following screen to appear provided that a parallel printer is attached to the system and it is on. While this screen is displayed, the printer will be in the process of printing the results.

Figure 14:

WRITING THE RESULTS TO THE PRINTER

If, however, the printer is not on, the following screen will be displayed.

Figure 15:

```
ERROR MESSAGE



Printer not ON.
```

To Modify Data Set

Running a particular region or even all the regions is quite simple. Modifying the values associated with a particular region will be slightly more difficult. Let us examine how we can accomplish this task.

If we depress F2 while the screen shown in Figure 3 is evident, the following screen will appear.

<u>Quick Reference</u>:

F1 : Go to Figure 17.
F2 : Go to Figure 30.
F3 : Go to Figure 32.
ESC : Go to Figure 3.

Figure 16:

```
     DATA MANAGEMENT MENU

   F1   Modify Data Set
   F2   Modify Model Constants
   F3   Print Data Set
   ESC  Return to MAIN MENU

   Enter the key for the desired option
```

While the screen shown in Figure 16 is evident, choosing option F1 yields the following screen. You will be asked for the name of the file which you want to modify or copy.

Figure 17:

```
:-------------------------------------------------------------------------:
:                                                                         :
:                                                                         :
:      DATA MANAGEMENT MENU                                               :
:                                                                         :
:   F1   Modify Data Set                                                  :
:   F2   M:---------------------------------------------:                 :
:   F3   P:                                             :                 :
:   ESC  R:              Filename Request               :                 :
:         :                                             :                 :
:   Enter :                                             :                 :
:         :      Enter the Filename to be used or       :                 :
:         :            RETURN key to exit               :                 :
:         :                                             :                 :
:         :====>                                        :                 :
:         :---------------------------------------------:                 :
:                                                                         :
:                                                                         :
:                                                                         :
:                                                                         :
:-------------------------------------------------------------------------:
```

After specifying the filename, you will be asked for a password "DATA". This password prevents someone who does not have authorization to modify the values associated with a region from causing havoc.

Figure 18:

```
:-------------------------------------------------------------------------:
:                                                                         :
:                                                                         :
:      DATA MANAGEMENT MENU                                               :
:                                                                         :
:   F1   Modify Data Set                                                  :
:   F2   M:---------------------------------------------:                 :
:   F3   P:                                             :                 :
:   ESC  R:              Filename Request               :                 :
:         :                                             :                 :
:   Enter :                                             :                 :
:         :      Enter the Filename to be used or       :                 :
:         :            RETURN key to exit               :                 :
:         :                                             :                 :
:         :====> imodel.dat                             :                 :
:         :---------------------------------------------:                 :
:-------------------------------------------------------------------------:
:         Modify Default Data file                                        :
:         Please enter the password to continue.                          :
:    :----------------------------------------------------------------:   :
:====>:                                                               :   :
:    :                                                                :   :
:    :----------------------------------------------------------------:   :
:-------------------------------------------------------------------------:
```

After entering in the correct password, the following screen pops up. At this point, you are being asked for the region number whose data values you would like to modify.

If, however, you are simply trying to copy an existing file, you may specify any region.

Figure 19:

```
|----------------------------------------------------------------------|
|                                                                      |
|                                                                      |
|                                                                      |
|        DATA MANAGEMENT MENU                                          |
|                                                                      |
|     F1   Modify Data Set                                             |
|     F2   Modify|-----------------------------------|                  |
|     F3   Print |                                   |                  |
|     ESC  Return|                                   |                  |
|                | Particular Region/Region Number Menu |               |
|     Enter the k|                                   |                  |
|                |     Enter the Number of the Region |                 |
|                |                                   |                  |
|                |                                   |                  |
|                |====>                              |                  |
|                |-----------------------------------|                  |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|----------------------------------------------------------------------|
```

After entering in the region number, the following screen pops up. What you see is a checker board that will allow you to modify the data set by including or excluding a particular mode/market cell, changing the values of a particular cell, or modifying the parameters associated with a region.

If you want to modify the values, please continue in the normal sequence. If, however, you wish to make a copy of a file go to Figure 23.

Please note that a "1" means the cell is included in the data set, and a "0" means that the cell is excluded. F1 toggles the value currently visible. For example, if you depress F1 while the cursor is in the position for Truck/Por, the "1" will change to a "0".

<u>Quick Reference</u>:
F1 : Go to Figure 20.
F2 : Go to Figure 21.
F3 : Go to Figure 22.
F4 : Go to Figure 23.
ESC : Go to Figure 3.

Figure 20:

```
Region No.  9
                  Por   Sea   Riv   Cal   Min   Grt   Ogd
 -----------------------------------------------------------
 Truck          :  1  :  1  :  1  :  1  :  0  :  0  :  0  :
 -----------------------------------------------------------
 Barge          :  0  :  0  :  0  :  0  :  0  :  0  :  0  :
 -----------------------------------------------------------
 Single-Car     :  1  :  1  :  1  :  1  :  0  :  0  :  0  :
 -----------------------------------------------------------
 Multi-Car      :  1  :  1  :  1  :  1  :  0  :  0  :  0  :
 -----------------------------------------------------------
 Unit-Train     :  1  :  1  :  0  :  0  :  0  :  0  :  0  :
 -----------------------------------------------------------
 Trk-MultiRl    :  0  :  0  :  0  :  0  :  0  :  0  :  0  :
 -----------------------------------------------------------
 Truck-Barge    :  1  :  0  :  0  :  0  :  0  :  0  :  0  :
 -----------------------------------------------------------
    Options :   Arrow Keys to move cursor
                F1    Add/Remove Item from Data Set
                F2    Modify Values Associated with Item
                F3    Modify the Region Parameters
                F4    Save the Changes and Exit
                ESC   Exit Without Saving Changes
```

If you choose F2 while the screen shown in Figure 20 is evident, the following screen appears. You may change none, one or more of the values simply by typing the new value over the underscore next to the current value. After completion of modification of the data values, you return to the checkerboard screen shown in Figure 20.

Figure 21:

```
                    Truck          Portland

NetPrice =    3.39464883  ______________
Wait     =    0.00586856  ______________
Transit  =    0.00680788  ______________
Load     =    0.01780103  ______________

Enter new value or press RETURN key to retain value
```

If you choose F3 while the screen shown in Figure 20 is evident, the following screen appears. You may change none, one or more of the values simply by typing the new value over the underscore next to the current value. After completion of modification of the data values, you return to the checkerboard screen shown in Figure 20.

Figure 22:

```
                  REGION No.  9

Number    =           11  ______________
Farm      =   0.02935000  ______________

Dist      =    17.727290  ______________
Capco     = 1149545.4000  ______________
CNetPr    =     1.583887  ______________

Enter new value or press RETURN key to retain value
```

If you choose F4 while the screen shown in Figure 20 is evident, the following screen appears.

Figure 23:

```
IF you specify a new filename you will destroy the contents of that file

                    Filename Request

           Enter the Filename to be used or
                RETURN key for default

====>
```

If you type a name other than IMODEL.DAT, the following screen will appear, after which you will return to the DATA MANAGEMENT MENU. If you specify IMODEL.DAT as the filename, then go to Figure 25.

Figure 24:

Region No. 9

	Por	Sea	Riv	Cal	Min	Grt	Ogd
Truck	1	1	1	1	0	0	0
Barge	0	0	0	0	0	0	0
Single-Car	1	1	1	1	0	0	0
Multi-Car	1	1	1	1	0	0	0
Unit-Train	1	1	0	0	0	0	0

```
Tr
Tr
              Saving Data to file NEW.DAT...

F4    Save the Changes and Exit
ESC   Exit Without Saving Changes
```

If, however, you specified the filename of IMODEL.DAT as the filename in the step above, the following screen will appear. You should avoid making changes to this file. But if you must, the password is "MODIFY".

Figure 25:

Region No. 9

	Por	Sea	Riv	Cal	Min	Grt	Ogd
Truck	1	1	1	1	0	0	0
Barge	0	0	0	0	0	0	0
Single-Car	1	1	1	1	0	0	0
Multi-Car	1	1	1	1	0	0	0

Making Permanent Changes to IMODEL.DAT

Please enter the password to continue.

If you entered the incorrect password the following screen appears. If you entered in the correct password go to Figure 29.

Figure 26:

Region No. 9

	Por	Sea	Riv	Cal	Min	Grt	Ogd
Truck	1	1	1	1	0	0	0
Barge	0	0	0	0	0	0	0
Single-Car	1	1	1	1	0	0	0
Multi-Car	1	1	1	1	0	0	0

Incorrect Password entered
You are not allowed to overwrite IMODEL.DAT
Please press RETURN to continue and enter another filename

The following screen will be displayed and you will be asked to enter a filename. You can not, however, enter the filename IMODEL.DAT. If you try to re-enter the filename of IMODEL.DAT, the pop-up menu will re-appear until you specify something else.

Figure 27:

```
|----------------------------------------------------------------------------|
| Region No.  9                                                              |
|                  Por   Sea   Riv   Cal   Min   Grt   Ogd                   |
| -------------------------------------------------------                    |
| Truck          |  1  |  1  |  1  |  1  |  0  |  0  |  0  |                   |
| -------------------------------------------------------                    |
| Barge          |  0  |  0  |  0  |  0  |  0  |  0  |  0  |                   |
| -------------|-----------------------------------------------|             |
| Single-Car   |                                               |             |
| -------------|            Filename Request                   |             |
| Multi-Car    |                                               |             |
| -------------|                                               |             |
|--------------|                                               |             |
|              |    Enter the Filename to be used or           |-------------|
|Incorrect Pas|       RETURN key for default                   |             |
|You are not a|                                                |             |
|Please press |====>                                           |             |
|             |------------------------------------------------|             |
|                                                                            |
|                                                                            |
|----------------------------------------------------------------------------|
```

If you type a name other than IMODEL.DAT the following screen will appear and at this point you will return to the DATA MANAGEMENT MENU.

Figure 28:

```
|----------------------------------------------------------------------------|
| Region No.  9                                                              |
|                  Por   Sea   Riv   Cal   Min   Grt   Ogd                   |
| -------------------------------------------------------                    |
| Truck          |  1  |  1  |  1  |  1  |  0  |  0  |  0  |                   |
| -------------------------------------------------------                    |
| Barge          |  0  |  0  |  0  |  0  |  0  |  0  |  0  |                   |
| -------------------------------------------------------                    |
| Single-Car     |  1  |  1  |  1  |  1  |  0  |  0  |  0  |                   |
| -------------------------------------------------------                    |
| Multi-Car      |  1  |  1  |  1  |  1  |  0  |  0  |  0  |                   |
| -------------------------------------------------------                    |
| Unit-Train     |  1  |  1  |  0  |  0  |  0  |  0  |  0  |                   |
| -------------------------------------------------------                    |
| Tr |-----------------------------------------------------------------|     |
| --|                                                                  |     |
| Tr|                                                                  |     |
| --|           Saving Data to file NOTIMODL.DAT...                    |     |
|   |                                                                  |     |
|   |------------------------------------------------------------------|     |
|                 F4    Save the Changes and Exit                            |
|                 ESC   Exit Without Saving Changes                          |
|----------------------------------------------------------------------------|
```

If you typed the correct password, the following system appears briefly. Then you will return to the DATA MANAGEMENT MENU screen.

Figure 29:

```
|------------------------------------------------------------------------------|
| Region No.  9                                                                |
|                  Por   Sea   Riv   Cal   Min   Grt   Ogd                     |
| ---------------------------------------------------------                    |
| Truck          |  1  |  1  |  1  |  1  |  0  |  0  |  0  |                   |
| ---------------------------------------------------------                    |
| Barge          |  0  |  0  |  0  |  0  |  0  |  0  |  0  |                   |
| ---------------------------------------------------------                    |
| Single-Car     |  1  |  1  |  1  |  1  |  0  |  0  |  0  |                   |
| ---------------------------------------------------------                    |
| Multi-Car      |  1  |  1  |  1  |  1  |  0  |  0  |  0  |                   |
| ---------------------------------------------------------                    |
| Unit-Train     |  1  |  1  |  0  |  0  |  0  |  0  |  0  |                   |
| ---------------------------------------------------------                    |
| Tr |-----------------------------------------------------------------|     |
| --|                                                                   |     |
| Tr|                                                                   |     |
| --|             Saving Data to file IMODEL.DAT...                     |     |
|   |                                                                   |     |
|   |                                                                   |     |
|   |                                                                   |     |
|   |-----------------------------------------------------------------|     |
|                  F4    Save the Changes and Exit                             |
|                  ESC   Exit Without Saving Changes                           |
|------------------------------------------------------------------------------|
```

To Modify Model Constants

Choosing F2 on the DATA MANAGEMENT MENU shown in Figure 16 causes the following screen to appear. The password is "CONST".

Figure 30:

```
|------------------------------------------------------------------------------|
|                                                                              |
|                                                                              |
|          DATA MANAGEMENT MENU                                                |
|                                                                              |
|       F1    Modify Data Set                                                  |
|       F2    Modify Model Constants                                           |
|       F3    Print Data Set                                                   |
|       ESC   Return to MAIN MENU                                              |
|                                                                              |
|       Enter the key for the desired option                                   |
|------------------------------------------------------------------------------|
|                                                                              |
|                                                                              |
|            Modify Transportation Model Constants                             |
|                                                                              |
|            Please enter the password to continue.                            |
|                                                                              |
|     |-----------------------------------------------------------------------||
|====>|                                                                       ||
|     |                                                                       ||
|     |-----------------------------------------------------------------------||
|------------------------------------------------------------------------------|
```

If the correct password was entered, then the following screen appears.

Figure 31:

```
            Modify Transportation Model Constants

 UTIL = EXP(u0*Boundary - u1*Wait - u2*Transit - u3*Load)

      u0        =      1.744000 ________________
      u1        =      8.705000 ________________
      u2        =     10.072000 ________________
      u3        =      8.575000 ________________

 SHIP =  s0*Boundary + s1*RCapco + s2*Select

      s0        =   1852.130000 ________________
      s1        =      0.005010 ________________
      s2        =     10.070000 ________________


      Enter new value or press RETURN key to retain value
```

Choosing F3 on the DATA MANAGEMENT MENU screen shown in Figure 16 causes the following screen to appear. You are asked for the filename of the file whose data values you wish to be printed.

Figure 32:

```
        DATA MANAGEMENT MENU

     F1    Modify Data Set
     F2    M|------------------------------------------|
     F3    P|                                          |
     ESC   R|            Filename Request              |
            |                                          |
     Enter  |                                          |
            |       Enter the Filename to be used or   |
            |             RETURN key for default       |
            |                                          |
            |====>                                     |
            |------------------------------------------|
```

APPENDIX: Mode, Market, Region Designations

Transportation Modes

Barge
Truck
Single-Car Rail
Multiple-Car Rail
Unit Train
Truck-Multiple-Car Rail
Truck Barge

Transportation Markets (Destination)

Seattle
Portland
River Subterminals
California
Minneapolis
Great Falls
Ogden

Region

1 - Montana
2 - Southern Idaho; Eastern border of Oregon
3 - Eastern Oregon; Klickitat and Skaminia counties of Washington
4 - Western Oregon; King, Clark, Cowlitz counties of Washington
5 - Asotin, Garfield, Columbia, Walla Walla counties of Washington
6 - Northern Idaho; Whitman, Adams counties of Washington
7 - Idaho Panhandle; Spokane, Lincoln, Stevens counties of Washington
8 - Yakima, Benton, Kittatas counties of Washington
9 - Grant, Douglas Counties of Washington

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