Measuring the Impacts of Freight Transport Regulatory Policies

VICTOR PRINS AND MAUREEN SCHULTHEIS

The purpose of this paper is to report on a disaggregate model of freight transport demand that was developed to forecast the impacts of freight transport regulatory policy options in South Africa. Two aspects of the methodology are emphasized: the compilation and tabulations of a disaggregate data base, and the policy option impacts predicted during application of the model. South Africa is currently undergoing a transition from a highly regulated to a deregulated freight transport industry. During the investigation leading up to this position, the data tabulations were used to illustrate to policymakers how regulation had created major distortions in the freight transport market. The predicted impacts of relaxing regulatory restrictions that were generated by the model helped to persuade these same policymakers to implement a more market-oriented freight transport policy for the country.

The major part of this paper focuses on the evaluation of options for a new freight transport regulatory policy in South Africa. To provide a perspective on that discussion, the background on the current regulatory situation is first summarized.

The freight transport industry in South Africa has historically operated within a strict regulatory environment. First, the central government controls the only railroad operation. The government has used this control to intervene significantly into the business matters of the railroad to promote the country's social and economic goals. This intervention has imposed a substantial cost burden on the railroad and has necessitated an extensive system of internal cross-subsidization, which has in turn led to tariff distortions in all transport modes.

To protect the economic health of the railroad as it performs its overall social and economic functions, the government has further intervened by regulating the other modes of transport in markets where the potential for competition with rail exists. Thus, for example, the road transport industry, composed primarily of private sector operators, is extensively regulated through a system of permits, licenses, and authorities. In particular, there are strict entry controls into the long-distance road transport market on a commodity basis for the private sector road operators.

The continuation of the regulatory system is problematic on two fronts. Over time, the administration of the system has become cumbersome, unwieldy, and difficult to enforce. A more serious problem, however, is that the policy of regulation has led to considerable distortion and inequities in the entire transport market. The lack of competition has led to the inefficient allocation of resources, resulting in an artificially high transport cost to the consumer.

The severity of the inefficiencies and inequities is of such magnitude that within the last several years there has been a move toward more competition in the freight transport market. A National Transport Policy Study (NTPS) was created in part to study the problems with the existing freight transport system and to make recommendations for a new national freight transport policy that would be based on the principle of equitable and effective competition *(1)*.

In the initial stages of the investigation it became clear that although the regulation of freight transport was opposed by many people, the actual relaxation of regulatory restrictions would be greatly facilitated if the frequent claims of regulatory distortions could be substantiated and if the consequences of a move away from the current system of regulation could be predicted. Comprehensive information in this regard had never been documented and the data needed to evaluate such an issue had not been collected.

Thus, as part of the National Transport Policy Study, it was determined that a tool for quantitatively evaluating freight transport regulatory policy options was needed so that the final policy selection would be made based on better researched, more rational decisions. Given this need, data were collected and a behaviorally based stochastic model of user choice was developed for the South African intercity freight transport market *(2, 3)*. This model was also applied to predict and understand the consequences of changing the regulatory framework of freight transport *(4)*.

In the rest of this paper, three salient aspects of the modeling work will be described. First, the basic theory on which the model depends and the methodology employed will be briefly summarized. Second, the data collection and tabulation aspects of the research will then be discussed because they clearly indicated to decision makers the distortions (and potential opportunities) inherent in the current regulatory system. Third, the forecasting package, the model on which it is based, and some of the results obtained from it will be described because they illustrated to policymakers the potential benefits and costs of moving to a less regulated system. Finally, a brief conclusion follows.

DESCRIPTION OF THE METHODOLOGY

A study of the demand for freight transport can be approached from several theoretical viewpoints *(5)*. The method employed

V. Prins, Van Wyk and Louw, Inc., P.O. Box 905, Pretoria 0001, Republic of South Africa. M. Schultheis, Van Wyk and Louw, Inc., P.O. Box 905, Pretoria 0001, Republic of South Africa. Current affiliation: Port of Seattle, P.O. Box 68727, Seattle, Wash. 98168.

by the NTPS team was based on the theory of disaggregate travel demand *(6, 7)*.

When this approach is applied to freight transport, it is important to decide on a time scale for the analysis. The approach taken in this study is essentially short term. It assumes that the firm's location is fixed. It also assumes that the firm's sources of raw materials as well as the destinations of its products are fixed. Under these circumstances, the profit-maximizing firm will be minimizing its total logistic costs. As shown by Chiang *(7)*, this implies the optimization by the firm of the decision on the mode choice and shipment size combinations available to the firm. In the model used in this study, the shipment size was accepted as a given and the mode choice decision was modeled conditional on the shipment size.

Following the choice of an appropriate methodology, a full-scale modeling exercise was undertaken: data collection, model specification and estimation of a multinomial logit model of freight demand, and the development of a forecasting package for use in policy analysis.

COMPILATION OF A DISAGGREGATE DATA BASE

The selected methodology requires data on decisions made by individual firms on the freight mode choice decision so that the coefficients of the model that capture the trade-offs between the various attributes of the alternatives as seen by firms in a real-world situation could be empirically determined.

As indicated by Roberts *(8)*, the factors that affect the choice of the firm can be classified into one of the following four categories: *(a)* the transport level of service attributes of the alternatives available to the firm (e.g., travel time, travel cost); *(b)* the attributes of the commodity to be transported (e.g., its value, density); *(c)* user and producer attributes (e.g., use of commodity, type of business); and *(d)* market attributes in general (e.g., modal ownership, interest rates).

These factors concerning the choice of mode of freight transport had not been documented for South African freight transport users. To obtain this information, a data-collection exercise was undertaken. Given that the focus of the study was on trips in which there either existed competition or the potential for competition between modes, the collection of data excluded the urban distribution of freight (road transport is the only major mode of freight transport in urban areas), and the movement of block trains that are used to transport large quantities of raw materials for export (an area dominated by rail transport). A survey form was designed to collect data on a selection of individual trips from selected firms nationwide. The data objectives of the questionnaire are outlined as follows:

- Transport Level of Service Attributes for all Modes in Choice Set
    - Wait and access time
    - Line-haul travel time
    - Reliability (variance in travel time)
    - Loss and damage
    - Tariff rate
    - Handling costs
    - Special charges
- Commodity Attributes
    - Commodity
    - Value per kg
    - Density
    - Base state
    - Consignment size
- Market Attributes
    - Modal availability
    - Ownership
- Receiver/Supplier Attributes
    - Annual use of production rate of commodity
    - Frequency of shipment
        - Seasonality
        - Use of commodity
    - Inventory policy
        - Industry classification
        - Employment size
        - Distance of trip
    - Main reason for selecting mode
    - Location of origin and destination of shipment

In formulating the sample design, a two-pronged approach was selected. First, to ensure a minimum response rate, an interview questionnaire was personally distributed to 84 transport users. These users were selected either because of the likelihood that they would use transport or to ensure coverage of industries not included in the mail questionnaire. Second, a mail questionnaire was distributed to ensure a wide coverage of commodities, trips, and geographic locations of firms. The mail questionnaire followed a stratified random sample design and was distributed to manufacturing firms across the country. For both the interview and the mail questionnaire, respondents were asked to complete information on their input and output trips occurring during the period March 12–23, 1984.

The two-pronged approach resulted in the coverage of a wide variety of trips, as seen in Figure 1. This type of coverage was necessary to ensure that a robust data set would be available for use in the model-estimation phase of the study.

The overall response rate for the interview questionnaire was 61.0 percent, yielding trip-based information for 51 of the larger users of transport.

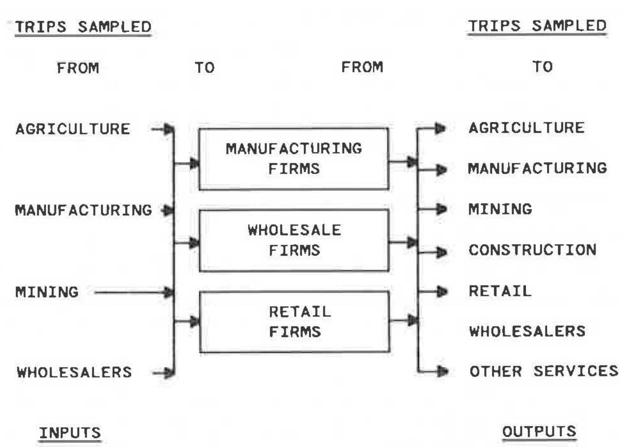

FIGURE 1 Types of trips sampled.

The population of interest from which a sample was drawn in the mail questionnaire numbered 10, from 235 manufacturing firms. The method of systematic sampling used yielded a sample of 5,034 firms, which was 49.1 percent of the population. Of the firms that were sampled, 45.2 percent responded in some way to the questionnaire. Responses can be broken down into two groups: firms that had trips greater than 100 km (and thus were able to complete the questionnaire); and firms indicating that all of their trips were less than 100 km (and thus fell into the intracity category).

Of the firms reporting applicable trips, 40.2 percent actually completed the questionnaire. This response is high when compared with other response rates reported in the literature *(9)*, which indicate that responses for mail questionnaires often range between 5 and 20 percent. Further, considering the extent of trip-based detail requested in the questionnaire, the amount of information received per questionnaire was exceptional. In fact, in many cases, firms provided information on more than the requested number of 60 trips.

The actual number of trip reports collected from the mail questionnaire responses totaled 9,783. However, some firms only completed the questionnaire for a sample of their total trips during the middle 2-week period in March 1984. They then indicated how many trips this sample represented. Taking such additional trips into account, and standardizing to Standard Industrial Classification Code (SICC) and geographic population characteristics, information was collected on 30,114 trips. When these 30,114 trips are factored up to represent the population of trips for the middle 2-week period in March 1984, the data represent a total of 352,334 trips. The relative standard error on this estimate has been calculated to be 10 percent of the true population, using a 95 percent confidence level.

The resulting data base provided a pool of information from which smaller samples could be drawn to calibrate the multinomial logit model. The data base itself is unique in that it contains data on trips in which the firm did not have a choice of mode as well as data on trips in which there was a choice involved. Each type of trip was identified by asking the respondent why, for the given trip, a particular mode was chosen. Respondents could choose between reasons such as regulatory restrictions, faster travel time, lowest cost, only available mode, and so on. During the forecasting phase, the impact of introducing more competition to the freight transport market was measured by taking the trips in which a mode was previously chosen because of regulatory restrictions and allowing firms responsible for these trips to then "choose" another mode.

Although the primary purpose of compiling this data base was to use it for estimation of the disaggregate mode choice model, descriptive statistics and tabulations compiled from survey responses were also used to comment on the current environment. Because data had been collected for all commodities on a nationwide basis, findings arising from the evaluation of the data tabulations proved interesting: not only did they provide a clear description of the status quo to the policymakers but they illustrated that regulatory restrictions do in fact inhibit the exploitation of inherent modal advantages.

UNDERSTANDING COMPETITION: SELECTED TABULATIONS

The status quo modal split between the modes of rail, public road (common carrier), private road (own transport), air, and coastal sea (shipping) is given in the following table, based on ton-kilometers carried by each mode.

Mode	*Percent of Total Ton-Kilometers (excludes block trains)*
Rail	61.46
Public road	21.68
Private road	12.75
Air	0.02
Coastal sea	4.09

Note that this table represents trips in which there is the potential for competition. Rail is the dominant mode of transport in South Africa followed by the road modes. Coastal sea has a small percentage of the ton-kilometer market share in part because it operates only along the coastal routes.

In Figure 2, the modal split within five commodity value categories is shown. As expected, the rail mode is responsible for the major share of low-valued goods. Their market share declines to approximately 19 percent when goods are evaluated with product values of between R2,000 and R10,000/ton (1 Rand = $0.80 in March 1984). However, road and rail have a relatively equal share of the ton-kilometer market for the highest product value category. Most of the sea ton-kilometers occur in the product value range of R100 to R2,000/ton, whereas all of the air ton-kilometers occur in the high-valued product range.

Note, however, that there is no consistent pattern of modal share by mode across the product value categories. If a hypothesis is made that product value has no effect on modal share, then the rail mode would be expected to have a 61 percent share in all product value categories. This is clearly not so, as seen in Figure 2. A more likely hypothesis would be that the lower the product value, the higher the modal share of rail. The converse is expected for the road modal share. This hypothesis is based on the premise that the higher the product value of the commodity the more time-sensitive the commodity becomes to users and the more likely they are to take the road mode. This trend was also previously empirically identified by Roth *(10)*. Consideration of Figure 2, however, indicates no such consistent pattern. Rail is carrying the lower-valued commodities, as expected, but it appears that it is carrying a greater-than-expected portion of the commodities in the highest product value category. This is not surprising, given the current legal restrictions on road haulers.

Although a similar analysis can be undertaken with various other variables such as density, type of commodity, and so on, the distortions are perhaps best illustrated by evaluating the mode split by consignment size and trip length relationship. Only road and rail were selected for this analysis because they are the major movers of freight and are capable of operating in most geographic areas.

This comparison exercise is modeled after a study conducted by the American Trucking Association (ATA) *(10)* in which

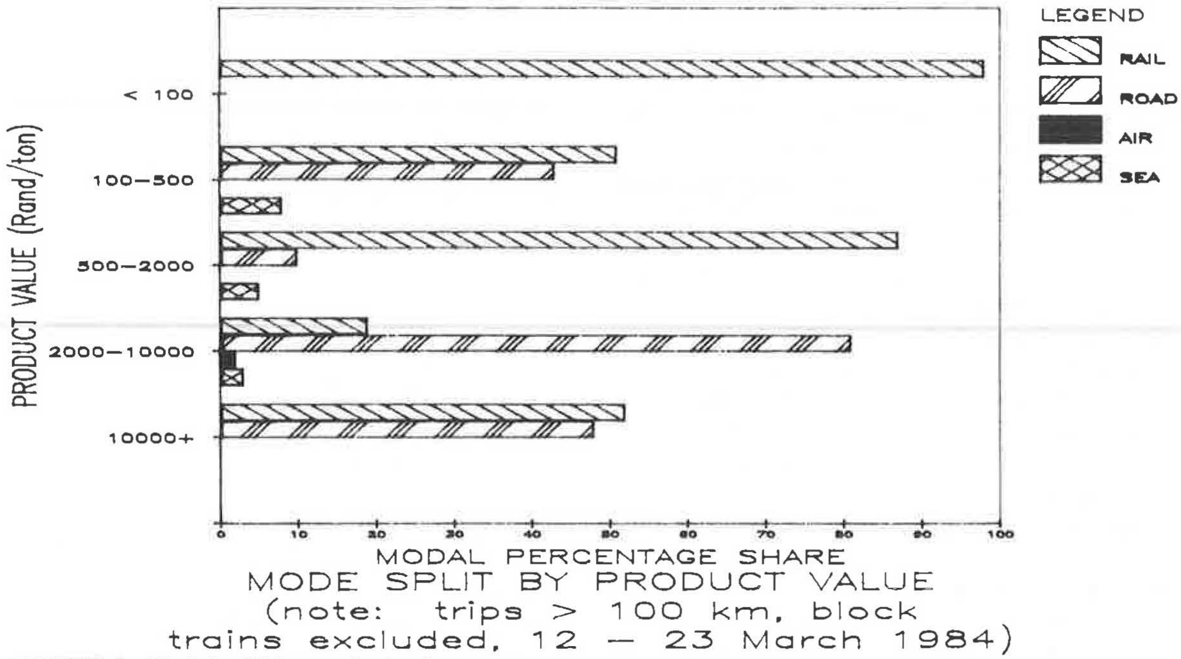

FIGURE 2 Modal split by product value.

data on manufactured commodities were arranged in a matrix table format and analyzed for the extent of road or rail involvement in handling tonnage of various consignment size brackets moving over a series of distance blocks. Figure 3 contains the ATA study results based on 1972 data *(10)*. The results show, as expected, that road dominated the movement of smaller consignment sizes and rail dominated the movement of larger consignment sizes. Competition, or involvement by both modes, was limited to tonnage shipped in medium consignment sizes, which was not an extensive amount. Note that rail-dominated tons represented 28.8 percent of total tons, road-dominated tons represent another 44.6 percent, and competitive tons represent a final 26.6 percent.

The results of a study conducted in South Africa in 1984 are given in Figure 4. Note that cells where the modes compete occur in the small consignment sizes and low-distance categories, even for consignments of less than 5 tons. This finding is interesting because these movements are generally thought to be handled by road and are the movements that tend to be handled better by road rather than by rail. In fact, in the ATA study, road transport was dominant for moving small consignment sizes at all distances. Rail became dominant only for large consignment sizes. The ATA study finding is in contrast to the findings shown in Figure 4, which is not surprising considering the protective measures used to retain the traditional rail market. Thus, rail is a competitor in these unexpected areas.

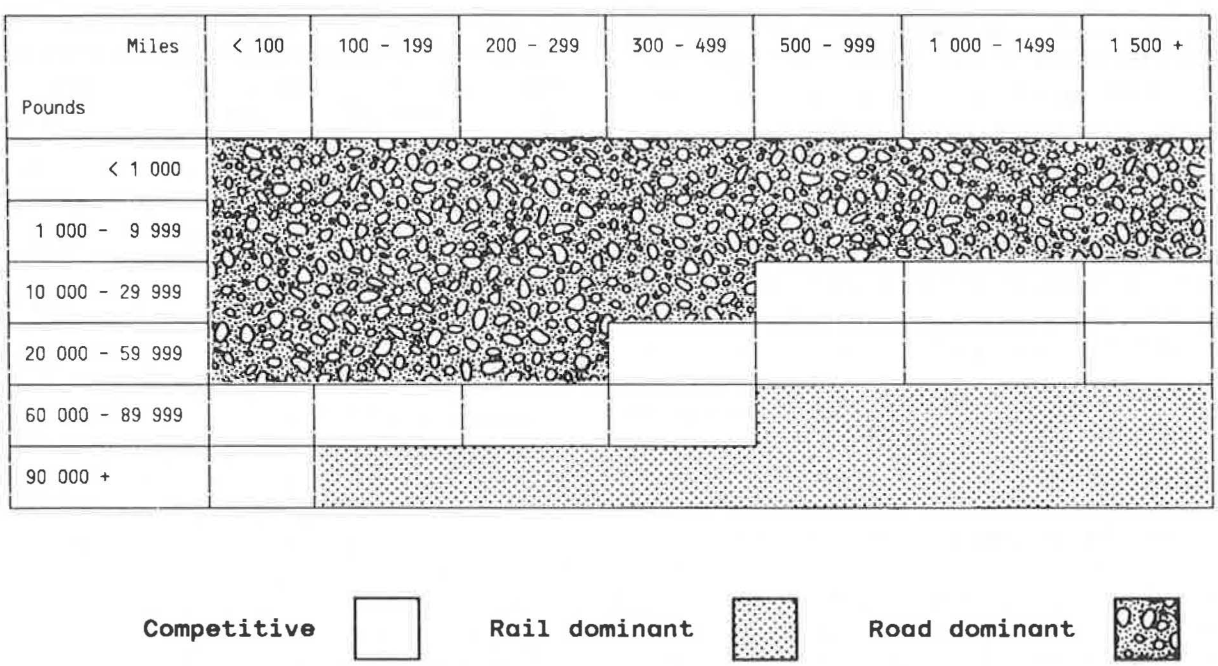

FIGURE 3 Distribution of road and rail mode split in United States for consignment size and distance criteria.

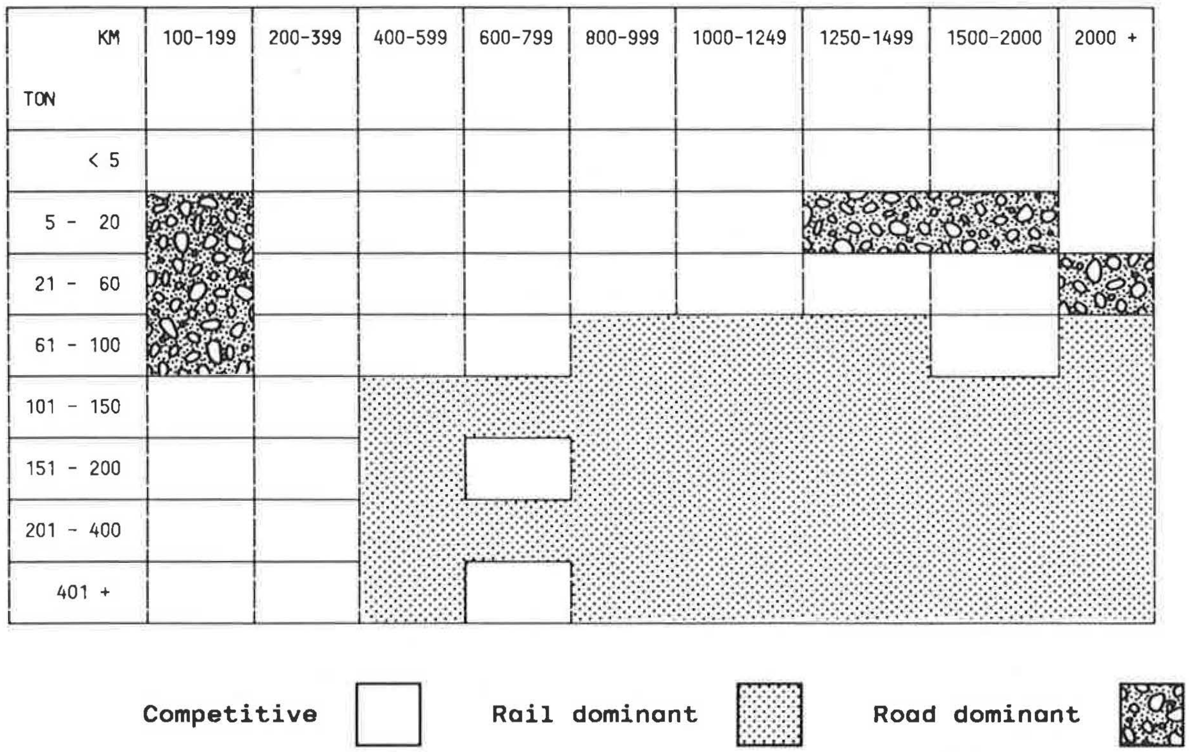

FIGURE 4 Distribution of rail and road mode split in South Africa for consignment size and distance criteria.

Note that road and rail are competitors for 30.7 percent of the tonnage hauled. Road is dominant for another 12.2 percent, with most of this dominance occurring in the shorter distance range. Finally, rail dominates in the larger consignment size and long-distance market, which represents 57.1 percent of total tonnage moved.

Different policy changes would potentially shift the dominance and competitive percentages. It would be expected that in a less regulated environment, road would tend to handle the major portion of the smaller consignment sizes, which constitute about 4.5 percent of the total tonnage market for this sample (where smaller consignment sizes are assumed to be less than 10 tons). Further, it may be expected that the competitive region of traffic would shrink in size as each mode settles into its natural share of the market—where the boundaries are defined more by inherent advantage than by regulatory restrictions.

It should be noted, however, that only two parameters were used in this analysis: consignment size and distance. Thus, before any conclusions on modal advantage can be made, other parameters such as product value, density, or commodity should be tested. So many elements, both observable and unobservable, enter into the mode-selection process that it cannot be conclusively stated that rail (or road) is best in a particular market. Modal advantage is specific to a given situation. The value of the exercise mentioned previously is that it illustrates tendencies or patterns of modal advantage and thus clarifies obvious distortions.

THE MODE CHOICE MODEL OF FREIGHT TRANSPORT DEMAND

On compilation of the disaggregate data base, a multinomial logit mode choice model of freight transport demand was specified and estimated using the BLOGIT maximum likelihood estimation package *(11)* [see *(4)* for a detailed discussion of the model]. Variables included in the model are shown in Table 1. Statistics indicated that the model was significant. It was therefore used as a forecasting tool because many policy-sensitive variables had been included.

One method of prediction using the model is to compare aggregate modal elasticities. Such modal elasticities can be used as an indication of the sensitivity of transport users to changes in the choice of a mode, given changes in a particular level-of-service variable. However, in order to have a more flexible and comprehensive method for evaluating the impacts of proposed changes to the current regulatory system, a forecasting package was developed.

DEVELOPMENT OF THE FORECASTING PACKAGE

The structure of the forecasting package is summarized in Figure 5. Note that the package is centered around the disaggregate mode choice model. As input to the mode choice model, a data set and a level-of-service model are required. The outputs of the model include disaggregate mode choice probabilities and aggregate modal shares.

Given a consignment of a certain commodity from an origin to a destination, the model predicts what the probability will be of choosing a particular mode. The model computes these probabilities for individual trips. Before the mode choice model can compute mode choice probabilities for a given trip, two things are needed: a data base of trips and a level-of-service model.

For the data base of trips, a sample from the same data set used in the model estimation phase was used in the forecasting package.

TABLE 1 DEFINITION OF VARIABLES FOR CONDITIONAL MODE CHOICE MODEL GIVEN CONSIGNMENT SIZE

Variable	Definition
CCNES	Capital carrying cost of the product in transit[a] for nonemergency consignments[b] of size less than 50 kg: value of the product (in rand × 10^3) multiplied by total time (in minutes × 10^3), 0 otherwise.
CCNEL	Capital carrying cost in transit for nonemergency consignments of size 50 kg or more, 0 otherwise.
CCE	Capital carrying cost for emergency[c] consignments, 0 otherwise.
SMLTCOST	Total cost[d] for small consignments, excluding those going by air.
C/TONL	Total cost per ton for large consignments, excluding those going by air.
COSTAIR	Total cost for air consignments, 0 otherwise.
LDCLAIM	The probability of loss and damage multiplied by the number of days to settle a claim.
AT/TTIMEAIR, AT/TTIMESEA	Access time/total time for air and sea, 0 otherwise.
1/DIST	Reciprocal of distance[e] for private road, 0 otherwise.
UR/TTRAIL	Unreliability/travel time for rail, 0 otherwise.
EXEMPT	1 for exempt commodities for public road, 0 otherwise.
SMLRAIL	1 for small consignments for rail, 0 otherwise.
HINTER	1 for hinterland origins for public road, 0 otherwise.
LV*LFD	Log of the vehicle population at the origin multiplied by log of the number of manufacturing and commercial firms at the destination for road, 0 otherwise.

[a]Travel and access time.
[b]Annual usage/consignment size ≤365.
[c]Annual usage/consignment size >365.
[d]Travel and access cost (in rand × 10^3).
[e]In kilometers × 10^2.

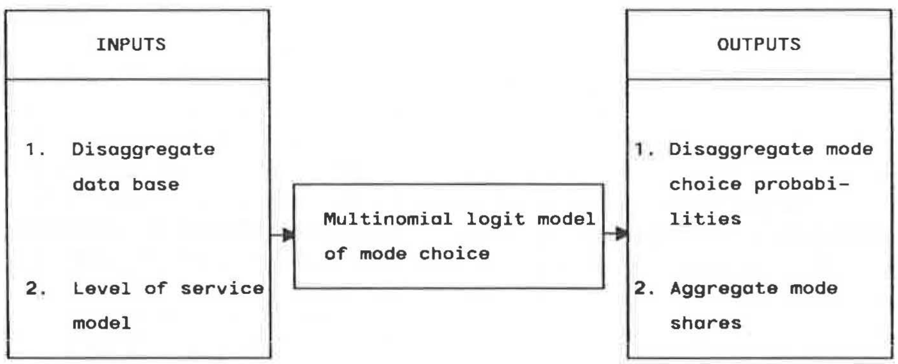

FIGURE 5 Structure of forecasting package.

A level-of-service model was developed to generate level-of-service data for all modes within a transport user's choice set (defined as the modes available to a given user). This model sis necessary because the data base only contains level-of-service information for the chosen mode.

The level-of-service information is computed for five different modes: rail, public road, private road, air, and sea. For each of the modal submodels, there are various models used to compute the level-of-service data. These are: an access cost model, a tariff model, an access time model, a travel time model, a loss and damage model, an unreliability model, and a distance model. In some cases these models are broken down further. For example, the rail tariff model computes different tariffs for rail less-than-carload consignments, rail carload consignments, and rail container consignments. The tariff models for the other modes compute tariffs in a similar manner.

In designing the outputs of the forecasting package, the study team had to keep in mind who would be using it. Although shifts in the modal split at the national level were obviously of general interest, policymakers were also concerned about how deregulation might affect selected commodities or how traffic between major city pairs would be affected. These concerns were taken into account and the resulting forecasting package can accommodate different types and levels of aggregation. For example, modes can be aggregated along a generic level (rail, road, air, sea) or along more specific consignment size dimensions (e.g., rail less-than-carload, road container, air parcels, coastal sea pallet, and so on). For commodity groupings, users can specify a range of classifications (from as coarse as 6 commodity categories to as fine as 38 categories) or they can concentrate on just one commodity sector. Similarly, for the geographic specification, data can be aggregated on a corridor basis or on a nationwide basis.

Policymakers were not only concerned with modal impacts but also with how a policy change would affect the transport users themselves. From a national standpoint, they were also interested in how effective a particular policy would be regarding government objectives such as energy conservation. Thus, the forecasting package was also designed so that results could be categorized for different population groups: the operators, the users, and the government. Operator impacts are measured by the percent change in revenue, whereas user impacts are given using the measure of percent change in consumer surplus. Government impacts are measured by the percent change in total energy consumption.

UNDERSTANDING COMPETITION: APPLICATION OF THE FORECASTING PACKAGE

During the course of the forecasting phase of the study, policymakers used the model to test out different regulatory policy changes. For example, the government-owned railroad had long been opposed to deregulation. One reason for this opposition was that it was believed that such a move would then place the railroad at a disadvantage compared with road operators (the main competitors). The contention was that road operators could charge artificially low transport prices because they did not pay their full share of road infrastructure costs. Road operators on the other hand strongly opposed paying more in infrastructure costs in part because they feared huge sums would be required and they would lose their fragile market share.

A sensitivity analysis was undertaken using the forecasting package to determine how the implementation of additional road infrastructure costs would affect rail and road operators. Policymakers as well as operators were surprised to learn that implementation of higher road-user infrastructure costs had only a minor effect nationwide. For low-valued commodities, for which fast travel times and minimal loss and damage are as important as cost considerations, it is predicted that road operators will not experience a loss in market share. Because higher-valued products make up the bulk of the road operators' business anyway, the findings helped to quell their concerns.

The model was used to answer many "what if" questions such as those already mentioned. However, probably the most significant use of the model came about when policymakers posed the following question: What would happen if all transport users were given the freedom to select the mode they preferred? As mentioned in the introductory section of this paper, road operators have been constrained by a system of permits to serve a relatively limited number of transport users. This constraint was exemplified in the ton-kilometer market share of the two competing modes: rail had a 61 percent market share of all intercity (excluding block train) ton-kilometers, whereas the road mode's market share was 34 percent. (The remaining market share was taken up by the sea and air modes.)

In Table 2, the impact of implementing a policy option of eliminating regulatory restrictions is quantified.

Note that this option represents the principle of allowing transport users to select the transport mode that best meets their needs. Under the current regulatory system, those transport users who are required to use a particular mode (rail) can be termed "captive." In Table 3 it can be estimated how these captives are affected by a change in the regulatory policy. When this change occurs, the forecasting package predicts a shift of 3.6 percent in ton-kilometers to the road mode and a 0.03 percent shift to the coastal sea mode. This percentage comes from the rail mode, as expected, and the shift measures the captive ton-kilometers (i.e., those ton-kilometers that were legally constrained to use rail before the implementation of the proposed option).

TABLE 2 IMPACTS OF POLICY OPTION IN WHICH USERS ARE FREE TO SELECT MODE OF THEIR CHOICE

Mode	Market Impact (± % in ton-km market share)	Operator Impacts (± % change in revenue)
Rail	−3.66	−2.60
Public road	+2.24	+1.68
Private road	+1.39	+1.02
Air	0.00	0.00
Sea	+0.03	+<0.01

NOTE: User impacts: Percentage change in consumer surplus = +7.82 percent. Government impacts: Percentage change in total energy consumption (MJ/ton-km) = +1.27 percent.

Overall, this result indicates that the current mode split would remain relatively stable if users were free to choose their preferred mode. Some transport users would shift to other modes, as expected, but the ceiling in any one commodity sector appears to be a shift of less than 20 percent of the previous share (not shown).

Most important, however, the consumer surplus has increased significantly by 7.82 percent for implementation of this option. This result shows that transport users are much better off when legal restrictions to the user are lifted—a result that strongly favored deregulation.

In contrast, if regulatory restrictions were indiscriminately tightened (a random selection of 20 percent of users were constrained to use rail), the results given in Table 3 suggest that the transport user would be negatively affected and the consumer surplus would decrease overall by 14.28 percent. Total energy consumption would decrease slightly as consumers switched to rail—the more energy-efficient mode. Note that the market changes indicate an overall increase in rail's share of the total ton-kilometer market of 1.92 percent. Rail's share of the total revenue also increases by 2.69 percent, as expected.

Overall, the major losers are the transport users, indicating that from an efficiency viewpoint, stricter economic regulations should be discouraged.

TABLE 3 IMPACTS OF POLICY OPTION IN WHICH STRICTER ECONOMIC REGULATIONS ARE IMPLEMENTED

Mode	Market Impact (± % in ton-km market share)	Operator Impacts (± % change in revenue)
Rail	+1.92	+2.69
Public road	−1.12	−2.13
Private road	−0.79	−1.26
Air	0.00	0.00
Sea	0.00	0.00

NOTE: User impacts: Percentage change in consumer surplus = −14.28 percent. Government impacts: Percentage change in total energy consumption (MJ/ton-km) = −0.20 percent.

CONCLUSIONS

As part of an investigation into competition in the South African freight transport market, the development of a model capable of predicting impacts of future policy changes was required. The disaggregate approach to estimating freight travel demand was chosen as the preferred methodology for the study, given that it follows a user-based individual firm oriented approach.

An extensive data base was compiled for use in the calibration of the multinomial logit model. As tabulations generated from this data indicated, the regulatory restrictions imposed on intercity freight transport inhibited the manifestation of inherent modal advantages and in fact distorted traffic patterns within the industry.

Calibration of the disaggregate mode choice model was successful and yielded statistically significant policy variables. This model was then used as the basis for developing a forecasting package. This package is capable of measuring how economic distortions could be minimized by a regulatory policy change.

The model provides a useful link between analysis and policymaking because by using the forecasting package, policymakers were able to evaluate alternative regulatory policies. The impacts predicted by the forecasting package facilitated the formulation of a more market-oriented freight transport policy that will soon be implemented for the country *(12)*.

ACKNOWLEDGMENT

The development of the methodology referred to in this paper was sponsored as part of the National Transport Policy Study of the Department of Transport in South Africa. The opinions expressed are, however, those of the authors and not those of the Department.

REFERENCES

1. *Recommendations.* Department of Transport, National Transport Policy Study, Pretoria, Republic of South Africa, Feb. 1986.
2. M. Schultheis and V. Prins. Collection, Validation, and Tabulations of a Disaggregate Data Base. *Proc., Annual Transport Convention*, Pretoria, Republic of South Africa, Aug. 1985.
3. V. Prins and M. Schultheis. A Disaggregate Model of Intercity Freight Transport Demand. *Proc., 5th IFA/IFORS/IFIP International Conference on Control in Transportation Systems*, University of Economics, Vienna, Austria, July 8–11, 1986.
4. M. Schultheis and V. Prins. *Quantifying Economic Impacts of Freight Transport Policy Options.* Paper presented at the Annual Transport Convention, Pretoria, Republic of South Africa, Aug. 1985.
5. C. Winston. The Demand for Freight Transportation: Models and Applications. *Transportation Research*, Vol. 17A, No. 6, Pergamon Press, Oxford, England, 1983.
6. T. A. Domencich and D. McFadden. *Urban Travel Demand: A Behavioral Approach.* North-Holland, Amsterdam/American Elsevier, New York, 1975.
7. Y. S. Chiang. *A Policy Sensitive Model of Freight Demand.* Ph.D. dissertation, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass., 1979.
8. P. O. Roberts and Y. S. Chiang. *Forecasting Freight Flow Using a Disaggregate Freight Demand Model.* CTS Report No. 76-1, Massachusetts Institute of Technology, Center for Transportation Studies, Cambridge, Mass., 1976.
9. P. R. Stopher and A. H. Meyburg. *Survey Sampling and Multivariate Analysis for Social Scientists and Engineers.* D. C. Heath Co., Lexington, Maine, 1979.
10. R. D. Roth. Approach to Measurement of Modal Advantage. In *Transportation Research Record 637*, TRB, National Research Council, Washington, D.C., 1977.
11. F. J. Cittle and L. W. Johnson. *Basic Logit (BLOGIT)—Technical Manual.* Technical Manual, ATM No. 9, Australian Road Research Board, Vermont South, Victoria, Australia, 1980.
12. *White Paper on National Transport Policy.* Department of Transport, WPM-86, Pretoria, Republic of South Africa, Jan. 1987.

Publication of this paper sponsored by Committee on Surface Freight Transport Regulation.