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ANALYSIS OF FREIGHT MODE CHOICE

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ABSTRACT: *This paper presents results of recent research conducted by ARRDO into factors affecting freight mode choice, and in particular, the choice between road and rail modes.*

Two models of freight mode choice were developed and calibrated - a logit model and an elimination-by-aspects model. These models were applied to a data set comprising perceptions of importances and satisfactions with respect to road and rail; the data were obtained in interviews conducted by ARRDO research staff in the Sydney-Brisbane and Adelaide-Perth corridors.

Results are presented in terms of the key modal attributes affecting mode choice for various categories of user, i.e. freight forwarders, shippers of manufactured goods and shippers of non-manufactured goods. Freight rates are important determinants of mode choice, but various aspects of service are of importance to different user groups.

INTRODUCTION

While most of rail's freight task in Australia involves the movement of bulk minerals and grain, a substantial proportion involves the movement of non-bulk or general freight. In these areas, rail is usually in competition with other modes - especially road - and rail's share of the market depends upon its competitive position vis a vis other modes. This paper reports some results of recent research by ARRDO concerned with identification of the factors affecting freight mode choice, and rail's performance in respect to these factors.

This research involved analysis of freight movements in two corridors, Sydney - Brisbane and Adelaide - Perth. Data for aggregate movements by mode and commodity in each corridor were assembled and used to identify the degree of competition between modes for each commodity. In addition, a series of interviews were conducted with a sample of freight shippers and forwarders in both corridors to provide, inter alia, data on perceptions affecting the choice of mode. This data was used to calibrate and test models of freight mode choice as a means of identifying and analysing the significant factors affecting choice.

NATIONAL FREIGHT TASK

Estimates of the total national freight task by mode are published from time to time by the Bureau of Transport Economics (BTE). Table 1 shows tonnes consigned for the period 1961-62 to 1976-77 based on work by the BTE. It can be seen that the domestic freight task was dominated by road, in terms of tonnes consigned, with this mode carrying around 80% of the total. Government rail carried about 8%.

However, the picture changes when the transport task is examined in terms of tonne-kilometres, which for many purposes is a better indicator of freight movements because it is a measure of both tonnes consigned and length of haul. Table 2 presents tonne-kilometres for 1961-62 to 1976-77 based on work done by the BTE. This table shows that sea was the dominant mode, accounting for over 50% of the total, with government rail and road approximately equal with around 16% of the total.

TABLE 1 - ESTIMATES OF FREIGHT TRAFFIC TASK: AUSTRALIA 1961-62 TO 1976-77[1]

TONNES CONSIGNED (MILLION)

YEAR	RAIL GOVERNMENT	RAIL NON GOVT[2]	ROAD	SEA[3]	AIR	TOTAL
1961-62	49.3	18.5	290.0	19.5	0.1	377.4
1966-67	63.4	32.3	520.0	24.4	0.1	640.2
1972-72	81.6	78.7	750.0	44.4	0.1	954.8
1975-76	96.0	116.7	900.0	47.5	0.1	1160.3
1976-77	99.8	123.6	n.a.	47.2	0.1	n.a.
			% SHARE			
1961-62	13.1	4.9	76.8	5.2	-	100.0
1966-67	9.9	5.0	81.2	3.8	-	100.0
1971-72	8.5	8.2	78.6	4.7	-	100.0
1975-76	8.3	10.1	77.6	4.1	-	100.0
1976-77	n.a.	n.a.	n.a.	n.a.	n.a.	100.0

n.a. not available

1. Excludes pipeline.

2. Excludes consignments tranferred to or from Government Railways.

3. New series commenced in 1971-72.

Source: Bureau of Transport Economics (1977) "Estimates of Freight Traffic Task" Information Paper B.T.E. Canberra

TABLE 2 - ESTIMATES OF FREIGHT TRAFFIC TASK: AUSTRALIA 1961-62 TO 1976-77 TONNE-KILOMETRES ('000 MILLION)[1]

	RAIL					
	GOVERNMENT	NON-GOVT[2]	ROAD	SEA[3]	AIR	TOTAL
1961-62	14	0.5	13	35	0.1	62.6
1966-67	19	2	21	48	0.1	90.1
1971-72	25	17	28	78	0.1	148.1
1975-76	31	26	33	101	0.1	191.1
1976-77	32	27	n.a.	n.a.	0.1	n.a.
			% SHARE			
1961-62	22.4	0.8	20.8	55.9	0.2	100.0
1966-67	21.1	2.2	23.3	53.3	0.1	100.0
1971-72	16.9	11.5	18.9	52.7	0.1	100.0
1975-76	16.2	13.6	17.3	52.9	0.1	100.0
1976-77	n.a	n.a.	n.a	n.a	n.a	100.0

n.a. not available

1. Excludes pipeline

2. Excludes consignments transferred to or from Government Railways.

3. New series commenced in 1971-72.

Source: Refer Table 1.

To put rail's contribution in perspective, intraregional movements need to be removed from the above statistics, since interregional movements are of most relevance to rail, and the transport task needs to be disaggregated by commodity. Table 3 shows interregional movements for 1971-72 and 1975-76 by mode for bulk liquids, bulk solids and non-bulk traffic.

Table 3 shows the strong degree of specialization by mode. Sea dominated the bulk liquids traffic (mostly petroleum products), while rail was the major carrier of bulk solids, which includes coal, other minerals and grain. In non-bulk traffic, which is the area of major relevance to this paper, road was dominant, with its market share increasing from 53% to 71% over the period 1971-72 to 1975-76. Rail's share fell from 34% to 21% over the same period.

FREIGHT MOVEMENTS IN SYDNEY - BRISBANE AND ADELAIDE - PERTH CORRIDORS

To investigate reasons for these changes in rail mode share, a more detailed analysis of freight movements in two corridors was undertaken. These particular corridors were selected because of their dissimilar nature, one being a relatively short and well populated corridor, with a number of cities within it, and the other being a long and sparsely populated corridor.

Data on movements within the corridor were assembled from a variety of sources to enable a comprehensive picture of freight flows to be drawn. Details of data and data sources are included in ARRDO, 1981. Only interregional freight flows with both origin and destination within the corridor were included.

Table 4 shows the estimated movement of goods by mode in the Sydney-Brisbane corridor, for 1971-72 and 1978-79. This shows that total movements in the corridor increased by 24% (tonnes) and 31% (tonne-km) over the period, and that road was the major mode. Moreover, all of the increase over the period was accommodated by road, with both rail and sea declining in absolute as well as relative terms.

Table 5 shows the breakdown of the 1978-79 freight task by mode, according to the commodity groups determined for this corridor. Excluding the nebulous classifications of "general merchandise" and "other" (source data did not permit a more specific breakdown), the varying degrees of specialisation by mode can be seen. Sea's task was almost wholly associated with petrol. Rail's task was

TABLE 3 - ESTIMATES OF INTERREGIONAL FREIGHT CONSIGNED WITHIN AUSTRALIA: 1971-72 AND 1975-76 BY COMMODITY[1] (MILLION TONNES)

MODE	BULK LIQUID 1971-72	BULK LIQUID 1975-76	BULK SOLID 1971-72	BULK SOLID 1975-76	NON-BULK 1971-72	NON-BULK 1975-76	TOTAL 1971-72	TOTAL 1975-76
Road	2.1	3.7	6.2	9.5	29.2	53.5	37.5	66.7
Rail	2.2	2.2	23.9	31.8	18.8	15.7	44.9	49.7
Sea	16.7	18.2	16.8	22.3	7.1	6.0	40.6	46.5
TOTAL	21.0	24.1	46.9	63.6	55.1	75.2	123.1	162.9
% SHARE								
Road	10.0	15.4	13.2	14.9	53.0	71.1	30.5	40.9
Rail	10.5	9.1	51.0	50.0	34.1	20.9	36.5	30.5
Sea	79.5	75.5	35.8	35.1	12.9	8.0	33.0	28.6
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

COMPOUND GROWTH RATE % PER ANNUM

MODE	BULK LIQUID 1971-2 to 75-6	BULK SOLID 1971-2 to 75-6	NON-BULK 1971-2 to 75-6	TOTAL 1971-2 to 75-6
Road	14.2	10.7	15.1	14.4
Rail	0.0	7.1	-4.5	2.5
Sea	2.2	7.1	-4.2	3.4
TOTAL	3.4	7.6	7.8	7.0

1. Excludes air and pipelines.

Source: Bureau of Transport Economics (1976) Estimates of Australian Inter-regional Freight Movements, 1971-72 AGPS, Canberra.
Bureau of Transport Economics (1978) Estimates of Australian Inter-regional Freight Movements 1975-6 AGPS, Canberra.

TABLE 4 FREIGHT MODAL SPLIT - SYDNEY-BRISBANE CORRIDOR

	1971-72				1978-79**			
	Tonnes ('000)	%	Tonne-Km* (Mill)	%	Tonnes ('000)	%	Tonne-km (mill)	%
Rail	4,125	36	1,500	39	3,195	23	1,461	29
Road	5,674	49	1,750	46	9,395	66	3,029	61
Sea	1,732	15	550	15	1,644	11	500	10
Total	11,557	100	3,800	100	14,183	100	4,990	100

* Tonne-Km have been estimated using average distance estimates.

** Sea results are for 1977/78.

Source: ARRDO estimates, based upon:

Rail: State Rail Authority of NSW: statistics

Road: McDonell enquiry Surveys (McDonell, 1980), Report of the Commission of Enquiry into the New South Wales Road Freight Industry Sydney.

Sea: Department of Transport Port Authority Cargo Movements, 1977-78, AGPS, Canberra predominantly in the movement of grain, containers and coal with other bulk loadings also featuring. By contrast, road's task was spread over a much wider range of commodities. For the corridor as a whole, road dominated all commodity movements except petrol (sea), containers (rail) and coal (rail). Further examination of Table 5 indicates that, according to the commodity classifications used, there were few "competitive" commodities. The only commodities where less than 85% of the traffic in the corridor was handled by a single mode were containers, bulk loading, petrol, bulk liquid and livestock.

For the Adelaide-Perth corridor, Table 6 shows the estimated movement of goods by mode for 1971-72 and 1978-79. It can be seen that rail dominated movements in this corridor, and that total traffic increased by 192% (tonnes) or 194% (tonne-km) over the period. All modes increased absolutely, but road gained slightly on both rail and sea in terms of market share.

Table 7 shows the 1978-79 freight task within the corridor disaggregated by commodity and mode, using the commodity specification available from the source data for this corridor. Grains and minerals were the major commodities moving within this corridor. Sea was oriented towards bulk commodities (petroleum, steel, minerals). Rail contributed to a wide range of commodity movements, but minerals and grains together accounted for three-quarters of its task. Road was similarly diversified, but only in livestock, refrigerated products and general freight did it carry more than rail. Several commodities in this corridor were "competitive" in that less than 85% of the tonneage was attributed to a single mode. These were livestock, petroleum, fertilizer, cement and general merchandise.

SURVEY OF SHIPPERS AND FORWARDERS

The freight flows and modal shares reported in the preceding sections are the manifestations of individual decisions made by people and firms shipping goods in the corridors. To gain insights and data on the factors affecting mode use, it was necessary to investigate this choice process directly, by conducting a survey among a sample of shippers and freight forwarders responsible for consigning freight in one or other of the corridors.

The survey took the form of a structured interview conducted by a member of ARRDO's research staff. A two-part questionnaire was used, the first part of

TABLE 5 - FREIGHT HAULED ON SYDNEY - BRISBANE CORRIDOR
1978-79
Tonnes ('000)

Commodity	Rail	%	Road	%	Sea	%	Total	%
Grains	334	10	491	5			825	6
Timber	12	-	675	7			697	5
Cement	0	-	235	3			235	2
Car Transport	19	1	146	2	3		168	1
Containers	665	21	164	2			829	6
Bulk Loading	152	5	167	2			319	2
Petrol	200	6	322	3	1337	81	1859	13
Bulk Liquid	201	6	261	3			462	3
Coal and Coke	795	25	498	5	34	2	1789	12
Sand, Gravel	20	1	404	4			424	3
Other Minerals	1	-	473	5			474	3
Livestock	10	-	243	3			253	2
General	169	5	1671	18	21	2	1861	13
Other	616	19	3593	38	249	15	4458	31
TOTAL	3195	100	9344	100	1644	100	14183	100

Source: Refer Table 4.

TABLE 6 FREIGHT MODAL SPLIT - ADELAIDE PERTH CORRIDOR

	1971-72				1978-79**			
	Tonnes ('000)	%	Tonne-km* (mill)	%	Tonnes ('000)	%	Tonne-km (mill)	%
Rail	4463	75	2396	66	8313	73	4970	71
Road	1025	17	424	12	2439	21	1151	16
Sea	473	8	822	22	796	6	937	13
Total	5961	100	3642	100	11449	100	7058	100

* Tonne-km have been estimated using average distance estimates

** Sea results are for 1977-78

Source: ARRDO estimates, based upon:
Rail - AN and Westrail statistics
Road - Main Roads Dept. of WA, surveys
Sea - Dept. of Transport Port Authority Cargo Movements 1977-78, ACPS, Canberra.

TABLE 7 FREIGHT HAULED ON ADELAIDE-PERTH CORRIDOR, 1978-79
Tonnes ('000)

Commodity	Rail	%	Road	%	Sea	%	Total	%
Livestock	104	1	413	17	-		517	4
Grains	2237	27	114	5			2351	21
Fertiliser	236	3	93	4			329	3
Refrigerated	19	-	134	5			153	1
Minerals, ores	4049	49	12	1	245	35	4306	38
Iron and Steel	288	4	48	2	57	8	393	3
Petroleum	344	4	78	3	318	46	740	7
Cement	69	1	61	2			130	1
Piggy-backing	62	1	0	0			62	-
Containers	283	3	15	1			298	3
Other, general merch.	622	7	1472	60	77	11	2171	19
Total	8313	100	2440	100	697	100	11450	100

Source: Refer Table 6.

which sought general information about the firm, its products, and its transport and distribution activities, while the second part sought specific information related to a commodity movement between a specific origin and destination.

This second part of the questionnaire was to be used to provide data for the calibration and testing of two models of mode choice - a logit model and an elimination-by-aspects model (see next section). To this end, the questionnaire required the respondent to indicate for each available mode how important each factor was to the firm for the specified movement and the degree of satisfaction with these same factors.

The factors which were included were those which were considered to be the significant ones affecting choice of mode, and were based upon the literature, discussion with rail marketing personnel, a priori reasoning, and experience with an ARRDO pilot study. Nine factors were included as follows:

- door to door transit time, using road or rail for the line haul (Time)
- reliability of meeting arrival time at destination (Reliability)
- availability of capacity when required (Capacity)
- frequency of service (Frequency)
- freight rates (Price)
- avoidance of damage or deterioration (Damage)
- avoidance of loss or theft (Loss)
- convenience of time of departure (Convenience)
- communication with respect to problems (Communications)

All respondents were asked to indicate the importance of each of these factors on a semantic scale, from 1 to 100.

Forwarders were asked to indicate their degree of satisfaction with both rail and road for each factor, again on a scale from 1 to 100. For shippers, four modal options were included: road or rail through forwarders or direct. However, in analysis the method of shipping was collapsed, and only the road or rail options were included. Thus the choice set for both shippers and forwarders was road and rail.

METHODS OF ANALYSIS

The data thus assembled was analysed in three ways, two of which involved the use of modal choice models which, although previously used for analysis of passenger mode choice, had received little if any previous use in freight. These models were the logit model and the elimination-by-aspects model. The third analysis approach involved direct examination of the questionnaire forms, particularly to extract comments made by the respondents in answer to non-numeric questions (for example about future expectations, particular problems, or factors affecting use of mode other than those listed). Full details of each of these are presented in ARRDO (1981), but a brief summary of the two models is outlined below.

Logit Model

The logit model has been widely used in the analysis of passenger mode choice. It is based on consumer theory, which states that the utility of a good or service, in this case a mode of freight transport, can be represented as a linear combination of the utilities of individual attributes of that good.

In application, it is further assumed that the utility of each attribute to a consumer is equal to the perceived satisfaction which the consumer has with that attribute, multiplied by the importance which he places on that attribute. Finally it is assumed that consumers are utility maximizers; they choose the mode which gives them the maximum utility as defined above.

The form of the model may be expressed as follows:

$$U_{ij} = a + \Sigma_{k=1}^{K} b_k I_k S_{ijk}$$

$$P_{ij} = \frac{\exp(U_{ij})}{\Sigma_{j=1}^{M} \exp(U_{ij})}$$

where P_{ij} = probability of firm i selecting mode j

I_{ik} = importance of attribute k to firm i

S_{ijk} = satisfaction with attribute k on mode j, to firm i

U_{ij} = utility of mode j to firm i

a, b are constants

K = numbers of attributes considered

M = number of modes available

Calibration of the model involves determination of the values of a and b_k. This was done using maximum likelihood estimation techniques.

Elimination-By-Aspects Model

The EBA model is also based upon consumer theory and thus can also use perceived importances and satisfactions as inputs. However whereas the logit model assumes that each individual considers all attributes of each alternative, the EBA model allows for the elimination from consideration of attributes which are unimportant. This is held to be a more realistic replication of the actual choice process, particularly in a complex choice situation.

The EBA model has two fundamental features. Firstly, it is assumed that, rather than consider all attributes of an alternative simultaneously, the individual conducts a mental search of the attributes in a sequential fashion proceeding from the attribute which is considered most important through to that attribute which is considered least important. It may well occur, however, that this search is not completed and that the individual will make a choice before all attributes have been considered.

Secondly, it is assumed that at each stage of the search, when each attribute is considered, the level of satisfaction of the attribute for each alternative is compared to a minimally acceptable level of that attribute. If an alternative fails this test (i.e. the attribute level is less than the minimally acceptable level) then that alternative is eliminated from further consideration. If it passes the test, it continues to be compared with remaining alternatives with respect to the next most important attribute. The search continues until all except one of the alternatives have been eliminated. The remaining alternative is then considered to be the chosen alternative.

A valuable feature of the EBA model used here is its ability to introduce a probabilitic choice rule. This has the effect of enabling inconsistencies in individuals choices to be accommodated by the model (Young, et al, 1982). A further feature of the model is its ability to examine elasticities of demand to changes in satisfaction levels of the various attributes. Since (say) increasing the satisfaction of rail with respect to a particular attribute may bring rail back into consideration for a shipper for whom it had previously been eliminated, the effect of changes in satisfaction levels on demand can readily be computed.

Details of both the logit and the EBA models, and results of tests with them, are presented in ARRDO, 1981.

MODEL RESULTS

Both the logit and the EBA models were applied to four data sets as follows:

(i) all shippers

(ii) shippers of manufactured goods (The main goods included here were metals and metal products, paper and paper products, machinery, motor vehicles and parts, furniture, clothing, etc)

(iii) shippers of non-manufactured goods (The main goods included here were food products, beverages and tobacco, metal ores and scrap, fertilizers, chemicals, pharmaceuticals, etc)

(iv) forwarders

All commodities were classified according to the classification of the Department of Transport (1980).

The results of the model calibrations are presented and compared below. Implications for rail are discussed in the concluding section of this paper.

Shippers

Before discussing the calibrations, it is important to note that certain of the variables were correlated. For the logit model, correlations in utilities (i.e.

importance multiplied by satisfaction) occurred between time and reliability, and between capacity and frequency. For the EBA model, importances were relatively uncorrelated, but high correlations in perceived satisfactions occurred between time and reliability, frequency and capacity, loss and damage, and reliability and communication.

For the logit model, a satisfactory model was obtained with four variables, as follows; the coefficient values for each variable are shown, those marked with an asterik being significant at the 5% level using the t-test.

price	(0.0614)*
reliability	(0.0218)*
frequency	(0.0266)
communication	(0.0080)

For the EBA model, the relevant value for each variable, or attribute, is the tolerance, defined as the percentage shortfall from the maximum satisfaction for an attribute before the particular mode is considered to be unsatisfactory with respect to that attribute (For example in the following list, if the satisfaction with convenience is within 5% of the maximum satisfaction with conveneince across all alternatives, then the lower satisfaction is regarded as acceptable). All else being equal, attributes with lower tolerances will have more effect on the mode choice.

For the shippers model, a satisfactory result was obtained with five variables, as follows; the tolerance values for each are shown, those marked with an asterisk being significant at the 5% level.

convenience	(0.05)*
damage	(0.37)*
reliability	(0.46)*
capacity	(0.11)*
price	(0.43)*

These results of the logit and EBA analysis are comparable, particularly when the correlations between variables are taken into account. However, more meaningful results are obtained by examination of the two separate categories of shippers, as follows.

Shippers Of Manufactured Goods

Again, certain of the variables were correlated for this data set. For the logit model, the utilities of time and reliability were correlated. For the EBA model, time and reliability were highly correlated in terms of both importance and satisfaction, as were loss and damage.

For the logit model, a satisfactory model was obtained with three variables, as follows, coefficients and their significance again being shown:

price	(0.0622)*
reliability	(0.0291)*
frequency	(0.0235)

For the EBA model, a satisfactory model was obtained with four variables, all of which were significant:

reliability	(0.53)*
communication	(0.70)*
price	(0.51)*
damage	(0.37)*

The elasticity of demand for rail with increases in the degree of satisfaction with each of the EBA variables is shown in Fig. 1; these elasticities were computed using the EBA model as described above. It can be seen that by far the most sensitive variable for shippers of manufactured goods was reliability of meeting arrival time at destination; a 10% improvement in the perception of rail's ability to perform in this regard would lead to an estimated improvement in rail's mode share of more than 10%. Improvements in perception of freight rates and damage were estimated to have little effect, while improvements of up to 10% in shippers' satisfaction with the communication attribute for rail would have no effect on traffic because the perceptions of rail were such that improvments of that magnitude would not bring any shippers' perception into the acceptable range.

It is important to note that the relationships shown in Fig 1 are in terms of increases in the shippers' satisfaction with rail for the variables indicated, not for changes in the physical level of the attributes. Thus, for example, while it can be

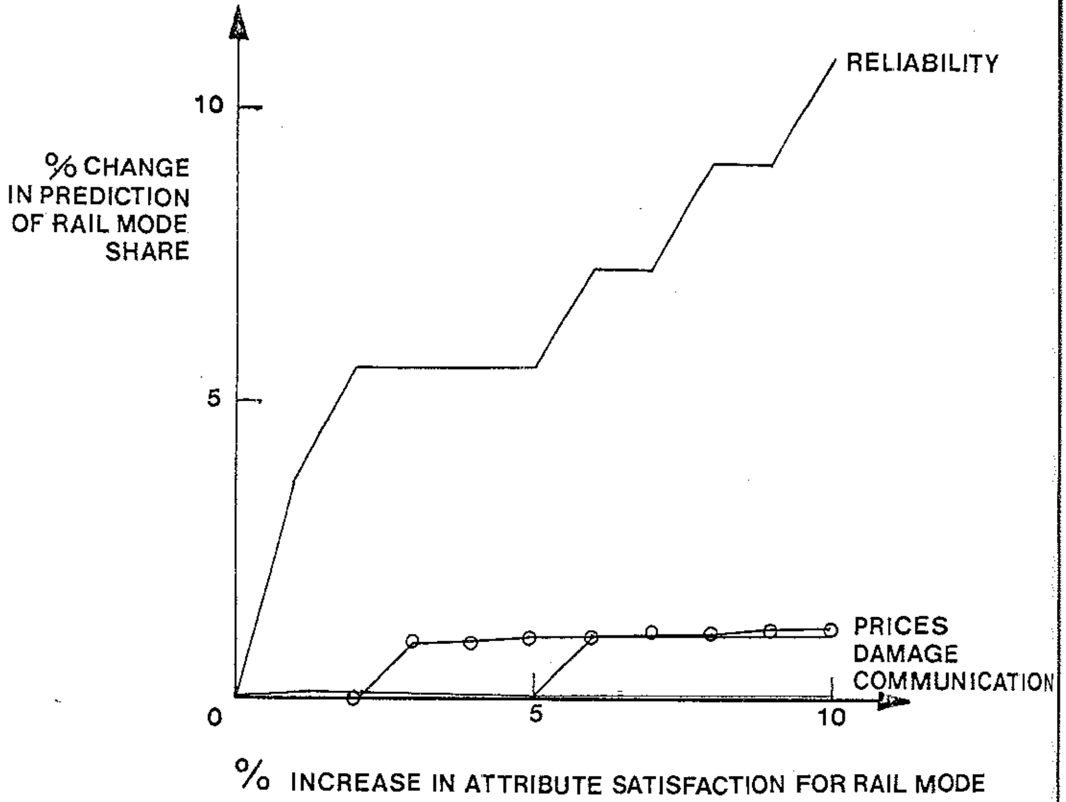

Fig 1 Curve showing effect on rail mode share of increases in perception of rail's reliability, price, damage and communication attributes. (shippers of manufactured goods)

stated with some confidence that rail's reliability is important, it is not possible to say how much more reliable rail would have to become in order to achieve the changes in mode share indicated.

Nevertheless, taking the results of the logit and EBA models, together with these elasticities, certain conclusions about the factors affecting the choice of mode by shippers of manufactured products can be made. Clearly reliability and price are of key importance, with these shippers being most sensitive to perceived reliability. Reliability correlates partly with transit time. Avoidance of loss, theft or damage is also important, and so to a lesser extent is frequency of service or the availability of capacity when required. Communication between the shipper and the transport operator is also considered to be significant, but rail's performance here is such that very large improvements would need to occur before such an improvement would affect rail's market share.

Shippers Of Non-Manufactured Goods

As before, several of the variables for this data set were correlated. For the logit model, utilities of time and reliability, and damage and communication were correlated. For the EBA model, the only relevant variables to be correlated were satisfactions of capacity and frequency.

For the logit model, a satisfactory result was obtained with four variables, as follows, coefficients and their significance again being shown:

price	(0.0636)*
reliability	(0.0122)
frequency	(0.0263)
communication	(0.0128)

For the EBA model, a satisfactory result was obtained with three variables, as follows:

price	(0.07)*
capacity	(0.07)*
loss	(0.45)*

Elasticities with respect to price and capacity are shown in Fig 2: the loss variable, although included in the model, was not significant.

Taking the results of the model calibration, and the elasticities, it is clear that for shippers of non-manufactured goods, price is the dominant variable. Service variables are less significant, although the availability of capacity to move the product (which correlated with the frequency of service offered) is of some importance to this group of shippers. Communication, reliability and loss also appear to have some effect.

Forwarders

The sample size for the forwarders was unfortunately too small to permit reliable estimates or model calibrations to be obtained. However, examination of the results of trials with the data for both modelling approaches would tend to suggest that three variables might be of most significance - price, loss, and capacity (the latter being correlated with frequency). These results must however be regarded as tentative, and no further analysis is presented.

RAIL'S PROSPECTS AND PROBLEMS

It was mentioned earlier that in addition to the modelling analysis reported in the previous section, a direct examination was made of the questionnaire forms, particularly to extract comments made by the respondents in answer to qualitative questions. The results of this analysis are briefly summarized in this section.

Prospects For Rail

For each commodity movement between the specified origins and destinations, respondents were asked about their overall satisfaction with road and rail now, and their expectations for the mid-1980's. Comparison of these responses gives some indication of future prospects for rail.

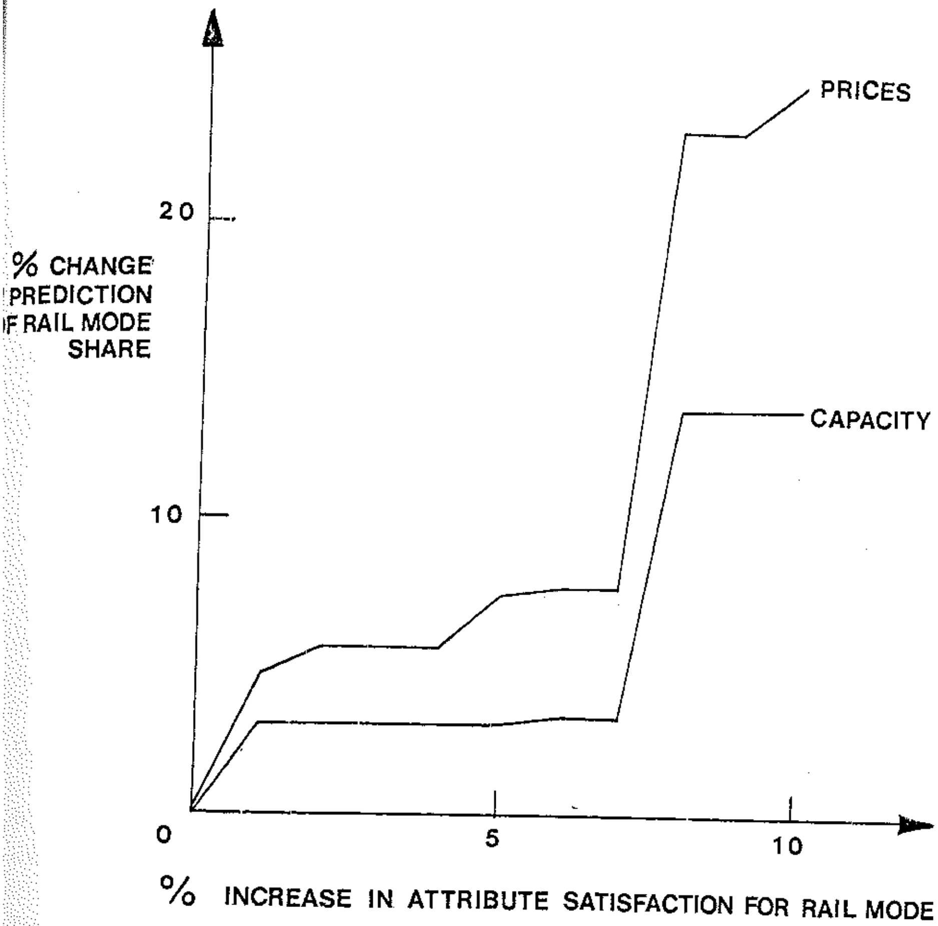

Fig 2 Curves showing effect on rail mode share of increases in perception of rail's price and capacity attributes. (shippers of non–manufactured goods)

Overall the outlook for rail from this comparison appears promising. Of current rail users, 40 out of 48 rail movements were anticipated to remain on rail; most of those movements anticipated to switch to road were very small tonneages.

With current road users, 45 movements were anticipated to switch to rail in the future, while 60 were anticipated to remain on road. Most of those anticipated to remain on road were short distance consignments between Sydney and Newcastle. There appears to be good prospects for rail everywhere but for this movement, and for movements between Adelaide-Perth where rail (including piggy-back) already dominates.

Of particular interest was the "competitive" category, where currently no mode has more than 90% of the market. Rail was expected to improve in 27 out of 34 such cases.

Although these prospects appear encouraging for rail, they are not to be taken for granted. Many of the comments relating to higher future rail use were predicated on the expectation of improved rail level of service; clearly the implication is that if these service improvements do not eventuate nor will the traffic.

Similarly, several comments were made to the effect that future road fuel prices would force business away from the road. Though shippers have this perception, it is not possible to estimate how future fuel prices will move, nor how such movements will affect useage of rail.

The key to rail's future is thus its ability to provide a satisfactory, consistent level of service. In this respect, the conclusion here mirrors and reinforces the results reported in the previous section. Although somewhat different service parameters apply to different markets or traffics, service expressed in one form or another is important to all categories of traffic.

Problems With Rail

The importance of such service parameters was also reflected in the problem areas mentioned by the respondents. Although not an exhaustive analysis since the question in the interview was open ended, it is salutory to note that there were over 3 times as many "complaints" about rail as about road. Moreover, some 44%

of the road complaints were about the price of road services; only 6% of rail complaints were about prices. By far the largest category of rail complaints was under the heading unreliable or unsatisfactory service. This included such problems as delay, unreliability and uncertainty of delivery time, and loss of wagons in transit. Other perceived problem areas with rail were its poor industrial relations record resulting in stoppages; loss, damage or theft of goods in transit; and staff attitude to customers. This last factor was particularly noted by forwarders who had learnt from their own experience the commercial necessity to maintain good relationships with their customers, and compared this with the "take it or leave it" attitude which they perceived as receiving from the rail systems. Poor communication with clients was also noted, especially in respect of delays or problems.

By contrast, complaints about the road mode (apart from its cost) were not strongly directed at any particular features although loss, damage and theft were mentioned relatively often, as was accidents and breakdowns, especially on the Adelaide-Perth run.

A further feature worthy of note was the comment that interstate shippers had to maintain contact with two or more rail systems. The observation was made on a few occasions that a single authority having responsibility for all inter-system movements would be advantageous, and put rail on a comparable basis so far as communication was concerned with the road mode.

Comparison Of Sydney-Brisbane And Adelaide-Perth Corridors

It was mentioned previously that one of the reasons for selecting these two corridors for study was to enable comparison to be made between them.

Tables 4 to 7 have shown that road dominates the Sydney-Brisbane corridor and rail dominates the Adelaide-Perth corridor. This is not surprising, given rail's inherent advantages in long-distance movements and road's flexibility which makes it more suited to shorter distance movements, and door to door deliveries.

Comparisons of the responses concerning factors considered as most important by the respondents in the two corridors is revealing. Rail users in the Sydney-Brisbane corridor tended to rate three factors as most important - reliability of meeting delivery time, avoidance of damage, and price. By contrast, rail users in the Adelaide-Perth corridor overwhelmingly rated price as the dominant consideration. Bearing in mind the long distance and resultant costs associated with the Adelaide-Perth corridor, the latter result is hardly surprising. Similarly, rail users in the Sydney-Brisbane corridor were price-sensitive, but regarded reliability and damage avoidance quite highly as well.

The picture with road users is rather different, and furthermore, comparisons are not possible because the number of road users found in the Adelaide-Perth was too small to enable any conclusions to be drawn. In the Sydney-Brisbane corridor, the above three factors (reliability, price and damage avoidance) were joined by door-to-door transit time, avoidance of loss or theft and communication with respect to problems as the common factors. The implication of this is that road users are more strongly service-sensitive, though they do not discriminate widely between the various service factors.

In the "competitive" group of users, the most important factors in the Sydney-Brisbane corridor were communication with respect to problems, price and damage avoidance. The sample size in the Adelaide-Perth corridor in this category is quite small, but a very tentative suggestion can be put that transit time, reliability and price might be the most important factors for this group.

In summary, the major conclusion is that in the Adelaide-Perth corridor, price is the dominant consideration. In the Sydney-Brisbane corridor, price is joined or exceeded by service factors of which reliability of meeting delivery time and avoidance of damage appear to be the most important. These observations complement those found in the previous section on modelling, though the models did not distinguish between corridors.

CONCLUSIONS

A range of service parameters, together with price, affects the use of road or rail by freight shippers and forwarders. The results obtained in this study suggest that for shippers of manufactured products, the following parameters are of importance, with the first two being of greatest significance:

- price
- reliability of meeting arrival time at destination (correlated with transit time)
- avoidance of loss, theft, damage or deterioration
- frequency of service
- communication with respect to problems

For shippers of non-manufactured goods, price is the most important variable. Service variables are of lesser importance, but those which appear to have some effect include

- availability of capacity when required (correlated with frequency of service)
- reliability of meeting arrival time at destination (correlated with transit time)
- communication with respect to probems
- avoidance of loss, theft, damage or deterioration

For forwarders, the conclusions are less clear; but it appears that the three key variables are price, avoidance of loss or theft, and availabity of capacity when required (or frequency of service).

The implications of these results for railways, from the viewpoint of improving their market share in competitive traffics, are reviewed as follows

<u>Price</u> The price of rail relative to road is clearly an important determinant. For some commodities or shippers it is the dominant one, but for others, service

factors are also important, and outweigh any price advantage which the rail mode may have over the road mode. The corollary is that if rail's level of service improves, higher rates will be likely to be accepted by rail's customers.

Reliability of transit time This is of importance to many customers. Delays or uncertainty cause costs to them in terms of delays to vehicles awaiting the arrival of goods for pickup, extra warehousing for buffer stock at the destination, managerial time taken up in seeking the whereabouts of late goods, and possibly lost sales. Reliability correlates with transit time, but appears to be more important.

Improvement of reliability involves a series of initiatives on the part of railways, and the incidence of these is likely to vary from place to place. Important ones are likely to be, for example, terminal throughput, mainline delays, shortage of suitable wagons, and industrial disputes. Solutions to these problems include investment options (e.g., improvement of mainline capacity, extra wagons, improvement to terminals), information options (e.g., wagon monitoring) and management options (eg., fewer industrial disputes, consistency between systems in criteria for red-carding of wagons).

Avoidance of damage of deterioration. Where these factors are present to a significant degree, obviously extra costs are incurred by the user. Causes of loss in the railways include such elements as heavy shunting, mixing or stacking of incompatible goods, inadequate cleaning of wagon interiors, missing or inadequate paperwork, pilfereage, and mis-handling of goods.

While railways are aware of these practices and seek to minimize them, improvements are possible through such avenues as staff training, improved management, or technological advances in packaging or shipment (including wider use of containers).

Capacity. As with the reliability variable, the ability of a transport system to delivery goods when the consignee requires them is an important feature of the system. If suitable wagons are not available, either unsuitable wagons must be used, possibly increasing the chance of damage or further delay, or the despatch of the goods is held up.

Causes of these problems may be an absolute shortage of particular wagons, or unavailability of wagons due to poor utilization or poor information about wagon locations. Solutions thus lie in investment, including private ownership of wagons, and improved wagon monitoring systems.

Communication with respect to problems. This feature was often mentioned in the interviews conducted by ARRDO staff. Many shippers and forwarders reported that their treatment by railway staff was not on a business-like basis; forwarders in particular contrasted rail attitudes to them with forwarders' attitude towards their own customers, where they had learned the necessity to maintain good relations with their customers. Other aspects included: not being told when things went wrong, for example when there was a delay; a lack of ability to supply requested information, for example about the expected time or date of delivery of a particular shipment; and an inability to locate shipments in transit.

Improvements in this area are partly in the nature of delivery of information (for example through a comprehensive wagon monitoring system), and partly in terms of changed management practices or staff training. It is interesting to note that at least some of those interviewed thought that rail had improved recently in this regard, suggesting that improvements are possible.

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