AN APPLICATION OF STATED PREFERENCE METHODS TO THE STUDY OF INTERMODAL FREIGHT TRANSPORT SERVICES IN INDIA

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others

Abstract

The Indian Railways (IR) have, over the past four decades, been steadily losing market share, in both passenger and freight markets. In the case of freight, they have gone from being the dominant mode to being carriers of bulk traffic only. Most of the general goods, high value, traffic has shifted to road. In line with the pattern of economic growth, the manufactured goods sector is the fastest growing sector of the economy. This leads on one hand, to exclusion of IR from an important, and growing, sector of the economy and on the other hand to heavy strains on the already saturated road network, higher environmental dis-benefits and higher costs of petroleum imports. The Container Corporation of India (CONCOR), a subsidiary of IR, is now attempting to enter the domestic freight market, to recapture some of this freight traffic.

The present work has been taken up, with the final objective of developing a methodology, for identifying sectors where viable intermodal services can be offered, in comparison to road, as well as rail, services and to determine the price and service levels required for the same.

In the absence of any revealed preference (RP) data, as well as any previous work on valuation of attributes for the different sectors, we have used an Adaptive Stated Preference (SP) design for our work. The Leeds Adaptive Stated Preference (LASP) software has been modified and used for the work. Various alternatives have also been examined, with regard to the approach to be used for analysis of the survey data and we have finally decided to use individual level models aggregated using weighted averages as these appear to provide the most robust estimates.

We have developed models for costing of, door to door, freight movement by road, rail and intermodal services. These models have been used in conjunction with the demand model to assess the viability of the different services for the sectors considered.

Our findings indicate that, using fully allocated door to door costs, rail is a clear leader for distances over about 500 Km, on cost basis alone. However, when the service quality factors are taken into account, intermodal services become more attractive for the high value, damage prone, products while road services are more attractive for the lower value products. Rail services break even under 1500 Km only in a few of the situations considered by us and Intermodal service break even under 1500 Km for a large number of the situations (in case of use of new high speed wagons this breakeven shifts to between 500 to 1000 Km). Rail services would need to match the quality of road services, or be priced on marginal cost basis, to be competitive, as compared to road services. Intermodal services can be quite profitable, with presently attained transit times using the older (BFK) wagons, if they are offered at least thrice a week. The larger firms also appear to be more likely to go for intermodal services, than smaller firms. In case of the newer, high speed wagons, the increased capital costs are offset by the gains due to faster turn-around and there is a substantial improvement in the quality of service (time & reliability) that can be provided. This provides an opportunity for a highly profitable service to be provided with the induction of the new wagons.

To all those from whom I have learnt

I dedicate this work

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Glossary of Terms Used

ASC	Alternative Specific Constant
ASP	Adaptive Stated Preference
CONCOR	Container Corporation of India
CRRI	Central Road Research Institute, New Delhi
GBP	Pound Sterling
GOI	Government of India
GTKM	Gross Tonne Kilometre
GVW	Gross Vehicle Weight
IM	Intermodal
INR	Indian Rupee (1 GBP = 70 INR approx.)
IR	Indian Railways
Lorry	Term used for road trucks, in UK
LRMC	Long Run Marginal Cost
MOR	Ministry of Railways, Government of India
MOST	Ministry of Surface Transport, Government of India
NTKM	Nett Tonne Kilometre
PC	Planning Commission
PKM	Passenger Kilometre
RFFC	Railway Fare and Freights Committee
RITES	Rail India Techno-Economic Services (the consultancy wing of IR)
RP	Revealed Preference
RTEC	Rail Tariff Enquiry Committee
SP	Stated Preference
TEU	Twenty foot Equivalent Unit (standard international container size)
TFI	Task Force on Infrastructure, Government of India
Trailer	Term used for rigid body tractor trailer unit
Truck	Term used for road lorries, in India
VOC	Vehicle Operating Costs (normally used for road traffic)

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Chapter 1: INTRODUCTION

1.1 The Background

The transport sector in India has grown tremendously in the past four decades, with the total volume of traffic growing more than 10 times and a network growth of 600% for road and about 20% for rail (World Bank 1995).

There has also been a major shift in the composition of freight traffic, from low value, bulk commodities to high value, manufactured goods, as a consequence of the economic development of the country. With the change in the product nature and the introduction of new technologies and manufacturing systems, there has been a demand for a corresponding change in the service quality requirements from the service providers. Both the road and the rail sectors have made vast changes in the technologies used as well as in the operational procedures, to meet the changing service requirements of their customers.

This change, in product compositions and service requirements, is a story which is common to most countries around the world. So, perhaps, is the difference in the speed with which road transport systems have been able to meet the requirement as compared to railway systems. The basic reasons, for this difference in the response, are also quite similar i.e. the fact that railways are monolithic organisations (largely government owned) having to build and maintain their own infrastructure and having very high entry and exit costs. Road operators, on the other hand, are much smaller businesses (largely in private hands) using infrastructure owned and maintained by the government. They have almost no sunk costs other than the cost of the lorries (which is also largely recoverable) and, as such, have almost no barriers to entry and exit. In addition to this, they have inherent advantages of lower consignment sizes, greater network connectivity and door to door service. The greater dependence on road, however, has its own consequences in terms of greater pollution (air and noise) and lower energy efficiency leading to atmospheric warming (and bigger import bills in case of oil importing countries). This has led to a desire to get freight back to rail in most countries.

The developed countries, due to easier availability of resources, have been able to upgrade the infrastructure to keep pace with the growth in demand. They are now at the stage of redefining the growth pattern, on the basis of the environmental and social effects.

The developing countries, on the other hand, have not always been able to upgrade the infrastructure, due to resource constraints, and are faced with the twin issues of impediments to economic growth as well as environment related aspects.

In the Indian case also the pattern has largely been the same. The World Bank report on 'India Transport Sector-Long term issues' (March 1995) points out that the Indian Transport system in general and the Indian Railways in particular are presently facing serious pressures. These arise from the fact that, at current rates of growth, the passenger output is required to double every 7 - 10 years and the freight output every 10 - 12 years. Simultaneously the foreign trade flows are to double every 8 years or so. In addition to this, under the current technology and operating regimes, both the road and the rail systems (which together account for 95% of the total freight movement in the country) are facing saturation on the core High Density Corridors (which are almost parallel routes for road and rail).

The growth in road traffic has been much faster than in rail and in case of freight the road output grew at 8.8% per annum and rail by 3.3% per annum between 1967 - 1987. In case of passenger transport the growth has been 9.8% p.a. for road and 4.7% p.a. for rail in the same period.

An ADB (Asian Development Bank) aided study on Development of a Long Term Plan for Expressways (1991) has reported that 40% of the freight vehicles on the core part of the road system, are travelling for distances greater than 500 Km and 26% of the total freight vehicles are travelling over 1000 Km. A rough idea about the density of road freight movement can be had from the finding of a recent study (RITES 1996) that the Delhi - Bombay corridor (1500 Km) carries about 44 million tonnes of freight per annum with an average length of haul of almost 1000 Km.

The 'Task Force on Infrastructure' set up by the Indian Government in their discussion paper (TFI 1999), have pointed out that in view of the benefits of rail transport (discussed subsequently in section 2.1.4.2), it may be desirable to increase the railway's share in long distance bulk freight (for which it is the most suitable mode) and go in for accelerated containerisation.

The extent of congestion, over both the rail and road networks has, so far, not significantly affected the growth rate of the economy due to the in-built flexibilities in the form of parallel routes in both the rail and road networks. However it is increasingly being felt that these flexibilities have been exhausted and major investments are required in transport infrastructure to prevent the transport system from becoming a bottleneck in the economic development of the country. To deal with these problems, the country has embarked on a program of four laning the existing high-density road routes and for building 7000 Km of new expressways. Indian Railways have, at the same time, embarked on a program of developing alternative routes through gauge conversions and new line construction. Simultaneously, existing alternate routes are being upgraded by patch doubling (doubling of existing stretches of single line already having double line sections at either end) and electrification.

However, even if the capacity constraints are dealt with, the quality aspects still need to be dealt with if general goods traffic is to be put back on the rails. The nature of the traditional rail freight services makes them inherently unsuitable for carriage of high value finished products, due to the involvement of additional road transport and handling at either end (collection and delivery). The requirement of door-to-door movement for finished goods is better met by container services. The Container Corporation of India (CONCOR) handles the domestic and international container services in India. It has been making efforts to get long haul traffic back to rail, by providing door - to - door delivery services. However, at present, it has only a very small market share in the domestic, general goods, freight sector.

1.2 Scope and Objectives of the Research

At present a substantial body of work is available with regards to the aggregate, sector level, demand forecasts (NTPC 1980, Planning Commission 1988), the volume of traffic travelling by road over various routes (RITES 1979, 1987, 1996) and the reasons for the decline of rail traffic (RFFC 1993).

The National Transport Planning Committee Report (NTPC 1980) and the Steering Committee (PC 1988) have concentrated on the macro level sectoral forecasts from previous studies based on regression analysis as well as projections of various ministries. These figures have been compared with forecasts using aggregate estimates based on GDP elasticities of demand for various modes. The desirable modal mix has also been determined, on the basis of costs to the economy.

Rail India Techno Economic Services (RITES), the consultancy wing of the Indian Railways, has carried out surveys (RITES 1979, 1987 & 1996), to determine the pattern of freight traffic in the country. These surveys have established origin-destination (O-D) traffic estimates on the basis of actual surveys of road traffic on major highways (by carrying out 24 hour census at various points) and combining this with the data on rail movement which is already available at a fairly dis-aggregate level.

The study commissioned by the Railway Fares & Freights Committee (RFFC 1993) on the 'Integrated Rail Road Transport System for Movement of Long Distance Freight' and the study carried out by RITES on the 'Reasons for Decline of Rail Freight' (RITES 1996) have attempted to look at the shortcomings in rail freight services.

At present, the Long Range Decision Support System (LRDSS) group, within IR, is attempting to develop a demand model based on total logistic costs to the shipper.

However, there is very little work, at a dis-aggregate level, looking into different factors influencing the mode choice, for individual commodity/routes sectors, and the difference between the existing service quality and the required service levels. This is especially so in case of intermodal traffic which is still in a state of infancy.

In this work, we attempt to fill this gap by identifying the important factors influencing mode choice and understanding the effect, of some of the most important factors, on the mode choice decision, for different firms and commodity groups. We, further, attempt to develop a methodology for identifying the sectors where the nascent domestic Intermodal services can be viable, and the strategies that need to be adopted for the success of the domestic intermodal services, for these sectors.

In this process, we also attempt to establish the applicability of Stated Preference methods to Indian conditions, as they are likely to be especially useful for container services, where Revealed Preference (RP) data is not available.

The objectives of the work are :-

1. To develop a freight transport mode choice model for non-bulk goods covering road, rail and container services.

2. To develop a cost model for comparing the cost of freight movement by road, rail and containers.

3. To use the demand model in conjunction with the cost model to identify segments where intermodal services can be viable.

4. To suggest price and service levels for the viable segments.

In the present work, we have taken one major route as a case study. It is envisaged that the methodology, once developed, can be easily applied to other routes and product groups to get corresponding results. The Delhi - Bombay (North to West) corridor has been selected for the case study, as it is one of the most important freight corridors in the country. As already mentioned, this corridor carries almost 44 million tons of freight per annum with an average length of haul of about 1000 Km. At the same time, there is also an interesting phenomenon of the main direction of flow being different for road and intermodal services. In case of road services, the main flow is from Bombay to Delhi (except for some months when the main direction reverses, due to the arrival of seasonal fruits) with rates from Delhi to Bombay usually being quoted at much lower levels than the Bombay to Delhi rates. In case of Intermodal services, on the other hand, the main direction is Delhi to Bombay and there is some amount of empty movement of containers, on account of various shipping lines, for picking up export traffic from Northern India.

Our analysis has, however, not taken capacity constraints, in either the road or the rail networks, into account. It is assumed that the ongoing and planned works, of increasing the capacities, on both the Road and Rail networks will create the additional capacities required over both the networks. In case we are to account for the existence of capacity constraints, throughput may become the sole criterion for determining what commodity is to be carried by rail. In that case bulk commodities, where a trainload is likely to be equivalent of about 200 lorry loads (2400 tons), would have preference over containerised general goods cargo, where a trainload may only be equal to about 100 lorry loads (1200 tons).

As such, in this project we have, attempted to look at the basic viability of container services and rail services (speed-link type services moving wagon-loads traffic in trainloads) vis-à-vis the road services, in a situation where adequate capacity is available over both the networks. The question, we are attempting to answer in this work is :- Is the movement of a particular type of traffic viable by containers or rail wagons, vis-à-vis road movement, over the distance and route considered?

1.3 Methodology

Stated Preference methods are commonly used in most of the developed world and in some developing countries as well. However, no previous work could be found on the use of these methods in India. It was felt that in the current situation, where few intermodal services are available, Stated Preference (SP) methods were the most appropriate method for the research.

Furthermore, since no previous work in this field could be found for India, the likely attribute valuations, which could be expected for the different sectors considered, were also not known. This led to the need for using some sort of adaptive SP design. It was decided to use the Leeds Adaptive Stated Preference (LASP) software, which had been successfully used for freight studies within Britain (Fowkes & Tweddle 1988, Fowkes, Tweddle & Nash 1991) and for the Cross Channel studies (Tweddle, Fowkes & Nash 1995, 1996; Fowkes & Tweddle 1997).

Finally, it is hoped that this work would help to demonstrate the usefulness of Stated Preference methods to transport research in India and thus help to bring these methods into more common usage in India.

In this work, we are primarily trying to model a commercial decision (about services to offer in case of service providers, and mode choice in case of the shippers). We, therefore, concentrate on the commercial costs and not on the economic resource costs, which would become necessary in case of governmental policy level decisions.

1.4 Outline of the Thesis

This thesis is composed of ten chapters. Following this introduction to the subject, chapter 2 goes on to describe the background and the current status of freight transport in India. First we give a brief overview of the developments in the past almost half a century and then describe the overall position of the freight transport industry and the position of the individual modes of land transport, in terms of volumes, freight rates and service levels.

In chapter 3, we review the demand analysis methods. The focus of the review is on the areas relevant to the current work.

In chapter 4, we present a detailed review of SP methods where we cover the theoretical basis of SP methods, their advantages/disadvantages, the design issues and case studies of use of SP in freight both in developed countries as well as in developing countries.

Chapter 5 discusses the survey methodology and describes the functioning of the LASP software. We describe the results of the Pilot survey and the modifications made in the software on the basis of these results. The results of simulations carried out to determine the appropriate analysis methodology, for individual firms, are also described. We then describe the pen & paper design, which was prepared as a backup in case of problems with the ASP experiments, but did not have to be used finally.

In chapter 6, we talk about the sample size and segmentation issues. Then we describe the main survey and the qualitative data from the same and present a summary of the sectors covered and respondents contacted.

The results of the data analysis are presented in chapter 7. We first present the individual level models and then go on to sector level, aggregate models. We have aggregated the results using weighted averages and compared this with results using pooled data. In case of pooled data three different methods have been used i.e. ordinary least squares (OLS), weighted least squares (WLS) and random coefficients model (RCM). The results obtained from each are described. We have also performed the same exercise with synthetic data, to attempt to explain the difference in the results using the different methods. The final demand model used is then described.

In chapter 8, we have developed the cost model. We first give a brief survey of literature, on transport costing in general and railway costing in particular. We then discuss three different costing models (i.e. the currently used fully distributed average cost model, the UIC model and the ESCAP model). Then we describe the model used here and the results of the cost model. In case of container services the basic cost model for trunk haulage (of containers by rail) remains the same and costs of collection & delivery and terminal handling are separately calculated and added on. In case of road vehicle operating cost (VOC), we have obtained data from road transport operators interviewed for the survey and have compared this with the results from an Indian statistical costing model to arrive at the final costs. We have further compared these costs with the round trip revenues.

In chapter 9, we compare the basic costs and freight rates for the three modes and then carry out a break-even analysis taking into account the quality of service parameters and the valuations obtained from the demand model. The analysis is performed, separately, for each of the sectors covered in the survey and then route specific aspects are discussed.

Finally, in chapter 10, we summarise the results of the sector-level analysis and present the conclusions and recommendations from the research along with some suggestions for further work.

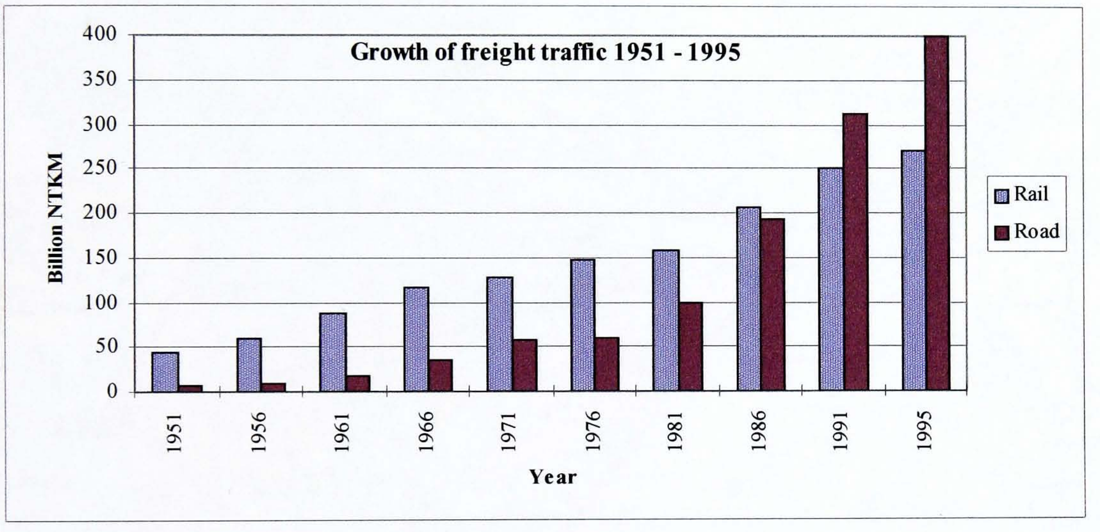
Chapter 2: STATUS OF FREIGHT TRANSPORT IN INDIA

In this chapter, we will briefly discuss the historical development of freight transport in India. We then go on to discuss the current status of the road, rail and intermodal freight services in the country.

2.1 The Historical Perspective

2.1.1 Freight Traffic Growth Over Four Decades

Figure 2.1: Freight Traffic Growth in India



Sources: 1) Perspective Planning for Transport Development – Report of the Steering committee 1988,
2) 9th Five Year Plan (1997 - 2002) documents.
3) Indian Railways: Facts & Figures 1996

If we look at the historical development of freight traffic in India (Figure 2.1) we see that there has been a steady growth in rail freight over the past four and a half decades (from about 44 Billion NTKM in 1951 to 270 Billion NTKM in 1995) . This growth has, however, been outpaced by the growth in road freight traffic, which has grown from 6 billion NTKM to almost 400 billion NTKM over the same period. In terms of market shares, the share of road has gone up from about 20% of the land freight (NTKM) in 1951 to almost 65% in 1995. The pattern is similar in case of passenger transport (not shown here).

Figure 2.2: The Golden Quadrilateral

2.1.2 Network Growth

In the same period, the road network has grown by almost 600% (Table 2.1). A large part of the growth has come in the rural roads, providing all weather access to far-flung villages.

Table 2.1: Network Growth

	1951	**1995**
Road - National Highways ('000 Km)	20	49.5
Road - Total Length ('000 Km)	400	2800
Rail - Route Km ('000 Km)	53.6	62.2

However the core part of the road network (the National Highways) has grown by 150%. This core part of the road network, which forms less than 2% of the network, carries almost 40% of the traffic. The rail network has grown by less than 20% in the same period and in this case the core part of about 10,000 Km (16% of the total network) carries over 56% of the freight and 47% of the passenger traffic (MOR 1998).

The 'Golden Quadrilateral' connecting the four biggest cities of Delhi, Bombay, Calcutta and Madras and its diagonals (see map Figure 2.2) form the High Density Corridors (HDCs) which carry the bulk of the traffic by both rail and road.

2.1.3 The Macro Level Changes

Some of the major macro level changes in the transport sector, over the past half a century are (World Bank 1995):-

1) The change from a rail dominant transport system to a road dominant system (see Table 2.2).

Table 2.2: Change in Market Share

Year	Freight		Passenger	
	Rail	Road	Rail	Road
1950-51	89%	11%	80%	20%
1996-97	40%	60%	20%	80%

Source: MOR 1998: Status Paper on Indian Railways

2) Change in the composition of rail traffic, from a variety of commodities to limited number of bulk, low value commodities. Today 9 bulk commodities account for almost 95% of the tonnage carried and 91% of the NTKM.
3) The change in the pattern of rail traffic, from freight dominant to passenger dominant. This leads to operational problems as passenger trains have priority over freight movements and end up crowding freight off the network.

Simultaneously financial problems arise on account of the fact that average passenger fares (per PKM) are almost a third of the average freight rates (per TKM).

2.1.4 The Current Scenario

2.1.4.1 Volume of Traffic

The Indian freight transport industry is dominated by the land modes (rail and road) which between them carry more than 95% of the traffic generated in the country (TFI 1999). The other modes, such as coastal shipping, inland waterways and airfreight, between them account for less than 5% of the traffic. These modes are not very important for any of the major routes considered by us. As such, in all our discussions we shall be referring to the land modes only.

Data on the extent of freight movement by rail is regularly maintained and available at a fairly dis-aggregate commodity level. However in case of road no records of overall movement are available in view of the nature of the industry which has a large number of small operators owning 2-5 lorries. The data for road is in the nature of aggregate estimates based on the number of lorries registered and their utilisation levels. The data for 1950-51 onwards (upto 1985) is available from two major studies (MOST 1987 & Planning Commission 1988). The estimates from MOST 1987 are significantly higher than the Planning Commission estimates (50% higher for 1985).

Based on the average estimates from these two studies, World Bank (1995) have calculated the road freight output for 1992 to be 384 Billion NTKM. The 9th Five-Year Plan (1997-2002) estimates the value for 1995 to be 398 Billion NTKM, which therefore appears to be a conservative estimate. The actual figure for freight traffic carried by the Railways in 1995-96 was 270.5 billion NTKM. If we take the above total of 668.5 billion NTKM (398 Billion NTKM for road and 270.5 Billion NTKM for rail) and extrapolate it to 1998-99 using a 5% growth in GDP and a GDP elasticity of 1.3 (World Bank 1995) we get a total figure of 807 billion NTKM out of which 280 billion NTKM (budget estimate) came from the railway leaving 527 billion NTKM for road.

If we look at the composition of this traffic in terms of bulk and non-bulk (Table 2.3) we find that Bulk commodities form almost a third of the freight carried by road. The percentage share of bulk commodities in total road traffic has increased almost five percentage points, in the 8 years between the two studies on which this data is based. There has also been an increase of average length of haul, for both bulk (314 km to 372 km) as well as non-bulk commodities (374 Km to 429 Km). These figures also show movement of traditional (bulk, long-distance) traffic away from rail to road.

Table 2.3: Movement of Bulk and Non-Bulk Commodities by Road

	1978-79			1986-87		
	Tonnes (%)	TKM (%)	Avg. length of haul (Km)	Tonnes (%)	TKM (%)	Avg. length of haul (Km)
Bulk	35	31	314	39	36	372
Non-bulk	65	69	374	61	64	429
Total	100	100	353	100	100	406

Source: RITES, all India traffic surveys, 1978-79 and 1986-87

2.1.4.2 The Need for Rail Movement (Opportunities)

The need for countering the slide in railway's share of its traditional traffic (bulk, long distance cargo) and for getting the increasing bulk of manufactured products onto rail arises from :-

Table 2.4: Relative External Costs of Road & Rail Transport

	Cost of External Effect (ECU/1000 TKM)	
	Road	Rail
Noise	12.7	4.7
Air Pollution	13.0	0.7
Climate Change	10.6	1.1

Source: IWW, Karlsruhe 1994: External Effects of Transport

1) The environmental effects of road movement. It is an accepted fact that road transport has greater environmental costs, than rail, in terms of emissions, noise and global warming. A study of 17 European countries (IWW, Karlsruhe 1994) shows (Table 2.4) that road causes almost 20 times more air pollution and 3 times more noise pollution than rail. The total figure, in case of freight is eight times higher for road, as compared to rail. Similar studies are not available from India, however TFI 1999 points out that 'in order to have an optimal inter-modal mix, it is necessary to incorporate the infrastructure and external costs into transport pricing...'.

   Lower inherent energy efficiency of road movement becomes an important factor since transport accounts for almost 22 % of the total commercial energy usage in India (World Bank 1995). Out of this only 4.3% is consumed by railways and the balance of almost 18% is mainly consumed by road transport.

As a very rough comparison of the fuel efficiencies, we take the unit consumption of diesel for rail freight (Indian Railways Annual Statistics) as 3.13 litres per 1000 GTKM. In case of road, the typical consumption levels (from interview data) are about 3.5 Km per litre (GVW = 16 tons). Converting to GTKM per litre of diesel, we get a figure of 319 GTKM per litre for rail and 56 GTKM per litre for road. This ratio of 5 - 6 times higher fuel efficiency is supported by the figures of 3-4 times higher fuel efficiency (ton miles/gallon) of rail (as compared to Heavy Duty Lorries) from TRB 1977 as quoted in RFFC 1993. The energy efficiency of electric traction is even higher than that of diesel traction and has been estimated to be about 50% higher in Indian conditions (RFFC 1993). Therefore, the weighted average energy efficiency, taking all the modes of traction into account, will be correspondingly higher (this would continue to be higher, even after taking into account the efficiency of generation and distribution of electricity used for railway traction). The Transport Energy Databook (Davis 1998) gives the aggregate level energy efficiency figures (for the US) as 2,790 BTU/ton-mile (BTU = British Thermal Unit) for road freight transport and 368 BTU/ton-mile for rail freight.

2) The fact, that petroleum products are the single largest and growing item of imports for India at the moment. In comparison, most of the core rail routes are already electrified and therefore are based on domestic sources of energy (coal based).

Total imports of petroleum products are presently over Rupees 350 billion p.a. TFI 1999 have estimated that an increase in rail share of total freight from 40% to 50% would lead to a saving of Rupees 25 billion in foreign exchange outgo on account of import of diesel.

3) Higher than proportionate numbers and cost of accidents by road (RFFC 1992) and the fact that loss on account of road accidents is estimated to be about Rupees 60 billion (approx. GBP 900 million) per annum (TFI 1999).

At the same time we need to remember, that the reasons for the popularity of road transport are its commercial advantages in terms of lower inventory costs (due to lower transit times) and better service reliability. The International Road Union (IRU) commissioned report on 'Social Benefits of Long Distance Road Transport' (April 1993) has attempted to visualise a situation of 'without road transport of goods...' and identified the benefits of road transport in form the of :-

1) Cost reductions and consequent gains to national economies through:-
    - reduced packaging costs through use of specialised vehicles
    - reduced damages due to reduced handling
    - flexible vehicles sizes allowing optimum utilisation of capacities
    - reduction in warehousing & inventory costs, by permitting lower inventory levels (in transit as well as at ends).
2) Competition with road industry setting service standards for rail
3) Assisting in economic development through permitting flexibility in location of plants away from railheads.
4) Promoting technical process innovations such as Just in Time (JIT) manufacturing etc.
5) Benefits to industry passed on to consumers in form of cost reductions.

2.1.4.3 The Threats

The ongoing program of four-laning of the major highways and the recently started program to build 7000 Km of new highways would go some way towards removing the bottlenecks in the road network. At the same time it would make the task of re-capturing any of the general goods freight traffic to rail, even more difficult.

2.2 Containerisation in India

2.2.1 Introduction

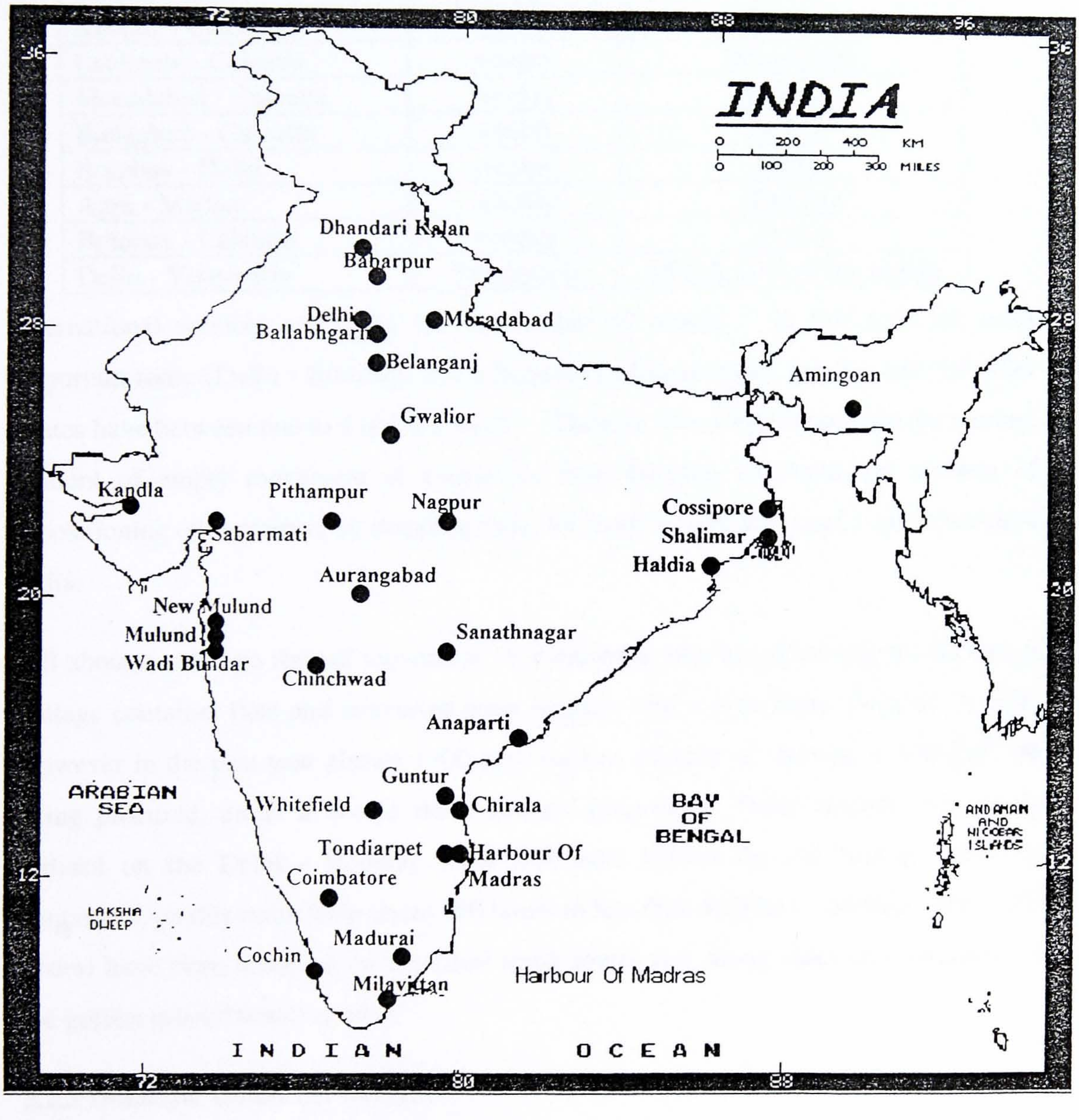
The concept of containerised, door to door, movement has been in existence in India since 1966-67 though the first ISO container only landed in India in 1973. In the early period, the containers used for domestic traffic had a carrying capacity of 5 tonnes and were almost a third of the size of the present 20-foot ISO containers. These container services were directly offered by Indian Railways and were used mainly for movement of general merchandise and household items etc.

The Container Corporation of India (CONCOR) was set up, as a subsidiary of the Indian Railways in 1988, for promoting containerisation in the country. In the initial phases, CONCOR was only handling the International traffic while the domestic container traffic (in the 5 tonne containers) continued to be handled by IR itself. Then, with the phasing out of the 5-ton containers, the domestic traffic was also taken over by CONCOR. In Intermodal traffic, the intermediate handling costs form a major part of the total transport cost. This is especially so in a country where capital is scarce and costs of handling operations involving use of dedicated heavy handling equipment is very high. As such, combination with international traffic was expected to provide economies of scope, between domestic and international traffic, and thus reduce the cost of intermediate handling. This was, in turn, expected to make intermodal transport more attractive for domestic traffic, thus bringing the general goods wagonload traffic back to rail. However, over time these expectations have not been fully realised.

From its inception in 1988 to date CONCOR has built up a network of 31 terminals (including domestic & international terminals) all over the country (Figure 2.3). These handled almost 720,000 containers in 1997-98 (about half a million TEUs international cargo and a quarter of a million TEUs of domestic cargo). However, even this number represents less than a quarter of the country's international trade and a minuscule proportion of the domestic freight movement.

कॉनकोर
CONCOR

Fig 2.3: CONCOR Terminal Network



2.2.2 Existing Container Services

At present CONCOR is running 10 scheduled services for domestic traffic with frequency varying from tri-weekly to fortnightly (Table 2.5).

Table 2.5: Domestic Container Service Schedule (return services, if any, are shown separately)

Stream	Frequency	Day
Delhi - Madras	tri-weekly	Friday, Sunday, Thursday
Madras - Delhi	weekly	Friday
Kanpur - Calcutta	weekly	Thursday
Lucknow - Calcutta	weekly	Wednesday
Moradabad - Calcutta	weekly	Monday
Bangalore - Calcutta	weekly	Sunday
Bombay - Delhi	weekly	Friday
Agra - Madras	weekly	Tuesday
Bombay - Calcutta	weekly	Friday
Delhi - Vijaywada	Fortnightly	15th & 30th of the month

International services are being run on another 10 routes. In this case the most important route (Delhi - Bombay) has a frequency of three trains per day and the other routes have between one to 4 trains a week. There is also a significant, but decreasing, amount of empty movement of containers from Bombay to Delhi, on account of repositioning of containers by shipping lines, for loading of export traffic from Northern India.

Till about a year ago the rail movement, of containers, was based entirely on the use of vintage container flats and converted open wagons with a maximum speed of 75 Kph. However in the past year almost 1700 new wagons capable of running at 100 Kph are being procured, under a World Bank assisted program. These wagons are mainly utilised on the Delhi - Bombay route and have halved the rail haulage time, of containers, on this route from about 100 hours to less than 48 hours. Similar times (100 hours) have been achieved on the other trunk routes (i.e. along sides and diagonals of the golden quadrilateral) as well.

2.2.3 Domestic Container Traffic

The domestic traffic can be broadly classified under two categories - firstly, bulk traffic offered in trainloads by large manufacturers including commodities like cement, food products and chemicals. Secondly, traffic offered by freight forwarders (bulk as well as non-bulk). In the first category, the loading is mainly from railway sidings within the factories and the consignments are then delivered to the factory/warehouse in containers or de-stuffed at the destination terminals and delivered by lorries. In the second category, the consignments are usually collected and delivered by lorries at either end.

As is apparent from the mode of handling at either end, a lot of this traffic is more suited to traditional railway operations and is moving by containers due to other considerations such as:-

1) shortage of suitable rail wagons
2) more customer friendly service being offered by CONCOR as compared to IR
3) possibility of some extent of storage in containers due to lower wharfage/demurrage charges being charged by CONCOR than by the railways.

The other factor contributing to this anomalous situation is the fact that it is cheaper to de-stuff the cargo at the terminal and load into lorries manually and deliver to(or collect from) the doorstep, than to move the container to the doorstep. This is due to the availability of cheap labour and the scarcity of funds for procurement of mechanical handling equipment. This is discussed in greater detail in section 5.3.

In terms of customer friendliness, the results of the interviews seemed to indicate that CONCOR ranks somewhere in between the railway (very unfriendly) and road (friendly). One of the advantages in using CONCOR services, especially for the train load offering, was that the party would get much longer loading/unloading times since the containers would be sent to the warehouse in lots of 5 per day. In case the same movement was done by rail, the party would be required to empty the entire trainload within 8 hours and remove to own warehouse within one day or pay demurrage and wharfage charges.

The arrangements with the freight forwarders, helps in providing a single window service and the parties do not need to contact CONCOR at all. Since the freight forwarders are themselves road transport operators, they are also able to provide a full road service in case of blockages in rail movement or if the party insists on road movement for the entire length of haul.

An interesting finding of a survey carried out for the Railway Freights & Fares Committee (RFFC 1993), was that the larger bulk customers were not very happy with the road service reliability and frequent rate changes prevalent in the road transport sector. The smaller customers, however, appeared to be satisfied with the level of service offered by the road sector as compared to the service offered by the rail alternative.

2.3 The Road Transport Industry

2.3.1 Introduction

The road transport industry, in India, operates in a highly competitive deregulated environment. According to the Ninth 5 Year Plan document (PC 1997) there were a total of almost 1.8 million goods vehicles registered in India in 1996, of which a majority were two axle rigid body lorries with a carrying capacity of 9 tons (but carry almost 1.5 times the capacity at times). There is also a significant and increasing number of LCVs (light commercial vehicles) including those of indigenous design as well as Japanese makes. As mentioned earlier, the National Highway network (Figure 2.4) forming about 2% of the road network, carries almost 40% of the road traffic and an even higher proportion of the long distance traffic.

The number of lorries allowed to operate across state borders was earlier regulated under provisions of the Motor Vehicles Act 1939, by limiting the number of National Permits allowed to be issued by any state. This ceiling on the number of National Permits was removed in 1986 and this deregulation led to a threefold increase in the number of National Permits in one year and today the industry can be considered to have open access and is highly competitive.

2.3.2 The Nature of Operations

The nature of operations in the road sector have been studied by RFFC 1993 and most of their findings have been found to match the information obtained from the interviews in the present survey. These are :-

1) the road transport industry has a few major players and a large number of small operators. The fleet sizes for the small operators would vary between 2-5 lorries and for big operators between 10 to 50. There would only be a few operators owning a fleet of over 50 lorries. This is, perhaps, consistent with the findings regarding the absence of economies of scale in the road transport industry, in studies carried out in the UK (Nash 1982).

Fig 2.4: The National Highway Network

2) In addition to using their own vehicles, most operators hire from the market as per their requirements. Most operators interviewed in the current survey (including the largest ones) were found to own lorries to meet less than 50 % of their requirement and were hiring the rest from the market.

3) The freight forwarders, on the other hand, were found to be having very few lorries of their own (mainly for local movement) and were mainly using hired vehicles for long distance movement.

4) A majority of the road transport operators have their operations restricted to one or two specific corridors.

5) The road transport sector is almost fully privatised and very competitive with very low profit margins.

6) The road freight rates have pronounced seasonal fluctuation, depending on the volume of traffic in either direction (which varies with the agricultural as well as the industrial production cycles).

7) The rates are higher in the main direction of movement in any particular season (the main direction can change from season to season) as lower freight charges are offered in the return direction, rather than return empty. However the round trip rate would still stay almost the same round the year.

8) The unit rate, per TKM, tends to be low on the high traffic routes compared to the low traffic routes.

9) The unit rate on medium and long hauls is comparatively lower than on short hauls.

10) The rate for very small distances/intra-city movement would be almost constant irrespective of the distance if the distance is within about 50 Km and is based on the 'cost per day' of operating a lorry.

11) The operators normally employ newer lorries on long distance routes, upto 5-6 years old. The older lorries are usually employed on the short or intra-city routes.

2.3.3 Service Quality

In terms of the quality of service, there are a large number of freight forwarders available at almost every major traffic generating point and lorries can be readily arranged at the going market rate. Most large shippers, however, tend to go in for annually contracted rate agreements for ensuring regular supply of lorries at fixed rates. Some companies also have penalty clauses for delayed deliveries but even in these cases the penalty is not charged for circumstances outside the transport operator's control.

The smaller towns also tend to have unions of lorry operators, which in some cases may be strong enough to force an industry to use lorries offered by it's own members at higher prices than the market. However in the larger cities these unions would not tend to be so effective due to the difficulty in enforcing such arrangements in a widely dispersed area.

2.4 The Indian Railways

2.4.1 The Network

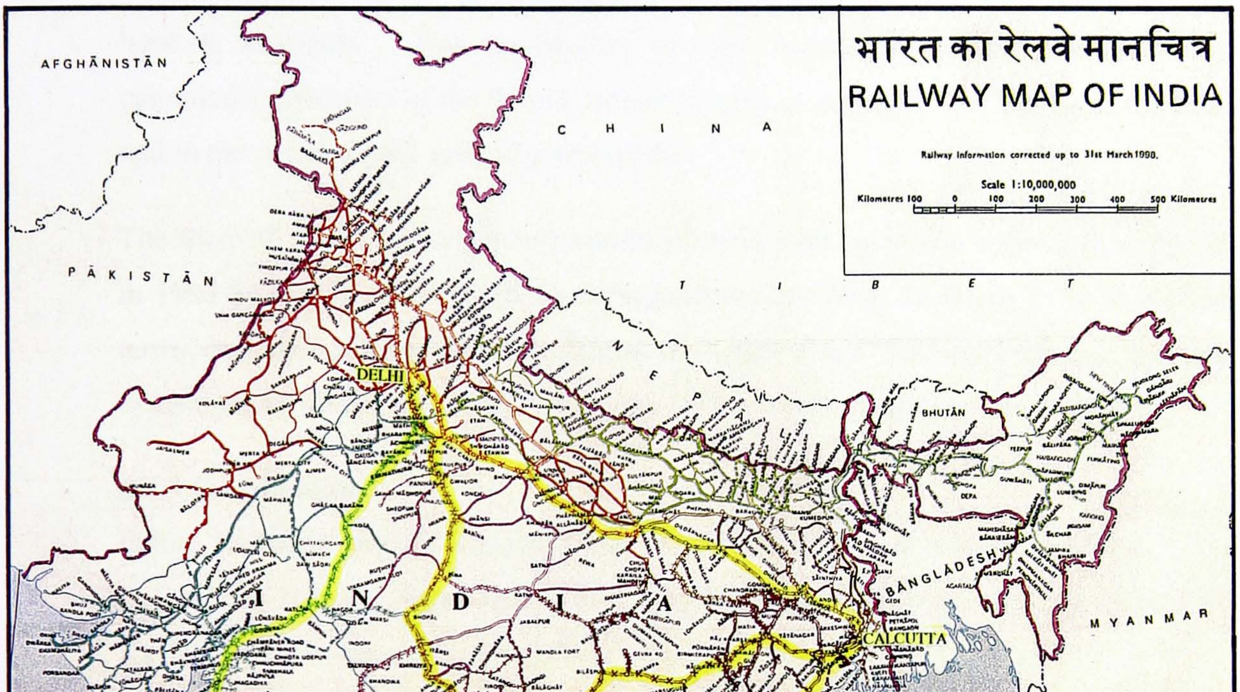
The Indian Railways is one of the largest rail networks in the world under single management (over 62,000 route km - Figure 2.5). It moved approximately 420 million tons (280 billion NTKM) of freight and 4.2 billion passengers (365 billion PKM) in 1997-98 with a staff of over 1.6 million. Gross traffic receipts amounted to Rupees 291 Billion and operating expenses amounted to Rupees 261 Billion (1 GBP = 70 Rupees approx.).

As mentioned before, about 16% of this network, which forms the sides and diagonals of the 'Golden Quadrilateral', carries most of the traffic (both passenger and freight). From having being the dominant mode of transport, in the early 1950's, it has now become the minor partner carrying only 40% of freight and 20% of passenger traffic.

2.4.2 Decline in Market Share

The railways have basically become beasts of burden carrying the low value bulk commodities. The growing volume of high value manufactured products continues to go to the road network, on account of the advantages mentioned in the previous sections.

Figure 2.5: Indian Railways Network



This process was given a further impetus in the early 1980's, when the Indian Railways adopted a strategy of end to end movement in full trainloads. This was an important step towards better meeting the needs of a bulk of the railways customers, in the power sector (coal traffic) and other bulk commodities, which accounted for over 90% of the railways freight volume. This was accompanied by a policy of closing smaller freight booking terminals. This combination of steps resulted in an improvement in the operational efficiency of the freight movements but at the same time served as the final nail in the coffin for the general goods traffic.

The share of 9 most important bulk commodities in total rail traffic went up from 89.3% in 1983-84 to 94% in 1995-96, in tonnage terms, and from 83.4% to 91%, in NTKM terms, over the same period. The volume of 'Other goods' traffic, on rail, has declined in absolute terms from 46.6 million tons in 1960-61 to 21.3 million tons in 1995-96.

2.4.3 Freight Rates

Indian Railways have a uniform freight tariff applicable all over the country. The freight tariff consists of two main parts. The first is a rate table giving the rates per 100 Kg for different distances and different classes. There are over 30 'classes' between 'class 80' and 'class 300'. The basic rate is defined as 'class 100' and is supposed to cover fully allocated average costs. The principle of telescopic rates is followed with a defined index of taper taken as 100 for a distance of 100 Km and falling to 49 for a distance of 3000 Km. This means that the rate per TKM for a distance of 3000 Km would be 49 % of the rate per TKM for a distance of 100 Km. All other class rates are supposed to be multiples of the basic 'Class 100' rate. The actual rates are not strict multiples due to the terminal charge element which is a constant figure being added to the basic telescopic freight rate. In addition to this, the rate structure, once defined, undergoes distortions over time due to adjustments made in the Railway Budget, which is presented to the parliament annually, till it is rationalised again. The classes below 'class 100' are concessional classes for essential, low value commodities for mass consumption such as salt etc.. Classes above 'class 100' are those that generate a profit over fully allocated costs.

The second part of the tariff is a classification table, which classifies individual commodities into the different rate classes. This classification is based on various factors such as the value of commodity, nature (e.g. corrosives are charged higher as they can cause damage to wagons), ability to bear the rate etc.. In case of weight constrained commodities, the freight is charged on the carrying capacity of the wagon (in tonnes). However, in case of volume constrained commodities the density of the commodity is taken into account by charging freight at a lower prescribed carrying capacity.

The basic rail freight is substantially lower than the road freight rates for similar distances. However, in terms of the cost to user, we need to take into account cost of additional handling, collection & delivery, additional packaging required for rail movement and inventory costs (for longer transit times). Taking these factors into account RFFC 1993 have found that the costs, to the shipper, by rail were about 7%, 18% and 26% lower than cost by road for the Delhi -Bombay, Delhi-Calcutta and Delhi-Madras routes respectively.

Over a period of time Indian Railways have also started offering special station to station rates for getting back traffic from road.

2.4.4 Service Quality and Efforts to recapture traffic

In terms of quality of service, Indian Railways stand a distant second to road services. This is partly due to the poorer connectivity as compared to road, and more so due to the procedural rigidities of the system, which often result in slow response to customer needs and a bureaucratic style of functioning.

If we look at the services between Delhi and the other cities of the quadrilateral, where connectivity is not a problem, it appears that Speed-link type, point to point, services (presently discontinued) are significantly slower than road services (Table 2.6). In addition to the longer transit time, rail freight also has much lower reliability of transit time. In case of road, a lorry that is late may reach at the most 1 - 2 days late. However in case of rail, a wagon that is late could have gone entirely off the route (due to destination labels getting damaged) and may not be traceable for weeks. In addition to this, in case a lorry breaks down or meets with an accident, the driver will inform the owner and the consignee so that they know where the consignment is and when to expect it. In case of rail, there is no system of giving information regarding defective wagons.

Table 2.6: Transit time by road and rail

Route	Transit time (days)	
	Road	Rail
Delhi - Bombay	4-5	6-8
Delhi - Calcutta	4-5	6-8
Delhi - Madras	7-9	12-15

Source: Interview results

Presently, IR is in the process of setting up a computerised freight information system, which should go a long way in solving these problems.

IR has made a series of attempts to stem the slide in market shares, over two decades (RFFC 1993). These started with the setting up of a Marketing & Sales organisation in 1967 and are listed below:-

1. Mobile booking service and street collection & delivery
2. Station to station (negotiated) rates
3. Leasing of brake-van space
4. Single window service for major customers
5. Priority service for High Profit Yielding commodities
6. Quick transit service
7. Guaranteed wagon supply
8. Own your wagon scheme
9. Speed link expresses
10. Freight Forwarder scheme
11. Domestic container services

The reasons for the failure of the different schemes have been summed up by RFFC 1993 as being due to the 'lack of seriousness in the functioning and performance and the ignorance and apathetic attitude of the rail staff'.

2.5 Conclusion

In this chapter we have seen that over the past four decades there has been rapid growth in freight output of road as well as rail. There has also been a change in the nature of the transport sector at the macro level from rail dominant to road dominant. At the same time IR has changed to a freight dominant to a passenger dominant mode. A very large proportion of the traffic is carried on the 'Golden Quadrilateral', which forms a fraction of the total network. Both the rail and road networks are currently heavily strained and are in the process of being upgraded.

There is a perceived need to get long distance freight traffic back to rail, due to the expected benefits to the economy, in terms of reduction in externalities as well as the reduction in petroleum imports.

The present state of the freight services offered by road, rail and CONCOR have also been discussed and we have seen that rail services have not been able to keep up with the requirement for improved services for the general goods freight. This traffic has been, almost entirely, taken over by road due to the faster and more reliable door to door services being offered by them. Intermodal services are attempting to capture some of this traffic by offering fast and reliable door to door service.

Chapter 3: DEMAND FORECASTING METHODS

In this chapter, we review the earlier work on transport demand forecasting, with a view to exploring the alternative methodologies available and to identify a suitable research methodology for the present work.

The methods available, for forecasting transport demand, can be broadly categorised into two main groups (i) Aggregate Methods (ii) Dis-aggregate methods. We will first review the aggregate methods and then go on to the dis-aggregate methods, where we will discuss the advantages and disadvantages of various methods such as Revealed Preference, Stated Preference and Transfer Price methods and the suitability of the different methods for our work.

3.1 Aggregate Methods

The aggregate approach to forecasting transport demand (Fowkes & Nash 1991) relies on aggregate level time series or cross section data (or a combination of the two) for forecasting demand. It would try to relate the variable of interest (e.g. total volume of traffic) to the explanatory variables through various functional forms (linear, log-linear, translog etc.). The explanatory variables would, typically, include price variables (usually in the form of average revenue per PKM or NTKM), service quality related variables (such as transit time, reliability), variables describing the state of the economy (such as GDP or employment etc.) and dummy variables to account for seasonal effects and data inconsistencies etc..

The parameters and measures of dispersion would be estimated using linear regressions, which choose those values of the coefficients which minimise the squares of the residuals between the observed and modelled values of dependent variables. If models cannot be linearised, then maximum likelihood techniques can be used. Maximum likelihood techniques are base on choosing those parameter estimates, which maximise the likelihood of the observed data having occurred. The relationship, thus established, would then be used for forecasting demand under varying circumstances.

This model form can also be represented in terms of ratios of market shares of two modes as a function of the attribute level differences and is referred to as 'Aggregate Mode Split Model'. Oum(1989) has compared alternative model forms and their elasticity estimates, using data for Canadian Inter-regional flows for 1979, and concluded that the functional form of the model used is very important. They found the translog form to give best results in their case. Winston (1983) points out that the 'Aggregate Mode Split Model' form facilitates empirical analysis but suffers from a lack of theoretical grounding (i.e. it is not based on any theory of shipper behaviour).

As opposed to this the 'Neo-Classical Transport Demand Model' considers transport to be a factor of production and recognises the fact that the shipment characteristics affect inventory costs hence inventory and shipment decisions are inter-dependent. As such, firms facing high inventory costs (e.g. manufacturers of high value commodities) would be more inclined to select faster (and therefore usually costlier) modes of transport with small shipment sizes. On the other hand, firms where inventory costs are not so important (e.g. bulk, low value chemicals) would opt for cheaper means of bulk transport. Oum (1979) has derived a neo-classical model for rail-truck competition using cross sectional data of Canadian inter-regional freight flows of 8 commodities. He has used a translog specification. He found that quality of service attributes had a significant impact on mode choice decisions for high value products but not for low value industrial raw materials. They also found that price and quality elasticities of demand vary substantially between commodities and links. Therefore, the results from a model aggregated over sectors or over links are likely to conceal a great deal of variability. His results also suggested that shippers tended to over estimate the quality of service attributes for road and under-estimate the same for rail.

Friedlander & Spady (1980) have derived a Neo-Classical model for freight transport demand in the USA using cross-sectional data for 96 manufacturing industries in five broad geographical regions. They have also found the estimates of demand to be generally robust.

3.1.1 Applicability of Aggregate Models to Current Work

Aggregate methods would be suitable for macro level estimates of traffic growth and investment requirements etc.. However in the present context there are a number of shortcomings. Some of these are: (1) In case of the Indian Railways, detailed statistics are maintained by commodity though at an aggregate level there would be significant loss of detail (2) In case of road traffic, no such record is available and it would, in fact, not even be possible to get cross sectional data for this; (3) Even for the railways, data on the change in service level, over time, would not be available; (4) For Intermodal traffic, very little data would be available due to the short period these services have been in operation and the low market share they have achieved. It would, consequently, not be possible to derive any reliable forecasts of demand with changed levels of service. In the present context, aggregate data can only be used for obtaining estimates of the market size and its growth rate.

3.2 Dis-Aggregate Methods

The dis-aggregate methods of demand forecasting are of comparatively recent origin and focus on the individual decision-maker and try to model his preferences and weights given by him to various attributes of the service. These dis-aggregate estimates are then used to build up aggregate level forecasts.

According to Fowkes & Wardman (1991) the main advantages of dis-aggregate methods stem from their avoidance of aggregating and averaging. Dis-aggregate models are claimed to provide a firmer behavioural basis, in the sense that the models are based on an explicit theory of consumer behaviour and aim to explain causality rather than capture correlation. Secondly, they avoid problems arising from using zonally averaged travel data. For example, the 'value of time' may vary little if taken as a zonal average, however, there may be considerable difference between values of different firms and this can be exploited in dis-aggregated models. Thirdly, they facilitate market segmentation since a firm's response can be directly related to the characteristics of the commodity (e.g. perishables or high value goods need faster transport), the characteristics of the consignor/consignee (a firm using Just In Time inventory process would need more reliable service) and the characteristics of the business (in case the norm in the business is to quote ex-warehouse prices then the consignor may not be very worried about higher transport costs). These methods are also likely to model the response to change, in service levels, better.

Dis-aggregate methods can be broadly divided into two categories (i) Logistics Cost Models which are discussed in section 3.3 and (ii) Behavioural models which are discussed in section 3.4.

3.3 The Logistics Cost Model

The Logistics Cost models are based on total logistic costs of the firm, which include the transport cost, inventory carrying cost and the cost of losses/damages in transit. In this, the decision regarding mode choice is made in conjunction with the shipment size and frequency decisions. Vieira (1992) has used the logistics cost model to assess the value of service in freight transportation which has taken into account the perceptions of modal attributes and their relation to the actual measured attribute levels. He has taken the logistics cost to include the transport cost, order cost, loss & damage cost, inventory capital carrying cost, reliability costs and intangible service related costs. For his study RP data has been obtained from a previous shipper survey in the US which covered nine attributes. The SP survey has taken the most important variable of cost, time and reliability. He has found that shippers are becoming increasingly sensitive to service quality and the relative importance of freight rates has decreased.

Sheffi et al (1988) have developed a micro-computer based model for comparing the modes. This is basically an economic order quantity (EOQ) type of formulation based on the trade off between inventory carrying costs and transportation cost in making the shipments size and frequency decisions for each mode of transport to minimise the overall logistics cost.

Logistics cost models would, typically, be formulated using data about the existing modes and decisions made. As we shall discuss subsequently, under the section on RP methods, this is not feasible in our case, as existing intermodal services are in their infancy and very little mode choice data is likely to be available. We are, therefore, not considering the use of logistics cost models. However, we will be considering door to door costs and factors like the shipment sizes and value will be considered for segmentation purposes, which should, to some extent, capture the inventory cost effects.

3.4 Behavioural Models

Behavioural models are categorised, on the basis of the nature of the data, into three categories viz. (a) Revealed Preference Methods (b) Transfer Price methods. (c) Stated Preference Methods. Each of these, is discussed briefly in this section and we will go into the details of the Stated Preference Methods in the following chapter.

3.4.1 The Theoretical Basis of Behavioural Models

Behavioural methods have their basis in the (Random) Utility theory of consumer behaviour. This states that each individual aims to maximise his utility, within his overall time and income constraints. He will, therefore, choose that alternative which yields highest utility. However, since it is not possible to recognise and measure all the factors that influence the individual's travel choice, they are treated as random variables (U_k) consisting of a deterministic component (V_k) and an error term ε_k such that :-

$$U_k = V_k + \varepsilon_k$$

where : the error term ε_k consists of all the unobserved attributes, taste variations and measurement errors.

The probability of choosing alternative 'i' out of 'k' alternatives is given by :-

$$P_i = \text{Prob}[(V_i + \varepsilon_i) > (V_k + \varepsilon_k)] \quad \text{for all k, } k \neq i$$

By assuming that the error terms are Independent Identical distributed with a Weibull distribution we get the Logit model (McFadden 1974) which is the most commonly used form.

$$P_1 = \frac{\exp(\Omega V_1)}{\sum_k \exp(\Omega V_k)}$$

Where Ω is a scaling factor, related to the standard deviation of the errors associated with each alternative, the purpose of which is to correctly weight the effects of the deterministic components and the error terms.

3.4.2 Revealed Preference Methods

These are based on data on the actual (observed) behaviour of individuals along with the attributes of the modes of transport and the individual circumstances giving rise to the behaviour. In a case where two alternatives are available and time and cost are the only attributes influencing choice - there is an implicit 'Boundary Value of Time' involved in the choice which, in the absence of an alternative specific preference, is given by (Fowkes 1991) :-

$$BVOT = \frac{(C_1 - C_2)}{(T_2 - T_1)}$$

Where: $C_1 =$ Cost for alternative '1'
$C_2 =$ Cost for alternative '2'
$T_1 =$ Time for alternative '1'
$T_2 =$ Time for alternative '2'

If the individual (firm) has a value of time greater than the BVOT, they will choose the faster mode, in the absence of any other factors. Since only one observation is available per individual we, in effect, can only get to know if the individuals value of time lies above or below the BVOT.

The main advantages of this method are that - firstly, it does not suffer from the problems of biased response (as this is the actual response of the individual in real life) which can occur in Stated Preference and Transfer Price methods (discussed in subsequent sections). Secondly, an individual's actual behaviour in the market place provides the best information on the relative importance placed on various factors.

The limitations in this are: Firstly, in a case where no market exists (a new/modified product) we cannot get any information on revealed preferences. Secondly, we are likely to get an insufficient range of boundary values in the existing choices. Thirdly, RP models also suffer from measurement errors in the independent variables, which can lead to inaccurate parameter estimates. In case engineering data is used for measuring the attribute levels, the actual measured levels may be different from the perceived levels, on which the choice is based. In case the attribute levels are obtained from the respondent in the course of the interview, the respondent may actually try to justify his choice by making the chosen alternative sound more attractive. Fourthly, we get only one observation per person and are not able to evaluate the conditions in which the decision would have been changed. Furthermore, the choice may not contain a boundary value as in the case of an alternative, which is both cheaper and faster. Therefore data for a large number of people is required, to model the actual determinants of the decision. However Fowkes and Wardman (1991) report that (1) even with a large number of observations the results can still be imprecise (2) It is also difficult to account for the individual (firm) level differences in such models.

3.4.3 Transfer Price Methods

The transfer price methods rely on answers to questions like 'How much would the cost of your chosen alternative have to rise in order for you to switch to the next best alternative?'. The answer can be taken as an estimate of the utility difference between the chosen and the rejected alternatives. In a case where the choice is influenced only by the Time and Cost we can model it in the form :-

$$C_1 + (VOT * T_1) + TP = C_2 + (VOT * T_2)$$
$$\text{i.e } TP = (C_2 - C_1) + VOT * (T_2 - T_1)$$

Or in a more general case with more than two attributes, say Reliability (R) as the third attribute and an alternative specific constant (ASC):-

$$TP = \alpha_0 + \alpha_1(C_2 - C_1) + \alpha_2(T_2 - T_1) + \alpha_3(R_2 - R_1)$$

Where TP is the Transfer Price
C_1, C_2 refer to Costs of mode '1'and '2'respectively
T_1, T_2 refer to Time taken by modes '1'and '2'respectively
R_1, R_2 refer to the Reliability of modes '1'and '2'respectively

The advantage lies in the fact that, if the TP responses are in the same units as cost, α_1 should be equal to 1 and α_0, α_2 and α_3 can be directly taken as the ASC and values of time and reliability respectively.

Since TP responses indicate the points at which the change in behaviour occurs, they can be used for obtaining the elasticity values by estimating the proportion of persons who would change their behaviour after a proportionate change in the price.

The problems with this method (Fowkes & Wardman -1991) are:-

1) People may not be willing/able to answer such questions with a monetary TP and the sample size may get reduced (in a non-random way)
2) more prone to strategic response biases since people would give answers so as to reduce the extent of unfavourable changes and increase that of favourable ones
3) problems of measurement error in the independent terms
4) the response may not reflect actual choice.

3.4.4 Stated Preference Methods

Stated Preference methods have been described (Kroes & Sheldon 1988) as "a family of techniques, which use individual respondents statements about their preferences in a set of transport options to estimate utility functions". As appears logical from the dictionary meaning, the core of the matter is a statement of preferences by the respondent (as against an actual demonstration of the same through actions). A set of such 'statements of preferences' of a respondent are, thereafter, used to estimate the utility function of the respondent and subsequently model the demand as a function of the various attributes of the service.

This statement of preferences is made in response to the alternatives offered to the respondent. Each alternative is a combination of attributes, some of which are specifically defined and varied in the exercise and the rest, which represent the respondents perception of the attributes of the alternatives, are aggregated by use of the name of the alternative, and would be reflected in the alternative specific constant.

3.5 Applicability To The Present Case

In the present case, intermodal services are in their infancy with existing services having low frequencies and there is limited awareness about services being offered. As such, it is not possible to get sufficient data about mode choices actually made in the presence of intermodal services. It is therefore, not possible to use RP methods for this work.

Furthermore, TP methods suffer from a serious shortcoming, that people are likely to answer in such a way as to maximise chances of a desired outcome and minimise chances of an undesirable outcome (Strategic Response Bias). As such these methods also do not appear to be usable.

SP methods, therefore, appear to be the best choice and these are discussed in detail in the next chapter.

Chapter 4: STATED PREFERENCE METHODS

In this chapter, we first look at the advantages and disadvantages of Stated Preference methods and then go on to the SP design issues in section 4.3 and the use of computers for SP exercises in section 4.5. We then look at the techniques of analysis of SP data in section 4.6. In section 4.7, we discuss some case studies of SP usage with special reference to freight. Finally in section 4.8 we discuss the implications of the issues discussed, to the present work.

The main advantages and disadvantages, of SP methods, have been discussed in detail by Fowkes & Wardman (1991) and Bradley & Kroes (1990). These are briefly summarised below: -

4.1 Advantages of Stated Preference Methods

The main advantages of these techniques over other techniques such as revealed preference and transfer price techniques, are: -

1) They can be used for modelling demand for products/services that do not exist. These can be entirely new services or the effect of changes in attributes of existing services.
2) They can be used without infringing confidentiality. This is especially relevant in the case of freight, where confidentially negotiated rates may be in existence. In case of stated preference, the respondent is not required to reveal the actual rates and the estimation can be made without asking for such rates.
3) The degree of correlation and variation in the attributes can be controlled.
4) Measurement error in the independent variables is avoided since the attributes are clearly and specifically defined.
5) Appropriate inter-attribute trade-offs can be introduced as may be faced by an individual in his normal decision making process.
6) The respondent is involved in repeat evaluation of choices and a greater number of observations are obtained per person. This provides two advantages, firstly it becomes possible to estimate a utility function for each respondent therefore we can allow for interpersonal taste variation and, if the

sample is properly stratified, we can get a good estimate of the response of the whole population. Secondly the number of interviews required comes down and hence the cost.

4.2 Disadvantages of Stated Preference Methods

Stated preference methods, however, are not without their problems. The problems/errors commonly associated with Stated Preference methods are: -

1) People are not committed to behave in accordance with their stated preferences (non commitment bias)
2) There could be an unconscious attempt to justify a choice already made (Rationalisation Bias). This may in fact cause the coefficient estimates to be biased in relation to one another - a serious error.
3) Unconstrained response bias: this arises from the failure to incorporate all the relevant constraints on behaviour when evaluating the hypothetical scenarios.
4) Policy Response Bias: this is a deliberate biasing of responses to affect the policy-making and influence the magnitude of changes (e.g. level of increases in fares). The likelihood of such biasing may however, not be severe on account of the fact that the respondent is presented with a number of changes (trade-offs) in different attributes and the effect of each may not be immediately obvious to him.

   With suitable design, deliberate biasing would give rise to otherwise rare patterns which can be eliminated during the analysis through a process of 'bin analysis' (Fowkes 1991) which identifies the responses falling outside the expected range of boundary values (irrational responses).

5) Affirmation Bias: The respondent may, consciously or unconsciously, respond in the way he feels that the interviewer expects him to.
6) Other errors may arise on account of misunderstanding or uncertainty on part of the respondent or simply a lack of interest. These errors are likely to increase with the increase in the number of alternatives being offered or complexity of the exercise. It may also increase as the levels of the various attributes go outside the realistic range for the individual.

7) It is also not possible to consider relatively unimportant characteristics in SP, since it would not be possible to trade-off against them.
8) The increase in the number of observations per person also comes at a cost - that of decrease in quality and quantity of data. With a greater number of responses required per person there are greater chances of deterioration in the quality of responses, due to fatigue, and the number of people willing to respond to the exercise may also come down.
9) Use of repeat measurements introduces 'serial correlation' in the data i.e. the error terms become correlated for data from one respondent.

4.3 Design Issues In Stated Preference Methods

4.3.1 Choice of Attributes

The choice of attributes is normally the first task in the design of any Stated Preference experiment. This involves (Bradley - 1988) selection of the attributes which are likely to be most important in making the choice and also the factors, response to which is, to be studied (for policy making purposes). Here, it is to be noted that an attribute considered for the analysis may not be exactly the one that is considered by the respondents. For example, for the purpose of analysis, we may be using 'waiting time' however, for the respondent the 'frequency' or 'headway' may be a more relevant attribute, which he can associate with.

The external validity is another important consideration in the design of Stated Preference exercises. The relevance of the predictions, from Stated Preference exercises, to choices made in actual situations depends on how well the actual external constraints/conditions have been handled in the design. Some dimensions of external validity are (Bradley 1988): -

1) The objectives of the study – these will determine the type of validation that needs to be done.

2) Choice of the context: i.e. Need to use the terms and measurements, which are familiar. A respondent used to calculating freight on a 'per package' basis, may be not be able to answer correctly to questions based on per tonne or per container rates. In such a situation, the rates would need to be converted to the basis that the respondent is familiar with.

3) The effect of external factors, such as seasonality of traffic /political uncertainty etc. at the time the exercise is carried out. Hence the need to choose a typical season/day for the exercise.

4) Sampling strategy: i.e. to take an appropriate mix of users/non-users, typical/atypical journeys etc.

5) Validation of the model: In case RP data is available, it may be possible to validate the forecasts, from the SP based model, against the RP data. This would help ensure that the model performs satisfactorily, over the range of parameters, likely to be encountered in real life.

In addition to this it is possible that different attributes may be important to different respondents. Some of these additional attributes can just be made a note of, while continuing with the exercise (such as e.g.: the availability of credit payment facilities). However, some attributes may be important enough to affect the credibility of the whole exercise (such as the effect of distribution of lateness on the reliability of the service) and information about such variables may need to be incorporated in the experiment design itself. In case of an adaptive design, it may be possible to include a 'free' attribute to be mentioned by the respondent and included by the interviewer. This may, however, also lead to problems of data compatibility since different individuals may give different free attributes and there would be problems in aggregating the data over sectors if attributes used by firms within the sector vary. Even in case of the individual level models, each of the additional attributes is likely to subtract from the value of the ASC (since the effects, not considered explicitly, are expected to be taken into the ASC). Further some 'free' attributes may actually affect the estimated values of the main effects as well. For example, in case the variation of transit time is also considered, in addition to average transit time, it may actually affect the VOT estimates (besides affecting the ASC, as different modes will have different variance levels).

The number of attributes selected may represent a trade-off between quality and quantity of data collection. In case a very large number of attributes are chosen we may be able to estimate a more realistic model incorporating the effects of a large number of variables. However the task of the respondent, in analysing the data presented to him, is made tougher and may result in the poorer quality of the responses.

4.3.2 The Choice of Levels of Attributes

Under the choice of levels there are two considerations - the number of levels of each attribute to be presented in the design and the actual levels/differences to be presented. The first issue is decided by the range of acceptable values which needs to be covered and the minimum changes that can be perceived by the respondents (e.g. in case of freight traffic, people may not be able to perceive changes in delivery time of 'hours' and may only perceive changes in units of 'three hours' i.e. delivery in morning, forenoon or evening. In case the transit time is a week or more changes may be perceived only in blocks of 12 or 24 hours). The increase in complexity of the task for the respondent with increase in the number of levels would also be important in deciding the number of levels.

The second issue is decided by the need to get a good range of 'boundary values' (Fowkes 1991) and bounds of 'realism' and 'competitiveness'. It is important to get a good range of boundary values, on both sides of the actual position of the respondent, for proper estimation of the model. However a close spread of values, over the entire range being considered, may lead to need for a large number of levels and increased fatigue of the respondents. In such cases computer based adaptive methods provide a solution by presenting the choices in the zone of consideration for each individual respondent. It has also been pointed out (Bradley -1988) that in case the values offered go outside the realistic levels, as perceived by the respondent, the reliability of response may suffer.

Initial qualitative research and survey piloting are important in ensuring optimal selection of the variables and the levels.

4.3.3 Selection of the Response Measurement Scale

Stated Preference experiments can be of three types, based on the method of response measurement i.e. choice, rating and ranking (Hensher 1994): -

(i) **Rank Ordering:** In this, the respondent is presented with a number of alternatives and is asked to rank the alternatives in order of attractiveness (it may be noted here, that a choice experiment is a case of first order ranking). In this case, the task is easier for the respondent than a rating exercise but more difficult than a choice exercise. The data is analysed by exploding a ranking of 'n' alternatives into a series of 'n-1' choice sets.

(ii) **Rating Scale:** In this, the respondent is asked to give a rating to each of the alternatives on the basis of its attractiveness. The rating is normally on a linear scale (normally 5 or 10 point but sometimes even a 100 point scale is used) which represents the underlying continuous scale. Fowkes, Nash & Tweddle (1991), however, found the respondents using a log scale in assessment of alternatives. The data, so obtained, is the richest in information content. It is also the toughest on the respondent since he has to define not just the ranking of the alternatives, but also the intensity of the attractiveness.

(iii) **Choice Task:** In this, the respondent is presented with a number of alternatives and is then asked to choose one of them. This is, obviously, the simplest exercise for the respondent and is also a realistic exercise since in normal life also the respondent is likely to be choosing one out of the available alternatives and is unlikely to be ranking or rating all of them. The number of alternatives offered can be two or more but is usually less than five. The increase, in the number of alternatives, is likely to result in increased fatigue and unreliability of responses due to the underlying process of respondents making pair-wise comparisons before arriving at a choice. Another advantage of this is that choice data can be analysed using conventional RP analysis software.

Ortuzar & Garrido (1994) have compared the practical aspects, of data collection and model estimation techniques, for the three methods. In a study, of the individuals coming to work or study at the Catholic University of Chile, they have found that for the designs used in their experiment: -

1) The choice experiment took the least time for data collection and the ranking took the highest.

2) The number of inconsistencies detected was lowest for the choice experiments and maximum for the ranking experiment.

3) In terms of effort required by analyst, the rating data was the easiest even though it required greater effort to detect inconsistencies. The ranking data required the minimum effort in detecting inconsistencies.

The authors found that in terms of the models estimated from the data, all the three methods gave an acceptable goodness of fit hence they have concluded that the choice of the method should be based on the difficulties expected in data collection and analysis. In this aspect, they find the ranking method to be least useful and the choice method to be the easiest and quickest, though the rating method incorporated more information.

The finding, regarding the ranking task being more difficult than the rating task, is contrary to the view expressed by Hensher (1994). This could, possibly, be related to the designs used by Ortuzar & Garrido (1994). In the rating exercise, the respondents have been asked to rate nine sets of situations, with two alternatives each, on a five point semantic scale (car Vs semi-metro for bus users and bus Vs semi-metro for bus users). In case of the ranking exercise, they have been asked to rank 12 cards.

4.3.4 The Orthogonality Issue

The conventional approach, to the design of stated preference experiments, is to combine the levels of the attributes in such a way that the attribute levels are un-correlated. This is referred to as an orthogonal design. The main advantage of orthogonal designs is that they ensure that the independent effects of the attributes can be estimated, without the accuracy of this estimate being affected by the cross effects of the other attributes. Fowkes, Wardman & Holden (1993) have pointed out that orthogonality is a desirable property where parameter estimates themselves are of prime importance, such as for forecasting purposes. However, in cases where it is the ratio of parameters which is of interest, such as for estimating relative values like VOT, some degree of correlation may be desirable. They have found that, in such cases, use of non-orthogonal designs results in improvement in the precision of estimates and therefore a reduction in the sample size required for achieving the same level of accuracy. Watson et. al. (1996) have found reductions in variance of the parameter ratios upto 51.8% for non-orthogonal designs as compared to orthogonal designs using Logit models also.

It has therefore been recommended that, non-cost parameters should be kept orthogonal to each other in the experiment design. However in case of the relationship of the cost parameter with the other parameters, some departure from orthogonality may be required for better estimation. For example, in a design, longer transit time corresponding to lower costs and higher reliability with higher costs i.e. the 'bads' being negatively correlated and the 'goods' positively correlated with cost.

Hensher (1994) has also pointed out that orthogonality at the design stage (design data orthogonality - DDO) may not necessarily result in orthogonality at the model estimation stage (estimation data orthogonality - EDO) where it is actually required. This is so because MNL estimation techniques require differencing the attributes (chosen minus each and every non-chosen). Since the chosen alternative is not known at the time of design, it is not possible to design for EDO.

4.3.5 General Design Issues

Ortuzar (1996) has reviewed the state of the practice of Stated Preference data collection methods and recommended that a high degree of realism should be maintained in the design of the Stated Preference experiment, to ensure the validity of the responses. For achieving this, he has recommended the use of focus group interviews, for ensuring that the correct attributes have been chosen and the attributes are described in an understandable manner. Besides this, simulated data should be used to ensure that the design can recover the expected model parameters and a pilot survey should be carried out for pre-testing the survey instrument.

He also recommends that the problem, of difference between SP responses and actual choice in a real life situation, can be solved by joint estimation using RP and SP data.

4.4 Cognitive Issues

An analysis of cognitive issues involved in Stated Preference techniques has been done by Ampt et. al. (1995) who have pointed out that the limits of the human data processing capability and the familiarity with the attributes offered, would affect the quality of the responses received. In case of complex tasks, people tend to break them down to first screening the alternatives and then analysing the screened alternatives in detail. In their evaluation people tend to value losses more than gains (loss aversion). As such, it may be advisable to separate changes into losses/gains from the existing service levels and analyse them separately. The tendency of respondents, to confirm to the interviewer's expectations, also needs to be kept in mind during the interviews. As such, the interviewer has a crucial role to play in the success of an interview.

Widlert (1998) has compared results from passenger surveys using 25 different SP designs, including computer based and manual designs with ranking, rating as well as pair-wise choice tasks, in about 5700 interviews. He has reported that the VOT estimates differ by a factor of four from the lowest to the highest, even with same base design (same attributes and attribute levels) and similar samples. The conclusion is that this divergence in estimates is caused by the simplification of the problem by respondents (Lexicographic responses) and is more for ranking tasks than for rating tasks and for non-customised experiments as compared to customised experiments. He has also found that computer based experiments gave much better results as compared to manual ones.

Bates (1998) has emphasised that, though SP design methods have reached a high standard, it is vital to avoid conceptual errors arising from failure to understand the respondent's approach to the SP task.

4.5 Computer Based Adaptive Stated Preference Methods

Use of computers, in the conduct of SP exercises is now quite well established. Computers were used initially for 'customising' SP designs and subsequently for 'Adapting' the designs. The use of the terms 'customisation' and 'adaptation' is explained in Fowkes & Shinghal (1999). The term 'customisation' refers to the practice of setting the attribute levels 'around' the current levels experienced by the respondent. With self-completion questionnaires, that would be possible by using descriptions such as 'As Now', or 'As now plus 6 hours'. It is not necessary that a respondent offered a choice between 'As now plus 6 hours' and 'As now less 3 hours' appreciates that a 9 hour time saving was being offered. With a computer, respondents can be asked for their current transit time, and the SP experiment can take this into account. In the previous example, a respondent with a transit time of 48 hours would be given alternatives with travel times of 54 hours and 45 hours to choose between. Furthermore, the design could offer bigger time-savings to respondents currently having longer transit times. Infeasibly small transit times can be checked for and the experiment amended. Obviously, this would go a long way to make the exercise simpler for the respondent (and the interviewer).

Adaptive Stated Preference (ASP) designs take the process one step further, and amend later stages in the experiment, in the light of responses to earlier stages. For example, a respondent who would not pay £5, for a new transport facility, would not be asked if they would pay £10 until it becomes clear that the earlier response was a mistake.

One great advantage of ASP designs, when studying freight, is that the experiment would be able to cope with a wide range of valuations, as in the present case. Some commodities will be highly perishable and so have a very high value of scheduled journey time and a great aversion to delays. The firm transporting these commodities might transport other sorts of commodities as well, so that we would have difficulty in coping with this situation in advance. Furthermore, some commodities will have different attribute valuations at different times, for example, a car radio being supplied as a part of a Just-in-Time supply chain will have higher journey time and reliability valuations than a car radio moving to a retail sales point.

Successful use of computer based adaptive SP designs, have been reported earlier by Ampt, Bradley & Jones (1987), Bradley, Grovesnor & Bouma (1988), Fowkes & Tweddle (1988), Bates & Terzis (1992) and Jones & Polak (1990). Widlert (1998) has found that respondents find the SP exercise easier if the options had been customised to their particular situation.

4.5.1 Problems with Adaptive Stated Preference Designs

Work by Bradley & Daly (1993) showed that bias could easily be introduced in Adaptive SP designs, if levels of independent variables become correlated with the unmeasured components of individual preferences across the sample. They have simulated data from different types of adaptive SP designs and then used this data to estimate models attempting to recover the underlying parameters. The detailed statistical explanation and simulated results given by them are not being repeated here. However the conclusions relevant to our work are that :-

Endogenous Stated Preference designs (where cost levels are adjusted, during the experiment, to levels representing boundary values at the midpoint of the current range of trade-offs) can lead to significant biases in the estimation. Fixed/Adaptive designs, where the base design (variables and levels) is specified in advance but only those choice sets are presented which are not eliminated by a previous choice made by the respondent, and Exogenous adaptive designs, where the levels of the variable are set in advance based on previous interview/data collected regarding the average levels (e.g. income levels/ commodity characteristics etc.), have been found to be less prone to such problems. They have suggested that these problems can, however, be dealt with by fitting models to individual respondents/firms though there is a possibility of these models having higher bias and errors (this issue has been examined subsequently in Chapter 7 here).

In the present context, specific care would need to be taken at the design stage to ensure, through simulation, that the design used is not prone to this problem. As described subsequently, in chapter 5, the LASP design used, for this study, allows models to be fitted to individual firms, which are then aggregated to get sectoral models. This would be expected to take care of the problem.

4.6 Techniques of Analysis

4.6.1 Conventional Techniques

Various statistical techniques are available to analyse SP data depending on the type of design used. In case of choice data the most commonly used method is to use Logit models. In case of ranked data the analysis is usually done using the exploded logit model where the ranked data is exploded into pair-wise choices. In case of rating data the additional information available in the ratings is utilised by exploding the data into pair-wise choice data with a weighting factor based on the ratings to take account of the strength of preference. Multiple regression is the simplest way to analyse such data. A detailed explanation of the different analysis methods is available in Kim (1998).

Analysis of LASP data has usually been done by first modelling the data for each individual respondent separately and then combining the individual estimates to obtain aggregate estimates (discussed in detail in chapter 5). However, we were able to find very little other published material on the use and statistical efficiency of the use of individual models. Bates (1988) has looked at the econometric issues in SP analysis and concluded that the analysis of the response of an individual, to a well conceived experiment, does not present serious statistical problems apart from those associated with low degrees of freedom. Morikawa (1989) has compared the statistical efficiency of individual models and taste variation models using synthetic ranking data. He found that the individual models have much higher bias and mean squared error than the taste variation models used by him for the ranking data. Our comparison using rating data and weighted least squares regression with individual models and Random Coefficients Model appears to give somewhat different results and is discussed in detail in chapter 7.

4.6.2 Random Coefficients Logit

The Multinomial Logit (MNL) model is based on the assumptions (Bhat 1997, Daly 1997) that :-

1) the unobserved parts of the utility of different alternatives are independent and identically distributed (IID) across alternatives. This causes the MNL to predict that change in attributes of one alternative (or introduction of a new alternative) will change the probabilities of choice of the other alternatives in proportion to their initial shares.
2) the utility parameters are the same across individuals (i.e. there is no taste variation between people).
3) the errors are identically distributed across individuals.

In the case of Stated Preference data, we usually have repeated observations from different individuals and the presence of taste variations between individuals leads to violation of assumption (2) above. In case of the conventional LASP analysis this problem is avoided by obtaining individual level models and then aggregating the individual models, using weighted averages with the weights taken as inverse of the variances.

Mixed Logit generalises the logit model and allows one or more of these assumptions to be relaxed. In this case the error term, which is assumed to be IID in a standard logit model, is split into one or more non-IID components and a true IID component. Various mixed logit specifications have been used in literature for different purposes (see Ouwersloot & Rietveld (1996), Abdel-Aty et. al.(1995), Train (1998), Brownstone & Train (1999) and Revelt & Train (1997)).

The standard logit model takes the utility of an alternative 'k' to be the sum of deterministic component represented as V_k and an error term ε_k.

$$\begin{aligned} U_k &= V^k + \varepsilon_k \\ &= \beta X_k + \varepsilon_k \end{aligned}$$

The Random Parameters Logit (RPL) model generalises the logit by allowing the coefficients of the observed variables to vary randomly over people rather than being fixed (Train 1998). In this case the coefficient 'β' can be split into a population mean 'b' and a term 'η'which represents the individual taste variation giving :-

$$U_k = bX^k + \eta X^k + \varepsilon_k$$

Train (1998) has used a Random Parameters Logit model to consider taste variation amongst individuals in modelling actual choice (i.e. RP data) of fishing sites used by a sample of anglers over a period of 14 months. He has found that estimated standard deviations of the coefficients are highly significant, indicating that the parameters do indeed vary in the population. He also found that the RPL model has substantially higher likelihood ratio compared to the logit model and concluded that RPL has greater explanatory power than the logit model. Revelt & Train (1997) have used RPL to model SP data on household's choice of appliance efficiency levels.

Ouwersloot & Rietveld (1996) and Abdel-Aty et. al. (1995) have used error-decomposing specifications to tackle repeated measurements problem and to explain correlation of repeated choices. Brownstone & Train (1999) have used an error decomposing specification to studying different substitution patterns.

Kim (1998) has compared estimates from Standard Logit and Random Components Logit models, using the data from the before and after surveys carried out to forecast the movement of freight through the Channel Tunnel (Tweddle et.al.1995, 1996). He has concluded that the parameters do indeed vary among the population and the Random Components Logit gives estimates with lower variances in the error terms, as compared to conventional logit models.

4.7 Case Studies of SP Usage in The Freight Industry

Two of the earliest reported applications of Stated Preference methods in freight transport are reported by Fowkes & Tweddle (1988) and Ortuzar & Palma (1988).

Fowkes & Tweddle (1988) have reported a computer based adaptive Stated Preference experiment using LASP (Leeds Adaptive Stated Preference) software which has been designed and used for finding the values placed by freight consignors on various aspects of trunk haul freight movement. They have selected one commodity from each major commodity group and taken a random sample of six firms involved in the production of each commodity. The interviews consisted of two parts - the first part, for obtaining background data of the firm and the second, concentrating on one product and also included the Stated Preference survey. The Stated Preference survey itself was based on a rating exercise.

It was not possible to use a single Stated Preference design for all the interviews since different respondents were likely to have different attribute valuations (Transit time, Reliability etc.), due to the commodities having different characteristics (e.g. perishability and value). As such, the problem, of designing tailor made Stated Preference experiments for each segment, was overcome by use of a computer based Adaptive Stated Preference design. The use of computer based Stated Preference was found to be very successful, both in generating interest and in the quality of data obtained. Various forms of analysis have been tried and the logit analysis on binary choices implied by the ranking has been found to be most reliable.

Further work, using LASP, has been reported in Fowkes, Nash & Tweddle (1991). In this, the attractiveness of intermodal transport vis-à-vis other modes has been evaluated. The rebates required for acceptance of lower levels of service have been estimated. These have been used, in conjunction with a cost model for intermodal services, to find out if competitive intermodal services could be operated with the required rebates. This evaluation has been done for different intermodal technologies and for varying lengths of haul.

Subsequently Tweddle, Fowkes & Nash (1995, 1996) have reported before and after results for cross channel freight (before and after the opening of the channel tunnel).

The validation of the results, with the actual flows, has been reported by Fowkes & Tweddle 1997.

Ortuzar & Palma (1988) have carried out a Stated Preference based research into the prospects of generating traffic for reefer containers/vessels, in the off season, in Chile. This was to be used later to develop a commercial strategy for the shipping companies involved. They have begun by creating a data bank of the products exported, their markets and distribution channels. This has been followed by a Delphi type survey for obtaining estimates of the growth rates of the various products and identifying the most attractive products. With this, they have selected two of the most promising products for conducting a Stated Preference survey, for identifying the important attributes and their weights in the decision regarding selection of a particular service.

The Stated Preference experiment used the ranking method with five attributes - fare (three levels), Service Headway (two levels), Travel Time (two levels), Shipment Type (two levels- container or chamber), Intermodal Service (with or without it). They have reported having obtained credible results, though some of the attributes had poor significance levels due to the small sample size.

de Jong, Gommers & Klooster (1992) have reported on work carried out for establishing VOT for freight in the Netherlands. They have used a three-step methodology starting with factor cost method to establish the reference levels. Thereafter 119 Stated Preference interviews (within Mode) have been conducted (referred to as Contextual Stated Preference -CSP) for obtaining VOT values for the short and medium terms. This has been followed up with, what they have referred to as, Strategic Stated Preference (SSP) interviews to determine long term values which are relevant for 'Strategic Planning' like change in depot location/size, Production location/technology etc..

For the purpose of the CSP exercise, the market was segmented by mode (Road, Rail, and Inland Waterway). The road transport market has further been segmented into (a) Low value raw materials (b) High value raw materials (c) Finished goods with loss of value (perishables) (d) other finished goods.

The attributes used were (1) Cost (2) Travel time (3) reliability (% not on time) (4) probability of damage (5) frequency of shipment. MINT software developed by the

HCG has been used in the interviews in which each respondent has been asked to participate in two sets of experiments depending on the primary modes used by him.

The models were estimated using ALOGIT programme. It was found that 'Time' and 'Cost' have almost equal importance whereas 'reliability' and 'Probability of damage' have lower importance and 'frequency' has almost negligible importance. Significant differences have also been found between the segments. The raw materials and semi-finished goods were found to have significantly higher values than finished goods, due to the production losses involved in case of delays in the intermediate products (this could also be interpreted as the reliability factor). Perishable commodities have also been found to have almost 10% higher VOTs than non-perishables. They have, in general, found good correspondences between the results of this study and those taken or calculated from national & international literature.

Terzis, Copley and Bates (1992) describe a study carried out, for Trainload Freight division of British Rail, to identify new opportunities for profitable business. They have used in-depth qualitative research for identifying the key determinants of modal choice followed by Adaptive Stated Preference (ASP) based research to place monetary attributes to these attributes.

A structured questionnaire was used for examining the characteristics of the industries covered. The ASP was a modified form of LASP and was based on the attributes identified in the in-depth research. The whole questionnaire was mounted on a notebook computer using BLAISE software developed by Central Bureau of Statistics, Netherlands.

In each interview, freight executives have been asked to rate four alternatives. The first is a recent consignment (rated as 100) with the other three alternatives to be rated against this 'reference' on a scale from 1 to 1000 where 200 represents a service twice as good as the reference. The respondents have been asked to trade off between 'cost' of service (represented both as absolute cost and as the percentage level), 'reliability' of service (represented as the percentage of pickups and deliveries on time) and 'responsiveness' of the service (represented as the notice time in days necessary for the shipment).

A maximum of ten screens are presented. The data from the first two alternatives was regressed to find the respondents 'line of indifference'. The next screen was based on this valuation. Thereafter all the previous sets of data have been used to arrive at the next set of attribute levels.

The data was analysed by calculating a linear as well as a log linear model of the forms given below :-

$$\text{Linear Model : } Y_i - Y_1 = d(D_i - D_1) + c(C_i - C_1) + t(N_i - N_1) + r(R_i - R_1) + \varepsilon_i'$$

$$\text{Log Model : } \log Y_i - \log Y_1 = d(D_i - D_1) + c(C_i - C_1) + t(N_i - N_1) + r(R_i - R_1) + \varepsilon_i'$$

The log model has been found to give better results.

It has been concluded that the results obtained for values of transit times are similar, on the average, to those obtained in other studies conducted by MVA and ITS .

NERA, MVA, STM & ITS (1997) have reviewed the existing literature on forecasting demand for freight. They have found that most studies available have used small sample sizes between 30 to 100 covering a large range of sectors. In some cases, conclusions for a particular sector have been derived from as few as 5 interviews. However, statistically significant results have been obtained by collecting a large number of observations per interview (more than 20) coupled with the fact that the interviews have been conducted by experienced researchers, with senior executives of the companies. They have concluded that despite the small number of studies available (due to the difficulties generally encountered in freight demand analysis) the results are encouraging and offer some understanding of the determinants of mode choice.

El Mahdi (1995) has used a combination of SP and TP methods for forecasting passenger demand and obtaining service attribute valuations on the Cairo-Alexandria line of the Egyptian Railways. She has used these results, in conjunction with a rail cost model, to evaluate various investment scenarios for upgradation of the services on this line. Even though this is a passenger study, it is the only one available using SP in a similar developing country context, as in the present case. The relevance of some of her findings, regarding the use of SP techniques in Egypt, to the Indian situation is discussed in the following section. She has found that large attribute level differences are required to be presented in the SP to make people trade off. She has also found that the use of self-completion questionnaires is not feasible, in view of the low literacy levels.

4.8 Conclusions & Implications For The Present Work

In this chapter, we have seen that the SP methods offer several advantages, over RP & TP methods, such as permitting modelling of demand for new/modified services, not infringing on confidentiality, not having measurement errors in the independent variables, permitting incorporation of useful tradeoffs in the design and permitting calibration of individual level models. They, however, also suffer from problems of non-commitment response bias, strategic response bias and unconstrained response bias.

We have discussed the major issues that need to be considered for ensuring a good SP design, such as the choice of attributes and their levels, selection of the design (rank, rate or choice) and orthogonality.

We have found that rating based designs give maximum information, though they are also the toughest on the respondent. In our case, given the small number of respondents available in most freight surveys, the use of rating based design has distinct advantages.

The attributes, to be used, need to be determined on the basis of objectives and context of the study. The levels used, would need to be a balance between the need to cover a suitable range of boundary values, on one hand, and the need to ensure realism of the exercise and not overloading the respondent, on the other. Orthogonality, would be desirable between pairs of non-cost attributes but not between pairs of cost and non-cost attributes.

In the data analysis, Random Coefficients models appear to offer some advantages over conventional logit models. Therefore, possibilities of their usage, in the present case, would need to be examined in greater depth

However, we have not come across any previous work using SP methods in India. Most case studies available, are from developed countries. The only one available for a comparable situation is the work by El-Mahdi 1995 which has used SP & TP methods for modelling demand for passenger services in Egypt. This indicated that large attribute level differences were required for making the respondents trade off. She also found that the use of self-completion questionnaires were not possible due to the low level of literacy. In our case, the first finding is directly relevant since the existing transit times on the major long distance corridors are of the order of 5-7 days or even more. The second finding is not directly relevant as we are contacting senior managers in the industry where we can expect to get a very high level of literacy and awareness. Even here however, use of self-completion questionnaires may not be feasible due to the fact that people may not find the time to complete and return a long questionnaire.

Another problem, in the present case, is that we are covering a range of sectors, which are likely to have very different service requirements and hence widely varying attribute valuations. There is no previous work available to tell us what range of valuations we can expect to find.

In view of these problems, use of adaptive SP designs appears to be the best alternative. However, the shortcomings of ASP design shown by Bradley & Daly (1993) need to be kept in mind. These issues will be discussed subsequently in chapter 5 when we go into the software design and modification issues in detail.

Chapter 5: SURVEY DESIGN AND METHODOLOGY

In this chapter we first discuss the survey design selected by us. Then, in section 5.3, we give the findings of the pilot survey carried out and its implications for our survey design. The modifications made and the final design used are discussed in sections 5.4 & 5.5. In sections 5.6, 5.7 & 5.8 we discuss issues examined regarding the most appropriate method for analysis of our survey data and the final model adopted by us. Finally in section 5.9 we present a separate pen and paper design, prepared as a back up in case of problems in obtaining adequate data in the LASP survey.

5.1 Introduction

The review of previous work in this area (and the non-availability of any such work from India) led to the need to use some sort of adaptive SP methods for the survey. We decided to use the Leeds Adaptive Stated Preference (LASP) software for the purpose, as this software had originally been designed in a similar context of new intermodal services.

Since the use of a computer based adaptive SP design was a very novel experiment in Indian conditions, it became necessary to test the design and presentation method, to identify any pitfalls and to ensure that the desired quality of results could be obtained. Initially, it was envisaged that two to three pilot interviews would be carried out, with respondents in India, using Fax/phone or email. Subsequently, it became possible to conduct a pilot survey in India and 6 interviews were carried out using LASP.

On the basis of the findings of the pilot survey (details in section 5.3), the LASP design was subjected to a series of modifications. At each stage of the modification, the recoverability of true values was tested using simulated data. Some of the modifications also had to be discarded in this process until the design was found to be giving satisfactory results.

We also tested various alternatives, for analysing our survey data, and finally decided on the method described subsequently in this chapter.

5.2 Leeds Adaptive Stated Preference (LASP) Software

LASP is an adaptive SP data collection software designed to be used on a laptop computer. It is designed for use in freight studies (Fowkes & Tweddle 1988), though it can also be adapted for other purposes. It has been successfully used for freight studies within Great Britain (Fowkes, Tweddle & Nash 1991) and for Cross Channel studies (Tweddle, Fowkes & Nash 1995, 1996; Fowkes & Tweddle 1997).

Figure 5.1: LASP screen format

1	CURRENT SERVICE	NEW ROAD	INTER-MODAL	RAIL
COST	1200	600	600	600
COST INDEX	100	50	50	50
DELIVERED	7am/4	7am/5	7am/4	7am/4
% ON TIME	85	85	85	85
RATINGS	100			
RATE NEW ROAD		150		
RATE INTER-MODAL			200	
RATE RAIL				175
RANKINGS	4	3	1	2

ARE RATINGS CORRECT <Y/N>:

LASP uses a four-column format with the initial attribute levels based on the data on the presently used mode and attribute levels for subsequent questions modified on the basis of the ratings given in the preceding iterations. The respondent is first asked to give details, such as cost, transit time and reliability, of a typical flow. Based on this data, the respondent is then presented with a screen having four columns (Figure 5.1). The first column is the base option, which is the currently used mode (Road service here) and remains unchanged throughout the exercise. Columns 2 (a new road service), column 3 (Intermodal service) & column 4 (through rail service) are the three alternatives available. For each alternative, the attribute levels for cost, cost index, scheduled delivery time, reliability (as % of shipments arriving within scheduled time) are given. The base option is given a rating of 100 and the respondent is then asked to give ratings for each of the three alternatives as compared to the base option. On the basis of the ratings given, the algorithm further modifies the attribute levels for the next iteration. In this way the respondent is presented with a series of 9 screens (it is however possible to terminate before the full 9 iterations, at the respondents request, or go beyond 9 iterations, in case adequate data has not been collected and the respondent is willing to continue).

In this exercise, each column has a series of 'tasks' to perform, such as obtaining data for estimating the Alternative Specific Constants (ASCs), Value of time (VOT), Value of Reliability (VOR) and the frequency discounts ('F1' for tri-weekly services as compared to daily service and 'F2' for weekly service as compared to daily service). The algorithm is designed to reach the level of indifference for a particular alternative in the minimum number of steps. A 'task' is considered to have converged when the rating for that alternative has reached within a certain 'tolerance band' around 100 (a rating of 100 would mean that the respondent is indifferent between the alternative under consideration and the base alternative). Once a particular 'task' has converged a new 'task' is assigned to that column (e.g. the first task for column 'B' is to obtain data for estimating the VOT. The mode for alternative 'B' has been kept same as the base mode. All attributes except 'time' and cost are kept same (in columns B & C) for this 'task'. The cost is varied till the level of indifference is reached. Once this is reached this column will go on to the next 'task'. Similarly, columns 'C' and 'D' first work on the 'ASC' task where all non-cost attributes are unchanged, only the modes are different and the cost is varied to achieve convergence, then each column goes on to further tasks).

Data from the interviews is first modelled at the individual level and then the individual level models are aggregated using weighted averages to give sector level models.

For the individual firm models, the data obtained from each iteration is exploded into binary choices, using differences in attribute values, and regressed against a Logit function derived from the ratings. Weighted Least Squares (WLS) Regressions are run using SPSS software, with the weighting function designed to give maximum weight to ratings around 100. This is based on the assumption that ratings around the zone of change of decision have the maximum information content. The respondents will know whether the rating should be 105 as opposed to 110 much better than if it should be 25 as compared to 20 (where the alternative is absolutely unacceptable in any case) or 205 as opposed to 210 (where the alternative is certainly preferred).

Aggregate sectoral models are obtained by taking weighted averages of the individual firm parameters with the weights set as equal to the inverse of the variances of the parameters (i.e. the estimate with higher variance {the poorer estimate} gets a lower weight).

5.3 The Pilot Survey

As already mentioned, we have not been able to locate any previous published work regarding the use of SP methods from India. In addition to this, the only work available to us, from a similar developing country context, was that of El-Mahdi (1995), who had used SP and TP methods in Egypt in a passenger study. In this case pen and paper SP designs were used and the target population was the ordinary standard class traveller. Her experience, regarding the need to keep higher attribute level differences in the design, was expected to be true in the present case as well due to the much higher transit times. However, her finding regarding the unsuitability of self-completion surveys due to low literacy levels, was not expected to be relevant in this case, due to the target population being senior managers of various firms. There was, however, a possibility of poor response due to the managers not being able to spare time to complete the questionnaires. This, non-availability of previous work, led to the need to test the survey design in field conditions to ensure that the exercise was giving desired results.

We carried out the pilot survey in September 1997. In all, we conducted 6 LASP interviews, covering 3 freight forwarders, a manufacturer, a transport consultant and an intermodal service provider. At the end of each interview, the respondents were asked to give their reactions to the exercise that they had been through and any suggestions for modifications.

The response was found to be quite good and in general the respondents were found to be trading off. Only in one case (the first interview), the respondent was not able to fully understand what was required and the interview had to be terminated after four iterations. As such, out of the six interviews, it was possible to get usable data in five cases. The results of the individual level models (Table 5.1), were found to have correct signs and also matched the qualitative information obtained from the respondents during the interviews. The main design related issues that came to light were: -

1) The existing domestic intermodal services run only once or twice a week on a particular route whereas the despatches can be made on any day of the week by lorry. This was an important factor in mode choice, since not all users can afford to keep the inventory levels required for a low frequency service. As such, it appeared to be necessary to include the frequency of service in our model.

Table 5.1: Results of the Pilot Survey (All Costs in INR, 1 GBP = 70 INR Approx.)

Firm		ASC (Container Service)	ASC (Thru Rail)	Value of Time (per day)	Value of Reliability (per % change in reliability)
A	Estimate	134	3568	288	71
	('t')	(0.56)	(8.51)	(1.32)	(2.76)
B	Estimate	163	5387	912	220
	('t')	(0.51)	(11.12)	(3.90)	(2.77)
C	Estimate	-5774	-1113	7512	1186
	('t')	(-3.59)	(-1.00)	(4.29)	(2.64)
D	Estimate	-12309	-1153	5400	511
	('t')	(-5.46)	(-0.63)	(6.54)	(2.95)
E	Estimate	5949	-204	672	254
	('t')	(25.56)	(-1.21)	(9.94)	(15.29)

2) The time and distance parameters in the current context were very different from those in the European context, where even for flows of over 1000 Km delivery times were quoted in hours and changes in transit time of a few hours were quite relevant. In the Indian context, the delivery times were normally counted in days and the normal working (at collection & delivery points) was day-time hours only. As such the minimum perceivable difference would be about one full day.

3) In case of service reliability, as well, changes of 2 to 3% in the reliability were not found to be causing the respondents to trade off. We therefore felt that the step values in this case would have to be kept as 5% point change in the main survey.

4) We felt that a change in the presentation format, by using a 'Windows' based system presenting the choices in 'card' format, was likely to be beneficial as it would make the data on the screen easier to comprehend.

Some other aspects also came to light during these interviews and the discussions with the service providers in India. These are: -

1) One very important difference, as far as the economics of movement by different modes is concerned, is that in the Indian context the collection and delivery costs in case of intermodal services are significantly greater than those for manually

unloading the cargo from rail wagons and then loading it into lorries and carrying it to destination. This is due to the availability of cheap labour and scarcity of capital for handling equipment etc. In a typical movement of about 1500 Km, the cost of rail haulage of loaded containers, payable by the shipper on the trunk leg, is likely to be of the order of INR (Indian Rupee) 11,000-12,000 (1 GBP = 70 INR approx.). On the other hand, the collection delivery charges, for distances upto 30 Km, are likely to be about INR 3,000 at each end. In contrast, the cost of collection/delivery by lorry (including the cost of the additional unloading from wagon and loading to lorry) is likely to be about INR 2,500 only at each end.

The Intermodal services lose out to lorry, in cases where the quality of service is important and, for the reason mentioned above, to rail where cost is the important factor. The existing domestic freight movement by containers is mainly restricted to flows where availability of covered rail wagons is a constraint, however, wagons for haulage of containers are available. Even in these cases door-to-door service is often not viable. It therefore becomes necessary to look at the quality parameters to be able to compete with road in the quality conscious segments.

2) Container services are at a disadvantage vis-à-vis road services with regard to the volumetric capacity also. A 20 foot ISO container, with carrying capacity 21 tonnes, only carries about 1.25 to 1.5 times the load that a lorry, with 9 tonne capacity, can carry, in case of volume constrained loads. Lorries are able to carry higher volumes (as compared to their relative weight carrying capacities) as they usually have open tops and can load above the roof level. This significantly affects the economics of container movement vis-à-vis road for volume constrained cargoes.

5.4 Changes made in LASP Design

On the basis of the pilot survey results, we first converted the LASP software to a Windows based format using Visual Basic programming language (see screen in Figure 5.3, page 70). This also permitted modular programming which was not possible with the original Qbasic program. Then the attribute level differences were modified to work in increments of 1 day in transit time and 5% in reliability. The frequency of service was added as the fourth attribute with 3 levels (daily, tri-weekly and weekly).

The addition of frequency meant that now two frequency discounts (for tri-weekly and weekly services as compared to daily services) were needed to be estimated in addition to the 2 ASCs, VOT and VOR. In effect, LASP was now being required to estimate more variables than it had ever before been used for. We tested the possibility, of this leading to problems in estimation, using simulated data.

LASP interview data was simulated over a range of attribute valuations, which was expected to cover most true valuation levels we expected to find in the survey. 21 sets of attribute valuations (Table 5.2) were used for the simulations. We have also simulated different rating behaviour using the 'K' factor to represent this. A narrow rating respondent, who rates all alternatives in a very small band around 100, will be represented by a low 'K' value. A wide rating respondent, who gives widely varying ratings, would be represented by a high 'K' value. An average rating respondent would be represented by a 'K' value of 100.

Table 5.2: Attribute Values use for Simulation ('K' in absolute terms and all other values are in percentage of base cost)

No.	K	ASC(IM)	ASC(Rail)	F1	F2	VOT	VOR
1	100	10	10	10	20	1	0.2
2	100	10	10	10	20	5	1
3	100	10	10	10	20	10	5
4	100	10	10	10	20	30	10
5	70	-20	40	10	20	1	0.5
6	70	-20	40	10	20	1	5
7	70	-20	40	10	20	10	1
8	50	30	40	10	20	10	10
9	50	30	40	10	20	30	10
10	50	30	40	10	20	30	5
11	70	0	20	5	10	5	2
12	70	0	20	5	10	5	5
13	70	0	20	5	10	5	10
14	150	20	40	10	20	30	10
15	150	20	40	10	20	10	5
16	150	20	40	10	20	30	5
17	20	10	20	10	20	1	0.2
18	20	10	20	10	20	1	5
19	20	-20	30	20	40	10	5
20	20	20	20	10	10	10	5
21	20	0	30	20	40	30	10

In the final survey, some of the estimated valuations (especially for F1 & F2) were found to be lying outside the range we had originally covered in our simulation testing.

We simulated these, subsequently, to ensure that satisfactory results could be obtained over the entire range of values of interest here.

The recoverability of input values was represented in terms of the percentage error in the estimated values, as compared to the actual values used for generating the simulated data. We have summed up the (absolute values of) % error values, for each attribute for all the 21 sets of values, to obtain an index to measure the performance of a design. In addition to this particular sets of values which gave extreme errors were also noted separately. We also felt that VOT and VOR estimates could be more important and the errors in these should be lower. As such we defined two additional indices where the VOT and VOR values were each given weights of 2 (second index) and 4 (third index) with the ASCs, F1 & F2 having weight 1 each.

For example, if we consider two designs (design 'A' & design 'B') in Table 5.3 where the % error in recovered values are given in the two columns for design 'A' and design 'B'. The simple sum of the (absolute values of) % errors is 80 in either case. However design 'B' has higher error in recovery of VOT and VOR. In case we are more bothered about the recovery of VOT and VOR then the weighted sums show us that design 'A' is better as it has lower indices for the weighted sums.

Table 5.3: example of weighted sum of (absolute values of) % errors

	Design 'A'	Design 'B'
ASC(IM)	10	10
ASC(Rail)	-20	-10
F1	20	10
F2	10	10
VOT	10	20
VOR	10	-20
Sum (simple)	80	80
Sum (1:2)	100	120
Sum (1:4)	120	200

We have used all the three indices to evaluate the performance of different designs and to select designs with lower recoverability indices. In case of difference between the results on the basis of the weighted and unweighted indices, we have selected the designs with lower weighted indices.

5.4.1 Task Order Modification

The next thing to be decided was the task order (i.e. the sequence in which each column would take up various tasks) with the objective of ensuring that all the required data, could be collected in an interview. To explain this point - we have six tasks in all, as mentioned in the preceding paragraph. With three columns available, this meant that each column would have to complete a minimum of 2 tasks, for ensuring that adequate data was collected, for estimation of the variables. However it was, at the same time, possible that one column may complete 3-4 tasks whereas the other may not even complete the first two. As such the task order would need to minimise the possibility of a particular job not getting done at all, by assigning it to more than one column, in a suitable sequence.

Table 5.4: Task order Modification

Task	Original Task Order			Revised Task Order			Final Task Order		
	Col. B	Col C	Col D	Col. B	Col C	Col D	Col. B	Col C	Col D
First	T	ASC	ASC	T	ASC	ASC	T	ASC	ASC
Second	R	T	R	R	F2	F1	R	F2	F2
Third	T	T	R	F1	T	R	F1	F1	F1
Fourth	T	T	T	T	R	T	T	T	R
Fifth	T	T	R	R	F1	F2	R	R	T
Sixth	T	T	R	T	T	R	T	T	R

Where: - T represents trading in Time
R represents trading in Reliability
F1 represents a frequency of three per week
F2 represents a frequency of one per week

To illustrate the procedure followed, we have given the initial task order, an intermediate task order and the finally used task order in Table 5.4. The original task order is given in the first 3 columns. The first row shows the starting tasks for each column. So we see in the original design the first task for Column 2 was to obtain data for estimating VOT and the other two columns would obtain data for estimating the ASCs. In the second task, Column 2 would be obtaining data for estimating VOR. Similarly column 3 would take VOT as the second task and column 4 would take up VOR as the second task.

With the addition of two frequency discounts to be estimated, the task order was modified as shown in the second set of 3 columns in Table 5.4. After simulation testing we found that, in case of column 'C', both the levels of frequency were likely to get tested in case the once a week service was found to be totally unacceptable. However, in the case of column 'D', we would need to come back to finishing with frequency only in the fifth task and there was very little chance of any interview progressing that far. In view of the importance 'Frequency' was likely to have, we decided to finish with the tasks involving frequency at the first go itself. As such the task sequence was further modified.

In addition to this several other options were examined such as: -

a) to return each attribute to the base level before changing the next attribute. However this was found to lead to repetition of values already tried and hence wasting of an iteration. As such the original system of leaving each attribute at the current level and proceeding with modification of the next one was used.

b) not resetting the frequency of service back to daily for the fourth and subsequent tasks in column C and D. However simulation results showed an increase in the errors in recovered values on making this change. As such the original process of resetting all the frequencies to daily for the subsequent tasks has been continued with.

The final task order is as given in the last of three columns in Table 5.4. These are explained in detail in the following section.

As already mentioned, the number of parameters to be estimated was being increased from 4 to 6 (with the addition of two frequency discounts). The alternative of estimating only 1 additional parameter (by keeping frequency at two levels) was also examined. This was found to result in some decrease in overall % errors in recovered values. However, the trade-off involved here is that by using the two additional values (i.e. a total of three frequencies - once a week, thrice a week, daily) we are able to get values for a service where the customer may have to wait for at the most one day extra to despatch his consignment and one where he may be faced with the prospect of having to wait for almost a full week. In case of having only one additional value we are able to check for a case where he has to wait at the most for three days. Since, at present, the rail as well as container services are normally available only once a week, we felt that obtaining the valuation for two additional levels outweighs the disadvantages of using two additional values in terms of a small increase in the errors in the estimates.

In case of transit time we decided to keep the jumps to one full day, in view of the possibility of difference in the valuation of different parts of the day. This could arise as there were restrictions on movement of trucks at certain times and some companies have no night working in the warehouses. However in case of unacceptable levels being reached if the jumps were still 24 hours we would go back to the same level where we started. As such, reduction in transit time is offered in steps of 8 hours.

In case of decrease in time by steps of 8 hours mentioned above the comparison with the base mode is no longer in multiples of 24 hours. However if the software comes back to a task in time, after this, the gap is restored to multiples of 24 hours.

Similarly, the jumps in percentage reliability, in such a case would be 2% (increase).

The final sequence of tasks for each column and the attribute levels presented are shown below: -

Column B (New Road Service)

The changes in values for new tasks for column B are: -

Task	Time	Reliability	Frequency	Cost Index
1	Base +24 hrs	Base	Base (Daily)	50
2	no change	base - 5%	no change	decr. by 30 or 10 or 0 %
3	no change	no change	thrice a week	" "
4	as task 3 + 24 hrs	no change	Daily	" "
5	no change	As task 4 - 5%	no change	" "
6	as task 5 + 24 hrs	no change	no change	" "

Note:- 1) no change implies that the values existing in the previous iteration are used
2) The % decrease in cost index depends on the previous value of cost Index. If it is greater than 65 then it is decreased by 30%, if it is between 45 & 65 then by 10% and 0 if less than 45.

In the first task (VOT) the delivery time is one day later than base. This is explained to the respondent as being due to increasing congestion on the roads. For the second task (VOR) the reliability is decreased by 5%, the delivery time is left unchanged and a discount is given (and cost index is reduced by 30%, 10%, 0% depending on whether the value of cost index is > 65, between 45 & 65, below 45 respectively). For the next task (Frequency discount) the frequency of service is reduced to tri-weekly (explained as trucks being available only on three fixed days in a week) with Time and Reliability attribute levels unchanged from previous iteration and a discount given. In the next task (VOT) the delivery time is further increased by 24 hours and frequency reverted to daily (to make the alternative realistic since normally trucks are available as per requirement and truck availability on fixed days only is rather unrealistic). A discount is also offered. In case the exercise reaches this far, thereafter the tasks would alternate between VOR and VOT (i.e. reduction in reliability by 5% and increase in delivery time by 24 hours).

It is also possible to reset time to base value for the second or third task and not offer a discount. However, for subsequent tasks it is not possible to do this as we would otherwise start repeating the attribute level combinations. The frequency has not been reduced beyond three a week, for lorry movement, to avoid making this service too unrealistic.

Column C (Intermodal Service)

The changes in values for new tasks for column C are: -

Task	Time	Reliability	Frequency	Cost Index
1	Base level	Base level	Base (Daily)	50
2	no change	no change	Once a week	decrease by 30 or 10 or 0 %
3	no change	no change	Thrice a Week	no change
4	as task 3 + 24 hrs	no change	no change	decrease by 30 or 10 or 0 %
5	no change	as task 4 - 5%	no change	" "
6	as task 5 + 24 hrs	no change	no change	" "

Here the first task is to get data on the ASC and the alternative is initially offered with same service levels and half the price. The second task in to get data for determining the frequency discount for a weekly service and the third task is to get data regarding tri-weekly service. In case the frequency of service has to be improved in the second task then the third task (frequency thrice a week) is also considered to have been achieved and the software proceeds to the fourth task directly. The frequency is left unchanged after the level reached in the third task.

The method of handling very low values of cost index would remain the same as in column B.

Column D

The changes in values for new tasks for column 'D' follow a similar pattern as Column 'C' and are given below. The first task here is also to obtain data on the ASC, the second to obtain data regarding discount for weekly service & the third to get data about a tri-weekly service.

Task	Time	Reliability	Frequency	Cost Index
1	Base level	Base Level	Base (Daily)	50
2	no change	no change	Once a Week	decrease by 30 or 10 or 0 %
3	no change	no change	Thrice a Week	no change
4	no change	as task 3 - 5%	no change	decrease by 30 or 10 or 0 %
5	as task 4+ 24 hrs	no change	no change	" "
6	no change	task 5 - 5%	no change	" "

5.4.2 The LASP Outputs

Three files are created by the program, with the filename as entered in the first screen and the extensions '*.raw*', '*.log*' and '*.dat*' respectively. The first, is a file containing raw data and can be used directly in case data is required to be modified for analysis. The second, is a log file in which the date and time of the interview are stored along with the background data. For each iteration the attribute values are also stored along with the time taken for each iteration and the values of the upper and lower bounds, the bound crossing flags and the 'F' value used for generating the next cost index. The file is opened in '*append*' mode so that in case the filename already exists the log file will contain the data for both the files (the '*.raw*' & '*.dat*' files will only contain the latest data). In case any modifications are made in the rating after asking for confirmation of ranking, the original values are also stored separately. This file is designed to have all data for debugging or for re-construction of an interview, if required.

The third file contains the exploded data in ASCII format for directly running the regression. This file can actually be created from either of the first two files. It is only created at this stage to make analysis a little simpler.

5.5 The final Design

5.5.1 Attributes and Their Levels

In our final design, we have taken the attributes of

1) Cost: to be represented in Rupees per consignment as well as in the form of a Cost Index with the cost of the currently used (base) alternative taken as 100.
2) Time: to be varied in steps of 24 hours normally and steps reduced to a third of a day in case change of a day leads to unacceptably low cost index.

3) Reliability: defined as the percentage of consignments arriving on time and varied in steps of 5 percent points. A decrease of 5% points in reliability would correspond to an increase of one day in the average transit time.
4) Frequency: taken at three levels (daily, tri-weekly and weekly).

5.5.2 The Presentation Format

The alternatives were presented in the form of cards on the screen. The final screen layout is given in Figure 5.2 to Figure 5.5. The interview starts with background data about the firm's operations. Then a suitable flow is selected, which moves on the route under consideration. In case no flow can be identified on that route then an alternative flow is selected.

The first screen of the laptop based interview (Figure 5.2) obtains data about the flow such as the origin, destination, distance, volume, loadability, value of consignment, cost of transport etc. From this, the data on the transport cost (per ton), the average transit time and the reliability (taken as a percentage of consignments arriving within the average transit time in the previous quarter) is used for setting the attribute levels for the first iteration of the SP interview (Figure 5.3).

The respondent is then asked to rate each of the alternatives against the base alternative (Existing Road Service - Column A). When all the alternatives have been rated, the software converts these to the underlying rankings and displays the cards in rank order (Figure 5.4) as a cross check. When the respondent accepts the ranking the next screen is displayed (Figure 5.5). In this fashion nine iterations are presented, though it is possible to terminate the interview before that at the request of the respondent, or to go further, in case sufficient data has not been collected and the respondent is willing to go on.

Figure 5.2: Initial Screen - Details of Selected Flow

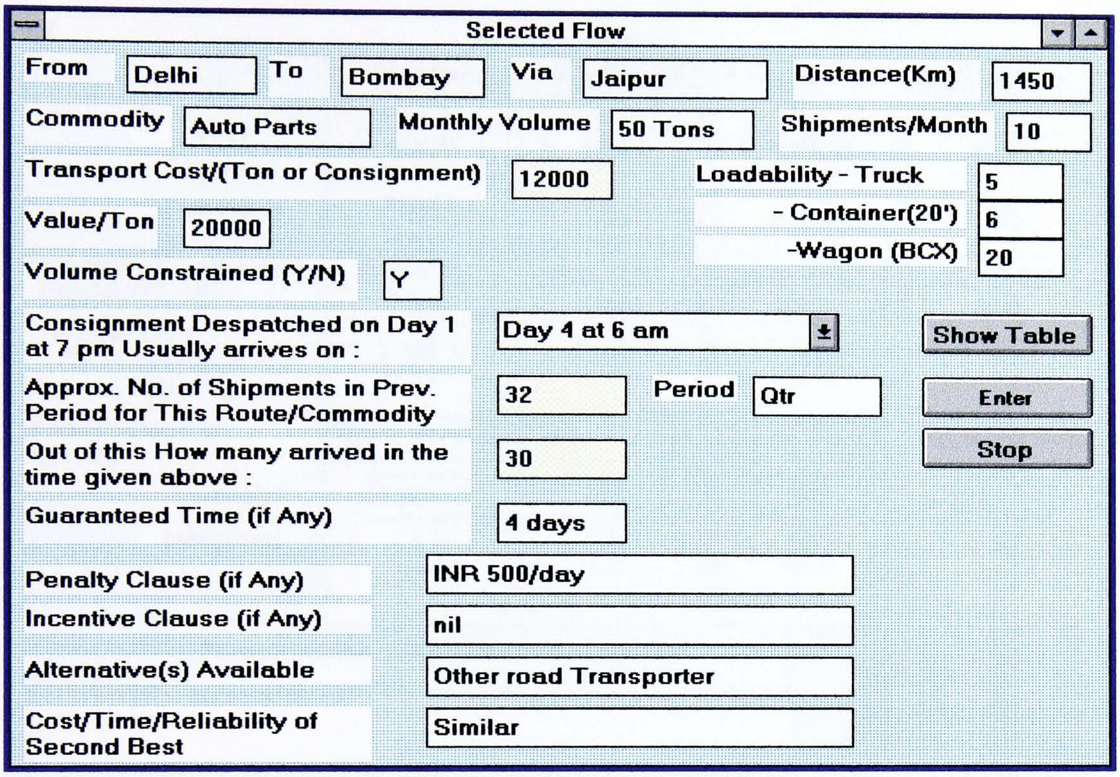


Figure 5.3: Screen For The First Iteration

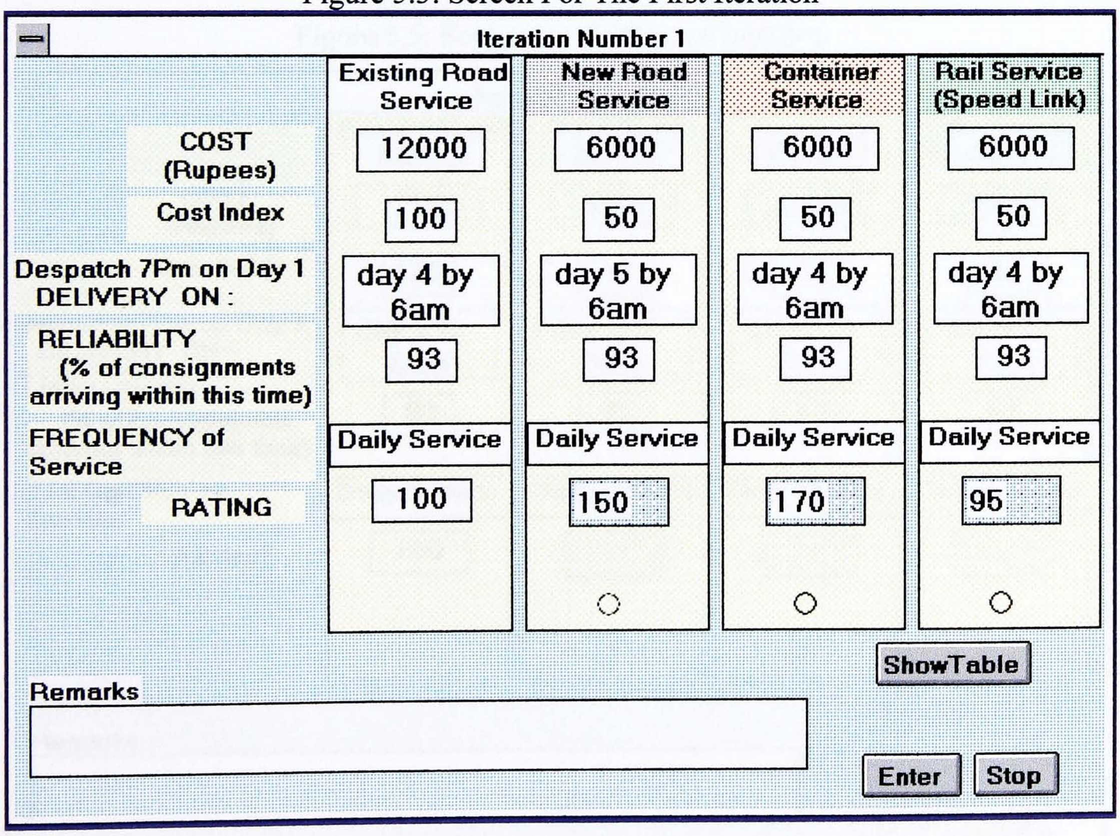


Figure 5.4: Confirmation of Implied Rankings

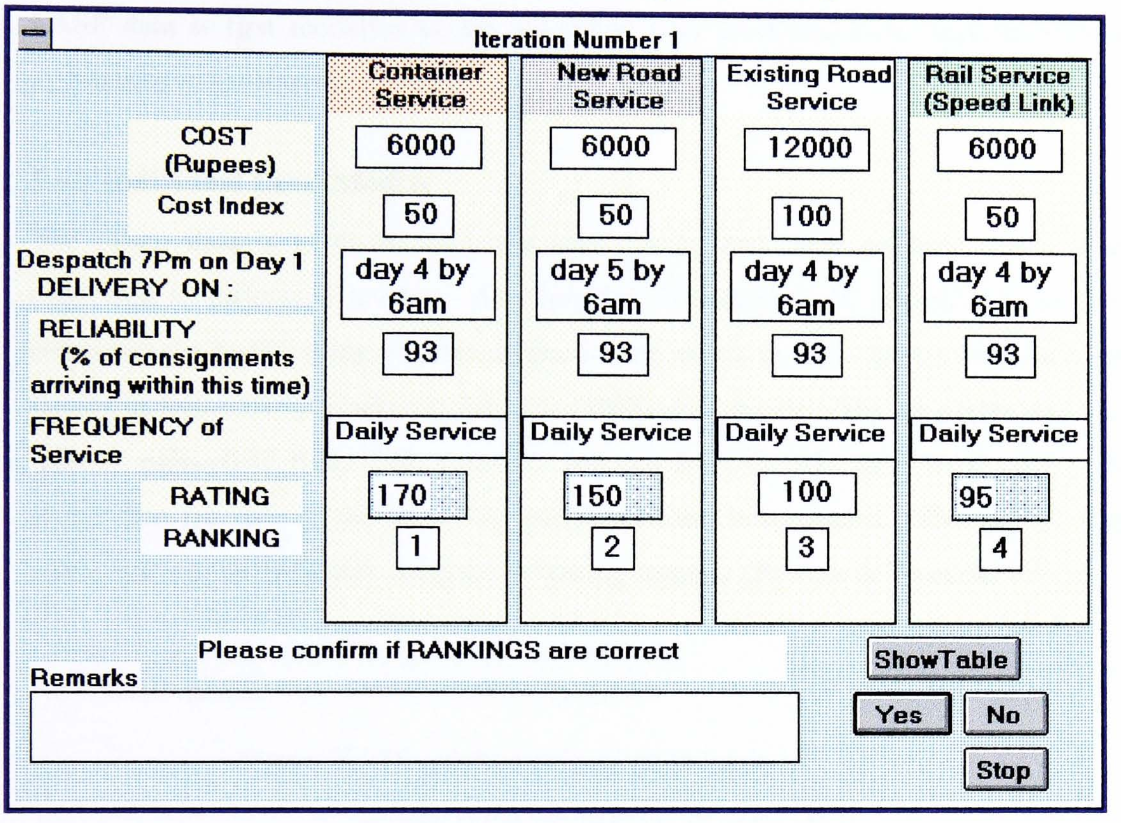
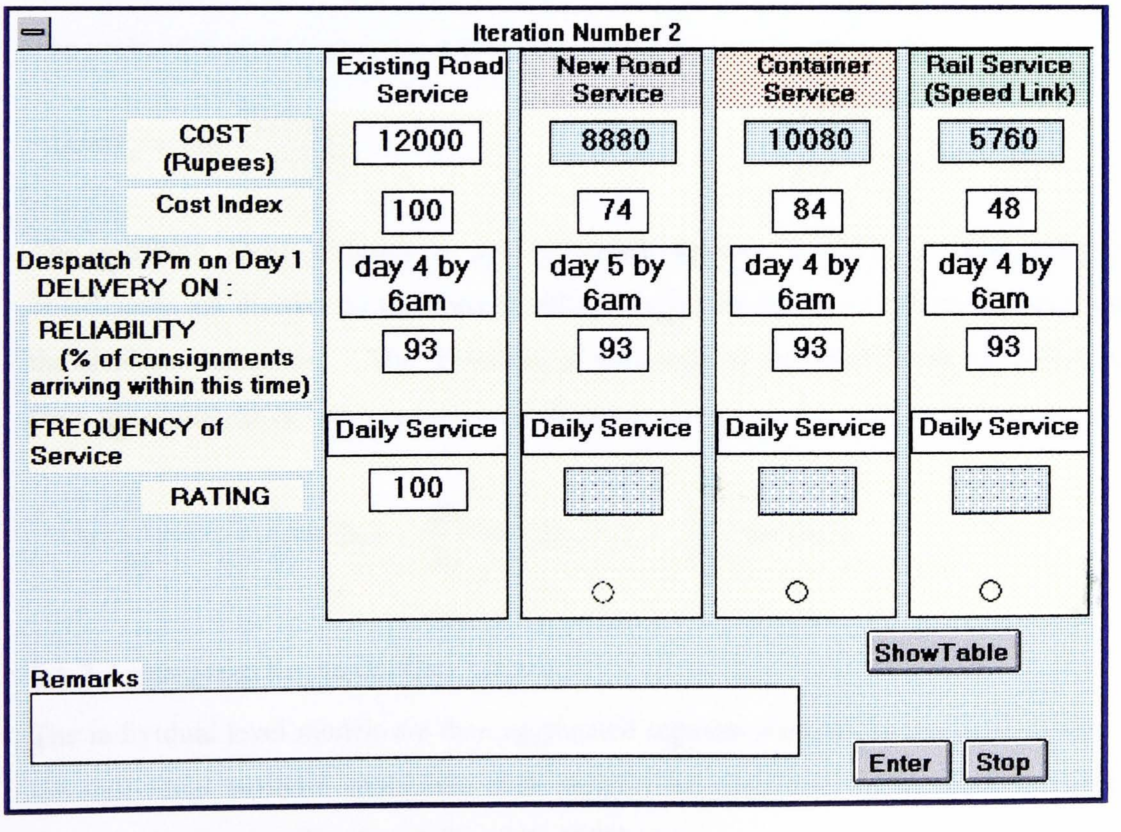


Figure 5.5: Screen for the Second Iteration



5.6 Data Analysis

LASP data is first modelled at the individual firm level and then these models are aggregated to get sectoral models.

5.6.1 Individual Level Models

The rating data is exploded into pair-wise choice data with attribute levels being converted to difference levels. As explained subsequently in section 5.8, we have compared the results using simulated data as well as survey data, for the explosion into 6 pairs as followed by Fowkes & Tweddle (1988) with results using for explosion into 3 'non-A' pairs (B-C, B-D, C-D), three 'A' pairs (A-B, A-C, A-D) and twelve pairs. We found that the use of the three 'A' pairs gave the best results. The ratings were converted into probabilities using the following formula (Fowkes & Tweddle 1997): -

$$\begin{aligned}&\text{If } RATE_A > RATE_B \text{ then } PROB_A = 1 - 0.5 * RATE_B/RATE_A \\ &\text{If } RATE_A < RATE_B \text{ then } PROB_A = 0.5 * RATE_A/RATE_B\end{aligned} \qquad (1)$$

where: $RATE_A$ is the rating given to mode 'A'

$RATE_B$ is the rating given to mode 'B'

$PROB_A$ is the probability of choosing mode 'A'

The probabilities are then subjected to a Logit transformation using: -

$$LOGIT_A = \text{Log} \frac{PROB_A}{1 - PROB_A} \qquad (2)$$

The attribute level differences are regressed against '$LOGIT_A$'. The resulting coefficients are divided by the corresponding coefficient for 'Cost difference' to obtain the attribute valuations. The 't' values of the ratios of the coefficients are calculated from the variances of ratios, which are estimated as: -

$$\text{var}\left(\frac{b_1}{b_2}\right) = \frac{1}{b_2^2}\left[\text{var}(b_1) - \frac{2b_1}{b_2}\text{cov}(b_1, b_2) + \frac{b_1^2}{b_2^2}\text{var}(b_2)\right] \qquad (3)$$

5.6.2 Aggregated Segment-Wise Models

The individual level models are then aggregated segment wise, using weighted means of the individual attribute valuations, with weights set as inverse of the variance of the individual estimates (Fowkes & Tweddle 1988) i.e.: -

$$r = \frac{\sum \frac{r_i}{V_i}}{\sum \frac{1}{V_i}} \qquad V = \frac{1}{\sum \frac{1}{V_i}} \qquad (4)$$

where: 'r' = the combined estimate
'r_i'= the estimates for individual firms
'V'= the variance of the combined estimate
'V_i'= the variance of individual estimates

This results in minimum weight being given to valuations having highest variances (i.e. the poorest estimates).

5.7 Modification of the Weighting scheme

The weighting system used "gives most weight to the least clear-cut decisions" on the basis that small changes in ratings around 100 are the most meaningful as they are most carefully considered.

Wt_A = RateA/100 (if RateA < 100)
100/RateA (otherwise)
Wt_B = RateB/100 (if RateB < 100)
100/RateB (otherwise)
$Wt = (Wt\_A * Wt\_B)^2$ (5)

We have used simulated data to compare the recoverability of underlying values with and without the use of the weighting function. We have also estimated the results using powers of 'Wt' from 1 to 32. We found that use of the weights improves the recoverability of values substantially over the results obtained without using any weights. The use of 'Wt' raised to the power 2 gave the best results in terms of stability as well as recoverability.

As an extension of the logic for the use of weights, it was felt that small changes in ratings even if they are away from 100 should be more meaningful than larger changes nearer 100. To test this hypothesis, we further modified the weights to: -

Wt = RateA/RateB (if RateA < RateB)
RateB/RateA (otherwise)

Table 5.5: Weights as per old and new method

	'A'	'B'	old wts	new wts
A-B	100	200	0.5	0.5
A-C	100	210	0.48	0.48
A-D	100	50	0.5	0.5
B-C	200	210	0.24	0.95
B-D	200	50	0.25	0.25
C-D	210	50	0.24	0.24

The effect of the different weights, for an imaginary set of ratings where A=100, B=200, C=210, D=50, is shown in Table 5.5. It can be seen that the only difference takes place in cases when both the ratings of a pair are on the same side of 100 (i.e. both are greater than 100 or both are less than 100). In this case as per the original weighting scheme, the weight would be (100/A)*(100/B) if both ratings are greater than 100 whereas it would be A/B (where B>A) for the new weighting scheme. The weight would decrease as we go away from 100 in the old scheme whereas it would increase as we go away from 100 in the new scheme.

We carried out a series of simulations with the same parameter values as used in previous simulations. We found that the percentage errors in recovered values went up by different degrees in all but 4 sets of values out of the total 21 sets. However since these appear rather extreme cases we have a reasonably good recovery of actual values in the range of interest. There is very little difference in the values obtained using the revised weighting scheme.

The modified weighting scheme considered above, effectively increases weight given to a rating pair as distance from 100 increases. To study the results with a weighting scheme where the weight is proportional to the percentage difference between the two ratings and independent of the distance from 100 the following weights were also simulated: -

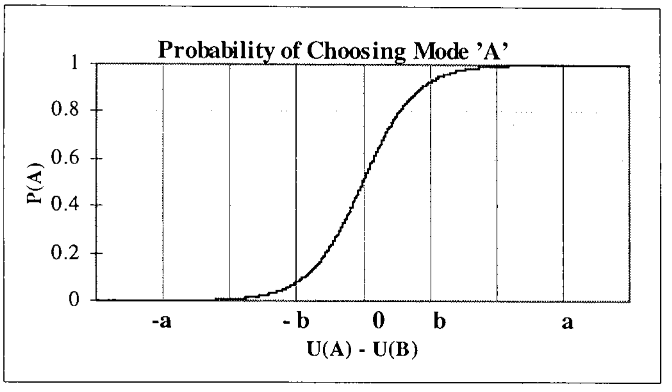
$$Wt = 1 - \frac{\text{ABS (RateA - RateB)}}{\text{RateA + RateB}} \qquad (6)$$

: where RateA and RateB are ratings given to alternatives A & B respectively

The results of this simulation show no major change in the % error in recovered values with change in weighting scheme.

This led us to conclude that the original weighting scheme is giving quite robust estimates. This would appear to be due to the fact that in our LASP design all the ratings are given in comparison with the base alternative, which is rated as 100. The ratings around 100 would lie on the sloping part of the logit curve which is where the most information about conditions for change of decision, would come from.

Figure 5.6: Logit Curve for P(A)



To illustrate this point let us consider two alternative modes 'A' and 'B'. Let P(A) be the probability of choosing mode 'A' and P(B) be the probability of choosing mode 'B'. In absence of any other alternative P(B) = 1 - P(A). In the Logit curve of Figure 5. let the Y-axis represent P(A) and the X-axis represent the difference of the utilities of the two alternatives {U(A)-U(B)}. Intuitively it can be seen that values of U(A)-U(B) lying between '-b' and 'b' are the values where a change of decision can take place. For values of U(A)-U(B) less than '-b' the choice is almost certainly 'B' and for values of U(A)-U(B) greater than 'b' the choice is almost clearly 'A'. As such, very little information is likely to be obtained from observations with utility ratio values lying outside the range (-b, b). If we consider the ratings to be indicative of the utilities of the modes, the range (-b, b) would correspond to ratings close to each other.

5.8 The Data Explosion Issue

Further simulation & analysis was also carried out to check if explosion of the set of 4 ratings into 6 pair-wise comparisons (A-B, A-C, A-D, B-C, B-D, C-D) was giving us any gain over the basic set of three (A-B, A-C, A-D) which was anyway taking account of all the data that we had. The hypotheses tested here are: -

H_{01}: In case of comparisons against the current alternative the respondent would tend to stay with the current alternative (inertia effect) and would rate the other alternatives more harshly. However in case the current alternative is not present the actual values may be reflected better.

H_{02} : Explosion into six pairs has additional information content, which improves the estimated values.

In this simulation analysis the % error in recovered values was first calculated using the fully exploded data set and then using only the first three pairs as mentioned above and lastly with the last three pairs only. In case the hypothesis regarding the presence of the inertia effect (H_{01}) was correct the last set should give the best results since the current alternative is not present here. In case H_{02} is correct we should get better 'Adjusted R square' values for the first set of data (i.e. the fully exploded data) as well as better recoverability of values.

The results obtained are shown in Table 5.6. From this it can be seen that the third set of results (considering the last three pairs only) shows very high % errors in recovered values. Between the first two sets the second one appears to be giving better results in terms of % error in recovered values. Another noticeable thing we found was that the recovery of values of 'F1' (not shown here), which was found to have some problems in the earlier simulations, improved significantly in the second set. However, if we look at the 'Adjusted R squared' values for the regressions (not shown here) we find that out of 21 cases the adjusted R squares were better (higher) for the regressions using fully exploded data in 14 cases and for the regressions using only first three terms in 7 of the 21 cases.

After this the data obtained from India was also re-analysed on the same basis. In this case no major differences were noticed in the results obtained using the fully exploded data and the first three sets only. However out of the 32 interviews 22 (20 with difference > 0.01) had better Adjusted R squared values for analysis with fully exploded data while 10 (6 with difference > 0.01) had better values using the first three pairs only.

Table 5.6: Simulation Results with different Explosion Methods

Sl. No.	Values Input							% Errors in Recovered Values											
	K	IMC	TRC	F1	F2	VOT	VOR	Fully Exploded (6)			First 3 Pairs			Last 3 Pairs			12 Pairs		
								1:1	1:2	1:4	1:1	1:2	1:4	1:1	1:2	1:4	1:1	1:2	1:4
1	100	-10	-10	-10	-20	1	-0.2	28	48	87	35	61	112	338	614	1167	53	93	173
2	100	-10	-10	-10	-20	5	-1	17	24	37	26	37	59	101	142	224	21	27	40
3	100	-10	-10	-10	-20	10	-5	26	31	41	24	28	38	346	387	470	30	36	46
4	100	-10	-10	-10	-20	30	-10	159	176	210	47	57	76	395	413	449	152	167	197
5	70	20	-40	-10	-20	1	-0.5	208	385	740	170	312	597	336	600	1127	184	334	635
6	70	20	-40	-10	-20	1	-5	79	102	150	68	94	146	396	622	1075	80	106	158
7	70	20	-40	-10	-20	10	-1	45	60	92	43	50	64	169	190	232	46	60	90
8	50	-30	-40	-10	-20	10	-10	56	72	103	33	43	62	394	498	708	63	79	111
9	50	-30	-40	-10	-20	30	-10	76	107	169	54	81	135	663	810	1106	128	178	279
10	50	-30	-40	-10	-20	30	-5	60	75	105	38	49	71	1187	2163	4115	212	293	454
11	70	0	-20	-5	-10	5	-2	30	44	73	27	44	78	115	160	249	31	45	72
12	70	0	-20	-5	-10	5	-5	50	61	85	35	45	66	215	262	356	53	64	86
13	70	0	-20	-5	-10	5	-10	53	65	89	63	75	100	114	123	140	58	71	99
14	150	-20	-40	-10	-20	30	-10	29	40	60	12	20	35	712	909	1302	22	23	24
15	150	-20	-40	-10	-20	10	-5	14	15	18	11	11	13	503	653	954	16	17	19
16	150	-20	-40	-10	-20	10	-5	212	418	831	208	413	823	315	322	338	226	440	867
17	20	-10	-20	-10	-20	1	-0.2	339	656	1288	169	305	578	753	1286	2350	362	700	1377
18	20	-10	-20	-10	-20	1	-5	98	154	266	125	190	320	192	323	583	100	160	279
19	20	20	-30	-20	-40	10	-5	56	68	91	61	71	91	289	339	440	57	70	94
20	20	-20	-20	-10	-10	10	-5	61	70	89	62	71	90	215	244	303	63	73	94
21	20	0	-30	-20	-40	30	-10	111	172	294	101	160	279	156	237	398	109	168	288
							Total ➔	1808	2844	4916	1412	2219	3833	7903	11297	18086	2065	3204	5482

From the above analysis, it would appear that our hypothesis about the existence of inertia effect (H_{01}) cannot be accepted on the basis of the present results. The same can be said of the hypothesis about the explosion into 6 pairs having additional information content since, even though the fully exploded data has resulted in better 'Adjusted R squared' values in case of the simulated data as well as for the survey data, the overall recoverability of values is better with the use of first 3 pairs only.

5.8.1 Simulation using explosion into 12 choices

A further possibility was explored - that of extracting more information from the data if we used each column as base (=100) in turn and rotated the columns A, B, C, D cyclically. In effect, this would get around the weighting problem as higher weights would be assigned to the 'B-C, B-D' pairs than in the first case and so on for the other pairs.

Simulations were carried out using the original 21 sets of attribute levels to generate data. Each set of 3 ratings was then exploded into 12 observations as follows: -

1) first three 'A-B', 'A-C', 'A-D' as done earlier.

2) then rating of 'B' was scaled to 100 and the other ratings (A, C, D) scaled appropriately by multiplying each by '100/B'. Using the resultant rating values the pairs 'B-A', 'B-C', 'B-D' were generated.

3) the next three pairs were generated by scaling 'C' to 100 and a further three by scaling 'D' to 100.

The results are shown in the last three columns of Table 5.6. In this case as well we find an increase in the percentage errors over the values for the first three pairs alone. As such it appears that explosion into three pairs A-B, A-C, A-D is indeed the most suitable form for obtaining the individual firm models.

This has an additional advantage that we no longer need to adjust the 't' values (which we would need to do in case we were to explode each set of ratings into 6 pair with only three degrees of freedom available).

5.9 Pen and Paper SP design for back up.

We have also designed a conventional pen and paper SP questionnaire, to be used as a backup in case of problems with the laptop based LASP exercise.

For this purpose we initially used designs from the 'cook-book' (Kocur et al 1985). A suitable plan was selected using four attributes (time, cost, reliability & frequency) with three attributes at two levels each (time, reliability & frequency) and one (cost) at four levels. Since we wanted data on three modes, we would need to have two sets of binary choice questions (one intermodal vs. road and second intermodal Vs rail). The minimum number of questions with 4 attributes in the design is 8. This gives us a minimum of 16 questions per respondent, if we are not to split the design across respondents (i.e. administer one part of the design to one set of respondents and the other part of the design to a second set of respondents).

The problem faced here was that it was not possible to cover a wide range of boundary values with only 8 questions (and we needed to cover a wide range due to the lack of information about the likely range of true valuations). We also faced a problem, which is common in most freight surveys, that of small sample sizes, due to the limited number of firms in a segment and the large amount of time and effort required to obtain each interview. Consequently the alternative of split designs was not available to us.

A four alternative rating design (Fowkes 1998b) was also tested. We tested several different sets of attribute values, with the same basic design, till we finally arrived at a design which appeared to give satisfactory results, over the range of values of interest to us (this was however a smaller range than the one used in the simulation tests of the LASP design). The simulation results (simulating 50 respondents) with this design are given in Table 5.7. Further simulations were carried out to check the recoverability of values with fewer respondents and it was found that about 30 respondent were required to give acceptable estimates. With only 10 respondents we were still able to recover the values but with very poor significance levels.

The design was tested on students of the Masters class in Transport Economics, attending the course on Freight Transport Planning and Management. Each of the students asked to consider himself/herself to be the logistics manager of a firm whose description was given (different products & sizes for each student). They were asked to reply to the questions and to point out any items, which appeared ambiguous. The design was corrected, on the basis of the feedback received, and further tested on research students from China and India.

The final questionnaire (Appendix 'A') faxed to three firms in India. One of the firms replied by fax and in this case the task appeared to be understood quite well and they also said that there was no ambiguity in the questions. In the course of the actual survey it was not necessary to use this questionnaire as satisfactory results were obtained with LASP which was found to be evoking a lot of interest due to the novelty of the presentation format as well.

Table 5.7: Simulation Results for 4 alternative rating design

Value Input				Value Recovered				Coefficients Estimated ('t' values)				
vot	vor	asc (im)	asc (rail)	vot	vor	asc (im)	asc (rail)	Cost	Time	Reliab	asc (im)	asc (rail)
1	2	0	0	0.98	-1.72	0.44	-2.13	-0.0605	-0.0591	0.1038	-0.0266	0.1287
								-(13.4)	-(11.6)	(5.3)	-(0.3)	(1.2)
4	2	40	20	4.14	-1.92	38.77	22.08	-0.066	-0.274	0.127	-2.564	-1.460
								-(10.1)	-(11.4)	(5.1)	-(15.3)	-(8.5)
2	10	20	50	2.20	-14.13	20.58	56.31	-0.0486	-0.1068	0.6861	-0.9993	-2.734
								-(8.8)	-(7.8)	(14.5)	-(7.5)	-(16.1)
2	20	-20	0	1.98	-19.18	-20.19	3.61	-0.0588	-0.1166	1.127	1.186	-0.212
								-(8.8)	-(12.0)	(6.3)	(9.4)	-(1.8)
2	4	10	30	2.09	-4.04	10.13	26.91	-0.0726	-0.1516	0.2936	-0.7353	-1.954
								-(13.4)	-(9.7)	(12.0)	-(5.9)	-(13.1)
2	2	10	20	2.13	-2.14	8.54	18.68	-0.0701	-0.1489	0.1499	-0.5982	-1.309
								-(13.5)	-(9.8)	(6.9)	-(5.0)	-(9.7)

5.10 Conclusion

In this chapter, we have seen that use of an adaptive SP design became necessary, in the present case, as we are looking at a service in the introductory phase where RP data was not available and we were not able to locate any previous work of a similar nature from India to get some idea about the sort of attribute valuations we could expect for the different sectors covered in our research. We have carried out a pilot survey in India using LASP, which gave a satisfactory response and also indicated that the design needed to be modified significantly for purpose of our main survey. The LASP design has been modified and tested, using simulated data, to ensure that satisfactory results could be obtained.

We have also examined data analysis issues to finalise the method of analysis. We have used a regression based analysis approach with individual level models, which have been aggregated using weighted averages. We found that, in our case the explosion of the rating data into three pairs gives the best results.

Finally we have prepared a pen and paper SP design. We found that the use of conventional choice designs would not be appropriate, with the limited number of respondents that we were likely to find, as we could not cover a wide range of boundary values. We have used a four alternative ranking design, as this was able to cover the wide range of boundary values required for our design.

Chapter 6: THE MAIN SURVEY

In this chapter, we describe the planning and execution of the main survey. We first discuss the selection of the route and sampling issues. Then in section 6.4 we give details of the main survey itself and the segments covered. In sections 6.5 & 6.6 we give qualitative results of the interviews and problems faced. Finally we give a summary of the firms contacted.

The main survey was planned for April-May 1998. This period appeared to be the most suitable since the financial year ends on 31st March and the period upto 31st March is a peak period. April is the time when there was a greater possibility of senior managers being able to spare time for the interviews. After May there are chances of people being away on holidays due to the school vacations having started and the extreme heat.

6.1 The Sample Size

One major problem faced, in most freight surveys, is the issue of small sample sizes. This arises because, unlike in the case of passenger surveys where we have a large population to sample from, in the case of freight the number of firms manufacturing and/or transporting a particular type product is likely to be limited. Typically, we may only have a handful of firms in many product sectors on any one route. As discussed previously in chapter 4, this was one of the reasons for choosing an adaptive SP design for the present survey.

Tweddle, Fowkes & Nash (1995) have used a sample of 34 firms for a much wider spread of routes for phase I (before the start of Channel Tunnel traffic) of the Cross Channel studies. This sample size was further reduced to 30 for the 'after' phase (phase II interviews, Tweddle, Fowkes & Nash (1996)). Terzis, Copley & Bates (1992) have used a sample of 48 successful ASP interviews for investigating new business opportunities for British Rail's trainload freight business. On the other hand, surveys using the more conventional Choice based SP designs have worked with larger sample sizes (de Jong et al 1992 used a sample of 119 firms for their study on the Value of Time in the Netherlands. Ortuzar & Paloma 1988 have used a sample of 240 firms for their study on refrigerated cargo). Even these sample sizes are substantially lower than the samples taken for most passenger surveys.

In our case, it was felt that a total of about 30 successful interviews would be sufficient since we are using an adaptive SP rating design which is designed for obtaining maximum usable information from each interview.

6.2 Route Selection for The Survey

Some data on movement of road traffic on various major routes was available from RFFC(1993). This study has been carried out on four of the most important routes on the 'Golden Quadrilateral' and has evaluated the existing traffic and made forecasts for the year 2000-2001. It has also broken down the existing road traffic into containerisable and non-containerisable commodities to estimate the availability of containerisable traffic.

They have taken traffic estimates for various routes for 1986-87 from RITES 1987 and for 1989-90 from various OD surveys carried out by the National Council for Applied Economic Research (NCAER) and the Consulting Engineering Services (CES). The road traffic flows on the selected routes for the years 1986-87 and 1989-90 are given in Table 6.1.

Table 6.1: Summary of Road Freight Traffic Data

O-D PAIR	**1986-87 (Tonnes)**	**1989-90 (Tonnes)**	**Annual Growth rate (%)**	**Daily Traffic 1989-90 (Tonnes/Day)**	
				Total	**Container-isable**
Bombay - Delhi	715,035	1,489,200	27.7	4080	2152
Delhi - Bombay	538,094	606,630	4.08	1662	1034
Bombay - Calcutta	148,920	163,520	3.17	448	309
Calcutta - Bombay	86,505	155,490	21.58	426	267
Delhi - Calcutta	224,475	410,260	22.26	1124	651
Calcutta - Delhi	370,698	405,150	3.00	1110	497
Delhi - Madras	56,101	23,360	-25.32	64	49
Madras - Delhi	76,650	110,595	13.00	303	119

Source: RFFC 1993

They have made two sets of projections (see Table 6.2) for road traffic for the year 2000-2001. In the first set (optimistic), the growth rate of the previous three years is assumed to be maintained, on each route, for the next 10 years. In the second set, a 10% per annum growth rate is assumed for all the routes, based on the general trend of growth in traffic over the National Highway network.

Some of the figures given in Table 6.1, appear a little surprising to us. This shows a negative growth rate for the Delhi - Madras route which would, when projected forward, result in traffic falling almost to zero in the target year (see table 6.2). In case of the Delhi - Bombay route, the growth rate in one direction is 28% and in the other direction it is only 4% p.a. This should have led to a very heavy imbalance in the flows and a high ratio of empty running. That would further have led to a very large difference in the rates in the two directions. This is quite different from the actual situation which we have seen in our survey. This difference is likely to have arisen due the fact that these surveys have been carried out by different organisations and for different purposes. This could possibly have led to differences in timing (seasonality effect) as well as the difference in the definition of the various zones taken in the surveys and in the locations where the checkpoints were set up on the highways. As such, we are only taking these figures in a very broad and indicative manner.

Table 6.2: Road Traffic Projections For 2000-2001

O-D PAIR	**Scenario I (present growth rate over the respective route)**		**Scenario II (10% p.a. growth over all the routes)**	
	Annual (000 Tonnes)	Daily (Tonnes)	Annual (000 Tonnes)	Daily (Tonnes)
Bombay - Delhi	21931	60085	4249	11641
Delhi - Bombay	942	2581	1731	4742
Bombay - Calcutta	230	630	467	1279
Calcutta - Bombay	1334	3655	444	1216
Delhi - Calcutta	3743	10255	1171	3208
Calcutta - Delhi	561	1537	1156	3167
Delhi - Madras	0.94	2.5	67	184
Madras - Delhi	424	1162	316	866

Source: RFFC 1993

A subsequent survey of road traffic (RITES 1996) indicated that the total traffic on the Delhi - Bombay corridor was about 44 Million tons per annum with a length of haul of almost 1000 Km. The difference, between this and the previous set of figures, arises because the first set only takes into account traffic originating in one zone and terminating in the other whereas this (RITE 1996) takes all traffic entering/leaving either zone and travelling on the route under consideration.

In addition to this, the Delhi-Bombay route is currently accounting for the largest share of international container traffic for CONCOR. One of our original objectives, was to examine the possible economies of scope between domestic and international container traffic. As such this appeared to be the most suitable route for the purpose of undertaking the survey.

6.3 Segmentation

On the basis of RITES 1996 data and discussion with managers at CONCOR and some of the major road transport agencies, the following main commodities were identified on this route (based on the volume, containerisability, location of production/distribution centres [near Delhi]) :-

a) Parcels & miscellaneous piecemeal traffic
b) Rice & Rice Products
c) Chemicals
d) Household Goods
e) Automobile Parts
f) Electrical & Electronics Products
g) Food Products

Besides this, exports were taken as a separate segment, as we wanted to get the corresponding attribute valuations for export traffic as well. The largest single component, in domestic traffic, was the parcels & piecemeal traffic and for getting data on this we decided to interview the road transport operators who were presently carrying this traffic(since any attempt to capture this traffic would have to work through these operators for aggregating piecemeal traffic).

6.4 The LASP Survey

In all, we contacted 41 firms, in the survey out of which 32 successful interviews could be obtained. Of these, all but 9 pertain to the Delhi-Bombay corridor (the corridor includes traffic originating/terminating around or beyond the two cities) including 9 originating from industrial towns adjoining Delhi and another three from places 100 to 300 Km from Delhi, which were routed through Delhi, and two terminating in cities within 150 Km of Bombay. Of the remaining nine, 3 are for the Delhi - Calcutta (i.e. North to East) route, Three for the Delhi - Madras route (North to South) and two for Delhi - Kandla(another western port). The last one pertains to a movement of Zinc from western India to Delhi area.

People contacted were the people who would be playing a significant role in the mode choice decision and in 16 cases it was at the level of the Chief Executive (MD, GM, and Partners). In some cases, the transport and logistics function was handled by the managers in the accounts & finance departments. On enquiring about the reason for this, it turned out that this was because they were the persons who handled the accounts for payment of Excise duty on the products. This duty was payable on the material going out of the factory gates (it is technically collected at the factory gates and the records are supposed to be maintained at the gates), therefore, the logistics function was also handled by them.

In most cases, the respondents actively participated in the exercise and got the required data from the concerned people, in case they did not have some specific details. Many of the respondents were also quite interested to know if domestic container services were likely to be offered, on the route in question, on a regular basis. One however, was only interested in new services to the extent that their existence could be used as a bargaining point with the existing service providers, to ensure good services and pre-empt demands for increase in freight rates. In many cases, calculators were extensively used to calculate the effect of delays on inventory holding costs as against the discounts being offered. In other cases the respondents said that the delays could lead to loss of sales and customer dissatisfaction. Inventory holding costs were mostly taken by the respondents to be between 16 to 20 % of consignment value per annum. In general, delays of one day did not appear to have significant impact whereas delays of 2 days or more were viewed quite adversely. Similarly, as regards the frequency of service, a tri-weekly service, which implied an additional delay of one day, was not considered bad whereas a weekly service was viewed quite adversely. In some of the cases, of bulk movement to central warehouses, weekly services were acceptable as the despatches were being made one to two times a month and could be programmed appropriately.

6.4.1 International Traffic

Monthly data of commodity-wise full container load (FCL) despatches (in terms of twenty foot container units (TEU)) from ICD Delhi were obtained (Table 6.3). These figures indicated that the most important commodities were Rice, Brassware, Cotton Yarn, Handicrafts, and Slate Stones.

Table 6.3: Important Commodities Exported Via ICD-Delhi (TEUS)

	6 months figure
Rice	4,804
Brass Artware	2,308
Cotton Yarn	1,828
Slate Stones	1,368
Polyester Film	1,254
Handicraft Items	1,156
Bicycle Components	869
Auto Parts	807
Iron Artware	752
Ready-made Garments	733
Misc. Goods	724
Utensils	683
Hand Tools	646

In case of rice three of the six large exporters were contacted. One interview had to be terminated after two iterations, as the respondent pleaded that he was not in a position to spare enough time that day and suggested continuing another day (which could not finally be done). In the course of the interviews, it turned out that the mode of inland haulage was dependant on the final destination as exports to the Middle East were in Bulk Cargo ships, hence these were sent by truck to Kandla Port from where it was directly loaded on the ship. In this case, it was found that the truck haulage was working out to be much cheaper than container movement, since the trucks were carrying almost 25-27 tons as against the 21 tons carried by containers. There were also problems in road haulage of rice containers due to shortage of suitable trailers (to carry containers with a gross load of 23 tons).

In case of handicrafts and Brassware, five companies were contacted out of which four successful interviews resulted. The fifth interviewee was preoccupied with some urgent operational problem when he was visited. Out of these five companies, one was not using container services at all between Delhi - Bombay but was instead sending the material by truck to Bombay and then stuffing it into containers at Bombay. Another was doing this for almost 80% of his cargo. The rest were transporting more material through CONCOR than by road. The company, not using container services, said that this was because the products were normally ready just in time to catch the nominated ship and in case they were sent by rail there were chances of missing the ship. They were, therefore, paying an incentive to the trucker to get the cargo to destination quickly by employing two drivers to drive in shifts.

One of the three main yarn manufacturers was interviewed. In this case ratings could be obtained only for 3 columns as the respondent always gave 50 as the rating for column D (rail). It was however possible to complete 12 iterations using only 3 columns and this data was found to be usable.

Two companies dealing with stone exports were contacted and one was interviewed in detail, however the LASP exercise could not be carried out in this case because 100% of the cargo was going by Containers, from Delhi, and the LASP software had not been modified to handle such cases at that time.

6.4.2 Domestic Traffic

In case of rice, some of the major parties were contacted. They indicated that, in the rice trade, the prices were quoted on ex-warehouse basis and the consignee bore the freight. Consequently, the mode and the transport operator were decided by the consignee. Due to the limited time available, it was not possible to visit the destination stations to meet the consignees.

6.4.2.1 The Auto-Parts Industry

In case of the Automotive Components industry, the national association for the industry (Automotive Components Manufacturers Association - ACMA) was contacted who were quite helpful in providing the list of members with details of the production facilities and main customers along with industry level data on the production. Using this, eight companies were contacted out of which two were solely supplying to Auto manufacturers within a radius of 50 KM. Another two did not have any long distance truckload despatches. The truckload despatches were only in the local area and all the long distance movement was in piecemeal, due to the small volumes involved. Four successful interviews were finally obtained with companies ranging in turnover from Rupees 280 million at the smaller end to the spare parts division of the largest auto manufacturer in India with a total turnover of Rupees 88 Billion (Spares - Rupees 3.5 Billion).

6.4.2.2 The Chemicals Industry

In case of the Chemicals industry, five companies were contacted out of which two were through CONCOR and another two were through a Freight Forwarder working with

CONCOR. The fifth was a joint venture between a Public Sector Petroleum company and an MNC, which was not using any of the services provided by CONCOR. One of the companies contacted had the manufacturing facility at Madras and therefore had no movement on the Delhi - Bombay route. As such the Madras - Delhi flow was selected for the purpose of the interviews. In addition to this the leading public sector Zinc manufacturer was also contacted as they were already moving a substantial part of the Zinc produced, by containers from there Smelters in Western India to Delhi area. This would not strictly fall in the group of Chemicals but has many similarities in terms of being an industrial intermediate product and having similar consignment values. In this case the company had gone in for progressive use of containers despite higher costs due to the poor availability of trucks in the region where the smelters were located.

6.4.2.3 Electrical and Electronics Industries

In case of electrical and electronics manufacturers, six companies were contacted, none of whom were using CONCOR services. In one case, a manufacturer of consumer electronics items, the respondent refused to trade. He said that in view of the high value of his products, he would not be willing to consider a rail wagon or rail based container service at any cost. The other five included a MNC manufacturing Air Conditioners, two cable manufacturers, a television manufacturer and a manufacturer of switchgear. In these cases, the turnover varied from Rupees 80 million for the smaller cable manufacturer to Rupees 3.5 billion for the air-conditioner manufacturer. Of the five companies, two did not have very significant movements on the Delhi - Bombay route and as such the Delhi - Calcutta route was used for the LASP exercise.

6.4.2.4 Food Products Manufacturers

Two food products manufacturers were contacted, of which one is an MNC and the other a Public Sector undertaking. Both were regular users of CONCOR services. The MNC had a rail siding at its main plant and was using the same for despatch of full container trains to its central warehouses. For the other movement it had no alternative since it had to deal with a local truck union which forced the firm to use trucks supplied by the union's members. This phenomenon, of local truck unions, was encountered in some other places as well and is discussed in detail later. In case of the second company, an attempt had been made to contact the person concerned earlier from Leeds, for pre-testing of the postal questionnaire. The gentleman (Sr GM of the plant) had been unable to send the reply by fax but had completed and kept the questionnaire ready before the interview. He was willing to go through the LASP interview and his having completed the previous questionnaire was a help, since he had already gone through the alternative scenarios to a great extent.

6.4.2.5 The Road Transport Industry

Nine road transport operators were contacted, of which one was not willing to spare the time. The firms contacted ranged from small operators working only on the Delhi - Bombay route to one of the largest operators in the country, with nation wide operations, having its own offices at 600 locations in the country. They were mainly partnership firms except for the large operator, which was a public limited company. The turnovers ranged from Rupees 150 million, for the smallest operator contacted to Rupees 5 billion, for the largest operator contacted. This also included two operators who were working as freight forwarders as well, for CONCOR, on the Delhi - Madras route.

Some interesting facts came to light, regarding the existing road movements, during these interviews. Most of the operators have a limited number of own vehicles and hire the rest from the market. Even the largest operator contacted, who had about 1000 trucks in operation on any given day, owned only about 150 trucks with the balance being employed from the market on a long/short term basis. This matches with the ownership pattern in the industry, where a large number of truck owners are actually agriculturists owning upto 2-3 trucks. The smaller operators mainly function as agents for full load movement and the larger ones also perform the task of aggregation of smalls traffic at their warehouses. The owner provides the truck and the driver and the agent procures the traffic. Costing figures were also obtained from many of the operators and are dealt with in detail in the chapter on road vehicle operating costs. These indicate that in the overall costing there was a 10% profit margin, after interest and depreciation, for the owner and another 10% for the agent.

There are three basic types of trucks in use. The first, was the standard 2 axle vehicle with a loadable length of 18 feet and carrying capacity (CC) of 9 tons (though it could be used to carry upto 15 tons in practice). The second was a three-axle truck with a loadable length of 22 feet and a CC of 16 tons (carrying upto 27 tons in practice). Both types are of Indian designs, manufactured by the two main truck manufacturers in the country and are designed for rough terrain and heavy loads. In terms of volume, the 2 axle trucks could carry upto 0.8 container-loads and the 3-axle truck could carry more than a container-load due to the fact that they could stack up in height. The third is the category of Light Commercial Vehicles (LCVs), of Japanese as well as Indian makes, which have come to be called by the generic name 'Canter' after one of the first brands in this category. These vehicles have a carrying capacity of upto 6 tonnes and are preferred in the auto parts industry etc. because they are more suitable for smaller consignment sizes and are faster (they cut down almost a day on the transit time between Delhi-Bombay). They are less prone to overloading as they are designed for light loads only and are mainly used on the Delhi - Bombay corridor which has good roads.

6.5 Some Qualitative Findings of the Survey

During the course of the interview with the firms and the discussions with senior managers of Indian Railways and CONCOR, some interesting facts came to light about the status and working of the transport industry in India.

1) Risk Spreading Behaviour: Some of the firms were utilising more than one mode to ensure that the operations did not suffer on account of seasonal shortages of lorries or rail wagons. This was true of a Zinc manufacturing firm, which was located away from the main transport centres and hence faced a shortage of lorries. They were using container services even though these services were taking longer time and were costlier (20 to 30 %) as well. Loss/damages were also not a major concern as the cargo was fully insured against losses and not a damageable item. They faced seasonal shortages where the lorry rates would become prohibitive if they had no other mode available.

2) In some industries, such as food products, electronics, lube oils etc. there was a tendency to move to containerised trucks. For this purpose, some of the operators had specially designed truck bodies and others had bought/hired old ISO dimension containers, which had been fitted onto truck bodies. These were also being used, to some extent, in case of exports, since the consignor could know exactly how many cartons were likely to fit into a container at the port (this was important in case of handicrafts, where the carton sizes varied with each product and it was not

possible to have a standard count of the quantity to be dispatched per container). In the domestic sector, these would also be preferred in areas/seasons with heavy rains and on hilly terrain as well as on routes prone to thefts.

3) The normal operation of trucks on long distance routes is with a driver and an assistant (referred to as the 'cleaner'). However in case of urgent cargo, especially in case of exports, the parties give an incentive of about Rupees one thousand for the trip and the operator employs an additional driver, so that the truck can move round the clock without stopping for rest. This cuts down the journey time by at least one day from the normal time of 4-5 days for the Delhi-Bombay route.

4) Some companies also had penalty clauses in their contracts with road operators but these clauses were not enforced in cases when the delay was not within the control of the operator. Most respondents replied that they did not keep penalty clauses since there was no way of verifying the cause of the delay. Some of the respondents also mentioned that, in case they imposed penalties, they would ultimately end up paying the amount in the long run, since the operator would increase the prices over time to make up for any losses on this account. The one notable exception to this was the car manufacturer who had a standardised contract with a penalty of 2% per day beyond the target time. They also charged a penalty of 20% for material received in transhipped vehicles. These clauses were being rigidly enforced.

5) There is also a tendency for the local truck owners to form truck unions, in smaller towns, which insist that outside trucks should not be employed by local industries. However a lot of this traffic (even in full loads) is transhipped to bigger trucks at some of the major transhipment points, for long distance movements. One of the most important transhipment points is situated on the outskirts of Delhi and handles over 300-400 trucks a day. We also visited the premises of the national level operator in this area, to get a feel of the operations being carried out here.

6) We also found that some commodities, like cement and fertilisers, were moving in significant quantities by containers as well. This movement, however, was not a door to door container service and in most cases containers were being stuffed, while on rail wagons, in the private sidings of the factory and getting unloaded at

the destination terminals and moving by road to the warehouses. It was not possible, for us to examine the possibility of obtaining combined RP-SP models for these sectors, as the routes were different from those selected by us and the concerned factories were located away from Delhi.

6.6 Problems Faced

During the course of the interviews it became obvious that the present software was not able to cater to respondents having 100% movement by container and those not willing to accept the rail option at all. Initially, in a couple of cases, the respondent was just asked to consider that the 'D' column was container movement by road (simultaneously covering the existing heading of 'Rail' with a sheet of paper). Subsequently, the software was modified to provide for both the eventualities mentioned above.

In the first interview, after the 3rd iteration it became obvious that the respondent was not willing to consider the rail option at all and he was asked to ignore the last column. It was possible to get 12 iterations with this so it was still possible to use this data after eliminating all the combinations containing column D. In another case, the column 'D' was changed to road containers from iteration 2 onwards so some modification was required in the rating for column 'D' in iteration 1. In case of one of the freight forwarders, the respondent was giving answers in the form of percentage of consignments he would be willing to despatch by that mode and was assisted in converting these percentages to some sort of ratings. However, it was later realised, some of the replies were still percentage figures requiring some modifications. In case of one of the respondents in the food products segment, it was found that the respondent was not willing to consider either the rail option or the open truck option hence again only 3 columns could be rated.

The summary of firms contacted is given in table 6.4. The names of the firms have been coded and some of the figures have been rounded off to maintain privacy.

6.7 Conclusion

In this chapter we have described the planning and conduct of the main survey. We carried out the survey in India in April-May 1998. The Delhi - Bombay corridor was selected, by us, as this is one of the most important corridors for road freight movement within India and for the existing international container traffic. This 1500 Km long corridor carries about 44 million tonnes of road freight per annum, with an average length of haul of about 1000 km. It also accounts for almost half of the total rail movement of international containers in India.

In all, we contacted 41 firms and obtained 32 successful LASP interviews, covering the exports sector and five of the most important sectors for domestic traffic on this corridor i.e. freight forwarders & transport operators (for piecemeal and parcels traffic), chemicals, auto parts, electrical & electronics and food products.

In addition to the LASP interview data, we have also obtained quantitative data pertaining to the road vehicle operating costs as well as qualitative results on various aspects of freight transportation in India.

Table 6.4: Summary of firms interviewed and selected flows

Company	Total Traffic Ton/Mth	Details of Selected Flow									
		Commodity	Distance (Km)	Tons/ Month	Freight Rate (£/ton)	Product Value (£/ton)	Vol. Constrained	Transit Time (Days)	Reliab. (%)	Current Main Mode	Used Rail/ Container
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Exporters											
A1	300	Brass-ware	1700	240	43	1,300	Y	4	90	Road	Y
A2	25	Carpets	1600	65	40	1,900	Y	8	90	Container	Y
A3	600	Carpets/Yarn	1600	210	29	1,900	Y	5	95	Road	Y
A4	300	Home Furnishings	1600	300	40	2,000	Y	5	90	Road	Y
A5	6000	Rice	1000	3000	7	600	N	5	85	Road	Y
A6	1500	Rice	1600	1300	9	600	N	4	80	Road	Y
A7	800	Yarn	1500	10	33	2,000	Y	5	80	Road	Y
Freight Forwarders & Transporters											
B1	15000	Indl. Intermediate	2200	350	21	600	Y	7	95	Road	Y
B2	5700	Indl. Intermediate	3000	900	24	900	N	9	70	Road	Y
B3	2500	Indl. Intermediate	1500	1300	13	500	N	5	90	Road	Y
B4	5000	Indl. Intermediate	3000	225	31	80	N	7	93	Road	Y
B5	2200	Mixed	1500	1100	14	1,900	N	4	90	Road	N
B6	1500	Mixed	1500	700	14	700	Y	5	95	Road	N
B7	1600	Mixed	1500	550	11	1,300	N	5	90	Road	N
B8	1800	Auto Parts	1500	250	29	4,300	Y	5	90	Road	N
Chemicals											
C1	3500	Chemicals	1800	450	21	150	N	8	85	Road	Y
C2	1700	Chemicals	1750	100	25	500	N	6	95	Road	Y
C3	3200	Chemicals	2200	280	40	1,400	Y	8	85	Road	Y
C4	3500	Petro. Products	1600	400	17	700	Y	7	80	Road	N
C5	1300	Chemicals	1550	200	26	500	Y	6	95	Road	Y
C6	20000	Chemicals	650	1500	7	1,100	N	3	90	Road	Y
Electrical & Electronics											
D1	1500	Home Appliances	1500	250	29	4,300	Y	5	95	Road	N
D2	350	Home Electronics	1250	80	57	7,100	Y	7	80	Road	N
D3	160	Cables	1500	15	18	800	Y	5	100	Road	Y
D4	80	Cables	1250	90	23	1,900	N	9	80	Road	N
D5	200	Misc. Equipment	1500	15	19	2,900	Y	5	90	Road	N
Auto Parts											
E1	600	Auto parts	1550	15	34	1,400	Y	7	90	Road	Y
E2	700	Auto parts	1700	30	57	3,100	Y	5	90	Road	Y
E3	300	Auto parts	1200	10	37	3,400	Y	6	100	Road	Y
E4	5500	Auto parts	1550	2000	59	2,700	Y	6	90	Road	Y
Food											
F1	6000	food products	1200	700	17	1,600	Y	5	100	Container	Y
F2	6000	Soya Oil	1250	2000	16	300	N	7	90	Road	Y

Chapter 7: DATA ANALYSIS

We have first modelled the data, at the individual firm level, by weighted least squares regression. Sectoral models are then obtained, by taking the weighted averages of the attribute valuations, for the individual firm models (sections 7.1 & 7.2).

To compare these results with results using pooled data, the data for all the firms was pooled together and analysed using three different methods viz. Ordinary Least Squares (OLS) regression, Weighted Least Squares (WLS) regression and Random Coefficients regression model (RCM) (sections 7.3 & 7.4).

The process has then been repeated using simulated data to compare the recoverability of underlying values by different methods (section 7.5).

We have then compared the sectoral aggregated results using % basis with the same results in absolute terms to determine the suitable basis for further analysis (section 7.6). Further analysis has been carried out to evaluate the effect of non-service quality variables (commodity, firm & route related variables) in section 7.7. The final demand model is presented and discussed in sections 7.8 & 7.9.

7.1 Individual Firm level models

In section 5.8 we have examined various alternatives for data analysis and concluded that explosion of rating data into three paired choices (A-B, A-C and A-D) gives the best results in our case. Accordingly, the rating data has first been exploded into paired choices, with the ratings being converted into probabilities of choosing option 'A', in each case (see section 5.6.1). These probabilities are then subjected to a logit transformation. The attribute level differences are then regressed against the resultant logit variable using the model: -

$$\begin{aligned} LOGIT_A = {} & \beta_1(C_A - C_i) + \beta_2(T_A - T_i) + \beta_3(R_A - R_i) + \beta_4(Dum1) \\ & + \beta_5(Dum2) + \beta_6(DumF1) + \beta_7(DumF2) \end{aligned} \qquad (1)$$

Here the dependent variable is '$LOGIT_A$' as defined in section 5.6.1. The subscript 'A' refers to the base alternative and 'i' refers to the other three alternatives (B, C and D in turn). β_1 to β_3 represent the coefficients of 'cost', 'time' and 'reliability' respectively,

β_4 and β_5 represent the ASC (Intermodal services) and ASC (rail) respectively as compared to road and β_6 and β_7 represent the two frequency discounts (tri-weekly services & weekly services as compared to daily services). The costs have been taken as percentage of the freight rate by the currently used mode, in order to obtain all valuations in percentages of the current cost. The resulting coefficients were divided by the corresponding coefficient for 'Cost difference' (β_1) to obtain the attribute valuations, as percentages of the current freight rate.

The results of the regression models, for the individual firms, are given in Table 7.1. Column 1 gives the company code, column 2 gives the adjusted R square values of the regressions, columns 3 to 7 are the ASCs where 'RC/IM' refers to the ASC for container movement by road with respect to intermodal container service. All other ASCs are with respect to open top road Lorries. IMC refers to Intermodal Container Services and C-L to containerised lorries (i.e. lorries with container type lockable bodies). Columns 8 & 9 are the frequency discounts where F1 represents a tri-weekly service and F2 represents a weekly service (both are in comparison to a daily service). Columns 10 & 11 give the values of Time (in percentage of freight rate per day) and Reliability (in percentage of freight rate per percent point change in reliability) respectively. Columns 12 to 20 give the 't' value of the estimates given in columns 3 to 11 respectively.

The values are given in terms of percentages of current cost. These figures have later been changed, to absolute values rather than percentages, for the purpose of estimating the break-even points. We do this because the estimates, there (in chapter 9), are being made for a range of distances and use in percentage terms would imply that the absolute value of all the attributes would increase with distance, which is not likely to be strictly correct in real life. The use of valuations in percentages and in absolute terms is discussed subsequently, in section 7.6.

Table 7.1: Individual Firm Models

Firm	Adj R2	Estimated Values									't' Values of Ratios								
		ASCs					Freq. Disc.				ASCs					Freq. Discs			
		Rd_Cont /IM	IM	Rail	Parcel	Cont_ Lorry	F1	F2	VOT	VOR	Rd_cont /IM	IM	Rail	Parcel	Cont_ Lorry	F1	F2	VOT	VOR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
A1	0.730		12.48			4.61	-18.07	-34.42	9.12	-3.35		2.8			1.2	-3.6	-6.0	1.4	-2.1
A2	0.364	10.53	23.02				-26.19		14.16	-1.76	1.4	2.6				-1.8		1.6	-0.8
A3	0.479		12.04			7.90	-42.10	-125.82	6.51	-10.78		1.0			0.6	-2.8	-6.9	0.5	-2.4
A4	0.620		27.54			3.20	-45.33	-84.94	9.72	-5.47		3.8			0.4	-4.4	-9.0	1.6	-2.9
A5	0.576		-7.39	-50.51			-61.62	-231.64	39.9	-0.19		-0.9	-6.8			-7.3	-4.0	5.1	-0.1
A6	0.769		5.65	-8.27			-48.81	-263.79	11.38	-11.25		0.9	-1.4			-7.7	-5.4	2.2	-7.2
A7	0.860		7.58				-19.03	-63.44	9.27	-1.81		2.4				-4.4	-12.3	3.6	-2.3
B1	0.429		-9.50	-61.30			27.99	2.27	1.53	-0.43		-0.9	-7.8			1.5	0.2	0.2	-0.2
B2	0.580		-5.82	-12.36			1.64	-31.91	6.54	-1.97		-0.9	-2.0			0.1	-3.8	0.7	-0.8
B3	0.649		0.29	-17.55			-21.71	-88.49	3.45	-3.55		0.1	-3.0			-3.5	-11.9	0.5	-2.2
B4	0.661		-16.08	-15.20			-38.77	-51.55	17.19	-1.49		-3.7	-3.4			-7.9	-8.7	4.1	-1.2
B5	0.771		-10.66	-24.99			-27.15	-65.04	13.92	-0.73		-3.2	-7.2			-4.1	-14.4	3.7	-0.6
B6	0.445		-2.75	-41.08			-21.31	-62.83	28.41	-4.24		-0.3	-5.2			-2.8	-6.4	3.9	-2.2
B7	0.409		-1.14	-34.25			13.39	-18.26	19.50	2.41		-0.2	-3.4			1.1	-1.7	2.0	0.9
B8	0.664		2.78	-29.37			-18.66	-84.87	7.86	-1.41		0.4	-4.1			-2.5	-6.5	1.2	-0.7
C1	0.541		-2.91	-26.15			-7.26	-2.39	10.26	-0.64		-0.5	-3.6			-0.7	-0.3	1.5	-0.3
C2	0.448		-3.44	-17.62			-22.36	-94.96	22.17	0.69		-0.3	-2.0			-1.5	-6.9	1.8	0.2
C3	0.412		6.54	-42.48			-14.37	-18.34	13.20	-4.25		0.8	-6.8			-1.6	-1.9	1.7	-2.3
C4	0.634		15.35	-28.32			-15.53	-56.81	14.97	-3.03		3.1	-4.9			-2.7	-7.2	3.2	-2.4
C5	0.750		-2.78			-3.89	-2.94	-19.75	5.79	-0.74		-0.7			-0.7	-0.4	-3.3	1.2	-0.5
C6	0.545		-7.90	-32.05			-15.74	-16.65	16.62	-1.55		-1.3	-6.0			-2.2	-2.1	3.4	-1.1
D1	0.799		-0.61			-3.97	-59.00	-124.54	9.12	-6.36		-0.1			-0.4	-5.2	-7.1	1.1	-2.6
D2	0.537		33.36	-77.46			-31.21	-87.32	11.82	2.12		2.5	-5.6			-1.2	-4.5	1.0	0.5
D3	0.527		-6.19	-11.44			2.29	5.43	7.47	-1.50		-1.0	-2.1			0.2	0.5	1.4	-0.8
D4	0.814		-14.57	-14.57			-16.48	-44.60	3.18	-1.30		-6.4	-6.4			-2.9	-13.2	1.0	-1.3
D5	0.851					-4.62	-2.40	-32.64	14.58	1.29					-1.8	-0.7	-9.7	4.0	1.4
E1	0.539		6.55		-31.33		-3.72	-28.99	10.74	-2.41		1.0		-5.0		-0.5	-2.6	1.6	-1.4
E2	0.692		26.52			6.18	-17.23	-46.93	14.28	-4.10		6.5			1.3	-2.1	-8.0	2.9	-2.7
E3	0.731		-11.96			-11.96	-0.59	0.13	11.82	-1.70		-2.8			-2.8	-0.1	0.0	2.1	-1.2
E4	0.763		-2.23	-37.88			32.38	-266.43	4.92	-10.05		-0.1	-2.1			0.9	-2.0	0.2	-1.4
F1	0.442		25.14				-31.62	-4.57	-1.56	-4.07		3.4				-2.0	-0.2	-0.2	-2.2
F2	0.759		12.65	-16.36			0.35	-6.32	7.20	-0.71		2.9	-4.1			0.1	-1.1	1.3	-0.6

7.2 Aggregate Models

We have aggregated the results, from the individual firm models, to obtain sectoral models (Table 7.2) by taking weighted averages with the weights set as inverse of the variances of the individual firm's estimates (see section 5.6.2). This weighting scheme is taken as it minimises the variances of the aggregate estimates.

Table 7.2: Sector estimates ('t' values shown in brackets)

Sector		**ASCs**					**Frequency Discounts**		**VOT**	**VOR**
		RC/IM	**IMC**	**Rail**	**Parcel**	**C_L**	**F1**	**F2**		
Exporters	Estimate	10.5	10.1	-25.4		4.6	-30.2	-59.7	11.5	-3.6
	't'	*(1.4)*	*(4.9)*	*(-5.4)*		*(1.4)*	*(-11.7)*	*(-17.2)*	*(6.1)*	*(-6.4)*
F. Forwarders	Estimate		-7.6	-24.9			-23.7	-56.2	13.5	-1.6
Transporters	't'		*(-3.9)*	*(-12.5)*			*(-8.8)*	*(-21.3)*	*(6.4)*	*(-2.7)*
Chemicals	Estimate		1.3	-30.9		-3.9	-12.8	-26.9	12.7	-2.0
	't'		*(0.5)*	*(-10.8)*		*(-0.7)*	*(-3.8)*	*(-8.1)*	*(5.3)*	*(-3.0)*
Electrical/	Estimate		-7.3	-15.5		-4.6	-8.6	-38.6	8.3	-0.4
Electronics	't'		*(-4.5)*	*(-7.5)*		*(-1.8)*	*(-3.3)*	*(-16.8)*	*(4.0)*	*(-0.7)*
Auto Parts	Estimate		7.6	-37.9	-31.3	-4.2	-4.0	-21.5	12.5	-2.8
	't'		*(2.8)*	*(-2.1)*	*(-5.0)*	*(-1.3)*	*(-1.1)*	*(-5.9)*	*(3.9)*	*(-3.2)*
Food	Estimate		15.9	-16.4			-3.1	-6.2	4.8	-1.7
	't'		*(4.23)*	*(-4.1)*			*(-0.6)*	*(-1.1)*	*(1.0)*	*(-1.7)*

7.3 Aggregate Models using Pooled Data

The aggregate models have also been estimated directly, using pooled data. We have used three different approaches, for direct estimation using pooled data. In the first instance, the data has been modelled using ordinary least squares regressions on pooled data, using the same basic model form as used in the estimation of the individual firm models (Equation 1). Secondly we have used weighted least squares (WLS), again using the same basic model form but this time with a weighting function which gives maximum weight to ratings near 100 (as used for the individual firm models). Finally we have attempted to estimate a random coefficients regression model (RCM) to take account of the taste variation between individuals. This has been estimated using LIMDEP 7.0 econometric software and in this case all the coefficients have been allowed to vary randomly across individuals.

In case of the RCM model, the basic model form is again the same as used for the individual firm level models. It was possible to run this model for only one of the sectors as the software required a minimum of 7 firms in a dataset (due to 7 parameters being estimated). In our dataset there are two sectors with 7 or more firms (exports and

Freight forwarders/transporters). However, in case of the exports segment, two of the firms had to be eliminated, since there was no variation in one of the attributes in each of these and the software did not accept these groups (in case of one firm only three alternatives have been taken hence there is no variation in the ASC-Rail and in the other one there is no variation in the F2 (weekly discount)). This left only 5 firms and hence the model could not be run for this sector either.

Table 7.3: Summary of Analysis results for Pooled data

Data Set	Model	Values Recovered						't' of ratio					
		IMC	TRC	F1	F2	VOT	VOR	IMC	TRC	F1	F2	VOT	VOR
29 Firms	Wt_Avg	-1.4	-22.2	-16.3	-38.7	3.9	-2.0	-1.5	-18.8	-12.4	-29.3	11.0	-6.7
	RCM	-3.5	-24.8	-17.0	-54.2	5.8	-1.8	-1.1	-6.2	-4.4	-5.7	8.0	-2.9
	WLS	14.1	-13.5	-9.9	-68.2	-1.0	-5.4	2.6	-2.6	-1.5	-8.8	-0.5	-3.6
	OLS	-1.8	-26.8	-18.8	-68.9	5.2	-2.9	-0.5	-7.6	-4.0	-13.5	4.1	-2.7
F.Forwarders Transporters (8 firms)	Wt_Avg	-7.6	-24.9	-23.7	-56.2	4.5	-1.6	-3.9	-12.5	-8.8	-21.3	6.4	-2.7
	RCM	-12.7	-34.4	-15.4	-45.0	6.3	-1.1	-3.5	-5.9	-2.4	-3.8	4.9	-1.4
	WLS	3.7	-23.5	-11.9	-60.4	2.2	-1.0	0.5	-3.6	-1.5	-6.9	0.9	-0.5
	OLS	-11.5	-36.1	-17.2	-46.9	6.7	-0.6	-3.1	-9.4	-3.6	-10.0	4.9	-0.5
Exports (7 firms)	Wt_Avg	10.1	-25.4	-30.2	-59.7	3.9	-3.6	4.9	-5.4	-11.7	-17.2	6.1	-6.4
	WLS	25.6	-1.7	-44.8	-100.5	1.5	-6.4	2.8	-0.2	-4.7	-6.0	0.6	-2.8
	OLS	8.5	-15.2	-45.0	-156.8	7.5	-3.1	1.0	-1.7	-4.3	-7.7	2.8	-1.3
Chemicals (6 firms)	Wt_Avg	1.3	-30.9	-12.8	-26.9	4.2	-2.0	0.5	-10.8	-3.8	-8.2	5.3	-3.0
	WLS	4.9	-21.1	-7.4	-36.5	1.4	-4.6	0.7	-3.0	-0.8	-4.0	0.6	-2.4
	OLS	8.6	-14.4	-13.5	-56.0	0.7	-5.2	1.2	-1.9	-1.4	-5.3	0.3	-2.6
Electrical (5 firms)	Wt_Avg	-7.4	-15.5	-8.6	-38.6	2.8	-0.4	-4.5	-7.5	-3.3	-16.8	4.0	-0.7
	WLS	9.3	-20.2	-2.6	-88.7	-2.6	-7.2	0.7	-1.6	-0.1	-4.1	-0.5	-1.8
	OLS	2.6	-38.3	-11.4	-67.3	3.0	-3.7	0.3	-4.6	-0.9	-5.5	1.0	-1.5
Auto (4 firms)	Wt_Avg	7.6	-37.9	-4.0	-21.5	4.2	-2.8	2.8	-2.1	-1.1	-5.9	3.9	-3.2
	WLS	9.8	-13.0	5.6	-52.1	-2.6	-4.6	0.7	-1.0	0.3	-2.6	-0.5	-1.2
	OLS	-0.6	-16.5	-3.3	-61.3	3.9	-6.8	-0.1	-1.4	-0.2	-3.5	0.8	-1.7
Food (2 firms)	Wt_Avg	2.7	-16.4	-3.1	-6.2	1.6	-1.7	0.7	-4.1	-0.6	-1.1	1.0	-1.7
	WLS	-13.4	-8.4	0.1	7.7	-2.1	-4.0	-1.7	-0.8	0.0	0.5	-0.6	-2.0
	OLS	-5.6	-12.9	1.4	-13.2	6.0	-2.2	-0.8	-1.3	0.1	-1.1	2.1	-1.2

Subsequently the data for all the firms has been pooled together to run an overall model. In this case, in addition to the two firms eliminated from the exports sector, one more firm had to be eliminated from the 'Food' sector as in this case as well we had only used three alternatives and no data was available regarding the ASC-rail. This left us with 29 firms and the results of the Random coefficients model, the weighted average, the Multiple regression models using weights (the usual LASP analysis) and the Multiple regression model without weights are summarised in Table 7.3.

7.4 Results of the Analysis

If we compare results, from the Weighted averages with the results from the pooled regressions (with and without weights), we find that the results from the pooled regression without using weights appear to be more reasonable than the results using weighted regressions. The Weighted Least Squares regressions (with pooled data) give negative values of VOT for the 29 firms pooled together as well as for three of the sectors (Electrical & Electronics, Autoparts, Food) at the sector level. We also get some changes of sign in case of the ASC-IM as well as the discount for tri-weekly service. In case of OLS regression without weights (using pooled data) the signs match with the results using weighted averages of individual firm models and the magnitudes are also similar. The adjusted R-square values (not shown here) are lower in case of the weighted regressions (than OLS without weights) in every sector.

When we compare the results of weighted averages of individual firm's models with results from RCM & OLS regression models (using pooled data), the results appear quite similar in sign and magnitude for all the three methods.

7.5 Analysis Using Simulated Data

In order to attempt to gain a better understanding of the recoverability of underlying values, using the different methods discussed above, we have repeated the analysis using synthetic data.

We have carried out simulations to compare the recoverability of underlying values, in presence of taste variation, using the weighted averages of individual firm models as against estimation using pooled data for all the firms. The analysis has been carried out using Limdep 7.0 Econometric Software. The matrix manipulation and programming facilities in this software allowed for automation of the entire process of analysis upto the point of producing comparative estimates for the different methods.

7.5.1 The Data generation

The basic range of attribute valuations, used for the simulation, is based on the low, medium and high values found in the survey results.

Two different types of attribute valuations have been used for generating the synthetic data: -

a) using three values of time and reliability (low, medium and high) with the middle values being given double weight and the low and the high values being given single weight. The ASCs and frequency discount values were kept constant at a medium level. The 'K' factor, which determines whether the respondent is giving ratings within a narrow range or widely varying ratings, was kept at a medium value of 100 (except for simulation set 'c' (section 7.5.3) where we have tried to evaluate the effect of variation in rating behaviour).

b) To compare the recoverability of the coefficients (as opposed to the attribute values), three different values of the coefficients of time and cost have been taken (low, medium, high), with the medium values being double weighted, and the value of time calculated for all combinations of the values (total 16 due to double weighting of medium values). The resulting values of time have been used for generating synthetic data with all other attribute values kept constant at medium levels.

7.5.1.1 Error Structure Introduced

Lognormal multiplicative error terms have been added in the data generation in each iteration, within LASP. Initially, the rating values obtained at each stage were multiplied with the error term and the resulting values used for the next iteration. For this process, the error terms were generated using the random number generation in Excel 5.0 package which was used to generate a set of 5000 random numbers distributed N[0,0.11]. These numbers were then converted to lognormal by exponentiation. This resulted in a lognormal distribution lying between 0.8 and 1.25 with mean = 1.0 and with 2.5% of distribution in either tail.

Subsequently, we found that this form of multiplicative error terms was resulting in non-convergence of the tasks (therefore the algorithm was not able to do all the tasks it needed to do). Besides this, in some cases, the error terms also caused the rating to cross over from 100 (i.e. if the actual rating was greater than 100, the error term could make it less than 100 or vice-versa). In reality, this would not be expected to happen as the respondent is likely to be quite clear regarding which alternative he prefers but the actual rating given may vary (i.e. it would still remain greater/less than 100 if the alternative was preferred/not preferred as compared to the base alternative).

Thereafter, we changed the form of the error terms, by multiplying the difference (of the rating) from 100, with the lognormal random numbers. Different sets of random numbers have been used with mean = 1.0 in each case. The target was to obtain a dataset giving similar values of Adjusted R Squares as obtained in the analysis of the actual survey data. In case of the individual firm models, this (the adjusted R squares values) ranged from about 0.5 to 0.85 and in case of the pooled models between 0.3 to 0.6. We have also given results for some of the other datasets used, to illustrate the behaviour of the different modelling approaches, as the error structures changed. The first, has a distribution lying between 0.6 to 1.6, another two with distributions lying between 0.35 and 2.7 (but different seed values) and the last between 0.3 to 3.25. The results from different sets of simulations are discussed below.

7.5.2 Index of Recoverability

We have taken the sum of the (absolute values of) percentage errors, in estimated values, as the index of recoverability of original values (lower numbers indicate better recovery). It was felt that better estimation of VOT & VOR may be desirable and as such we have also re-computed the sum of the % errors by weighting the percentage errors for VOT & VOR by 2 and by 4 with the other four attributes being given single weight. The effect of this weighting has been illustrated in section 5.4.

7.5.3 Simulation results

Simulation Set 'b' :

combinations of VOT (% of present cost per 8 hrs) = 2% (low), 4% (med), 10% (high)

VOR (% of present cost per % pt)= 1% (low), 5% (med), 10% (high)

run no. 0: no error terms in the rating process

run no. 1: lognormal error terms distributed between 0.6 - 1.6 (mean = 1.0)

(80 firms = 2160 observations)

run no. 2: " " " " 0.35 - 2.7(mean =1.0)

(80 firms = 2160 observations)

run no. 3: Same distribution as 3 & 4 but different seed value and 800 firms giving us 21600 observations.

run no. 4: Lognormal error terms distributed between 0.3 and 3.25

(800 firms = 21600 observations)

We have shown the detailed results of the first 3 runs in Table 7.4 and summarised the recoverability index values of all the 5 runs subsequently, in Table 7.5 along with those from simulation set 'c'.

Table 7.4: Results of simulation set ‘b’

Attribute values input : ASC(IM)= -5, ASC(RI)= -10, F1=10, F2=15, VOT(wt avg.)=5, VOR(wt avg.)= -5.25													
		run 0				run 1				run 2			
	Model	OLS	WLS	RCM	Wt. Avg.	OLS	WLS	RCM	Wt. Avg.	OLS	WLS	RCM	Wt. Avg.
Value	ASC (IMC)	2.1	2.6	-6.3	-5.5	-0.9	-1.8	-5.5	-5.3	-0.7	-1.9	-3.5	-4.3
‘t’		*0.9*	*1.1*	*-13.6*	*-32.1*	*-0.90*	*-2.36*	*-18.96*	*-37.27*	*-0.65*	*-2.69*	*-3.91*	*-15.20*
Value	ASC (Rail)	-0.4	-0.9	-10.6	-10.3	-3.8	-5.6	-9.6	-9.7	-4.9	-6.3	-8.4	-9.4
‘t’		*-0.1*	*-0.3*	*-26.5*	*-53.7*	*-3.65*	*-7.06*	*-34.89*	*-67.20*	*-4.10*	*-8.49*	*-10.84*	*-32.81*
Value	Tri-Weekly	-11.7	-11.1	-9.7	-9.6	-10.4	-9.9	-9.9	-9.9	-9.3	-10.8	-9.9	-10.2
‘t’		*-4.5*	*-4.4*	*-30.2*	*-51.5*	*-8.51*	*-10.54*	*-26.09*	*-56.71*	*-5.74*	*-11.06*	*-10.23*	*-27.61*
Value	Wkly Disct.	-20.8	-19.8	-14.1	-14.4	-16.6	-14.5	-14.6	-14.6	-17.1	-15.3	-15.6	-14.9
‘t’		*-7.0*	*-6.9*	*-38.0*	*-66.9*	*-12.66*	*-14.11*	*-44.77*	*-76.03*	*-10.99*	*-15.85*	*-18.03*	*-39.88*
Value	VOT	4.0	3.4	5.3	3.8	4.2	3.9	5.2	4.2	5.0	3.9	4.9	4.7
‘t’		*5.6*	*4.6*	*6.0*	*61.2*	*14.22*	*16.15*	*12.60*	*93.25*	*13.09*	*15.36*	*9.35*	*49.44*
Value	VOR	-6.4	-6.4	-5.6	-2.1	-6.5	-5.9	-5.7	-4.2	-6.1	-5.5	-5.9	-5.2
‘t’		*-11.6*	*-11.3*	*-6.1*	*-48.3*	*-26.46*	*-29.78*	*-12.51*	*-111.08*	*-18.74*	*-26.18*	*-10.85*	*-64.65*
% error in Estimated Values	ASC (IMC)	-141	-153	26	10	-82	-63	10	5	-85	-61	-29	-14
	ASC (Rail)	-96	-91	6	3	-62	-44	-4	-3	-51	-37	-16	-6
	Tri-Weekly	17	11	-3	-4	4	0	0	0	-7	8	-1	2
	Wkly Disct.	38	32	-6	-4	11	-3	-3	-3	14	2	4	0
	VOT	-20	-32	6	-23	-16	-22	3	-17	1	-23	-2	-6
	VOR	22	21	6	-61	24	12	8	-21	16	4	14	-1
Recoverability Index	1:1	335	340	53	106	200	145	28	48	175	135	65	29
	1:2	377	393	64	190	240	180	39	86	193	162	80	36
	1:4	461	499	87	358	321	249	61	161	227	216	111	50
Goodness of fit	Adj R2	0.44	0.35	0.27		0.409	0.419	0.331		0.423	0.529	0.383	
	Rho	0.24	0.28			0.16	0.22			0.06	0.12		
	Log L	-111	-22			-878	-61			-1486	-127		

Comparing the results (Table 7.5) for runs 1, 2, 3 & 4 for the present set (simulation set ‘b’) we find that, as expected, the OLS & WLS regressions on pooled data do not give very good results. The overall results, using weighted averages and RCM, are much better. The RCM model appears to give much better results with no or small errors in the rating (i.e. run 1 & 2). The weighted averages of individual firm models, appear to perform better in the presence of bigger error terms (runs 2, 3 & 4).

<u>Simulation Set ‘c’ :</u> combinations of VOT = 2%(low), 4% (medium), 10% (high)

VOR = 1%(low), 5% (medium), 10% (high)

K (rating behaviour)= 50 (narrow rating)

100 (average rating)

150 (wide rating)

The purpose of this dataset was to see the effect of variation in rating behaviour, on the recoverability of the underlying values, using the different methods. The hypothesis, tested here, was that the OLS & WLS on pooled data would give much worse results in the presence of variation in rating behaviour because they cannot account for the effect of difference in rating behaviour between respondents (Kim 1998).

run no. 0: no error terms in the rating process (16 firms = 432 observations)

run no 1 : lognormal error terms distributed between 0.6 - 1.6 (mean = 1.0)
(80 firms = 2160 observations)

run no 2 : " " " " " 0.35 - 2.7(mean =1.0)
(80 firms = 2160 observations)

run no. 3: Same distribution as 2 but different seed value and 800 firms in all giving us 21600 observations.

run no. 4: Lognormal error terms distributed between 0.3 and 3.25
(800 firms = 21600 observations)

If we compare the results (sums of the percentage errors) from this simulation with those of the previous set (Table 7.5), it appears that there is some improvement in the results of the OLS, WLS and weighted averages of individual firm models, in the presence of variation in rating behaviour. However, the results in case of the RCM model have actually become worse in all but run 2, where they have shown some improvement. The result, appears to be rather unexpected in case of OLS and WLS estimations.

We have also aggregated the individual model results using means rather than weighted averages (the last rows for run 4 & 5). The recoverability using the means of the individual firm models is poorer than that achieved using weighted averages. In case of set 'b' (with uniform rating behaviour) the recoverability, using means of individual firm models, appears to be poorer than both the RCM model with pooled data and the weighted averages of individual firm models.

In case of set 'c' (with variation in rating behaviour), the performance of the means of individual models appear to be poorer than that of the weighted average models. However in comparison to the RCM, it is better in one case and slightly worse in the other.

This seems to indicate that the method based on individual firm models, aggregated using weighted averages, appears to give better results than pooled estimation, using

RCM model, in the presence of variation in rating behaviour as well as in the presence of errors in the rating process. The use of the weighted averages could be responsible for the individual firm models giving better results than the pooled RCM results.

Table 7.5: Comparative results of simulation set 'b' & 'c'

Run	Model Used	Set 'b' (uniform rating behavior)			Set 'c' (variation in rating behavior)		
		1:1	1:2	1:4	1:1	1:2	1:4
run_0 no errors in rating	OLS	335	377	461	124	169	261
	WLS	340	393	499	101	137	208
	RCM	53	64	87	78	143	273
	Wt. Avg	106	190	358	84	110	163
run 1 (0.6 – 1.6) 80 firms 2160 Obs	OLS	200	240	321	181	246	374
	WLS	145	180	249	110	141	202
	RCM	28	39	61	67	90	137
	Wt. Avg	48	86	161	44	73	130
run 2 (0.35 – 2.7) 80 firms 2160 Obs	OLS	175	193	227	72	86	115
	WLS	135	162	216	98	114	148
	RCM	65	80	111	28	35	50
	Wt. Avg	29	36	50	17	20	26
run 4 (0.35 – 2.7) 800 firms 21600 Obs	OLS	187	224	297	76	108	171
	WLS	136	162	214	106	129	176
	RCM	37	50	77	38	54	85
	Wt. Avg	25	36	58	20	32	58
	Mean	58	70	93	50	63	89
run 5 (0.3 – 3.25) 800 firms 21600 Obs	OLS	123	156	222	108	144	217
	WLS	132	157	208	112	137	187
	RCM	27	40	67	63	85	127
	Wt. Avg	24	33	51	21	30	50
	Mean	57	68	92	50	63	87

<u>Simulation Set 'd':</u> taking three different level of coefficients of time and cost and then combining them into VOT values as follows:-

Table 7.6: Details of coefficients of 'time' & 'cost' used for simulation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	Wt. Avg.	
Time coeff.	5	40	120	5	40	120	5	40	120	51.25	
Cost Coeff.	5	5	5	10	10	10	40	40	40	16.25	**3.15**
VOT	1	8	24	0.5	4	12	0.125	1	3	**5.45**	
Weight	1	2	1	2	4	2	1	2	1		

The weighted average of the VOT values in the above case is 5.45 whereas if we take the weighed averages of the coefficients and use them to obtain the resulting VOT we get 51.25/16.25= 3.15. The purpose of this exercise was to test the hypothesis that mixed logit may give us estimates nearer to the weighted averages of the coefficients instead of the weighted average of the VOT values themselves.

In this case, all the other parameters (ASC-IM, ASC-Rail, F1, F2, K and VOR) were kept fixed at medium values with the same error terms in each run as used in the previous sets:-

run no 1 : lognormal error terms distributed between 0.6 - 1.6 (mean = 1.0)

run no 2 : " " " " " 0.35 - 2.7(mean =1.0)

run no 3 ; same distribution as 2 with different seed value.

The results (Table 7.7) show that the estimated value using RCM is nearer to the value of 5.45 than 3.15 in all cases and using Wt. Avg. in two cases. This seems to reject the hypothesis that the RCM model may estimate results based on the weighted averages of the coefficients. However in the present set the weighted averages give consistently better results than the RCM in terms of lower values of sums of percentage errors.

Table 7.7: Results of simulation set 'd'

values input : ASC(IM)= -5, ASC(Rl)= -10, F1=10, F2=15, VOT(wt avg.)=5.45 (ratio=3.15), VOR= -5													
		run 1				run 2				run 3			
		OLS	WLS	RCM	Wt. Avg.	OLS	WLS	RCM	Wt. Avg.	OLS	WLS	RCM	Wt. Avg.
Value	ASC (IMC)	1.7	-0.1	-5.9	-5.2	-0.8	-1.9	-3.6	-4.3	-1.5	-1.8	-4.1	-4.6
't'		1.0	-0.1	-13.7	-36.2	-0.6	-2.0	-4.2	-14.9	-1.2	-2.3	-6.3	-16.6
Value	ASC (Rail)	0.5	-3.7	-9.8	-9.6	-4.9	-5.4	-8.5	-9.1	-5.8	-6.7	-8.7	-9.2
't'		0.2	-3.7	-27.3	-65.5	-3.7	-5.9	-10.8	-31.5	-4.3	-8.5	-14.8	-32.9
Value	Tri-wkly disct.	-10.0	-10.4	-10.0	-10.0	-8.5	-9.0	-10.7	-10.3	-5.5	-8.6	-10.2	-9.9
't'		-4.7	-9.1	-14.6	-55.9	-4.8	-7.6	-13.1	-27.8	-3.1	-8.5	-13.6	-27.2
Value	Weekly Disct.	-17.1	-14.8	-14.4	-14.7	-16.4	-15.0	-15.5	-15.0	-16.0	-15.2	-15.2	-14.9
't'		-7.4	-11.8	-36.1	-75.2	-9.3	-12.5	-18.1	-39.6	-9.2	-15.0	-21.8	-40.4
Value	VOT	4.4	4.1	6.6	3.6	4.3	4.4	5.5	4.9	4.8	4.4	5.8	4.6
't'		8.6	14.2	6.5	79.8	10.0	14.5	5.3	51.0	11.2	16.3	5.6	48.0
Value	VOR	-6.7	-5.0	-5.5	-4.9	-6.0	-4.9	-5.5	-5.0	-6.3	-4.8	-5.6	-4.9
't'		-14.9	-20.6	-18.3	-127.8	-15.9	-18.9	-14.6	-61.0	-16.3	-20.7	-15.3	-58.9
% error in Recovered Values	ASC (IMC)	-135	-98	18	4	-84	-63	-29	-15	-70	-63	-18	-8
	ASC (Rail)	-105	-63	-2	-4	-51	-46	-15	-9	-42	-33	-13	-8
	Tri-Wkly Disc.	0	4	0	0	-15	-10	7	3	-45	-14	2	-1
	Weekly Disct.	14	-1	-4	-2	9	0	4	0	7	1	1	-1
	VOT(frm 5.45)	-19	-25	21	-35	-21	-19	2	-10	-11	-20	7	-16
	VOR	34	0	9	-3	19	-2	10	0	25	-5	13	-2
Error Sum	1:1	307	192	54	47	198	140	66	37	200	136	53	35
	1:2	360	217	85	85	239	162	77	47	237	161	73	52
	1:4	468	268	146	159	319	205	101	67	310	210	113	87
Goodness of fit	Adj R2	0.21	0.35	0.02		0.38	0.44	0.29		0.36	0.49	0.29	
	Rho	0.20	0.21			0.13	0.14			0.07	0.07		
	Log L	-1533	-181			-1487	-267			-1579	-200		

7.5.4 Conclusions from Simulations

On the whole, these simulations seem to indicate that the results obtained by use of individual firm models, aggregated using weighted averages, and by using pooled data, modelled by Random Coefficients regressions, are better than the results from use of OLS and WLS regressions on the pooled data. However, in the present case, variation in rating behaviour has not led to increase in errors in estimation using OLS & WLS.

Between the weighted average of individual firm models with and the pooled RCM model, the pooled RCM model seems to perform better in the case of simulations without any error terms in the rating. However, in the presence of error terms, the performance of the individual firm models seems to be consistently better. There is also a significant improvement in results, using individual firm models, in the presence of variation in rating behaviour. It would therefore, appear that the method using weighted averages of individual firm models is more robust. This result is quite different from the results obtained by Morikawa (1989) using ranked logit models. This difference is perhaps attributable to the use of rating data as well as the use of weighted averages in our case, instead of simple means of the individual models.

The 't' values obtained through the individual firm models aggregated using weighted average method, are higher than those from the pooled RCM models. But it needs to be remembered that these 't' values are not directly calculated from the standard errors of regression in the conventional way but are based on weighted average of the variances of individual estimates.

In field surveys, we would normally expect to get a fair amount of variation in rating behaviour and the ratings would also be expected to have errors. Use of individual models would, therefore, be expected to give better results than any of the pooled analysis methods we have tested. In addition, this is also the computationally simpler method and the models can be estimated using any standard statistical package such as SPSS or SAS. Accordingly, this is the method we continue to use in our work.

7.6 Attribute Valuations in Percentage Terms or Absolute Values

7.6.1 The Problem

In the analysis of the LASP data, so far, all the attribute valuations have been taken in terms of percentages of cost by the currently used mode. When carrying out the break-even analysis, this results in a problem as the use of percentages results in change of slope of the cost curves for Rail and Intermodal services. This is due to the fact that we are adding/subtracting the ASCs & service quality valuations, from the cost calculated, as a percentage of the road cost, for the corresponding distance. The extent of change of slope depends on the sum of all the attribute valuations taken into account, in the form of percentages, for that particular service (e.g. in case of costing of a tri-weekly Rail service the shift is proportional to ASC(Rail) + frequency discount for tri-weekly services). The final solution of this problem can be arrived at by modelling data for another corridor (or set of flows) with a wide range of distances (the current data set pertains to Delhi-Bombay corridor with distances of about 1500 Km) to obtain a direct relationship of attribute valuations with distance.

However, for the present, we have attempted to arrive at a conclusion through discussion of individual attributes based on the comments encountered in the course of the surveys and on prior experience of the freight transport industry. We have also attempted to carry out analysis of the available data to evaluate the relationship between valuation and distance in either case. This quantitative analysis has not yielded any usable results, since our survey has been designed to have a narrow range of distances.

7.6.2 Discussion of individual attributes

<u>ASC(Rail)</u>: In this case the ASC is likely to represent the sum of valuations of the problems faced/anticipated with rail transport such as losses & damages (including damages in transit as well as due to the additional handling involved though the cost of the handling itself has been explicitly included in the total cost taken), the inconvenience of lower availability of information about the likely arrival of the cargo, problems faced at the time of booking of cargo and the delivery, lack of information about the rail services etc.. The rail service has been defined to have the same door to door time and reliability, as the road service. However, some respondents took that with a pinch of salt and there is a possibility that some of this 'credibility factor' may have crept into the ASC.

We would expect that the users would have adverse opinion, about very short hauls by rail, due to the nuisance value of the adverse factors being far greater in proportion to the magnitude of the task involved. This is basically an argument against use of percentage figures for ASCs as we would then have a smaller cost involved for a smaller distance.

ASC(Intermodal Container Service): In this case, the problems on account of loss/damage in transit and due to the additional handling are likely to be almost negligible, due to the nature of the service. However, the perception of poorer customer service and anticipated/actual problems, in locating any lost/delayed consignments, remains the same as in the previous case. We would, therefore, expect better results from the use of absolute values in this case as well.

Frequency discounts (F1 & F2): In case of the frequency discounts, as well, the perceived dis-utility, of lower frequency service, over shorter distances is likely to be more than over longer distances due to the proportion of the delay involved in relation to the total transit time.

VOT: the absolute valuation of time is unlikely to vary with the distance (or total transit time) involved. It is, however, possible that a day's delay, for a flow taking only half a day, may be less acceptable than a two day delay for a flow taking 10 days.

VOR: In our exercise, reliability has been defined as the percentage of consignments arriving within the scheduled time and a 5 % decrease in reliability is taken to result in a days increase in the average transit time. On the basis of this definition, it appears that a delay of one day in case of a short distance movement (e.g. one taking a day on an average) would be less acceptable than a delay of one day in case of a longer distance movement (e.g. one taking 7-8 days).

7.6.3 Regression Analysis

There are some flows available, in the current dataset, with different distances. An attempt has been made to evaluate the effect of distances by regressing the attribute valuations for individual firms against the distance of the flow considered as the independent variable. This has been done, first using valuations in percentage terms and then repeated with absolute valuations. Both the sets of results are presented in Table 7.8 below:-

Table 7.8: Results of regressions of attribute valuations on distance.

	ASC(IM)	F1	F2	VOT	VOR
Valuations in %					
Adj. R^2	-0.029	-0.012	-0.017	-0.015	-0.031
Intercept	5.007153	-27.8864	-95.1568	5.12933	-2.14864
't'	*(0.58)*	*(-1.98)*	*(-2.04)*	*(2.99)*	*(-1.00)*
Coefficient	-0.00193	0.006652	0.019388	-0.00076	-0.0003
't'	*(-0.37)*	*(0.79)*	*(0.69)*	*(-0.74)*	*(-0.24)*
Absolute valuations					
Adj. R^2	-0.016	-0.033	-0.32	-0.016	-0.022
Intercept	1544	-2437	-10512	384	-211
't'	*(1.08)*	*(-1.16)*	*(-1.48)*	*(1.68)*	*(-0.63)*
Coefficient	-0.6223	-0.00607	0.8316	-0.0982	-0.118
't'	*(-0.72)*	*(-0.05)*	*(0.20)*	*(-0.72)*	*(-0.59)*

All the regressions have negative values of Adjusted R squares and very low R squares (not shown here) which appears to indicate that there is little (if any) meaning in the regressions. The main reason for this is that there is very little variation in the distance of haul in this dataset (it was specifically designed to consider a particular route and distance segments).

The regression results are further interpreted in terms of values for distances of 1000, 2000 and 3000 Km in Table 7.9. The results for the ASC(IM) appear to be counter intuitive as they seem to say that Container services are preferred for shorter distances but disliked for longer distances. In case of the discounts for tri- weekly services (F1) the results in percentage terms appear to be intuitively correct as the discount required decreases as the distance increases however the results in absolute terms are the reverse of this.

Table 7.9: Valuations derived from regression results

Distance	ASC(IM)	F1	F2	VOT	VOR
Valuations in %					
1000 Km	3.1	-21	-76	4.4	-2.5
2000 Km	1.2	-15	-57	3.6	-2.8
3000 Km	-0.7	- 8	-38	2.9	-3.1
Absolute Valuations (Rs)					
1000 Km	922	-2500	-9700	482	-329
2000 Km	300	-2560	-8900	580	-457
3000 Km	-322	-2620	-8100	678	-575

In case of the discount for weekly services (F2) the results, on both percentage basis and absolute value basis, appear intuitively in the correct direction as the discount required is decreasing with increase in distance (i.e. poorer frequency has less effect for longer distances where time in transit will be longer anyway). In case of the VOT, the results on percentage basis appear intuitive. However, the absolute values give counter intuitive results with the VOT increasing with distance. In case of VOR, both the percentage values and the absolute values, increase as the distance increases.

7.6.4 Conclusion

Considering both the poor regression fit and low 't' values and the fact that the numerical values also do not appear consistent, it would seem that sufficient data is not available to prove or disprove the correctness of either form of attribute valuation. Further surveys would be required with a wider range of distances to conclusively prove the correctness of either method.

The discussion in section 7.6.2, based on findings from the interviews as well as prior experience, seem to suggest that the use of absolute valuation would be preferable in case of the ASC, F1, F2 and VOT. However in case of VOR the result is not very clear.

We will, therefore, adopt the use of absolute valuations, for the purpose of the break-even analysis, as this appears to be, intuitively, the better approach.

7.7 Segmentation Variables (Commodity Value, Firm Size and Distance)

We have also attempted to model the effect of non-service related variables, to identify suitable variables for segmentation of the market.

The first variable considered, was commodity value per ton (the hypothesis being that higher value commodities would have different service requirements than low value commodities). The second variable was taken as the size of the firm (represented by the turnover). Here we tried to capture the difference in decision making process and emphasis on quality attributes between smaller and larger size firms. The third variable considered was the distance of haul. This was taken with a view to evaluating differences in service requirements, for short distance movements as compared to long distance movements.

In each case, we have first regressed the attribute valuations for each firm against the variable in question, to identify any correlation which may exist. Then the dataset was segmented on the basis of the variable in question and weighted averages of the attribute valuations were calculated for each segment.

7.7.1 Effect of Size of Firm

We have run a set of 5 ordinary least squares (OLS) regressions using the basic model

$y = a + b\,x$

where : 'x' is the turnover of the firm

'y' is the attribute valuation considered in the model (IMC for the first regression, F1 for the second regression and F2, VOT & VOR respectively for the next three regressions)

The regression results are summarised in Table 7.10. In this case F1, F2 and VOR show positive values of adjusted 'R squares' with 't' values over 2 for the slope.

Table 7.10: Regressions on firm turnover (summary of results)

		Coeffs.		't'	
	Adj R^2	Intercept	Rs/Ton	Intercept	Rs/Ton
IMC	-0.026	766	-0.0115	1.90	-0.45
F1	0.152	-2915	0.0883	-5.33	2.56
F2	0.284	-7499	-0.3893	-4.43	-3.65
VOT	-0.009	557	-0.0035	8.55	-0.86
VOR	0.164	-338	-0.0145	-3.90	-2.66

We then segmented the individual firm estimates, on the basis of firm's turnover, into 4 segments (upto Rupees 70 million, 70 to 350 million, 350-1400 Million and above 1400 million). The aggregated results are given in Table 7.11. In this case we find that the aggregated results show quite clear trends with the ASC(IMC) being negative for the first two segments and not different from '0' in the third segment whereas it is strongly positive in the last segment. In case of the ASC(Rail) as well, the last segment has an adverse value which is almost twice that of the first two segments and the third segment has an intermediate value. In case of the frequency discounts and VOT as well, the last segment shows the largest values. However, in case of the VOR, we do not seem to have a clear pattern.

It, therefore, appears that the size of firm is an important basis for segmentation of the market with the large firms forming the best target market for intermodal services. This result also matches some of the qualitative findings of RITES 1996, which found that there is a significant difference in the perceptions of the small and the large firms about the quality of road services. They found that the large firms were not satisfied with the quality of road services, due to the frequent changes in prices and the poor reliability of services. On the other hand the small firms had a relatively better opinion of road services and appeared to be satisfied with the level of service offered by road.

Table 7.11: Aggregation on Turnover (all values in Rupees)

Turnover (Rs)	RC/IM	IMC	Rail	Parcel	C_L	F1	F2	VOT	VOR
0-70 Mill		-448	-2463		628	-1905	-5494	465	-142
't'		-(1.95)	-(10.14)		(0.42)	-(5.52)	-(17.71)	(5.69)	-(1.98)
70-350 Mill.	2358	-796	-2158	-3008	1105	-2375	-5693	278	-390
't'	(1.36)	-(3.62)	-(9.18)	-(5.03)	(1.18)	-(6.77)	-(16.94)	(3.27)	-(5.33)
350-1400 Mill		201	-3436		-535	-868	-3288	530	-59
't'		(0.80)	-(7.67)		-(2.45)	-(3.45)	-(13.26)	(6.73)	-(0.93)
>1400 Mill		738	-4213		39	-3446	-6439	571	-331
't'		(2.71)	-(11.60)		(0.03)	-(9.76)	-(14.05)	(7.04)	-(4.79)

The above discussion would seem to suggest that the intermodal services should be targeted at the larger firms, where there is scope to build on their better perceptions of intermodal movement and their adverse perceptions of road.

7.7.2 Effect of Commodity Value

We have also carried out regression on a similar basis to the previous section with commodity value as the independent variable and the attribute valuations (one at a time) as dependent variables. The results are summarised in Table 7.12. We have negative values of the adjusted 'R' squares with low 't' values in all cases except for the first one (IMC). In case of the IMC we appear to have a significant coefficient.

Table 7.12: Regressions on Commodity Value (summary of results)

		Coeffs.		t' Values	
	Adj R2	Intercept	Rs/Ton	Intercept	Rs/Ton
IMC	0.108	-184	0.00760	-0.34	2.18
F1	-0.027	-2239	-0.00249	-2.55	-0.45
F2	-0.023	-7947	-0.01039	-2.68	-0.55
VOT	-0.013	598	-0.00048	6.27	-0.78
VOR	-0.030	-434	0.00028	-3.08	0.31

The dataset is split into two segments, on the basis of the commodity value (upto Rupees 140,000/ton and over Rupees 140,000/ton). The aggregate values for the two segments (Table 7.13) shows that there is a significant difference in the IMC values, with the lower value commodities preferring movement by lorry and the higher value commodities showing a preference for intermodal container services. Similarly, in case of rail services the ASC for the high value group is about 50% higher (both adverse) than that for the lower value commodity group. In case of the other attributes the results show lower service quality valuations corresponding to higher value commodities.

Table 7.13: Aggregation on Commodity Value

	RC/IM	IMC	Rail	Parcel	R_C	F1	F2	VOT	VOR
<Rs 140,000/ton	2358	-303	-2666	-3008	124	-2487	-5162	459	-258
't'	(1.4)	-(2.3)	-(18.0)	-(5.0)	(0.3)	-(12.7)	-(27.5)	(10.0)	-(6.6)
>Rs 140,000/ton		299	-3957		-550	-817	-3800	493	-87
't'		(1.4)	-(5.9)		-(2.4)	-(3.1)	-(13.1)	(5.5)	-(1.2)

These results appear to further suggest that the Intermodal Container Services need to be targeted at the high value commodities.

7.7.3 Effect of Length of Haul

The results of the regressions with length of haul as the independent variable and the individual attribute valuations as dependent variables, are repeated in Table 7.14 from section 7.6.3. In this case all the regressions have negative values of Adjusted R Square, which indicates that no relationship can be seen in this data.

Table 7.14: Regression against Length of Haul (repeated from Table 7.9)

		Coeffs.		t' Values	
	Adj R2	Intercept	Rs/Ton	Intercept	Rs/Ton
IMC	-0.016	1544	-0.6223	1.08	-0.72
F1	-0.033	-2437	-0.0607	-1.16	-0.05
F2	-0.032	-10512	0.8316	-1.48	0.20
VOT	-0.016	384	0.0982	1.68	0.72
VOR	-0.022	-211	-0.1181	-0.63	-0.59

On segmenting the valuations into three groups, on the basis of distance (Table 7.15), we find that no trend can be seen in the case of the ASCs. However, the frequency discounts, VOT & VOR appear to show an increasing trend with distance. The increase in frequency discounts, with distance, does not appear intuitively correct, as we would have expected the frequency discount to be higher for shorter distances, where the implied delay would be much higher, as compared to the actual transit time.

These results are different from the results shown in Table 7.9 as that set is based on the use of regression coefficients for obtaining the valuations for different distances, whereas the present set is based on the aggregation of actual valuations.

We therefore, conclude that the present data does not support the possibility of segmentation on the basis of distance. This is likely to be due to the fact that there is very little variation of distance in the dataset, as the survey has been designed for a specific route and narrow distance range.

Table 7.15: Aggregate results for segmentation on Length of Haul

	RC/IM	IMC	Rail	Parcel	R_C	F1	F2	VOT	VOR
< 1250 Km		-905	-2795		-1555	-1783	-3419	444	-181
‘t’		-(4.15)	-(11.76)		-(2.82)	-(5.43)	-(10.64)	(5.27)	-(2.65)
1250 - 1800 Km	2358	220	-2370	-3008	-222	-1768	-5153	457	-224
‘t’	(1.36)	(1.66)	-(12.07)	-(5.03)	-(1.00)	-(9.57)	-(27.55)	(9.49)	-(5.44)
> 1800 Km		-1625	-4749			-4678	-5586	716	-345
‘t’		-(2.91)	-(9.49)			-(6.24)	-(7.92)	(3.84)	-(2.20)

7.8 The Final Demand Model

As discussed in the previous sections, we are going to use attribute valuations in absolute terms, for our demand model, to permit us to perform break-even analysis over a range of distances. In addition to this, we continue to use the method of calibrating individual firm models and then forming sectoral models using weighted averages of individual estimates. The individual firm models are given in Table 7.16. Column 1 gives the company code, columns 2 to 6 are the ASCs where ‘RC/IM’ refers to the ASC for container movement by road with respect to intermodal container service. All other ASCs are with respect to open top road Lorries. IMC refers to Intermodal Container Services and C-L to containerised lorries (i.e. lorries with container type lockable bodies). Columns 7 & 8 are the frequency discounts where F1 represents a tri-weekly service and F2 represents a weekly service (both are in comparison to a daily service). Columns 9 & 10 give the values of Time (in percentage of freight rate per day) and Reliability (in percentage of freight rate per percent point change in reliability) respectively. Columns 11 to 19 give the ‘t’ value of the estimates given in columns 2 to 10 respectively.

Table 7.16: Individual Firm Values (Absolute Values) — All Figures in Rupees (1 GPB = 70 Rupees)

		Values Recovered								t' Values of Ratios								
Firm	RC/IM	IMC	Rail	Parcel	C_L	F1	F2	VOT	VOR	RC/IM	IMC	Rail	Parcel	C_L	F1	F2	VOT	VOR
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
A1		2995			1105	-4337	-8261	2190	-805		2.8			1.2	-3.6	-6.0	1.4	-2.1
A2	2358	5156				-5866		3171	-395	1.4	2.6				-1.8		1.6	-0.8
A3		1685			1106	-5893	-17615	912	-1509		1.0			0.6	-2.8	-6.9	0.5	-2.4
A4		5397			628	-8884	-16648	1905	-1073		3.8			0.4	-4.4	-9.0	1.6	-2.9
A5		-776	-5304			-6470	-24322	4191	-20		-0.9	-6.8			-7.3	-4.0	5.1	-0.1
A6		915	-1340			-7907	-42734	1830	-1823		0.9	-1.4			-7.7	-5.4	2.2	-7.2
A7		1221				-3064	-10214	1494	-291		2.4				-4.4	-12.3	3.6	-2.3
B1		-1283	-8276			3779	307	204	-58		-0.9	-7.8			1.5	0.2	0.2	-0.2
B2		-890	-1891			250	-4882	1002	-301		-0.9	-2.0			0.1	-3.8	0.7	-0.8
B3		34	-2053			-2539	-10354	402	-416		0.1	-3.0			-3.5	-11.9	0.5	-2.2
B4		-3184	-3009			-7676	-10207	3405	-295		-3.7	-3.4			-7.9	-8.7	4.1	-1.2
B5		-911	-2136			-2321	-5561	1191	-62		-3.2	-7.2			-4.1	-14.4	3.7	-0.6
B6		-235	-3512			-1822	-5372	2427	-362		-0.3	-5.2			-2.8	-6.4	3.9	-2.2
B7		-94	-2826			1104	-1506	1608	199		-0.2	-3.4			1.1	-1.7	2.0	0.9
B8		278	-2937			-1866	-8487	786	-141		0.4	-4.1			-2.5	-6.5	1.2	-0.7
C1		-392	-3530			-979	-323	1386	-87		-0.5	-3.6			-0.7	-0.3	1.5	-0.3
C2		-610	-3118			-3958	-16807	3927	122		-0.3	-2.0			-1.5	-6.9	1.8	0.2
C3		1282	-8327			-2816	-3594	2568	-833		0.8	-6.8			-1.6	-1.9	1.7	-2.3
C4		2947	-5438			-2983	-10907	2874	-582		3.1	-4.9			-2.7	-7.2	3.2	-2.4
C5		-300			-420	-318	-2133	627	-80		-0.7			-0.7	-0.4	-3.3	1.2	-0.5
C6		-711	-2885			-1417	-1499	1497	-139		-1.3	-6.0			-2.2	-2.1	3.4	-1.1
D1		-67			-437	-6490	-13700	1005	-699		-0.1			-0.4	-5.2	-7.1	1.1	-2.6
D2		5338	-12394			-4993	-13971	1893	339		2.5	-5.6			-1.2	-4.5	1.0	0.5
D3		-619	-1144			229	543	747	-150		-1.0	-2.1			0.2	0.5	1.4	-0.8
D4		-2097	-2097			-2373	-6422	459	-186		-6.4	-6.4			-2.9	-13.2	1.0	-1.3
D5					-495	-257	-3501	1566	139					-1.8	-0.7	-9.7	4.0	1.4
E1		629		-3008		-357	-2783	1332	-231		1.0		-5.0		-0.5	-2.6	1.6	-1.4
E2		4244			989	-2757	-7509	2283	-657		6.5			1.3	-2.1	-8.0	2.9	-2.7
E3		-1555			-1555	-77	18	1536	-221		-2.8			-2.8	-0.1	0.0	2.1	-1.2
E4		-366	-6212			5310	-43694	810	-1648		-0.1	-2.1			0.9	-2.0	0.2	-1.4
F1		2715				-3415	-494	-168	-440		3.4				-2.0	-0.2	-0.2	-2.2
F2		2182	-2823			61	-1090	1239	-122		2.9	-4.1			0.1	-1.1	1.3	-0.6

The aggregated estimates are given in Table 7.17.

Table 7.17: Aggregated Models Using Absolute Values ('t' values given in brackets)

	RC/IM	IMC	Rail	Parcel	C_L	F1	F2	VOT	VOR
Exporters	2358 (1.36)	1443 (4.13)	-3795 -(6.21)		993 (1.37)	-5245 -(12.37)	-11392 -(17.87)	2000 (6.46)	-570 -(6.15)
Transporters F.Forwarders		-693 -(3.41)	-2658 -(12.57)			-2266 -(7.68)	-5788 -(20.99)	1395 (6.27)	-158 -(2.49)
Chemicals		-81 -(0.28)	-3776 -(10.17)		-420 -(0.73)	-1499 -(3.47)	-2771 -(6.86)	1452 (5.01)	-203 -(2.44)
Elect/electronic total (5 firms)		-785 -(3.98)	-2006 -(7.26)		-492 -(1.82)	-896 -(2.99)	-4443 -(16.10)	1044 (4.17)	-40 -(0.56)
Elect/electronics Hi Value (2)		765 (0.93)	-12394 -(5.62)		-437 -(0.37)	-6359 -(5.36)	-13774 -(8.38)	1179 (1.38)	-540 -(2.17)
Electrical Low Val (2)		-1798 -(6.18)	-1840 -(6.61)			-1596 -(2.30)	-5177 -(11.70)	582 (1.63)	-174 -(1.53)
Auto Parts		776 (2.19)	-6212 -(2.07)	-3008 -(5.03)	-712 -(1.58)	-437 -(1.01)	-2602 -(5.34)	1515 (3.73)	-325 -(2.98)
Food		2436 (4.45)	-2823 -(4.06)			-755 -(0.90)	-991 -(1.08)	552 (0.81)	-282 -(2.03)
All 32 firms	2358 (1.36)	-251 -(2.26)	-2728 -(18.82)	-3008 -(5.03)	-409 -(1.98)	-1900 -(12.07)	-4758 -(30.19)	1398 (11.43)	-219 -(6.36)
29 Firms		-294 -(2.55)	-2728 -(18.82)	-3008 -(5.03)	-409 -(1.98)	-1813 -(11.15)	-4575 -(28.43)	1410 (10.88)	-205 -(5.60)

7.9 Discussion Of Results

We shall be using the results shown in Table 7.17 for our further work. We have shown the aggregate results for each sector as well as the overall combined results here. These results are discussed in detail below.

7.9.1 Exporters

Fairly sensible looking results appear to have been obtained with the ASC for Intermodal Container Service being between Rupees 1000 to 5000 (in favour of intermodal) for all the exporters excepting one exporter having a negative ASC of Rupees 800. The combined estimate for the group was Rupees 1450 ('t' = 4.1). The negative value was for a rice exporter, moving almost all his cargo by road for further dispatch in break-bulk. All the others were primarily shipping their cargoes in containers and therefore naturally preferred to despatch in containers from the factory itself. The ASC is, however, not as high as may have been expected in some cases, due to a perception among some of the exporters that if the cargo was despatched by lorry to Bombay and then got stuffed into containers at Bombay, it was likely to get a higher priority in shipping as the CHA (Clearing and Handling Agent) in this case was located in Bombay itself and would be having better information and liaison with the shipping lines. It has, however, not been possible to check the veracity of this perception or whether it could be related to operating practices of particular shipping lines. The ASC for containers moving by road (with respect to movement by normal lorries) was also positive though smaller and with lower significance levels (aggregate estimate for 3 firms was Rupees 1000 (t' = 1.4)).

The ASC for Rail services, is only available for two firms as the rest refused to even consider a rail wagon service. Therefore, we are not considering the valuations obtained for this as rail service can be considered to be totally un-viable for this sector.

The discount required for a tri-weekly service varied from Rupees 3000 to 9000 with a combined estimate of Rupees 5200 ('t' = 12.4) and the discount required for a weekly service varied between Rupees 8000 to about 42000 (i.e. representing firms not willing to use this service at all) with a combined estimate of Rupees 11400 ('t' = 17.9). This group (exporters) had some of the highest figures for discounts required for lower frequency services.

The value of time varied from about Rupees 1000 per day to about 4000 per day with the combined estimate being Rupees 2000 per day ('t' =6.5). The value of Reliability varied from almost 0 to Rupees 1500 per percentage point change in reliability, with a combined figure of 570 ('t' = 5.1). As per the reliability tables used during the interviews, a 5% decrease in reliability would correspond to an average increase of about a day in the transit time. However on the basis of the reliability values obtained, a 5% decrease in reliability would require a discount of Rupees 2800. This is much larger than the Rupees 2000 discount required for an additional day in transit. This represents the fact that this segment requires a higher level of reliability of service since longer transit times can be planned for, if transport costs are reduced, however poorer reliability of service would carry a higher penalty to the consignor in terms of shipments delayed/sailings missed. The higher discounts required, for lower frequency of service, also represents the same thing in that this means that there is one more variable for the exporter to keep track of (i.e. whether or not the day the service is available matches with the day the ship is to sail).

7.9.2 Freight Forwarders And Transporters

For this group the value of the ASC for Intermodal Container Services is negative (i.e. they prefer Road Service over Intermodal Container Service) and varies from 0 to Rupees 3200 with a combined estimate of Rupees 700 ('t' = 3.4). It can, however, be seen that the 't' values in all but 2 cases are rather low. The ASC for rail services was, predictably, also negative and varies from Rupees 1900 to 8000 with a combined estimate of 2650 ('t' = 12.6). The discount required for a tri-weekly service varies from Rupees 1800 to 7500 with three values with wrong signs and with low 't' values. The combined estimate is almost 2300 ('t' =7.6). The discount for weekly service varies between Rupees 1500 to 7500 with one value with wrong sign and low 't' statistic. The combined estimate is 5800 ('t'=21.0). The value of time varies between Rupees 210 to 3400 per day with a combined estimate of 1400 per day ('t' = 6.3). The value of Reliability varies between Rupees 60 to 410 per percentage point change in reliability with one value with wrong sign and low 't' statistic. The combined estimate is Rupees 160 per percent ('t' = 2.5).

The ASC (Intermodal Container service) is negative in this case reflecting the fact that a lot of this movement is of piecemeal/parcel traffic where the goods still need to be delivered to the individual parties and as such a door-to-door container service has little advantage. The low 't' values coupled with low values of estimates in most cases are an indicator of the indifference to Intermodal Container Services, as compared to road services, in this segment. Besides this, the value of reliability is almost a quarter of the corresponding value for the export segment. This reflects on the corresponding greater importance of the reliability of transit time for export traffic. The Value of Time is higher than the corresponding value obtained for a 5% decrease in reliability, indicating that time is a very important factor here.

The high value of ASC(Rail) also seems to reflect the fact that the firms are working as intermediaries for the consignors and prefer to keep the movement within their control. This was borne out by the qualitative interview data where some of the respondents mentioned that, in case of lorry, if there was a problem enroute the driver would inform them over phone and they would in turn be able to inform their customers. However, in case of despatch by rail, they may not even get to know that the consignment was getting delayed till the last moment and even then may not know fully what has happened. The high discounts required, for lower frequency of service, reflect upon the fact that these firms work on a high turnover and need to collect the material at their own warehouses prior to despatch. They cannot afford to keep more than one or two days' collections, due to the storage space constraints as well as the need to ensure quick service to their own customers.

7.9.3 Chemicals

In this segment the ASC(Intermodal Container services) varied between Rupees -300 to +3000 (the negative figure indicating a dislike for Intermodal Container services) with rather low 't' values in all but one case. The exception was a petroleum company despatching Lubricating oils in small packings, which were highly prone to pilferage/theft. As such they expressed a strong preference for containerised services. The combined estimate for the segment was not different from 0. The ASC(Rail) varied between Rupees 2900 to 8300 (adverse) with a combined estimate of 3800 ('t' = 10.2). The frequency discounts required varied between Rupees 300 to 4000 for tri-weekly service and 300 to 16000 for weekly service with combined estimates of Rupees 1500 ('t' = 3.5) and 2800 ('t' = 6.9) respectively. The value of time varied between Rupees 600 to 3900 per day with a combined estimate of Rupees 1450 ('t' = 5.0) and Value of Reliability varied between 80 to 800 per percentage point change, with one value with wrong sign and low 't' value. The combined estimate was Rupees 200 ('t' = 2.4).

The indifference to Intermodal Services is on account of the fact that most of these were low value bulk products, where containerised movement would have little benefits. The lower frequency discounts required are also due to the fact that these firms are bulk producers of intermediate products with geographically dispersed markets. Most of the despatches go into inventories, rather than for immediate consumption or sale. Since the individual flows are not too large, in relation to the total production of the firm, the storage is not likely to be such a severe problem. As such it is possible to program the movement to match the poorer frequency of service. These facts are also reflected in the lower value of reliability. The value of time matches the corresponding valuation if a 5% decrease in reliability is taken to represent a days' increase in the average transit time. However the high ASC for rail needs to be looked into further.

7.9.4 Electrical & Electronics Manufacturers

In this segment the ASC(Intermodal Container Services) varied between Rupees - 2000 (i.e. adverse) to +5000(i.e. in favour) but only the two extreme cases had significant 't' values. The first was a cable manufacturer, with fairly large individual item sizes, and the second was a manufacturer of Consumer Electronics products, who was very keen to have Intermodal Container services due to the fragile nature and high value of the products. The ASC(rail) was Rupees 1100 and 2100 (adverse) for two cable manufacturers and Rupees 12400 (adverse) for the Electronics firm. Very high values of Frequency discounts were required for the Electronics & Home Appliance firms since both products were high value and were normally being despatched for further distribution to retailers. As such, inventory holding costs and opportunity cost of sales lost are very high. The Appliances firm also had a very high value of reliability (Rupees 700 per percent point change, 't'=2.6). All the other firms had low 't' values for VOR. The VOT values also had low 't' values except for the firm making equipment for industrial and home use which had a value of about Rupees 1600 per day ('t'=4.0). The two cable manufacturers both had low values of time and reliability but the one with a higher volume flow and higher value product required higher discounts for low frequency services (Rupees 2400 & 6400 for tri-weekly & weekly service). The last firm was manufacturing electrical equipment for domestic & industrial use. Here the volume and frequency of despatches were both low hence it was possible to match despatch schedules to transport service schedules to some extent and this was reflected in the lower discount for tri-weekly service (Rupees 260) but even in this case the weekly service was not attractive. The high Value of time reflects the high value of the products and the consequent high inventory holding costs.

7.9.5 Automotive Parts Manufacturers

In this segment, out of the four firms contacted two yielded results with very low 't' values for the ASC(IM), F1, VOT & VOR estimates and the third for the frequency & VOR estimates. The one firm where good 't' values could be obtained was manufacturing high value and damageable components. They indicated a strong preference for Intermodal Container Services due to the fragile nature of the products. They also required higher discounts for low frequency of service (Rupees 2700 & 7500 for tri-weekly and weekly services respectively) and had comparatively high values of

Time & Reliability (Rupees 2300 per day & 660 per percent point respectively) due to the high value of the cargo.

Even in this sector fairly reasonable looking aggregate estimates have been obtained with a favourable ASC(Intermodal Container Service) of Rupees 780 ('t'=2.2) and a high, adverse ASC(Rail) of Rupees 6200 ('t'=2.1) both representing the high value and damageable nature of the products. The discounts required for tri-weekly and weekly services are Rupees 440 ('t' =1.0) and 2600 ('t'=5.3) respectively. These represent the low frequency of despatches and the fact that the product is going into inventory for vehicle manufacture (not JIT), as such the poorer frequency can be programmed for. The values of VOT and VOR are consistent in terms of the average delay implied by the poorer reliability and are comparatively high, again representing the high value of the product and the fact that unprogrammed delays can effect the production.

7.9.6 Food Products

In this sector only two firms could be contacted and the results obtained had poor 't' values for individual as well as combined estimates except for the ASCs.

7.10 Conclusions

The survey data has first been modelled at the individual firm level and then these firm level models have been aggregated to get sectoral models. We have also estimated models using pooled data and used simulated data to evaluate the recoverability of underlying values using different methods. In addition to this, the alternatives of using % valuation as well as absolute values have also been evaluated. Finally, we have analysed the effect of some non-service variables such as value of commodity, size of firm and length of haul.

We have, finally, decided to continue calibrating models for individual firms with sector level models obtained from aggregation of the individual firm models using weighted averages. We are also using absolute values for the purpose of the break-even analysis even though the use of percentage valuations permits ease of analysis and presentation of results.

Analysis of the non-service variables indicates that it should be possible to segment the market on basis of the value of the products and the size of the firms. Intermodal container services should be targeted at high value products and the bigger firms.

Fairly sensible looking models appear to have been obtained. All the sectors indicate a dislike for Through Rail services and require discounts between Rupees 2000 to 6200, over the cost of transport by road, for using rail even if it was able to match the road service quality. As far as Intermodal Container Services are concerned, some sectors like exports and Electrical/Electronic products have shown a preference for the service whereas the others have shown a dislike for it with the ASC ranging between Rupees 1200 (favourable) to -800 (i.e. unfavourable). The frequency of service appears to be an important factor in mode choice with tri-weekly services being acceptable to some sectors but weekly services not being acceptable to any sector. The Value Of Time ranges between Rupees 1000 to 2000 per day. As expected the Reliability of transit times appears to be very important for exporters and also important for the Autoparts sector due to the effect it can have on the production process but it is not so important for some of the other sectors.

Chapter 8: THE COST MODEL

In this chapter, we establish the cost of door to door movement of freight using intermodal container services, rail wagon services and road services.

In section 8.1, we first look at the internal and external costs of transport. Then in section 8.2, we give a brief overview of the internal costs of road transport. In section 8.3, we discuss the unique features of railway costing, the different approaches to costing and some applications of these approaches. In section 8.4, we discuss the Indian Railway's costing system. In section 8.5, we look at some existing systems of costing for point to point movement of containers and wagons and develop the final cost model to be used in this work. In sections 8.6, 8.7 & 8.8, we give the final costing of door to door movement using intermodal container services, rail wagon services and road services respectively.

8.1 The Internal & External Costs of Transport

The costs of transport can be, broadly, divided into two categories - Internal costs and External costs. Internal costs are the costs that are borne by the user, such as costs of fuel, vehicle maintenance costs, crew costs and vehicle capital costs. These costs are directly taken into account in the transport decision. On the other hand, external costs are those costs which the transport user imposes on other people (transport users as well as non-users) such as the pollution costs, infrastructure costs not fully covered and congestion costs. Since these costs are not normally borne by the user, they are normally not explicitly taken into account in the transport decision.

Various approaches are possible for quantifying the external costs, such as (IWW Karlsruhe 1994) the **Resource Cost Approach** which attempts to estimate the value of damaged/depleted resource (e.g. in case of a fatality the cost could be taken on the basis of the cost of raising a human being to the particular age level (cost-value) or the expected productive contribution over the remaining life of the person (income-value)). The **Utility Approach** is based on the determination of the willingness to pay (e.g. for cleaner air or for not having an accident). The **Prevention Cost Approach** is based on the cost of preventing ill effects. In contrast to the foregoing approaches, the **Risk Approach** is concerned with the future and works on future risks and the strategies of managing the same (such as Diversification (developing alternate modes of transport), Insurance (compulsory third party insurance) and Prevention).

The estimates, of external costs of transport, are likely to vary with the approach followed for quantifying them and therefore estimates from different studies are not likely to be strictly comparable. IWW Karlsruhe (1994) have attempted to establish a consistent framework for comparing the external costs of different modes of transport, for 17 European countries. Individual components of the external costs have been identified and estimated, on a similar basis, for all the countries using Purchasing Power Parity (PPP) data. Combinations of the different approaches have been followed (e.g. in case of accident costs the administrative & medical costs have been estimated along with the production loss and human value. In case of noise pollution the willingness to pay approach has been used). The final aggregated results show that, in case of freight, the external costs of road transport are almost eight times the external costs of rail transport.

In view of the significant differences in the external costs of the different modes, we would, ideally, have liked to take these costs into consideration for our work. However very little (if any) work is available, in this field, from India (or similar developing country situations) and it is not possible to take up the task of quantification of the external costs in the present study. Secondly, the main focus of our work is on the commercial decisions involved and not on the governmental policy formulation. Therefore, we will concentrate entirely on the internal costs, which are actually taken into account in the commercial decision making about the level of services to provide (on part of the service provider) and in the mode choice decision (on part of the shipper). As already discussed in Chapter 1, for similar reasons we mainly take the financial costs into consideration and not the economic resource costs in our analysis.

In the next section, we will briefly discuss the road costing methodology, which becomes fairly simple in the absence of external costs. We then go on to discuss the railway costing in somewhat greater detail, due to the greater complexity involved. The reasons, for the greater level of complexity in the railway costing task, will also be discussed there.

8.2 Internal Costs of Road Transport

The internal costs of road transport are also referred to as the road user costs. These are relatively easy to determine, as compared to rail transport, because in case of road, the task of allocation of infrastructure costs has already been done by the government and the user only has to take into account the taxes paid by him. The user costs can be divided into 'Standing Costs', 'Running Costs' and 'Overheads' (Ratcliffe 1982). The standing costs consist of the (non-fuel) taxes/licence fees, insurance, capital costs (depreciation and interest) and wages of the crew. The running costs consist of fuel and oils, tyres, repairs and maintenance. The overheads would consist of the administrative costs like managerial staff, buildings, telephones and advertising costs etc. The estimation of these costs becomes a fairly straightforward task, since the running costs can be separated for each lorry/journey and the standing and overhead costs can be apportioned on the basis of time. The separation, into running and standing costs, also takes into account the effect of vehicle utilisation levels on the overall unit costs, which appear to have a significant effect on the cost levels (Nash 1982).

In India, statistical relationships for road Vehicle Operating Costs (VOCs), were established in the Road User Cost Study (CRRI 1982). That study covered 939 vehicles (640 buses, 232 lorries, 67 cars) travelling over homogenous routes (total route-length 42,000 KM) for periods between 12 to 24 months. Relationships have been established using multiple regression techniques. Basic speed flow relationships have also been established, through field observations, for different road conditions. Fuel consumption under varying speeds and road profiles, was experimentally determined. This work has been subsequently updated in the 'Study for Updating Road User Cost Data' (Kadiyali 1992). The second study has covered newer generations of cars, LCVs (Light Commercial Vehicles) and MAVs (Multi-Axle Vehicles) and has also compared the results with those obtained using Engineering Principles for prediction of VOCs. It has also suggested a method for price indexing to account for price increases. This data has been further updated for 1993 prices in the 'Manual on Economic Evaluation of Highway Projects in India' (Indian Roads Congress 1993) using the indexing procedure recommended by Kadiyali (1992). We use data from IRC (1993), after further updating it to April 1998 levels, for our work.

8.3 Railway Costing

"God almighty did not know the cost of carrying a hundred pounds of freight from Boston to New York"

Arthur Twining Hadley, 1885

"Almost a century later, this quote can only be challenged in a theological context ..."

Canadian Transport Commission, 1978
(As quoted in Waters II - 1985)

The costing of rail transport is a much more complex task, as compared to road transport costing, primarily on account of the fact that rail transport requires the creation and maintenance of dedicated and expensive infrastructure. Determining the causality of the infrastructure costs is a complex task.

In this section, we will first take up the definitions of some terms, which are commonly used in the context of costing in general and railway costing in particular. Then the characteristics specific to railway costing are discussed in section 8.3.2. Section 8.3.3, discusses the need to base the costing on the end use of the costing exercise. The different approaches to railway costing are discussed in section 8.3.4. Section 8.3.5, looks at the approaches being followed by British Rail and by the American railroads. Section 8.4 describes the existing costing system on Indian Railways and section 8.5 looks at various models for costing of rail haulage of containers.

8.3.1 Some Commonly used Definitions

In this section we discuss some of the terms commonly used in transport costing (BRB 1978, Button 1993, Nash 1982 and Ogden 1985).

Specific costs are those costs, which are incurred on account of a specific service, for example the labour cost for loading a wagon is a specific cost. When separating costs, between freight and passenger services, the capital cost of a wagon becomes specific to freight.

Common costs are shared costs, incurred as a result of providing services to a range of users but the provision of one service does not *unavoidably* result in the production of a different one. The overall cost changes with the change in the volume of each service. The cost of maintenance of railway track is common between all the services using the track. It is, usually, possible to understand the causality of these costs through engineering and statistical studies and thus allocate them on a reasonably correct basis.

Joint costs: in this case two slightly different definitions are available. Button(1993) describes these as arising 'when the provision of a specific service entails the output of some other service.' Such as the provision of transport services necessarily entailing the provision of a return service. Hence the costs are Joint to the outward and return service. The other, and more commonly used definition we have come across (BRB 1978, Ogden 1985) is that 'these are shared costs where the total cost will not vary with the change in the volume of each service'. In this case the fixed costs of a single track would be considered to be joint to the services using the same as this is not avoidable to any service.

Joint costs can only be escaped jointly. These costs can only be allocated on some arbitrary but justifiable basis.

Avoidable Costs are costs uniquely associated with a particular output and would not be incurred if that output was not to be produced. It is, therefore, the appropriate cost to be used as the 'floor' for setting prices.

Variable Costs are those costs which vary with the volume of traffic. However the variability of costs also depends on the time period under consideration and the purpose of the costing exercise. In case of a line closure the only costs which would be variable in the immediate context would be the maintenance costs. However in the long run when the track becomes due for renewal then even the renewal cost needs to be taken as a variable cost for the purpose under consideration.

Fixed Costs are those costs which do not vary with the level of traffic over the period under consideration. As mentioned in the example above, the cost of the track would be fixed in the short run, for the purpose of line closure but would be variable in case the time span under consideration is longer than the life of the track. However the formation can be considered to be 'fixed' for most practical purposes as it would normally not need to be renewed.

8.3.2 Characteristics of Railway Costs

Some characteristics of railway operations, that make rail costing a complex exercise, are:-

1) **Costs are incurred jointly/commonly**. Railways are multi-product enterprises simultaneously supplying a range of services. There are difficulties in separating the front-haul costs from the back-haul costs (Joint Costs) or the track maintenance costs for parcel, freight and passenger services moving over the same line (Common Costs). In the second case engineering and statistical cost studies make it somewhat possible to separate the cost of track usage (the extent of work available on this topic is a proof of the difficulties involved), however in the first case there is still no 'correct' method of separating these costs.

2) There are **indivisibilities inherent in the production process** of the railways. The output can only be expanded in lumps. For example, the haulage capacity available on a certain route can only be increased in indivisible increments (i.e. by wagon-loads, further when a full train load has been achieved the next wagon load would actually represent a new train and would therefore bear most of the costs of a full train).

3) **The time horizon involved.** Running a one-time additional train, between two points, may involve use of some spare stock, however a regular service may involve investment in new locomotives and wagons. Hence the identification of the variable costs differs with the time horizon of the decision involved. The other dimension, of the effect of time horizon (Joy 1989), arises in case of falling demand, this is the additional problem of estimating the duration of fall off. This becomes important because of the cost of re-deploying resources away from and then back to a particular activity.

4) There are many **limitations in the management information and accounting systems** of the railways. The cost classifications, used in the accounting systems, still tend to be based on the type of expenditure (i.e. wages, fuel, etc.) and not related to the output measure. Absence of appropriate cost categories can limit the usefulness of engineering or statistical studies.

8.3.3 The end use of the Costing exercise

The above limitations can lead to ambiguities in the costing system and the relevant costs to be used would depend on the end use of the costing exercise. Some of the most common end uses (Waters II 1985) are (these are, however, not hard and fast categories):-

1) **Costing for Commercial Enterprises**

a) cost analysis for financial planning and budgeting
b) Traffic costing (i.e. estimating the costs of a particular service),
c) Facility or project costing, for major investment decisions.

These have, traditionally, been based on fully distributed average cost type of frameworks. These types of figures, however, tend to hide the causation aspect and hence could be misleading for the purpose of making commercial decisions, regarding continuation/modification or introduction of services. This shortcoming has led to substantial work on the concepts of 'Avoidable Costs' and 'Contribution Accounting' to obtain more meaningful figures for commercial decision making. This is discussed in greater detail in subsequent sections.

2) **Costing for regulatory purposes**

a) Cost analysis for setting minimum/maximum rates: In case of setting of minimum rates the relevant concepts are those of 'Contribution Costing' or 'Avoidable Costing' since normally any service would be expected to recover at least the additional costs which it causes. However, in case of the maximum rates the fully distributed costs become relevant.

b) Costing for rail closures: In this the only costs, which are relevant in the short run, are the variable maintenance costs and the opportunity cost of using the assets elsewhere. However, in case the line is allowed to continue to operate, then on completion of the life of the track & signalling infrastructure, the capital costs of renewal will also become relevant.

c) Costing for subsidy payments and Public Service Obligations: In this case, the costs to be considered are the avoidable costs and the opportunity costs, in case of saturated lines.

3) **Estimating social costs**: This is more relevant for government policy decisions and goes beyond the cost elements considered above. It needs to take into

consideration factors like the external costs of various modes of transport and the shadow costs to the economy, such as the shadow wage rate, the shadow exchange rate and the separation of tax elements.

4) **Cost analysis for economic research**: The research on rail cost characteristics generally focuses on refining the methodology of cost estimation and tends to employ sophisticated econometric methods. They also have significant policy relevance, in terms of verifying aspects like economies of scale, scope and density which lend support to merger policies and protection against new entry etc.

8.3.4 Approaches to Costing

There are three basic approaches to costing and most costing exercises use one or a combination of more than one of these approaches:-

1) **The accounting approach:** This approach relies on the conventional railway accounting systems, where all the expenditure is compiled under different cost heads, and uses these accounts figures to estimate the costs of various services/outputs. For this purpose, costs specific to a service are directly applied and common costs are apportioned on basis of related usage figures, such as track costs on basis of Gross Tonne Kilometres of the respective services and Signalling costs on basis of Train Kilometres. This is the cheapest and the easiest system to adopt due to the ready availability of basic accounting figures.

   The approach, however, suffers from some serious shortcomings :-

   a) The historical accounting costs may not reflect the opportunity costs of the assets.
   b) Difficulty in clearly distinguishing the fixed and variable costs and as such failure to account for economies of scale.
   c) The accounting categories tend to be based on the nature of expenditure while revenues are recorded according to the type of service provided. It may therefore be difficult to correlate the two.
   d) There may be a loss in information regarding the causality due to the data having been aggregated. We may end up creating artificial instances of common costs which would require to be allocated rather than booked directly (for example if the crew costs of freight and passenger services are recorded

under the same head, we end up making this a common cost needing to be allocated rather than a direct cost to be booked to the corresponding service).

The accounting costs also provide the basic data for statistical cost studies.

2) **Engineering Cost approach.** This approach focuses on the technical relationship between inputs and outputs. These relationships may either be derived from the basic physical laws or established empirically through controlled experiments (e.g. establishing the relationship between traffic level and rail wear by carefully monitoring the speed and weight of axles passing a section of track). It is possible to use both these in conjunction with one another. It is, therefore, possible to overcome the common cost problem by this approach. Engineering cost studies also provide the basis for allocation of common costs, in systems based on Accounting Costs.

   The problem with this approach is that it can be costly and may require repetitive efforts for updating the concerned parameters, with change in technology or operating practices. We would also need to keep in mind the danger of theoretical costs differing widely from the actual costs.

3) **Statistical Costing Approach.** This approach relies on the use of statistical techniques to derive cost-output relationships, from actual operating data. Instances of different cost-output levels are analysed, through regressions, to identify the variability of costs with output levels.

   Two type of studies can generally be identified under this approach. The first, are the 'Operational Cost Studies', often carried out by the railways themselves, which are based on dis-aggregate cost functions. The second being 'Econometric Studies' carried out by academic researchers which are generally based on aggregate cost functions and are characterised by rigorous specification of cost-output relationships and use of more sophisticated econometric techniques than those used for the first category.

   The drawbacks, in the case of 'Statistical Costing Techniques', are that the relationships between costs and outputs are not precisely measured and only statistically derived hence the degree of precision of the estimates depends on various factors such as the sample size, accuracy of measurements, validity of underlying assumptions etc.. It is also not possible to breakdown the relationships to the individual cost element level for obtaining detailed cost estimates for a specific service with this approach.

The application of the different costing approaches is illustrated from some of the work carried out in America and in Britain in section 8.3.5.1 and 8.3.5.2.

8.3.5 Practical Railway Costing Systems

The main elements of the costs of rail services are a) Crew costs b) Fuel/Energy costs c) Cost of provision and maintenance of rolling stock (wagons & Locomotives) d) Cost of Provision and Maintenance of Track and Signalling Infrastructure e) Safe working costs (transportation staff and equipment) and f) Terminal costs.

Out of the elements identified above the allocation of ‘a’ & ‘b’ can, usually, be done on actuals as the costs pertaining to different services should be uniquely identifiable. In case of ‘c’ also the costs can usually be apportioned on the basis of the usage. The safe working cost (element ‘e’) can be dealt with as a fixed cost since it is not likely to vary to any great extent with the level of traffic (except for technology up-gradation to increase capacity). In our specific case, the terminals are special purpose terminals with container handling equipment and the entire cost (element ‘f’) is borne by the Intermodal Service Provider. The only remaining element (element ‘d’) is the cost of provision & maintenance of track & signalling infrastructure. This is, probably, the most difficult element to handle. This is also borne out by the fact that the greatest volume of literature available in the area of railway costing is on different aspects of infrastructure cost allocation.

A bulk of the work, in this field, has been done for British Rail, Canadian Railways and the American Railroads (by the Interstate Commerce Commission in the last case). Due to the sensitive nature of cost data, for commercial organisations, a lot of the work in this area has been confidential and little is available in public domain. From the information available in public domain it would appear that British Rail has attempted the greatest amount of experimentation in this field. We shall look at some of the work done on BR, which has largely followed an Accounting approach, and compare the approach with that of some of the US models, which have followed Statistical and Engineering approaches.

8.3.5.1 Cost allocation in British Rail

The costing systems developed over BR were essentially based on the Accounting Approach. Upto 1969 BR followed a method of '**Full Cost Allocation**' (BRB 1978) for allocation of cost of track and signalling infrastructure. In this, the cost of a facility is allocated on the basis of the usage of the facility by different services (based on gross tonne miles for track costs and train miles for signalling costs). The common costs (Button 1993) were subsequently allocated, from 1969 to 1974, according to the **Cooper Brothers formula,** which placed emphasis on cost variability/escapement and the time-scales. It was, however, still a fully distributed average cost type of framework rather than a marginal cost one. The problem, with fully distributed costing systems, is that they do not reflect the causality of costs and can lead to ambiguities like the fall in traffic levels of one sector leading to an increase in the infrastructure charge for another sector, where there has been no change at all.

From 1974 to 1981, BR used a system of '**Contribution Accounting'**. This entailed (BRB 1978) breaking down the revenues and costs into about 700 different profit centres, which were designed so as to ensure specific identification of resources and involve a minimum of allocation of common or jointly used resources. The surplus, of revenue over direct expenses, being presented as a contribution to the joint costs of track & signalling and administrative overheads. This did not allocate the joint costs at all.

From 1981 onwards BR used a system of **Prime User Costing**. Under this system (Nash 1985) the sector which was the main user of the infrastructure was identified as the 'Prime User'. The other users were identified as secondary users. The costs which would not be incurred in the absence of the secondary users (Avoidable costs) were allocated to the secondary users and the balance of the infrastructure costs were allocated to the 'Prime User'. This system allowed for full allocation of infrastructure costs, however this resulted in the Inter-city sector being saddled with a very large proportion of the infrastructure costs, which it could not cover.

This system was followed by a variant, **Sole User Costing,** where a bottom up approach was adopted and the Sole User had to bear the cost of infrastructure which would be required if it was the sole user of the route. The other users would bear the additional costs that they would entail. This left a part of current costs unallocated (representing surplus capacity).

8.3.5.2 Some American Costing Models

In case of the American railroads, various cost models were developed, primarily, for regulatory purposes. The Interstate Commerce Commission (ICC) which was charged with the task of regulating railroad freight rates, initially used the 'Rail Form A' (Resor & Smith 1993, Waters II 1985). This was, basically, an accounting structure based on a cross sectional analysis of Class I railroads. Regressions were used to divide each component into fixed and variable components, which then determined the base and the roof levels for railway rates. This model was improved upon in the Uniform System of Accounts (USOA), which separated expense by 'car type' and recommended greater use of statistical analysis for determining variability. This was further followed by the Uniform Railroad Costing System (URCS). This first estimated cost output relationships, based on separate regressions for each railroad, and then used the coefficients, so obtained, for costing of different traffics.

The Speed Factored Gross Tonnage (SFGT) model is an econometric model and was developed in the 1970's for allocation of track maintenance costs between passenger and freight trains (Resor & Smith 1993). This model was extensively used in litigation between the railroads and the shipper, of coal traffic, regarding the determination of 'fair and just rates' for rail haulage of coal. The SFGT model gives separate equations for estimating the costs of roadway (formation), ties, rail & other track material and ballast. These are based on the cross sectional analysis, of data for a number of Class I railroads, and assumes that the costs are related to the square root of the traffic density. The most important criticism against this model is that the 'square root of density' relationship implies that costs will continue to fall indefinitely as volume increases, hence the optimal level of traffic is infinite. This problem arises because the model is based on 1956 data with traffic density in the range of 9 to 25 MGT (million gross tonnes) and should not be extrapolated to higher traffic levels.

A subsequent model is the Weighted System Average Cost (WSAC) model, which is essentially based on an engineering approach (Resor 1994). In this case engineering equations are used to reflect the relative track damage caused by different types of traffic (defined in terms of axle loads and speed) taking the track curvature, grade and weight of rail into consideration.

8.4 Indian Railway's Costing System

The costing system being followed on IR is a fully distributed costing system where the costs are first booked to the different gauges (Broad Gauge, Meter Gauge and Narrow Gauge) on the basis of actual expenditure pertaining to each. For the purpose of allocation of common costs, surveys of offices/stations on a railway are carried out and output parameters established for allocation of costs (for example cost of a booking office may be allocated on the basis of the number of tickets sold/invoices prepared).

Within each gauge, the costs are further bifurcated between freight and passenger, on the basis of the relevant output parameters. The passenger costs are further split between suburban and non-suburban traffic. The allocation between freight and passenger services is done on the following basis:-

i) Direct costs on actuals (e.g. repair and maintenance of wagons, goods shed staff etc. to freight services and booking and ticket checking staff, station maintenance etc. to passenger services).

ii) Common costs:-

⇒ Track: station yards to passenger service, marshalling yards/siding to freight services and mainline track on ratio of GTKM pertaining to each service.

⇒ Fuel: on actual consumption as per shed records for diesel and on the basis of a specific formula for electric traction.

⇒ Crew: wages are charged to a common head, hence cannot be directly apportioned. However the strength and grade of staff allocated for various services are available with the bill-preparing offices. The share of expenses for respective services are worked out for a representative period through analysis of records from these offices and this ratio is applied for apportioning the total expenses over the year.

iii) Joint Costs are allocated on basis of specific formulae.

Depreciation: The depreciation charges are calculated on the book value of the assets, using straight-line depreciation over the life of the asset. In the case of rolling stock this is done on the basis of replacement value of an asset.

Interest: Interest is calculated on the basis of the dividend payable, on the capital at charge. The entire monies invested in (or loaned to) the Indian Railways by the Central Government is taken as capital at charge and dividend is paid, on this amount, to the Central Government, at rates prescribed by the railway convention committee from time to time. The existing rate is 7% per annum. This, however, takes no account of the inflation, which has varied between about 4% to 8% in the past five years (and has recently come down to under 2%).

General Overheads: The expenditure which cannot be identified, with any specific function, is classified under General Overheads and is taken as a percentage of the total allocated expenditure, excluding overheads. This includes expenditure on the Security department, Medical, Training, Provident fund and pension & retirement benefits etc.

Central Charges: Expenditure on Policy formulation and services common to all the railways (Railway Board, Research & Development, Recruitment Boards, Training Institutions etc.) are booked separately and taken as a percentage of the total allocated expenditure including General Overheads.

Costing of freight Services

Unit costs are worked out separately, for the different gauges, for each railway under two groups: A & B.

Group 'A': These costs are derived from the aggregate expenditure of the railways and the element of overhead expenditure is included in these costs. The cost of provision and maintenance of wagons is also included as an element in each facet of the operation. Line-haul costs are given as aggregate costs in terms of per Train Km, per Wagon Km and per TKM. Traction-wise break-up is not available and these unit costs are used for working out the overall cost of movement where the mode of traction is not specified and a mix of traction is prevalent. The unit costs are calculated for:-

i) Terminal cost per tonne (separately for 'smalls', 'wagon-load' & 'trainload' traffic)

ii) Repacking costs for 'smalls'

iii) Transhipment costs at break of gauge.

iv) Marshalling cost per wagon per yard.

v) Linehaul costs per Train KM, Wagon Km, TKM separately for Shunting Trains and Through Trains.

Group 'B': The basic elements are similar to group 'A' but the Interest and Depreciation charges are given separately with each element. 'Overheads' and 'Central charges' are given as separate heads, as percentages to the total. The cost of provision and maintenance of wagons is shown separately. The linehaul cost is split into three elements (traction, train passing staff, track and signalling). The traction cost is further separated for different modes of traction. The linehaul costs are calculated separately for through trains and shunting trains.

This system has the advantage of a well established basis for allocation of costs. However, at the same time, it suffers from serious disadvantages in case of use for commercial decision making since:-

1) It relies on system wide average costs, it suffers from the basic problem of fall in traffic, on one sector, leading to an increase in the costs on another sector, where there may actually not have been any change at all.

2) It is a fully allocated system and does not separately identify the marginal costs, which would actually be the relevant costs in case of a commercial decision.

3) It does not provide current cost data. The final figures, by the time they are compiled, are already 18 month old and cannot reflect the actual trends in costs.

8.5 Costing Of Rail Haulage Of Containers

8.5.1 The Present System

Under the present system The Container Corporation of India (CONCOR), which is the sole provider of domestic intermodal services in India, pays a flat per TEU per KM charge for rail haulage of containers based on (RFFC 1993) the weighted average cost per GTKM of all streams of traffic with a 15% rebate for services not rendered by IR in this case (marketing, documentation etc.). There is also an element of 20% profit for IR added to this adjusted cost. The Railway Fares & Freights Committee (RFFC)1993 have recommended changes in this system, including the use of Long Term Variable costs instead of fully distributed costs in the case of Multimodal transport.

8.5.2 The UIC Method

The UIC leaflet 381R (1970) describes the 'Method Of Calculating The Cost Of Transport In Trans-containers'. Even though the publication is rather dated, the basic methodology is valid and covers costing for loaded as well as empty movement of containers and includes costing for rail haul, terminal handling and road collection & delivery.

For calculation of the cost of rail haulage, the model requires train-wise data about total and marginal costs of various components such as 'motive power', 'rolling stock', 'track' (bridges, tunnels, inspections etc.), 'taxes', 'documentation', 'accidents', 'handling' (at source and destination separately), 'crew', 'fuel', 'lubricants', 'maintenance' etc..

Similarly, the calculation of the costs of road collection and delivery, requires data about the distance, average speed of road vehicle, annual utilisation of road vehicle, fuel consumption, drivers pay etc. and the total and marginal costs of maintenance, tyres, fuel and insurance etc..

The costs of provision and maintenance of containers are also calculated based on the capital costs, expected life, accidental damage & repair charges and other miscellaneous expenses.

The inputs required, for using this model, would need detailed costing data from a sophisticated costing system for both rail and road. In the present case, neither is available, therefore, it does not seem to be feasible to use this model.

8.5.3 The ESCAP model

The Economic and Social Commission for Asia and the Pacific (ESCAP) has developed a point to point traffic costing model, for use by the member railways (ESCAP 1997). This model has been developed as an aid to commercial functioning of the various, primarily state owned, railways in the region. It attempts to use, as input, the data available from traditional railway costing systems, based on system wide average figures, for providing estimates of costs of point to point movement. It uses unit cost data from the traditional costing system (such as fuel consumption per 1000 GTKM, cost of maintenance of wagons and locomotives per Km etc.) along with financial parameters such as fuel prices per litre/per KWH and wage rates and calculates the costs based on given parameters of operating efficiency (transit time, wagon turn around, locomotive utilisation etc.). It is possible to test the sensitivity to changes in various parameters, such as estimating costs with improved operational efficiency, by using expected efficiency figures.

The outputs of this model are provided in three groups which have been defined here as:-

Short Run Marginal Cost: This consists of cost elements which are likely to vary in the short run (defined here as within 12 months). It has been assumed that capital cost elements will not vary in the period considered.

Long Run Marginal Cost: This consists of costs which are likely to vary in the long run (i.e. more than 12 months here). Thus it will include the Short Run Marginal cost and any capital increments required, to support additions to the output, in the long run.

Fully Distributed Costs: this includes the elements of overheads, General management costs, Interest and Depreciation costs. The distribution of overhead costs is made on an arbitrary basis, as a percentage on total cost excluding overheads.

The inputs required are of two types:-

Physical Costing Parameters: operational data such as the distance, wagon tare and payloads, number of wagons to a train, annual volume of traffic, fuel consumption rate, locomotive availability, transit time etc..

Financial Costing Parameters: such as the hourly crew costs, fuel costs per unit, rolling stock capital costs and life, maintenance cost per Km or per day etc..

The final figures of interest to us, would be the Long Run Marginal Costs (LRMC) which (along with corresponding figures of collection and delivery costs) would serve as the floor level for setting of prices in case of traffic, where there is significant competition from road, and the Fully Allocated Costs, which the business as a whole would need to cover, to function on commercial lines.

8.5.4 The Model Used

As mentioned earlier, the present IR costing system is not suitable for use in commercial decision making. It also does not appear feasible to use the UIC model in the present case since the data, required by this model, is not available. In addition to this, the ESCAP model also has the advantages of giving outputs in a suitable format and the possibility of using the available data with some modifications. We have, therefore, used the ESCAP model with some modifications. The modifications made and the assumptions used are discussed in the next two subsections.

We have used the 'Group- B' cost explained in section 8.4. Since these are entirely based on fully distributed costs, they tend to overlook the existing/expected differences in the nature of the rolling stock and the movement patterns. It, therefore, becomes necessary to have the cost build-ups under different assumptions. The fully allocated unit costs are modified appropriately to reflect these differences, as explained below.

We have also calculated the costs of movement under different scenarios, to give a good picture of the effect of changes in operating efficiency as well as the basis of allocation of costs, on the final viability of the services.

8.5.4.1 Modifications Made in the ESCAP Model

We could not obtain the financial costing data in the exact format as required by this model. Therefore, some modifications and simplification of the model were required which are explained below:-

1) The model requires inputting of the number of days, the service is to run in a year and uses annual traffic figures for its calculations. However in our case this would not be appropriate as we are looking at different service frequency levels as well. Therefore, we have done the costing on a round trip basis.

2) The ESCAP model takes into account the cost of new infrastructure specifically required for the flow in question (e.g. cost of a new dedicated line for handling iron ore traffic). In the present case there was no requirement of new dedicated track or signalling infrastructure and, for the present, we are not likely to face a situation where the terminal facilities would need to be expanded for the traffic in question. However the renewal cost of track infrastructure has to be accounted for in the long run. Therefore the elements of depreciation and interest, available in the 'Group-B' costs, were taken as the cost of provision of infrastructure, under the fully allocated costs. This element was available as a 'per 1000 GTKM' figure and was multiplied by the average gross load of a freight train over IR to get a 'per train KM' figure (since this would be the fixed cost of capacity).

3) The model requires the input of unit cost of wagon maintenance per wagon Km. The cost of wagon maintenance available represents an average over different types and ages of wagons. Container movement requires special types of flat wagons with fittings for securing the containers. However, separate figures of maintenance costs are not available for these wagons. As such, the results using average unit costs were compared with the results using the commonly adopted thumb rule, of annual maintenance cost being equal to 5% of capital cost. The difference between the two was quite minor, as such the unit costs have been used.

8.5.4.2 Assumptions Used

The assumptions used in the costing exercise are discussed below:-

1) Variable Costs of Track & Signalling Infrastructure Maintenance: The model requires, as input, the variable cost of track maintenance per GTKM and the fixed cost of track maintenance per train (KM). In our case there is only one figure available of 'Maintenance cost per 1000 GTKM'. It became necessary to split this cost into fixed and variable parts. Johansson & Nilsson (1998) have estimated the elasticity, of track maintenance costs to marginal changes in traffic levels, to lie between 0.13 to 0.28 on main and between 0.23 and 0.34 on secondary lines, over the Swedish Railways. Over the Indian Railways the norm (based on statistical studies) is to take the track maintenance costs to be 60% variable. The difference can be explained on basis of the fact that the Swedish railways (and most other

European railways) are primarily passenger based railways, where a much higher level of preventive maintenance is required, to ensure safety and also because of the high speeds for which the track is built. In case of developing country railways, which tend to be more freight oriented, the maintenance is likely to be more need based.

Over Indian Railways also there is a great difference in the level of maintenance of the Trunk routes (the sides and diagonals of the Golden Quadrilateral), the other main routes and the branch lines. The norm, of 60% variable cost for Indian Railways, represents an average of all the three types of routes mentioned above. However, the traffic under consideration is moving almost entirely on the trunk routes and in this case the variable component of the costs is likely to be lower as these routes are maintained to much higher standards. We have, therefore, calculated the costs taking variability ratios of 40% as well as 60%. We found that there was a difference of only about 2%, in the LRMC figure, between the two sets of calculations, and a difference of only Rupees 0.02 in the Fully Allocated Cost per TEU/Km (i.e. less than 0.5% of the total cost figure). As such, we have taken the average of the two figures (i.e. 50% variable) for further work.

2) Fixed Costs of Track & Signalling Infrastructure Maintenance: The fixed element (i.e. the balance after removing the variable element from the track & signalling infrastructure maintenance costs) has been converted from per 1000 GTKM basis to per KM basis by multiplying by the average gross load of freight trains over Indian Railways. This became necessary since use of per 1000 GTKM figures would result in a difference in the cost borne by loaded and empty trains whereas the fixed maintenance cost element is not expected to change with the load of a train.

3) Wagon Capital Costs: At present, there are three types of wagons in use. The first are the conventional, vacuum braked, flat cars designed for container haulage (BFK). They form the main bulk of the wagon fleet used for container movement and are presently owned by Indian Railways. These are to be purchased by CONCOR and converted to air-brake systems. The second type of wagons are old open top (BOX) wagons which have been converted for container haulage. Both these types of wagons (BFK and BOX) are capable of running at 70 kph. The third

type are the new Hi-Speed wagons (BLCA), being obtained under a world bank aided programme, which are capable of running at 100 kph.

The second type (BOX wagons) is basically a stop gap arrangement and also results in poorer reliability of services as such it is not considered in our analysis. We therefore, consider the use of BFK wagons with a cost (after conversion to air brake) of about Rupees 850,000 and the hi-speed BLCA wagons with a cost of approximately Rupees 1.1 million in our analysis.

4) Cost of Finance for Locomotives and Wagons: The modes of finance available and used at the moment are

   a) Internal funds: there is no norm available for cost of internal funds. However the memorandum of understanding (MOU), between CONCOR and MOR, specifies that CONCOR has to get a 20% return on capital employed.
   b) Capital at charge from the government of India on which IR currently pays dividend at the rate of 7% per annum.
   c) Market borrowings which carry an interest rate of about 16% per annum.
   d) World bank loans which carry an interest rate of about 8% per annum (including the guarantee charges) in addition to this they also bear an exchange rate risk.

None of the above take any account of the rate of inflation.

If we are to consider the long term costs, the most appropriate rate would appear to be the market rate of interest, since this best reflects the opportunity cost of funds invested.

We use the Annual Capital Charge (ACC) method to calculate the annual payment required (in real terms) to recover the full cost of the asset at the end of its life. We need an annual payment 'a' which will give us a present value of 100 over a life of 30 years, given a real interest rate 'r'. We have :-

$$100 = \frac{a}{1+r} + \frac{a}{(1+r)^2} + \_\ \_\ \_ + \frac{a}{(1+r)^{30}} \qquad (1)$$

multiplying both sides by (1+r) we have :-

$$100(1+r) = a + \frac{a}{1+r} + \_\ \_\ \_ + \frac{a}{(1+r)^{29}} \qquad (2)$$

(2) - (1) gives us :-

$$100r = a(1 - \frac{1}{(1+r)^{30}})$$

$$a = \frac{100\,r}{(1 - \frac{1}{(1+r)^{30}})} \qquad (3)$$

Taking 'r' = 10% (the real rate with current rate as 16 % and inflation at 6%) we get 'a'= 10.61%. If we were to consider a 2% p.a. variation in the market rate of interest we would get a corresponding value of ACC to be 8.88% (for 'r' = 8%) and 12.41% (for 'r'=12%).

5) Transit Time: the currently achieved average transit times, between Delhi and Bombay, are under 4 days in case of the BFK wagons and 2 days in case of the BLCA wagons. For ease of calculation, when calculating break-even distances we convert this into a figure of 'Wagon Km per Wagon Day in Transit' and use figures of 400 wagon Km/wagon day and 750 wagon Km/wagon day in transit for BFK and BLCA wagons respectively. In addition, for illustration purposes, we have also calculated the costs using a figure of 200 wagon Km/wagon day, which is the figure conventionally taken for costing purposes in IR.

6) Terminal Detention: The average terminal detention of wagons is of the order of 2 days (loaded to loaded). We therefore take a figure of 1 day at each end (Empty to Loaded and Loaded to Empty).

7) Overheads: in case of rail traffic, the administrative costs and all other unallocated costs are taken as general overheads and are allocated as a percentage of the total costs (excluding overheads). These include the costs of marketing, supervision costs, medical and other staff welfare costs, training and pension funds etc.. In case of Intermodal traffic, a significant part of these costs, which pertain to marketing and the terminal costs, are not borne by IR but are borne by CONCOR. As we shall see later, the general overheads in case of CONCOR come to about 9% and in case of IR the overheads come to about 22%. Taking both into consideration

would lead to double charging of the marketing and other administrative expenses. Under the present system, this is accounted for by giving CONCOR a rebate of 15% on fully allocated costs (RFFC 1993). We account for this by taking only half of the IR overheads that would otherwise be allocated to the container haulage by rail. In addition, we also demonstrate the effect of taking a higher proportion (75%) of the IR overheads into consideration, for this traffic.

8) Empty Return Ratio (ERR): At present there is almost no empty running of flat cars on the route under consideration. As such, we assume the ERR to be '0' in this case. We also test the sensitivity of the final cost, to a change in the extent of empty running, by recalculating the costs with an ERR of 0.25 (i.e. 25% of the wagons running empty in the return direction).

8.6 Cost of Door to Door Movement of Containers

8.6.1 Cost of Rail Haulage of Containers

The costing has been carried out based on the ESCAP model, after incorporating the modifications and assumptions discussed above. For the purpose of this exercise, we have considered the costs involved in a trainload movement of containers on the selected route (Delhi to Bombay). The results of this costing exercise are given in Table 8.1. All costs have been converted to indexed costs with the fully allocated costs, using BFK wagons with ERR = 0 and ACC = 10.61%, taken as the base. This table also shows the effect of change in interest rates and the assumption regarding the proportion of IR overheads to be allocated to container haulage costs.

The costs have been calculated using unit cost data for 1996-97 (MOR 1997 & 1998) updated to April 1998 levels. The 1996-97 costs are based on the final accounts for that year and escalation factors are available for 1997-98 (based on revised estimates made at the end of that 1997-98) and for 1998-99 (based on the budget estimates for 1998-99). Since these figures pertain to the average cost for the year, we have obtained the cost at the start of the year by taking half of the escalation factor for the corresponding year. Taking costs for April 1998 makes all the costs comparable since our road VOCs are based on April 1998 data.

The main figure of interest to us would be the 'Long Run Marginal Cost', as this represents the level of costs to be recovered for running a new service, on a long term basis.

Table 8.1: Indexed Cost of Rail haulage under different assumptions

Wagon Km/Wagon Day	400	400	400	750	750	750	200	200	200
Wagon Type	BFK	BFK	BFK	BLCA	BLCA	BLCA	BFK	BFK	BFK
Loco & Wagon Financing (ACC) % p.a.	10.6	12.4	8.88	10.6	12.4	8.88	10.6	12.4	8.88
ERR = 0									
SHORT RUN MARGINAL COST	41	41	41	40	40	40	44	44	44
LONG RUN MARGINAL COST	54	56	52	52	54	50	68	72	64
Fully Allocated Cost (50% of OH)	100	102	98	98	100	95	116	120	111
Fully Allocated Cost (75% of OH)	105	108	102	102	105	100	121	126	117
ERR = 0.25									
SHORT RUN MARGINAL COST	46	46	46	44	44	44	49	49	49
LONG RUN MARGINAL COST	62	65	59	59	61	56	80	85	75
Fully Allocated Cost (50% of OH)	109	112	106	105	108	103	128	134	123
Fully Allocated Cost (75% of OH)	114	117	111	110	113	108	135	141	129

From Table 8.1 it can be seen that the transit time has a significant effect on the final cost. A figure of 200 wagon Km/wagon day would increase the LRMC by 27% and fully allocated costs by 16% as compared to costs obtained using a figure of 400 wagon Km/wagon day. In case of the hi-speed wagons, the decrease in costs, due to lower transit time, is partially offset by the higher wagon costs and we would end up with a reduction of 4% in LRMC and 2% in the fully allocated costs. If the ERR goes up to 0.25 there is an increase of 9% in the fully allocated costs and 15% in the LRMC.

Change in the cost of financing of wagons and locomotives also has a small effect with a 20% (2 percent point) change in the interest rate leading to a 4% change in the LRMC and a 2% change in the fully allocated costs. In case 75% of the IR overheads are taken into account, for container haulage costs, the fully allocated costs increase by 5% over the figure obtained by taking only 50% of the IR overheads into account.

8.6.2 Terminal Costs (Collection & Delivery Costs)

The collection and delivery operations are carried out on contractual basis. At most terminals, the cranes and operating staff are also employed on a contractual basis. In such a case, the contractor is responsible for the lifting of the container from wagon (or ground stack) onto a road trailer, then moving it to the consignor/consignee's premises for loading/unloading and finally returning the trailer to the terminal where the container is again taken off and put on rail wagon or ground stack. Typically, the road trailers are combined tractor-trailer units where the two stay together all the time and are of two types i.e. rigid body units which can carry only 20 foot containers and articulated tractor-trailers which can carry two 20 foot containers or one 40 foot container. Our calculations are based on the smaller trailers carrying one 20 foot container as this is the more commonly used one and will also be more useful in case of the traffic we are looking at.

The current charges for terminal handling and door delivery are based on the charges paid, to the handling contractor, for both these activities and are finalised on the basis of an open tender. The present level is approximately Rupees 2,500 at each end.

The costing, for the door delivery, is based on a trailer making one round trip in a day (typically upto 30 KM each way) as it is rarely possible to make two trips, due to restrictions on entry of heavy vehicles in city areas during the day. As such the capital costs form a large part of the total cost. One option for reducing the costs is to use older (second hand) equipment (trailers) but this leads to poor reliability of services due to frequent break downs of trailers.

The cost data obtained from one contractor is given in columns 2 & 3 in Table 8.2. The average trip length is about 60 KM (return) and a trailer is assumed to be working 300 days a year (this is the figure of usage arrived at in the Road User Cost Study). The depreciation is calculated on straight line basis over the normal life of 10 years (obtained from the interviews with road transport operators) of these vehicles. The interest charges in this case were given as 14% by the contractor, as this was the rate he was paying to his bank. However, a rate of 16% has been taken here so as to have the same rate for both the rail and the road operations costs.

When we compared these figures, with the data available from other road transport operators (discussed subsequently in section 8.8), we found that there were major differences in the elements of insurance, cost of lube oil, cost of tyres and capital costs. In case of the lube oil, it is possible that there is higher consumption in the present case, since older vehicles are used for the short distance running. However in case of the other elements, the data obtained from the interviews with the road transport operators appears to be more reliable.

Table 8.2: Cost of Road haulage of containers (all figs in Rupees at April 1998 Prices)

	From Contractor		From Interview data		Using ACC method	
	Annual	Per Trip	Annual	Per Trip	Annual	Per Trip
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Fuel Cost 60 Km @ 3.5 Km/litre (Rupees/trip)		137		137		137
Road Tax (Rupees/Year)	21,000	70	18,000	60	18,000	60
Insurance (Rupees/Year)	25,000	83	12,000	40	12,000	40
Driver +Asst. (Rupees/Year)	66,000	220	66,000	220	66,000	220
Maintenance (Rupees/Year)	18,000	60	18,000	60	18,000	60
Lube Oils (Rupees/Year)	24,000	80	24,000	80	24,000	80
Tyres (Rupees/Year)	110,000	367	60,000	200	60,000	200
Total (1 - 7)		1,017	204,000	797	204,000	797
Cost of rigid body trailer (Rupees)	800,000		600,000		600,000	
Depreciation (Rupees/Year)	80,000	267	60,000	200		
Interest @16% (Rupees/Year)	128,000	427	96,000	320		
Total of 10-11	208,000	693	156,000	520	97,620	325
Cost per trip (Rupees)		1,710		1,317		1,122

In case of the capital cost of the trailer-tractor unit, the figure given by the contractor was Rupees 800,000 whereas the figures given by the other operators were around Rupees 600,000 for new units and about Rupees 350,000 for second hand units. We have taken the figure of 600,000, as we are looking at a reliable service and it is unlikely that this can be provided, by using second hand trailers. In addition to this, the decrease in capital cost, through the use of second hand trailers, is likely to be partially compensated by the increase in running and maintenance costs. Accordingly, the modified figures are shown in columns 4 & 5. Finally, in columns 6& 7, we have re-calculated the cost based on the second set of figures using the ACC method. We have taken a real interest rate of 10% and life of asset of 10 years, which gives the annual charge to be 16.27%. The last set of figures will be used for the purpose of the break-even analysis, to ensure consistency in the calculation method for all the different modes.

In a total cost of almost Rupees 1300 (column 5) the only variable element is the fuel cost amounting to about 10% of the total cost for a journey of upto 30 KM each way. Because of the short distance movement, all the other expenses such as crew, maintenance etc. become fixed as the crew is paid on a monthly basis and the maintenance also has to be on a time bound basis rather than on a distance basis.

The cost of handling of containers (i.e. lifting from wagon to trailer or ground to trailer and vice-versa plus one additional operation per round trip) is worked out to about

Rupees 800 for a round trip. In view of the fact that the entire collection & delivery activities are carried out on a contractual basis, it would be appropriate to take the cost paid by CONCOR, rather than the cost to the contractor, as the basis for further calculations. This gives us a total cost of about Rupees 5,000 for collection and delivery at both ends.

8.6.3 Total Cost of Door to Door Services

The total cost of the door to door service is arrived at by adding up the individual components of 1) Rail Haulage 2) Collection & Delivery 3) Container cost 4) CONCOR's overheads. The first two elements have already been discussed in detail in the preceding sections. In case of the container cost we can quite simply take the rental being paid for container hire by CONCOR which is Rupees 110 per day.

We have estimated the overheads from the 'Profit & Loss Statement' in the Annual Accounts for the year ending March 1998 (CONCOR 1998). This shows Rupees 4,009 Million as the outgoing on account of the Terminal & other Services and Rupees 71 Million Staff costs and 290 Million under Administrative and other expenses. From these figures it appears reasonable to take a figure of 9% over total costs (excluding overheads) as the general overheads.

The total cost, on this basis, is calculated for the two wagon utilisation scenarios (i.e. 400 Km/day and 750 Km/day), for distances of 500, 1000, 1500, 2000, 2500 & 3000 Km and is shown in Table 8.3. This seems to show that there is very little difference in the door to door costs using either the conventional flat wagons or with the new high speed wagons since the increase in capital costs is made up for by the higher utilisation of these wagons. The per TEU/Km costs fall off quite rapidly with distance and the costs for distances of 1500 Km are almost half the costs for a distance of 500 Km on a fully allocated basis and a third on LRMC basis. This would seem to indicate that the intermodal container services are not likely to be very competitive at short distances due to the high instance of door collection/delivery costs. However for long distances they could be quite competitive.

Table 8.3: Index of Total cost of Movement by Intermodal Container Services

Distance (Km) →	500	1000	1500	2000	2500	3000
Conventional (BFK) Wagons						
LRMC	78	47	37	32	29	27
Fully Allocated	100	65	54	48	45	42
New (BLCA) Wagons						
LRMC	76	45	35	30	26	24
Fully Allocated	99	63	52	46	42	40

Table 8.4 shows the collection and delivery costs as a percentage of the marginal cost, including the container rental and the collection & delivery costs, and as a percentage of the fully allocated costs including CONCOR overheads. These figures are based on the use of BFK wagons, however, the pattern is almost the same for BLCA wagons as well. It can be seen that for a distance of 500 Km the collection and delivery costs form more than two thirds of the marginal costs and more than half of the total cost. This goes to almost half of marginal cost and a third of fully allocated cost for a distance of 1500 km and one third and one fifth respectively for a distance of 3000 Km.

Table 8.4: Collection & Delivery Costs as % of Total Costs

Distance in Km →	500	1000	1500	2000	2500	3000
Collection & Delivery Cost as % of LRMC	71	59	50	43	38	34
Collection & Delivery Cost as % of Fully Distributed Cost	55	42	34	28	25	22

This goes to illustrate, that the collection and delivery costs are the most crucial element of the cost of intermodal services. Reduction of these costs needs to be the most crucial target for making intermodal services competitive. The above results would appear to be in line with CONRAIL estimates (Morlok et.al. 1990) which suggest that payments for drayage can cost upto 40% of the total price paid by a shipper for door to door intermodal movement. Morlok et.al.(1990) have estimated that a saving of 25 to 40% of drayage costs could be achieved through centralised planning of drayage operations for the whole terminal rather than the existing system of fragmented planning.

In the present case, this would need a revamping of the drayage operation and attempting to program for round trips (i.e. unloading of loaded container and repositioning for loading of empty container and return to base, rather than one movement each from base for loading and unloading).

In addition to this, the feasibility of continuing the current practice of charging a mark-up (for CONCOR) on the collection and delivery costs may need to be re-examined.

This practice is only likely to make matters worse in regard to the current situation, where containers are being stuffed & de-stuffed at the terminals for collection & delivery by lorries (because it becomes cheaper to do this than to have door to door movement of containers). The main cost advantage, of a rail based service, lies in the long distance haulage, which should therefore, be the main source of profitability as well.

8.7 Costing for Movement by Rail Wagons

In the case of costing for movement by railway wagons, the wagon Km/wagon day figure stays as 400 wagon Km/wagon day since we are looking at block train movement using air braked wagons. The ACC rate also remains the same as for container haulage. In case of fully distributed costs we take the full level of overheads of IR into account. The terminal detention is taken as 1.5 days for each operation (i.e. loaded to empty or empty to loaded). This is higher than the terminal detention for container movement because firstly, the loading and unloading time has to be taken into account here (in case of container haulage it is only time for lift off/on by the crane) and secondly, in this case, the possibility of wagons having to be repositioned for loading also arises. The door delivery/collection charges are taken to be Rupees 4000 per wagon at each end (based on data obtained during the interviews).

We have also recalculated the costs with an ERR = 0.25 to examine the effect of 25% of the wagons returning empty.

Table 8.5: Indexed Costs of Movement by Rail Wagons

Wagon Km/Wagon day	400	400	400	400	400	400	200	200	200
Empty Return Ratio (ERR)	0	0	0	0.25	0.25	0.25	0	0	0
Loco & Wagon Financing Cost (ACC) - %	10.61	12.41	8.88	10.61	12.41	8.88	10.61	12.41	8.88
SHORT RUN MARGINAL COST	59	59	59	61	61	61	60	60	60
LONG RUN MARGINAL COST	70	72	68	76	78	73	79	82	76
Fully Allocated Cost	100	102	98	107	110	104	111	115	107

The results of the costing are shown in Table 8.5. All costs are shown in terms of indexed costs with the fully allocated cost with ERR=0% and ACC = 10.61 taken as base. From this we can see that in case 25% of the wagons had to return empty, the fully allocated cost would go up by 7% and the LRMC would go up by about 9%. The effect of change in the interest rate is much lower and a 20% (2 percent point) change in the interest rates leads to a 2% change in the fully allocated costs and a 3% change in the LRMC. A fall in the operational efficiency (doubling of transit time) would lead to an increase of 10% in marginal costs and 11% in fully allocated costs.

8.8 Road vehicle Operating Costs

8.8.1 Interview data

Road VOC data has been collected from five of the transport operators contacted in the course of the LASP interviews. These are given separately for each company in Table 8.6. Most of the figures were actually guesstimates made by the road transport operators concerned. Actual figures, from a computerised database, were available only in one case. This (Company A) was a large freight transport operator with nation-wide operations, operating a total of about 1000 lorries on any given day. They owned only about 150 lorries and the rest were hired from the market. The hired vehicles had an almost even split between long term contracts and temporary hire. In this case the figures were obtained for the most common type of two axle lorries as well as the three axle lorries. Companies 'B', 'C', & 'D' were medium sized operators (mainly partnership firms) operating between 20-100 lorries on a daily basis. Company 'E' was a small operator only owning 2 lorries and hiring the rest from the market and acting as a broker. In the last case, the data pertains to an alternative North to West route with poorer roads and some hilly terrain.

There is some ambiguity as regards the crew costs, due to two basic reasons – firstly, in some cases these costs have been calculated with two drivers and one assistant and in other cases this is with one driver and one assistant. Secondly, there appear to be two elements to this cost - one being the salary paid and the second being in form of expenses paid for food, fuel and contingencies enroute. This ambiguity also extends to the diesel costs since money for the fuel is paid to the driver before the trip, except in case of the large transport operators who have credit arrangements for fuelling at major locations.

In view of this ambiguity, it is better to look at the total cost figure (excluding interest and depreciation) rather than the components. The crew costs have been included in the variable portion rather than in the fixed cost since, given the nature of ownership, the drivers are likely to be employed only when traffic is available. In case of lorries owned and operated by the big transport operators, the crew would be hired on long term basis but, in this case, operator owned lorries are likely to be utilised fully all the year round with the market hire taking care of the fluctuations in traffic levels.

Table 8.6: VOC Data (All Costs in Rupees, 1 GBP = 70 Rupees {approx.})

	Company A				**Company B**		**Company C**		**Company D**		**Company E**	
Route	(North - South)		(North - South)		(North -East)		(North - West)		(North - West)		(North - West)	
Vehicle	2 axle lorry		3 axle container lorry		2 axle lorry		2 axle lorry		2 axle lorry		2 axle lorry	
	Annual	Per Km	Annual	Per Km	Annual	Per Km	Annual	Per Km	Annual	Per Km	Annual	Per Km
Trips per Yr.	24		27		36		36		38		48	
Distance p.a.	122,880		118,800		105,000		105,000		105,000		84,000	
Diesel	387,072	3.15	475,200	4.00		3	396,000	3.77	418,000	3.98	240,000	2.86
Oil							18,000	0.17	18,000	0.17		
Tyres	100,000	0.81	140,000	1.18		1	86,400	0.82	96,000	0.91	89,600	1.07
Maintenance	55,296	0.45	41,580	0.35		1	45,000	0.43	36,000	0.34	36,000	0.43
Misc.	61,440	0.50	83,160	0.70								
Crew Cost	85,440	0.70	118,800	1.00		1.5	36,000	0.34	30,000	0.29	133,200	1.59
Fixed Charges												
National Permit	36,600	0.30	36,850	0.31	36,000	0.34	25,000	0.24	30,000	0.29	25,000	0.30
Insurance	10,000	0.08	20,500	0.17	12,000	0.11	18,000	0.17	15,000	0.14	12,000	0.14
Container Rent			49,896	0.42							10,000 tarpaulin	
Sub-Total		**5.99**		**8.13**		**6.96**		**5.95**		**6.12**		**6.38**
Interest					108,000	1.03	115,200	1.10	72,000	0.69	72,000	0.86
Depreciation					60,000	0.57	60,000	0.57	50,000	0.48	50,000	0.60
TOTAL (A)		**N.A.**		**N.A.**		**8.56**		**7.62**		**7.29**		**7.83**
Recalculation on ACC basis												
K Cost	600,000		800000		600,000		600,000		600,000		600,000	
ACC@ 16.27	97,620	0.79	130,160	1.10	97,620	0.93	97,620	0.93	97,620	0.93	97,620	1.16
TOTAL(B)		**6.78**		**9.23**		**7.89**		**6.88**		**7.05**		**7.54**

There appear to be some amount of difference in the individual cost elements. However, if we consider the total cost excluding Interest and Depreciation, the figures are quite similar with the figures for the North to West and North to South routes lying between Rupees 5.95 to 6.12 per KM (except for company E where we are actually considering a rough and hilly route alternate North to West route) while that for the North to East route (with poorer road condition and sections of rolling & hilly terrain) is almost Rupees 7 per KM.

We have re-estimated the costs using the ACC method (Total(B)) and this is the cost which will be used for the break-even analysis. The total cost on ACC basis, for the Bombay to Delhi route, would appear to be about Rupees 7.00 (not considering the data for company 'E' because it is a different route with poorer roads).

8.8.2 Results from the Statistical Model

As discussed in section 8.2, the VOC data has also been taken from the statistical model (IRC 1993) which provides VOC tables for different road types, roughness levels and terrain. The indicative values of these parameters are:-

Table 8.7: Typical Roughness Values for Indian roads (mm/KM)

	Road Condition			
Surface Type	**Good**	**Average**	**Poor**	**Very Poor**
Asphaltic Concrete	2000-2500	2500-3500	3500-4000	over 4000
Premix bituminous Carpet	2500-4500	4500-5500	5500-6500	over 6500

(*Source: IRC 1993*)

Table 8.8: Typical RF values for various types of terrain in India (M/Km)

Terrain	**RF Value**
Plain	0-15
Rolling	15-30
Hilly	30-50

(Source: IRC 1993)

The route under consideration is a recently upgraded 4 lane highway with mostly plain terrain. We therefore, take the roughness value as 2000-2500 mm/Km and the rise and fall (RF) as 5 m/Km. In case of the alternative routes, for which we have VOC data, for the North to East route the road quality can be taken to be poor with a roughness value of 3500-4000 mm/Km and there are some stretches with rolling/hilly terrain so we have taken the average RF value to be 15-20 m/Km. The North to South route and the alternative North to West route would have values somewhere in between these. We have calculated the costs for a range of road conditions covering all these types.

The calculated VOC values are given in Table 8.10. Fixed costs, in this case, consist of Interest on capital, Insurance, road tax, fines and elements of overheads such as managerial/clerical staff, office expenses etc.. To make the costs comparable to the costs calculated from the survey data (given in Table 8.6) we have also calculated the VOC after removing overheads, depreciation and interest (given in the last row in Table 8.10). This however includes a component of approximately 20% of the fixed cost representing insurance charges and taxes.

These VOC values (IRC 1993) are based on April 1993 prices. In order to adjust them to 1998 prices, the prices of important inputs as given in IRC 1993 were compared with the April 1998 prices (Table 8.9). The adjustment factor, for crew costs, was based on the rise in the All India Consumer Price Index (CPI) on the assumption that the wages would have kept pace with the CPI. From Table 8.9 it is seen that there is an increase of about 30% in the prices of the inputs. There is however an increase of over 50% in the Consumer Price Index. The VOC has therefore been adjusted to 1998 levels by inflating the crew wages by 50% and all the other elements by 30%.

Table 8.9: Price comparison

Item	April 1993 Price	April 1998 Price	% Increase
Cost of 2 axle HCV	480,000	600,000	25%
Diesel (Rupees per litre)	6.17	8.00	30%
Tyres	7,790	10,000	28%
Consumer Price Index	216	336	55%

In case of the Delhi - Bombay (North to West) route the value of VOC from Table 8.10 (excluding interest, depreciation and overheads) would be expected to be about Rupees 5.30 per KM (at April 1998 prices). The same value for the North to South route would be somewhat higher on account of the somewhat poorer road condition. In case of the North to East route the values of VOC (excluding interest, depreciation & overheads) would be expected to be about Rupees 6.00, on the average, for the entire route.

8.8.3 Comparison of Interview Results with Statistical Model

Using the values from the statistical VOC model, after removing the elements of overheads, depreciation & interest and adjusting to 1998 prices, it appears that the VOC values obtained during the interviews were about 10 to 15% higher than the values obtained from the statistical costing exercise. If, however, we look at the overall figure including interest, depreciation and overheads, then the VOC data obtained during the interviews closely matches the values obtained from the statistical model. It would, therefore, appear that the respondents, in making the guesstimates, have in fact been working with the total cost figure in mind. One of the respondents had mentioned that in this industry the norm was to take a 10% profit for the lorry owner and another 10% for the booking agent. In case of the small owners having 2-3 lorries (which constitutes a very large part of the lorry ownership in India) the managerial salary and overheads (elements included in the overheads in the statistical model) would, in effect, represent the owners' profits. In case of company 'A', where actual data has been maintained, the 'Miscellaneous' head covers the cost of loading and unloading of lorries etc.. If we exclude this we get a figure of Rupees 5.49 per KM (excluding Depreciation, Interest & Overheads) which is very near the figure obtained from the statistical model.

Table 8.10: VOC from Statistical Model for different types of roads (All costs in Rupees per Km)

Road Type	4 lane						2 lane								
Roughness (mm/Km)	2000	2000	3000	3000	4000	4000	2000	2000	2000	3000	3000	3000	4000	4000	4000
Terrain (Rise/Fall M/Km)	5	10	5	10	5	10	10	20	40	10	20	40	10	20	40
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**
COSTS															
Fuel	1.12	1.13	1.12	1.14	1.13	1.15	1.13	1.18	1.36	1.14	1.19	1.37	1.14	1.20	1.39
Tyre	1.06	1.10	1.08	1.13	1.11	1.16	1.10	1.21	1.49	1.13	1.24	1.54	1.16	1.27	1.59
Oils	0.19	0.20	0.20	0.22	0.22	0.22	0.20	0.23	0.30	0.22	0.25	0.31	0.23	0.26	0.32
Spares & Maint.	0.30	0.30	0.36	0.36	0.41	0.41	0.30	0.30	0.30	0.36	0.36	0.36	0.41	0.41	0.41
Fixed Cost	1.70	1.77	1.71	1.78	1.73	1.8	1.88	2.03	2.42	1.89	2.04	2.44	1.91	2.06	2.47
Depreciation	0.31	0.33	0.32	0.33	0.32	0.33	0.35	0.37	0.44	0.35	0.38	0.45	0.35	0.38	0.45
Crew Cost	0.82	0.86	0.83	0.86	0.84	0.87	0.91	0.98	1.17	0.92	0.99	1.18	0.92	1.00	1.19
Total (April 1993 prices)	5.50	5.69	5.62	5.82	5.76	5.94	5.87	6.30	7.48	6.01	6.45	7.65	6.12	6.58	7.82
Total at April 1998 prices	7.31	7.57	7.47	7.74	7.66	7.90	7.81	8.39	9.96	8.00	8.58	10.18	8.14	8.75	10.40
Total Excluding Interest, depreciation & overheads (April 1998 Prices)	5.14	5.30	5.28	5.46	5.44	5.60	5.40	5.79	6.87	5.58	5.97	7.06	5.70	6.12	7.25

(Source: Manual on Economic Evaluation of Highway Projects in India, *Indian Roads Congress 1993*)

It appears that we could take the total figure (including depreciation, interest and overheads as mentioned above, but excluding the profit margin of the transport agents) to be about Rupees 7.30 per kilometre for the better (four lane and plain) routes (e.g. Delhi to Bombay) rising to almost Rupees 8.60 per KM for routes with some rolling terrain and two lane roads. The second category would in fact constitute a major portion of the highway network in India. For our calculations, we shall take the corresponding costs based on ACC calculations, which come to about Rupees 7.00 and Rupees 7.90 per Km respectively.

8.8.4 Comparison of the VOC With Round Trip Revenues

We have attempted to further compare these results with the round trip revenues. Though actual data on empty running of lorries on this route is not available, discussion with researchers working in this field and transport operators, seem to indicate that there is almost negligible empty running over such long distances. Lorries would, normally, move to nearby towns where traffic is likely to be available and then go loaded over the main leg of the journey. In cases where the destination of the outward leg is an area where return traffic is not likely to be available, the cost of empty running to, the nearest point where traffic is usually available, is built into the freight rate quoted. In the course of our interviews with transport operators, we have taken VOC data pertaining to the Delhi to Bombay movement, where there is very little empty running. On this particular route the narrow difference in the outward and return rates is also an indicator of the fact that traffic is available in both directions. We are, therefore, taking an overall average figure of empty running to be 5%, based on the interviews and discussions with other researchers in the field in India.

On the basis of a total cost (including depreciation, interest and overheads) of about Rupees 7.30 per Km the cost for a round trip distance of about 3000 Km would be about Rupees 22,000. If we take the cost of 7.00 per Km on ACC basis, the total cost comes to Rupees 21,000. This figure is almost equal to the round trip revenue (Rupees 12,000 + Rupees 10,000) with 5% empty running giving us a total of about Rupees 21,000. In case of the survey data the VOC data has been collected from freight transport operators and freight forwarders who have been asked to give the rates for lorries hired from the market. As such this data should include the profit element of the lorry owner but not of the transport agent (in this case the transport operator/ freight forwarder is effectively the transport agent). These results could perhaps suggest that our cost calculations based in interview data are slightly on the higher side and actual VOCs for road movement are a little lower than this. However, these results are also supported by the results from the Indian statistical costing model therefore the extent of difference may not be very high. This further confirms the qualitative findings of the survey that the Indian road transport industry is highly competitive.

These findings regarding the narrow spread between costs and prices are quite similar to the findings of Hine & Chilver (Hine 1991, Hine & Chilver 1991, 1994) regarding the cost and price structure of the road transport industry in Pakistan.

8.9 Conclusion

In this chapter, we have seen the importance of considering the external costs of transport and seen the different approaches to their calculation. We have found that it is not possible to consider these costs in the present research, due to non-availability of data from India or similar developing country situations.

We have also seen that rail costing is much more complex, than costing for road transport, due to the need for creation and maintenance of dedicated infrastructure for rail transport. A lot of work has been done, on the American Railroads, on costing for regulatory purposes and this has tended to use combinations of Statistical and Engineering approaches. Work on British Rail has tended to be based more on the use of the Accounting approach.

Indian Railways follows an accounting approach based on fully allocated, system wide, average costs supported by statistical and engineering studies to complement it. This approach is not suitable for estimating the costs of point to point movement of specific traffics. The UIC model has also been found to be unsuitable due to the vast amount of data required, as input, for this model. The ESCAP model has been found suitable for the present purpose and has been adopted with some modifications.

We have calculated the costs of haulage of containers by road using the ESCAP model and tested the sensitivity to various assumptions regarding the rate of interest, the operational efficiency, the extent of empty running and the type of wagons used. We have then estimated the cost of door to door movement by containers by adding the cost of door delivery/collection, container rental and the overheads for CONCOR. We have found that the collection and delivery costs form almost half of the marginal cost and a third of the fully allocated costs of movement for a distance of 1500 Km. This high fixed element makes door to door services un-viable for smaller distances. As such, the efficiency of drayage operations is likely to be a major contributor to the success of intermodal services.

We have obtained the costs of movement by rail wagons using the same model with some change in the operational parameters. We have also tested the sensitivity of these costs to change in the transit time, change in the extent of empty running and change in the rate of interest on capital employed (for rolling stock). We find that the change in transit time has a significant effect on the cost. However the effect of the other two factors is lower.

Finally, we have estimated the cost of road transport using survey data and have compared it with the cost obtained using the Indian statistical model. There appears to be very little difference between the round trip revenue and the VOC, which indicates that the road transport industry in India is highly competitive.

Chapter 9: BREAK EVEN ANALYSIS

In this chapter, we first compare the basic costs of door to door transport by road, rail and intermodal services, which have been arrived at in the previous chapter, and carry out a break-even analysis for the same. Subsequently, in section 9.2, we take the service quality issues into account and combine our cost model with the demand model developed in chapter 7. Break-even analysis is carried out for each sector separately and then the results are summarised in section 9.3. In section 9.4 we look at some route specific factors. Finally, in section 9.5, we compare the results from section 9.3 with the actual price data for rail and intermodal services, to see where the present services stand.

9.1 Analysis of Break-even Distances on Cost Basis

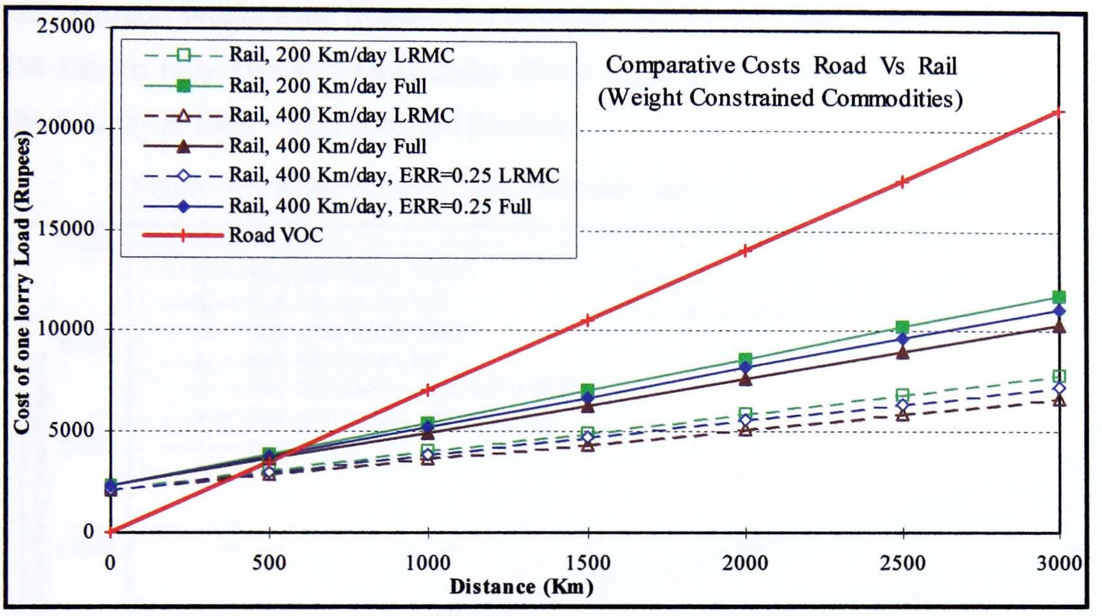
For purpose of the break-even analysis, all costs have been taken as door to door costs. In case of container and wagonload services, we have taken costs of movement of wagon/container loads in block trains and then obtained equivalent costs for one lorry load by dividing by the respective loadability factors. Separate analysis has been carried out, for weight constrained and volume constrained commodities, as the loadability factors are different. The loadability factors are based on the capacity levels given in Table 9.1.

Table 9.1: Carrying Capacities

	Capacity - Tonnes	Capacity - Cu Feet
Lorry (2 axle)	9 - 12	900
20 ft Container	21	1150
Covered Wagon (BCN)	57	3300

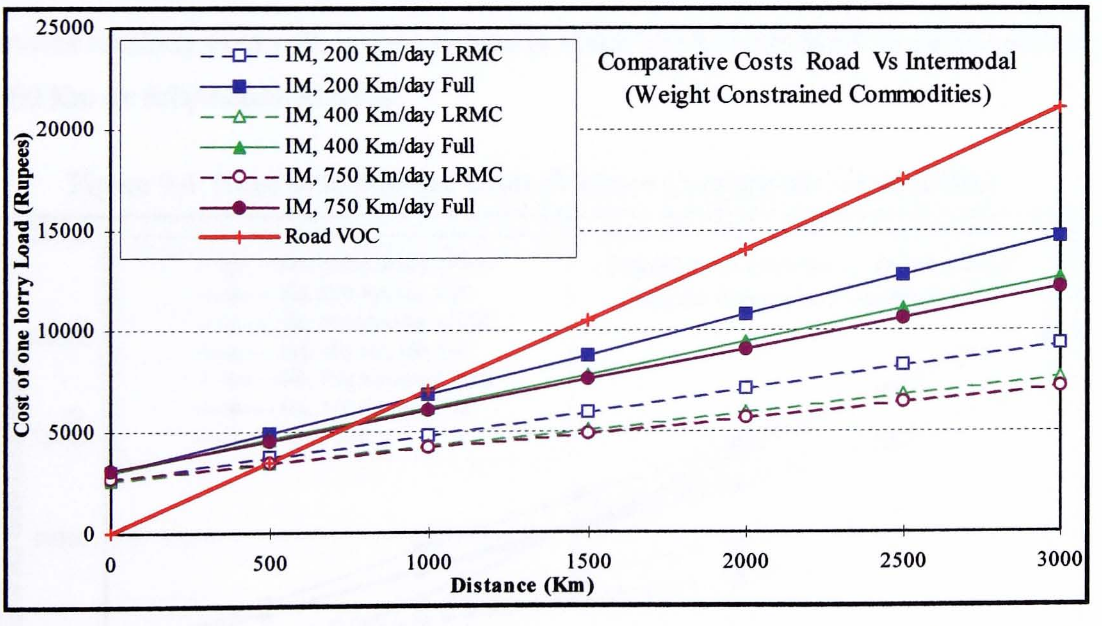
Figure 9.1 shows the comparative cost of movement by road and rail for weight constrained commodities. We have shown the results for 200 wagon Km/wagon day as well as 400 wagon Km/wagon day. However, we are mainly interested in the latter figure. In this case rail service becomes viable, on LRMC basis, for distances of about 400 Km and on fully allocated cost basis for distances between 500 and 600 Km. Even if 25% of the wagons return empty, the change in the break-even distance is not very large (we have not considered cases of higher percentage of empty running as the route under consideration, is a saturated route and it would not be possible to introduce services resulting in heavy empty movement on this route).

Figure 9.1: Road & Rail costs (Weight Constrained Commodities)



In case of the comparison of road services with intermodal services (Figure 9.2), the intermodal services break-even at about 500 Km in case of LRMC costs and about 750 Km in case of fully distributed costs.

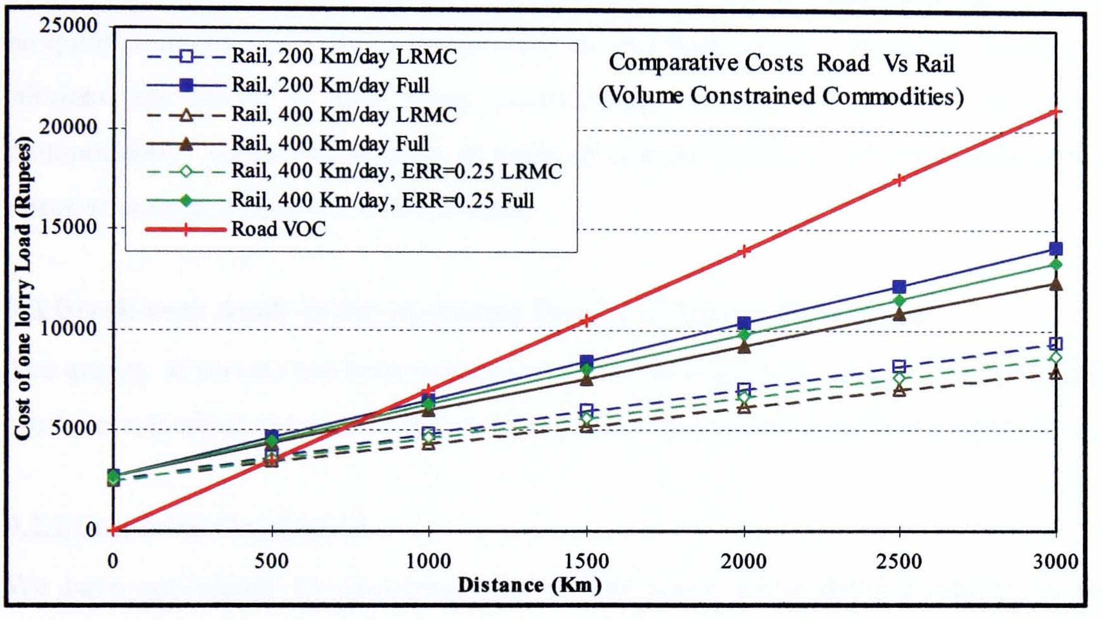
Figure 9.2: Road and Intermodal Costs (Weight Constrained Commodities)



In this case if we were to consider higher transit times (as reflected by figure of 200 wagon km/wagon day) there would be some change in the break-even distances which would then shift to about 550 Km with LRMC costs and about 1000 Km with fully distributed costs.

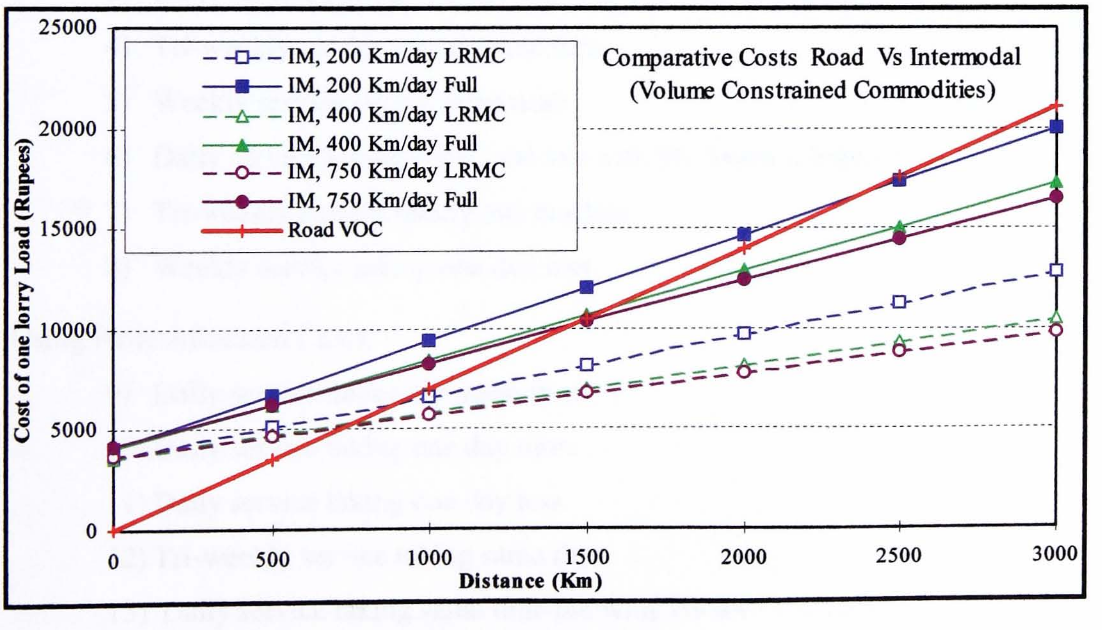
When we look at volume constrained commodities the picture is only slightly different. Rail transport breaks even (Figure 9.3) at about 500 Km on LRMC basis and at about 750 Km on fully allocated basis under all the scenarios considered (i.e. 400 Km/day, 200 Km/day & ERR = 0.25 with 400 Km/day).

Figure 9.3: Road & Rail Costs (Volume Constrained Commodities)



In case of Intermodal services (Figure 9.4) the difference is greater, with the intermodal services breaking even with respect to road at about 750 Km on LRMC basis and almost 1500 Km on fully allocated basis.

Figure 9.4: Road & Intermodal Costs (Volume Constrained Commodities)



In this case, a change in the operational efficiency has a significant impact and the break-even shifts to about 900 km on LRMC basis and 2300 Km on fully allocated basis considering a figure of 200 wagon Km per wagon day. However, an increase in the ERR to 0.25 does not have a major impact.

The analysis, shown above, seems to indicate that both rail and intermodal services can be quite competitive, as compared to road, on cost basis alone. However, intermodal services are likely to face some disadvantages in case of volume constrained commodities. This arises because, in terms of volume, 1TEU = 1.25 lorry loads and, in terms of weight, 1TEU = 1.75 lorry loads.

9.2 Break-even Analysis Incorporating Quality of Service Parameters.

The quality of service has been incorporated into the break-even analysis, by taking the attribute valuations obtained in chapter 7 together with the cost data from chapter 8.

9.2.1 Scenarios Considered

We have considered 13 scenarios, with service levels being defined relative to the current road service levels and all the times are for door to door movement: -

Using LRMC Costs: -

1) Daily service taking same time as the present road services
2) Daily service taking one day more than the present road services
3) Daily service taking one day less than the present road services
4) Tri-weekly service taking same time
5) Weekly service taking same time
6) Daily service taking same time but with 5% lower reliability
7) Tri-weekly service taking one day less
8) Weekly service taking one day less

Using Fully Allocated Costs: -

9) Daily service taking the same time
10) Daily service taking one day more
11) Daily service taking one day less
12) Tri-weekly service taking same time
13) Daily service taking same time but with 5% lower reliability

For each scenario, we have obtained a generalised cost, taking into account the attribute valuations for the ASC, time, frequency and reliability. The 'Solver' utility in 'Excel' software package has been used to calculate the break-even point for each scenario. The Excel worksheet has been programmed to calculate the break-even points, for a given set of attribute valuations, for weight constrained as well as volume constrained loads, under varying assumptions about transit speeds and frequency of service.

The calculations were done for a poor operational performance scenario (200 wagon Km/wagon day) a good performance level already achieved (400 wagon Km/wagon day) and the higher performance achieved with new wagons (750 Km/day). However, in the final compilation of results, we have only retained the results pertaining to 400 Km/day for rail and 400 & 750 Km/day in case of intermodal services. In case of rail, there appears to be no possibility of achieving better transit times at present than those represented by a figure of 400 wagon Km/wagon day in transit. In case of Intermodal container services, the 400 Km/day figure corresponds to the time taken using conventional container flats (BFK wagons) and the 750 Km/day figure corresponds to the time taken using the new wagons (BLCA) so these are the scenarios we need to look at. Scenarios of improved performance (over currently achieved levels) are also implicitly covered in the case where we consider services taking a day less than the current time by road.

9.2.2 General Format Used for The Discussions of Individual Sectors

The discussion is mainly related to the Delhi - Bombay route with a distance of 1500 Km. It should, however, be possible to extend it to other routes as well, though there is some possibility of difference in the ASCs on other routes, due to the nature of the route. This is possible as some firms may prefer container services, in case the route is through hilly areas with a lot of rain or where roads are bad or prone to theft. In such a case, the breakeven would shift in favour of Intermodal services (i.e. become lower).

In case of the first sector considered, exports, we have given break-even distances for 'rail Vs road' and 'intermodal Vs road' in tabular as well as graphical form and have also shown the change in costs by rail and intermodal service with change in distance (to get an idea of the relative position of rail and intermodal services for that sector). For the subsequent sectors, we have only shown the break-even distances for rail Vs road and intermodal Vs road in the text and the charts for the rail Vs intermodal case are given in the appendices. We only briefly refer to the main conclusions for these, in the text.

The primary difference between the road Vs rail or road Vs intermodal cases and the rail Vs intermodal case is that, in case of the latter, if we consider similar quality of service for both the modes then the service quality valuations are the same for both (other than the ASCs) and the break-even distance stays the same for all the scenarios. The difference between the generalised cost of a rail service and that of an intermodal service will remain same irrespective of the attribute levels considered, as long as both the services have the same attribute levels. We have compared different quality services in some cases for reasons explained in the text.

In our discussion, we shall generally speaking, first consider the viability on fully allocated cost basis. In case a service is viable on fully allocated cost basis it will definitely be viable on marginal cost basis hence we will not explicitly discuss the marginal cost case for such services. Then we shall go on to consider the marginal costs in case of services which are not viable on a fully allocated basis.

We have some negative values of the breakeven distances in case of services taking one day less than the existing services. These arise because the VOT for one day is getting subtracted even though the distance may involve less than a days transit time. For the 1500 Km route considered here, these are simply taken to indicate that the service is likely to be highly profitable. If we were considering a much shorter route we would have to look at the actual values and distances involved in greater detail.

9.2.3 Exports Sector

Figure 9.5 shows the results for the rail/intermodal Vs road analysis. Breakeven points for each of the thirteen scenarios, are first given in tabular form and then illustrated graphically if form of thirteen sets of six bars each. Each set of six bars represents one of the thirteen scenarios listed above. The bars represent (from left to right): -

1) Rail service (400 wagon km/wagon day, wt constrained)
2) Rail service (400 wagon km/wagon day, vol. constrained)
3) Intermodal container service (400 wagon km/wagon day, wt constrained)
4) Intermodal container service (400 wagon km/wagon day, vol. constrained)

5) Intermodal container service (750 wagon km/wagon day, wt. constrained)
6) Intermodal container service (750 wagon km/wagon day, vol. constrained)

It can be seen, from column 1 of the table in Figure 9.5, that intermodal services can be highly competitive, in this sector, even on fully allocated cost basis, as long as the service can match the existing quality of services offered by road. A service taking one day more (column 2) can be viable for weight constrained commodities but would need to be priced on marginal cost basis for volume constrained commodities.

We have already seen in chapter 7, that rail services are not at all viable for this sector. The data for rail, in this sector, is obtained from only two firms as the rest were not even willing to consider these services and therefore it is not really representative of the sector. We are, however, discussing these services here, on the basis of the estimated valuations, for the sake of explaining the methodology in full for one sector.

Lower frequency services are not at all competitive with tri-weekly services (col. 9) just breaking even on marginal cost basis at about 1250 Km for weight constrained commodities and not being at all viable for volume constrained commodities. A faster service (than the existing road service) would be highly competitive, even on fully allocated cost basis, for both weight and volume constrained cargoes.

In case of the Delhi - Bombay route, presently, there are typically three container trains a day in either direction for international traffic (with some empty haulage of containers in the Bombay to Delhi direction). The transit time, with the new wagons, is two days so the door to port time would be less than the time of five days taken by road consequently the services are highly competitive and profitable. As such, some of these conclusions could be trivial for this route, however the importance lies in the case of introduction of new services for exports traffic on other routes. In such a case it would need to be kept in mind that if the services are fast and run daily, high profitability levels can be achieved but lower frequency services cannot be expected to be very competitive.

The comparison between rail and intermodal services is shown in Figure 9.6 to Figure 9.9. In Figure 9.6 and Figure 9.7 we show the comparison, for weight constrained commodities, on LRMC basis and fully allocated basis respectively. The broken lines represent rail service costs and the solid lines the intermodal service costs.

Fig 9.5: Exporters Breakeven Points

Mode	Wagon Km/ Wagon Day	Wt/Vol Constrained	Full, Daily, Same time (1)	Full,Daily, 1 day more (2)	Full,Daily, 1 day less (3)	Full, Tri-weekly (4)	Full, Daily, 5% less Rel (5)	LRMC,Daily, Same time (6)	LRMC,Daily, 1 day more (7)	LRMC,Daily, 1 day less (8)	LRMC, Tri-weekly (9)	LRMC, Weekly (10)	LRMC,Daily, 5% less Rel (11)	LRMC, Tri-wkly, 1day less (12)	LRMC, Weekly ,1 day less (13)
Rail	400 Km	Wt	1407	1871	943	2623	2068	1079	1443	714	2034	3153	1598	1670	2789
Rail	400 Km	Vol.	1727	2257	1198	3117	2483	1223	1609	838	2234	3419	1773	1849	3033
IM	400 Km	Wt	435	970	-100	1838	1198	238	618	-141	1233	2398	779	854	2019
IM	400 Km	Vol.	1065	1845	286	3110	2177	479	909	49	1606	2927	1092	1177	2498
IM	750 Km	Wt	436	941	-69	1760	1156	245	611	-121	1205	2330	767	839	1964
IM	750 Km	Vol.	1001	1698	303	2830	1996	477	884	70	1545	2796	1058	1138	2389

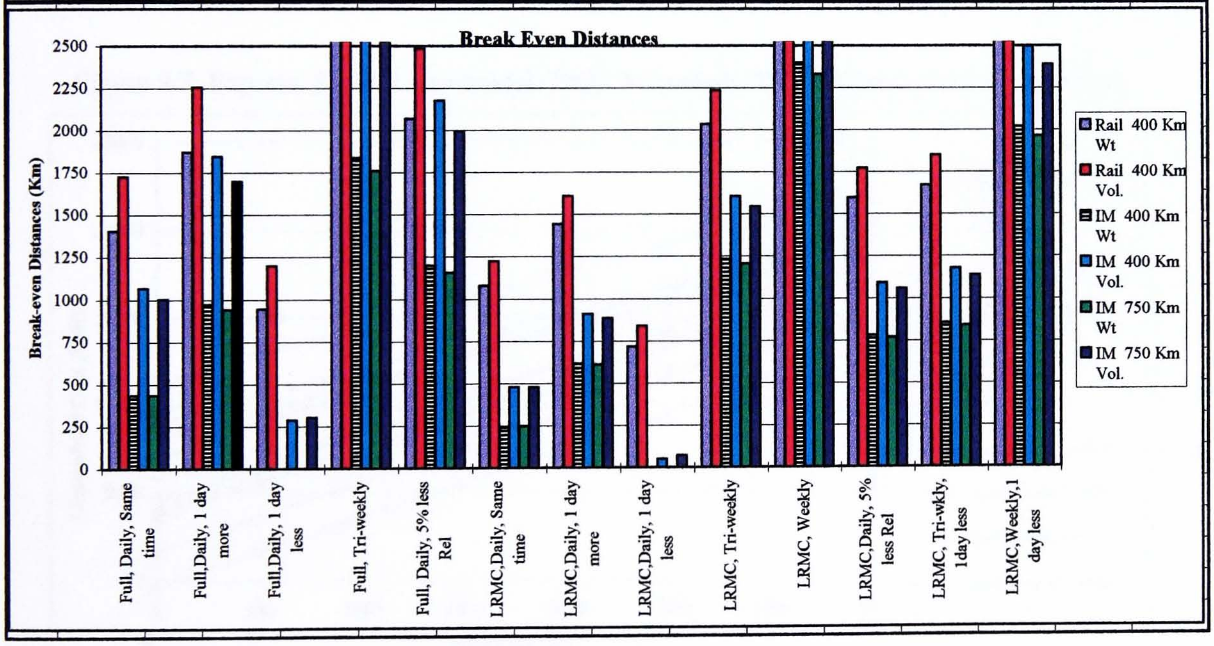


Figure 9.6: Exports, Rail Vs Intermodal (LRMC basis) Wt Constrained Commodities

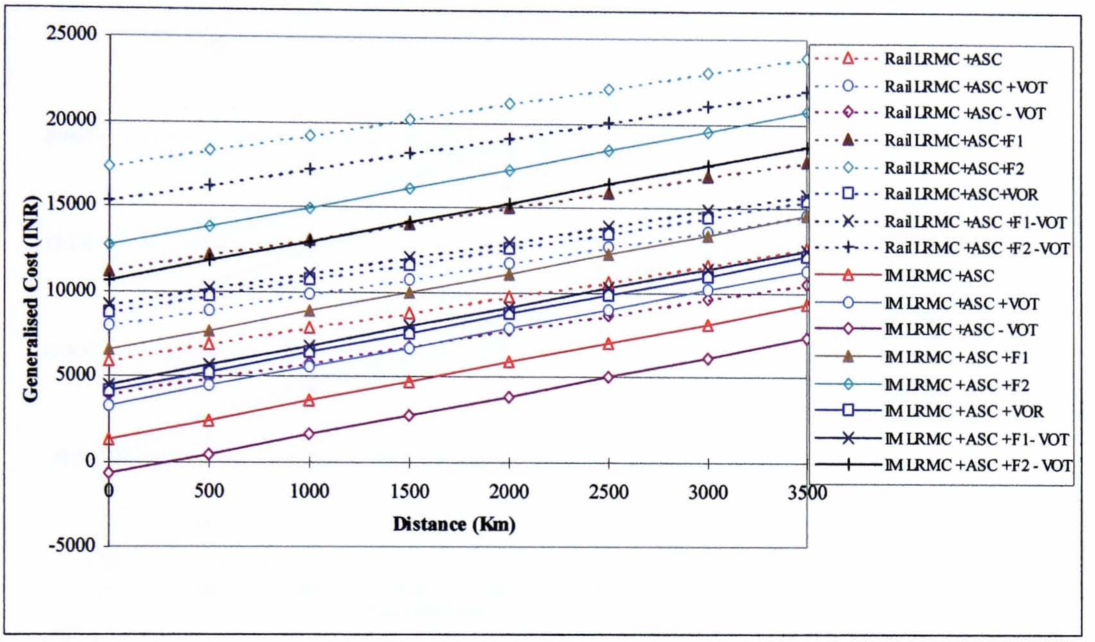


Figure 9.7: Exports, Rail Vs Intermodal (Fully Allocated) Weight Constrained commodities

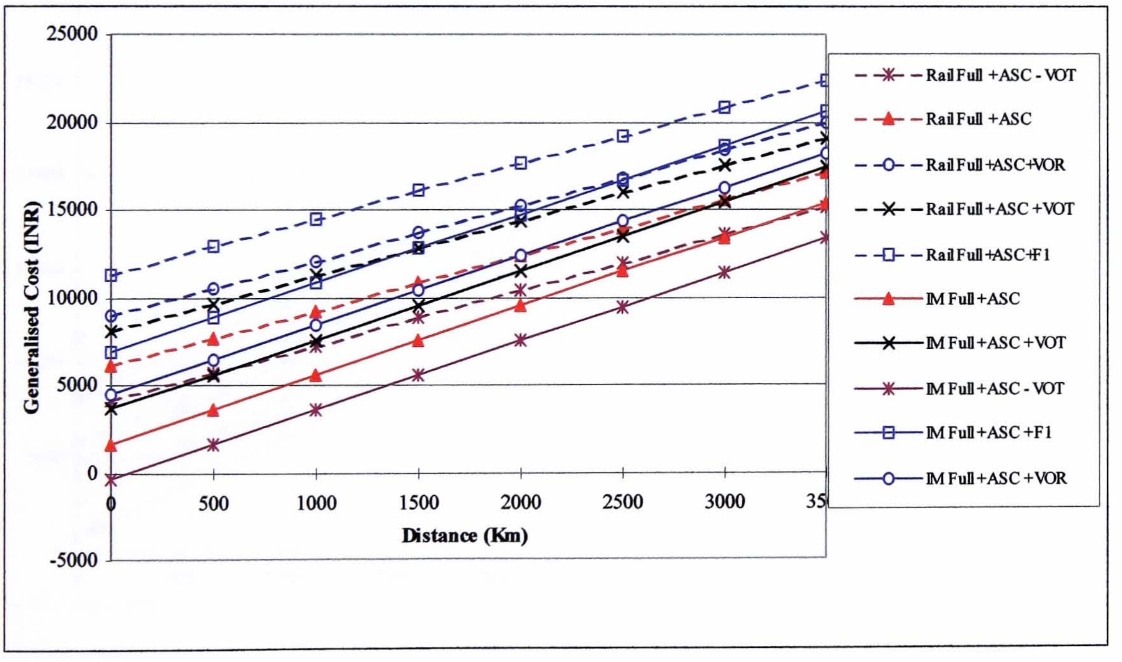


Figure 9.8: Exports, Rail Vs Intermodal (LRMC) for Volume Constrained commodities

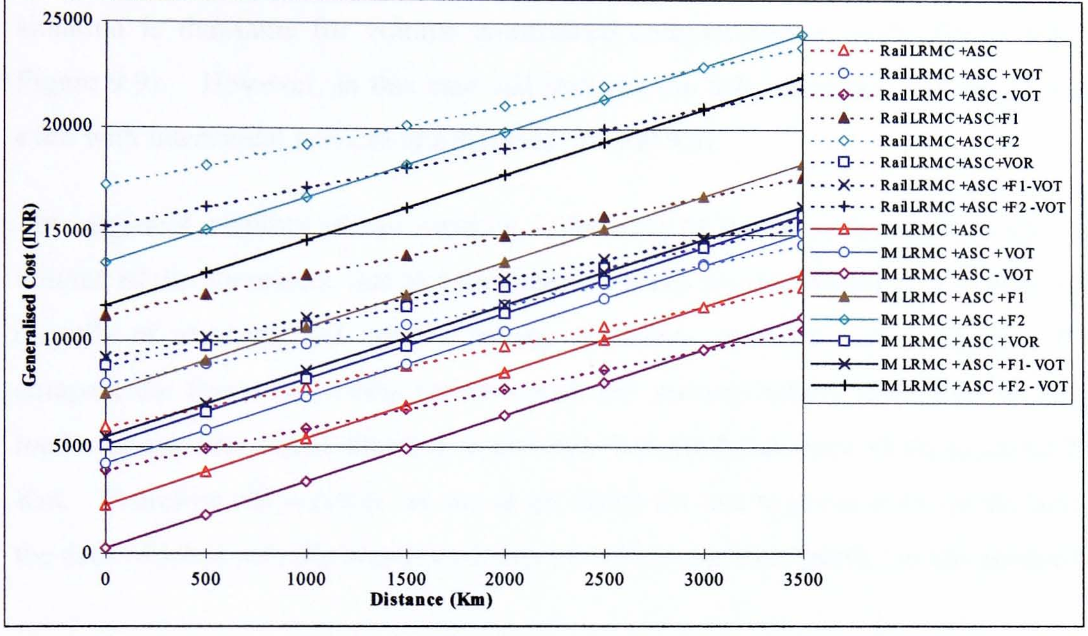
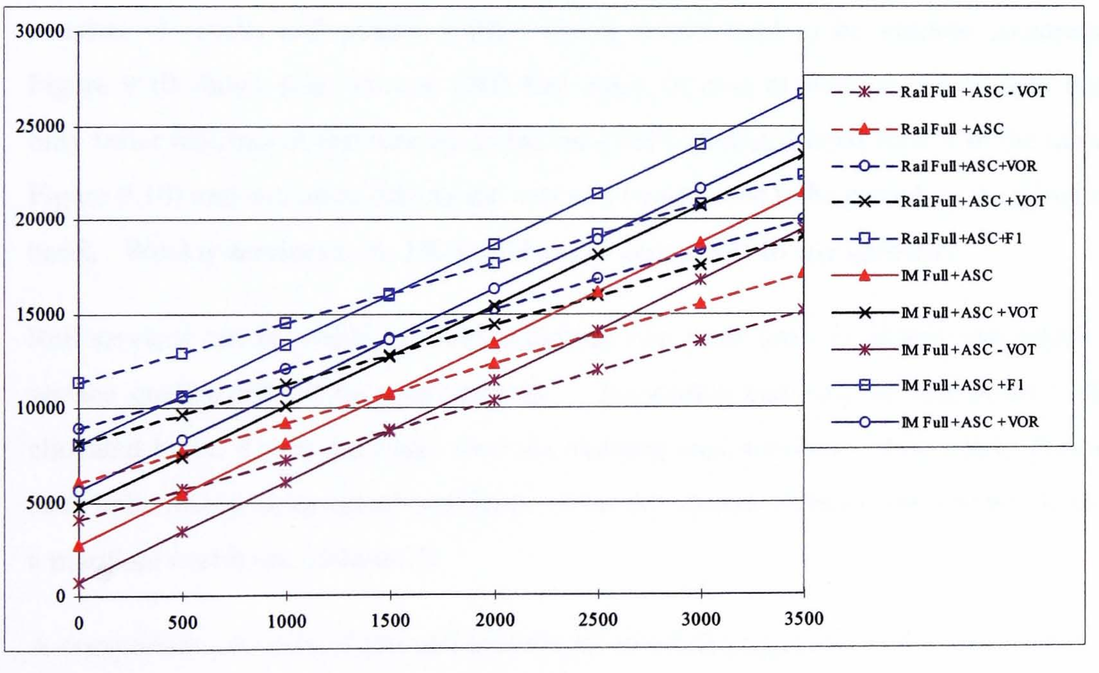


Figure 9.9: Exports, Rail Vs Intermodal (Fully Allocated basis) for Volume Constrained commodities



These figures show that intermodal services dominate under all scenarios. The situation is the same for volume constrained commodities as well (Figure 9.8 and Figure 9.9). However, in this case rail services (on fully allocated cost basis) break-even with intermodal services at a distance of 1500 Km.

This apparent viability of rail services, is because of the proportionately much lower volume of the containers, due to which the overheads are distributed over a much lower quantity of material, and not due to any advantage related to rail services. If we compare the faster intermodal services with rail services taking same time as current road services (the actual situation at present) then the break-even shifts to about 2500 Km. Therefore rail services are not at all viable for this segment even on the basis of the data which is actually biased in favour of rail (as explained earlier in this section).

9.2.4 Freight Forwarders & Transport Operators

In case of the Freight Forwarders and transport operators, a very large part of the traffic consists of smalls and parcels traffic, which would tend to be volume constrained. Figure 9.10 shows that, for our 1500 Km route, in case of volume constrained traffic only faster intermodal services are viable on a fully allocated basis (col. 3 in the table in Figure 9.10) and any other intermodal services would need to be priced on marginal cost basis. Weekly services (col. 10) would not be acceptable in any scenario.

Rail services can be viable, on fully allocated cost basis (col. 1), if they can match the service quality offered by road services. Tri-weekly can only be viable, on a fully allocated basis, if they are faster than the existing road services. Alternately they will need to be priced on marginal cost basis. One day slower services can also be viable on a marginal cost basis (column 7).

A comparison of costs of rail and intermodal services (Appendix – 'B') shows that rail services are likely to be competitive, as compared to intermodal services, on fully allocated as well as marginal cost basis for volume constrained commodities. In case of weight constrained commodities the container services become more competitive. This perhaps, explains why the attempted replacement of the rail Speed Link services by container services was not very successful.

Fig. 9.10: Freight Forwarders & Transporters Breakeven Points

Mode	Wagon Km/ Wagon Day	Wt/Vol Constrained	Full, Daily, Same time (1)	Full,Daily, 1 day more (2)	Full,Daily, 1 day less (3)	Full, Tri-weekly (4)	Full, Daily, 5% less Rel (5)	LRMC,Daily, Same time (6)	LRMC,Daily, 1 day more (7)	LRMC,Daily, 1 day less (8)	LRMC, Tri-weekly (9)	LRMC, Weekly (10)	LRMC,Daily, 5% less Rel (11)	LRMC, Tri-wkly, 1day less (12)	LRMC,Weekly ,1 day less (13)
Rail	400 Km	Wt	1143	1466	820	1668	1326	872	1125	618	1284	1925	1015	1030	1672
Rail	400 Km	Vol.	1426	1796	1057	2026	1635	1004	1273	735	1441	2119	1156	1172	1851
IM	400 Km	Wt	1007	1379	634	1612	1217	643	908	379	1073	1741	793	809	1476
IM	400 Km	Vol.	1898	2442	1354	2781	2205	938	1238	639	1425	2182	1108	1125	1882
IM	750 Km	Wt	975	1327	623	1547	1174	636	891	381	1051	1695	780	796	1440
IM	750 Km	Vol.	1746	2232	1259	2536	2021	912	1196	628	1373	2090	1072	1089	1806

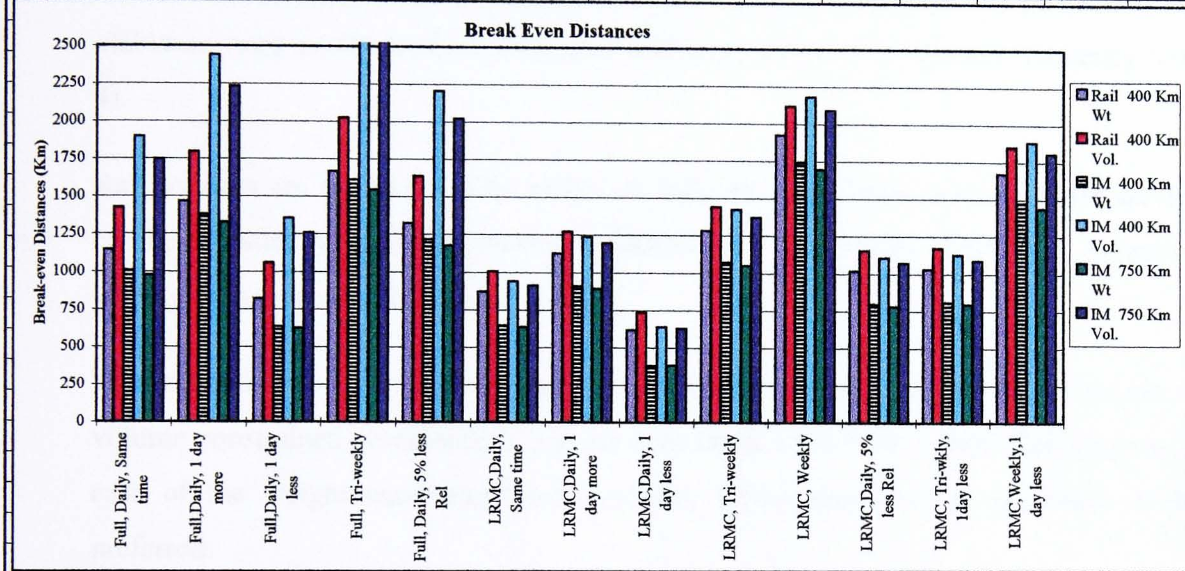
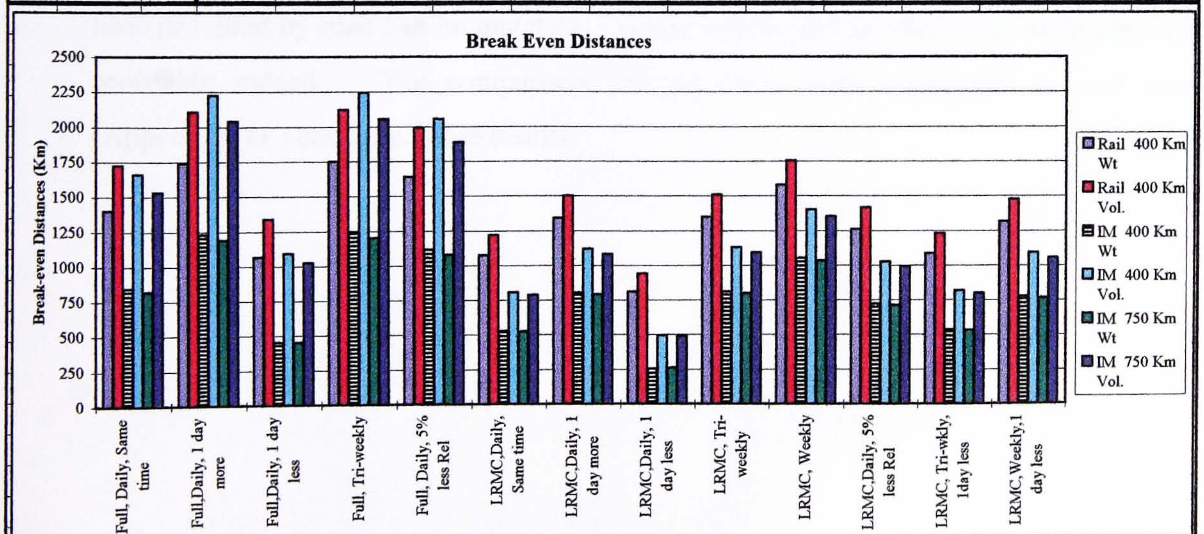


Fig 9.11: Chemicals Industry - Breakeven Points

Mode	Wagon Km/ Wagon Day	Wt/Vol Constrained	Full, Daily, Same time (1)	Full,Daily, 1 day more (2)	Full,Daily, 1 day less (3)	Full, Tri-weekly (4)	Full, Daily, 5% less Rel (5)	LRMC,Daily, Same time (6)	LRMC,Daily, 1 day more (7)	LRMC,Daily, 1 day less (8)	LRMC, Tri-weekly (9)	LRMC, Weekly (10)	LRMC,Daily, 5% less Rel (11)	LRMC, Tri-wkly, 1day less (12)	LRMC,Weekly ,1 day less (13)
Rail	400 Km	Wt	1402	1739	1066	1750	1637	1075	1339	811	1348	1580	1260	1084	1315
Rail	400 Km	Vol.	1722	2107	1338	2119	1991	1220	1499	940	1508	1754	1415	1229	1474
IM	400 Km	Wt	843	1231	455	1244	1114	527	802	252	812	1053	720	536	778
IM	400 Km	Vol.	1659	2225	1094	2244	2055	807	1119	495	1129	1402	1025	817	1090
IM	750 Km	Wt	821	1187	454	1199	1077	524	790	259	798	1031	710	533	766
IM	750 Km	Vol.	1532	2038	1026	2055	1886	787	1083	492	1092	1351	994	797	1056



9.2.5 Chemicals Industry

In case of chemicals (Figure 9.11) we find that with volume constrained cargo, Intermodal services cannot be viable on this 1500 Km route, on fully allocated cost basis, unless (col. 3 in the table in Figure 9.11) they are able to provide daily services with better transit times than road services. However, on LRMC basis (col. 6 to 13) all the services would be viable. In case of weight constrained cargoes, it is possible to run viable services on the basis of fully allocated costs even for tri-weekly frequency (col. 4).

Rail services are not likely to be viable on fully allocated basis unless a faster service can be provided (col. 3). However on LRMC basis all services considered, excepting weekly ones, appear to be viable.

The comparison of rail costs with intermodal costs (Appendix C) shows that, in case of volume constrained commodities, rail services break even below 1000 Km whereas in case of the weight constrained commodities, intermodal services are likely to be preferred.

9.2.6 Automotive Components Industry

In case of the Autoparts Industry (Figure 9.12), almost all the cargo is likely to be volume constrained therefore we will only discuss the findings pertaining to the volume constrained cargo here. In this case rail services cannot be viable at all (col. 6 to 13 in the table in Figure 9.12). In case of intermodal services, even lower frequency (tri-weekly) services (col. 4) can be viable on a fully allocated basis, provided the transit time provided by road can be matched. Faster intermodal services (col. 3) can be very profitable indeed. The comparison, of rail costs, with intermodal service costs (Appendix 'D') confirms these results.

Fig 9.12: Autoparts Industry - Breakeven Points

Mode	Wagon Km/ Wagon Day	Wt/Vol Constrained	Full, Daily, Same time (1)	Full,Daily, 1 day more (2)	Full,Daily, 1 day less (3)	Full, Tri-weekly (4)	Full, Daily, 5% less Rel (5)	LRMC,Daily, Same time (6)	LRMC,Daily, 1 day more (7)	LRMC,Daily, 1 day less (8)	LRMC, Tri-weekly (9)	LRMC, Weekly (10)	LRMC,Daily, 5% less Rel (11)	LRMC, Tri-wkly, 1day less (12)	LRMC, Weekly,1 day less (13)
Rail	400 Km	Wt	1967	2319	1616	2069	2344	1519	1795	1243	1598	1993	1814	1322	1717
Rail	400 Km	Vol.	2368	2769	1966	2483	2798	1689	1981	1397	1773	2191	2002	1481	1899
IM	400 Km	Wt	614	1019	208	730	1048	365	652	78	448	858	673	160	571
IM	400 Km	Vol.	1325	1916	734	1496	1958	623	948	297	716	1182	971	391	856
IM	750 Km	Wt	604	987	222	715	1014	367	645	90	447	843	664	170	566
IM	750 Km	Vol.	1233	1762	705	1386	1799	613	921	304	702	1142	943	393	834

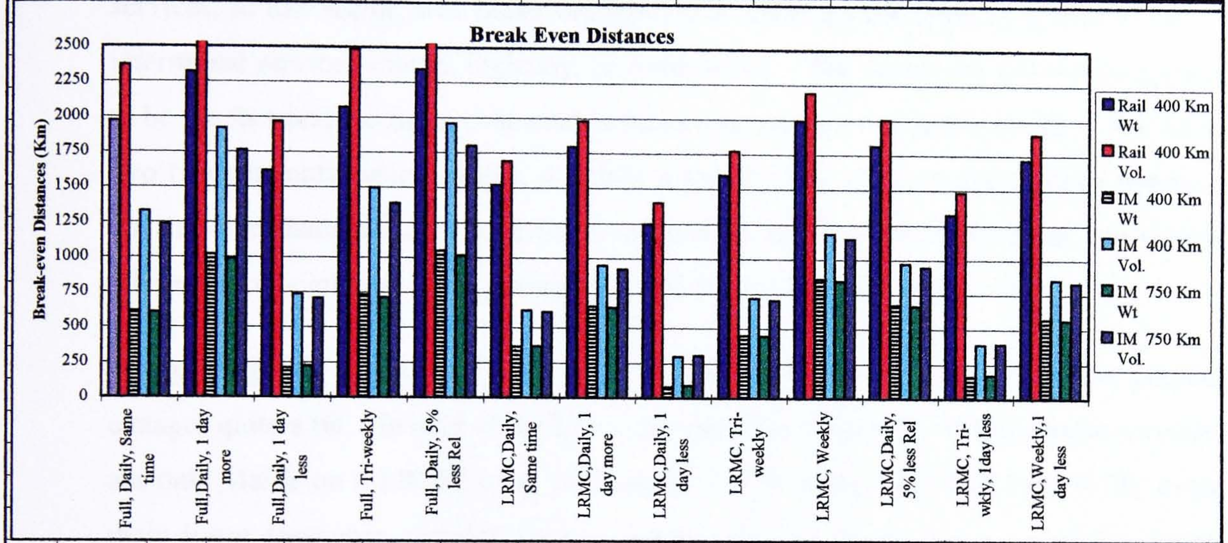
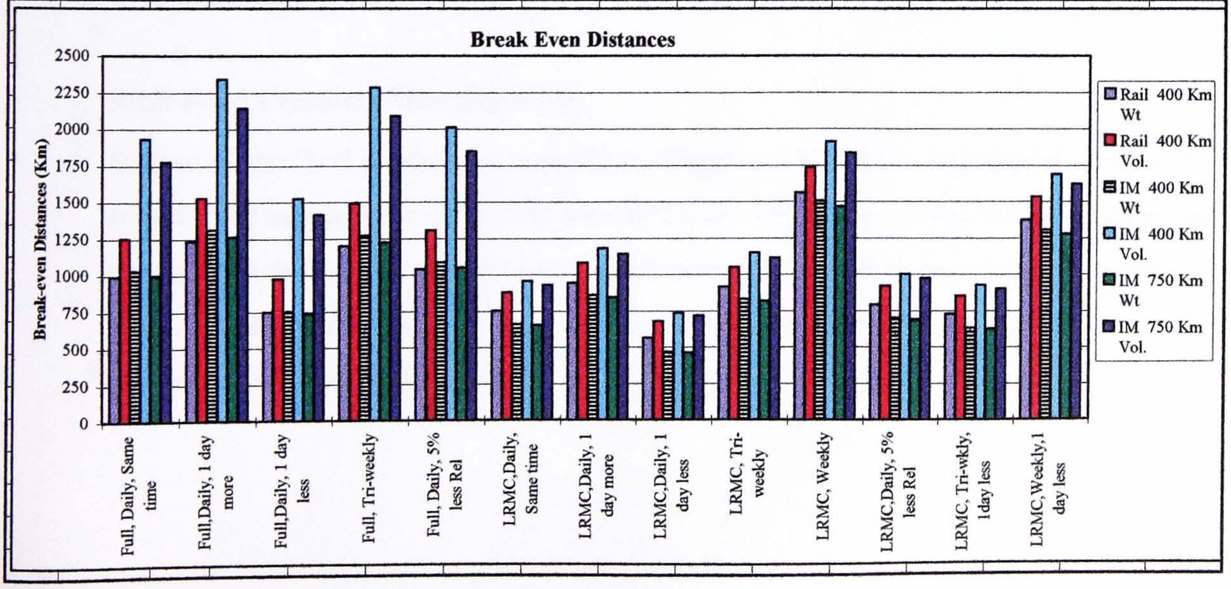


Fig 9.13: Electrical & Electronics Industry - Breakeven Points

Mode	Wagon Km/ Wagon Day	Wt/Vol Constrained	Full, Daily, Same time (1)	Full,Daily, 1 day more (2)	Full,Daily, 1 day less (3)	Full, Tri-weekly (4)	Full, Daily, 5% less Rel (5)	LRMC,Daily, Same time (6)	LRMC,Daily, 1 day more (7)	LRMC,Daily, 1 day less (8)	LRMC, Tri-weekly (9)	LRMC, Weekly (10)	LRMC,Daily, 5% less Rel (11)	LRMC, Tri-wkly, 1day less (12)	LRMC, Weekly,1 day less (13)
Rail	400 Km	Wt	992	1234	750	1200	1038	753	943	563	916	1562	789	726	1372
Rail	400 Km	Vol.	1253	1530	977	1491	1306	879	1080	677	1051	1735	917	850	1533
IM	400 Km	Wt	1031	1310	752	1271	1085	661	859	463	831	1503	699	633	1305
IM	400 Km	Vol.	1934	2341	1527	2283	2012	958	1182	733	1150	1913	1001	926	1688
IM	750 Km	Wt	999	1262	735	1225	1049	653	844	462	817	1466	690	626	1275
IM	750 Km	Vol.	1778	2142	1413	2090	1848	930	1143	718	1113	1835	971	900	1622



9.2.7 Electrical and Electronic products

In this sector most products are likely to be volume constrained. Column 10 in the table in Figure 9.13 shows that weekly services are not found to be viable at all. Intermodal services cannot be viable on a fully allocated basis whereas it appears that rail services can be viable even on a fully allocated basis. The poorer viability of the intermodal services, in this sector, was rather unexpected as these are the types of products where intermodal services should, logically, be most useful. The reason for this would appear to be the fact that the firms contacted in this sector are not very homogenous. We have two firms manufacturing cables, which is a lower value and less damageable product. On the other hand we also have firms manufacturing televisions and home appliances where the consignment value is very high and the product is damageable as well.

On splitting this group, into high value products and low value products, the picture changes quite a bit. In case of the low value products (Figure 9.14) intermodal services are only viable on a LRMC basis (column 6, 7 & 8 in the table in Figure 9.14), even there lower frequency services are not viable. In case of rail, even a slightly slower service is viable on fully allocated basis though lower frequency services are not.

In case of the high value products (Figure 9.15) we find that faster intermodal services (col. 3) can be highly profitable though lower frequency services (col. 9) are not viable even on a marginal cost basis. Rail services are not viable at all.

The results of the comparison of rail Vs intermodal (Appendix 'E') are also similar and, in case of the high value products, the intermodal services appear highly competitive whereas in case of the low value products (cables) the rail services are competitive.

9.2.8 Food Products Manufacturers

In case of the food product manufacturers (Figure 9.16), all the intermodal services are found to be competitive on a fully allocated cost basis however the rail services would need to match the road service time and frequency to be viable on a fully allocated cost basis. The comparison of the rail and intermodal services also shows a similar preference for intermodal services.

Fig 9.14: Electrical & Electronics Industry (Low Value Products)

Mode	Wagon Km/ Wagon Day	Wt/Vol Constrained	Full, Daily, Same time (1)	Full,Daily, 1 day more (2)	Full,Daily, 1 day less (3)	Full, Tri-weekly (4)	Full, Daily, 5% less Rel (5)	LRMC,Daily, Same time (6)	LRMC,Daily, 1 day more (7)	LRMC,Daily, 1 day less (8)	LRMC, Tri-weekly (9)	LRMC, Weekly (10)	LRMC,Daily, 5% less Rel (11)	LRMC, Tri-wkly, 1day less (12)	LRMC,Weekly ,1 day less (13)
Rail	400 Km	Wt	954	1088	819	1324	1155	723	828	617	1013	1665	881	908	1560
Rail	400 Km	Vol.	1210	1364	1056	1633	1440	847	959	735	1154	1844	1014	1042	1732
IM	400 Km	Wt	1302	1457	1147	1729	1534	853	963	743	1156	1834	1018	1045	1724
IM	400 Km	Vol.	2329	2555	2102	2951	2668	1176	1301	1051	1519	2288	1362	1394	2163
IM	750 Km	Wt	1254	1401	1108	1657	1474	838	945	732	1131	1786	997	1024	1679
IM	750 Km	Vol.	2131	2334	1929	2688	2434	1137	1255	1019	1462	2191	1314	1344	2072

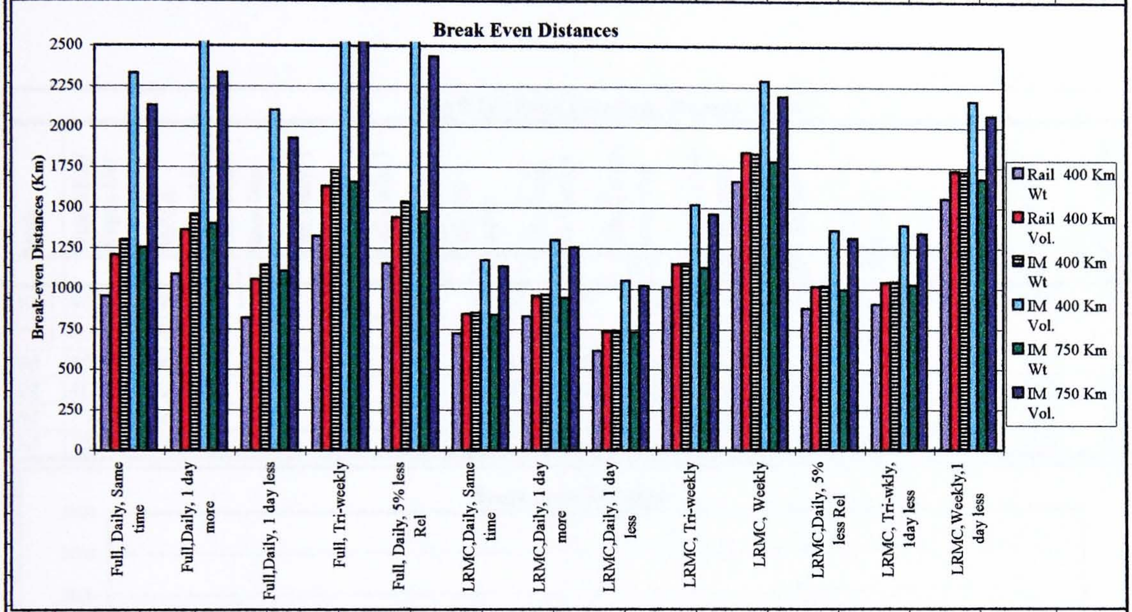


Fig 9.15: Electrical & Electronics Industry (High Value Products)

Mode	Wagon Km/ Wagon Day	Wt/Vol Constrained	Full, Daily, Same time (1)	Full,Daily, 1 day more (2)	Full,Daily, 1 day less (3)	Full, Tri-weekly (4)	Full, Daily, 5% less Rel (5)	LRMC,Daily, Same time (6)	LRMC,Daily, 1 day more (7)	LRMC,Daily, 1 day less (8)	LRMC, Tri-weekly (9)	LRMC, Weekly (10)	LRMC,Daily, 5% less Rel (11)	LRMC, Tri-wkly, 1day less (12)	LRMC,Weekly, 1 day less (13)
Rail	400 Km	Wt	3401	3674	3127	4875	4027	2644	2859	2430	3803	5153	3136	3588	4938
Rail	400 Km	Vol.	4005	4318	3693	5690	4720	2880	3107	2653	4106	5534	3401	3878	5307
IM	400 Km	Wt	617	932	301	2317	1339	367	591	143	1573	2979	879	1349	2755
IM	400 Km	Vol.	1330	1789	870	3809	2382	625	878	371	1992	3585	1205	1738	3332
IM	750 Km	Wt	607	905	310	2213	1289	369	585	154	1533	2890	864	1317	2674
IM	750 Km	Vol.	1237	1649	826	3456	2179	615	855	375	1910	3419	1165	1670	3179

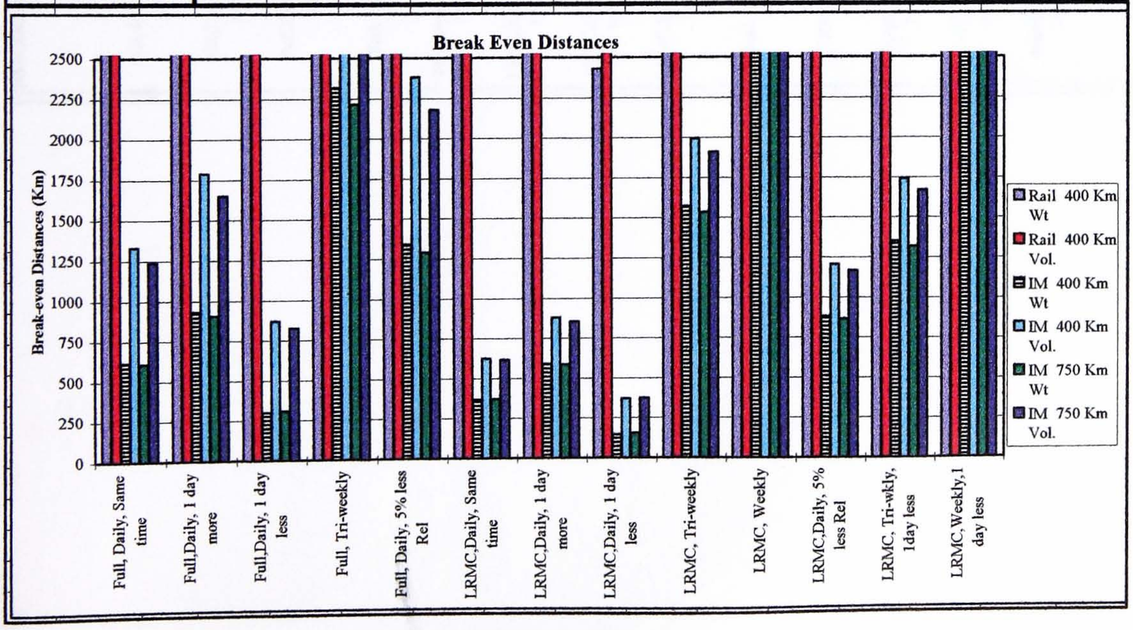
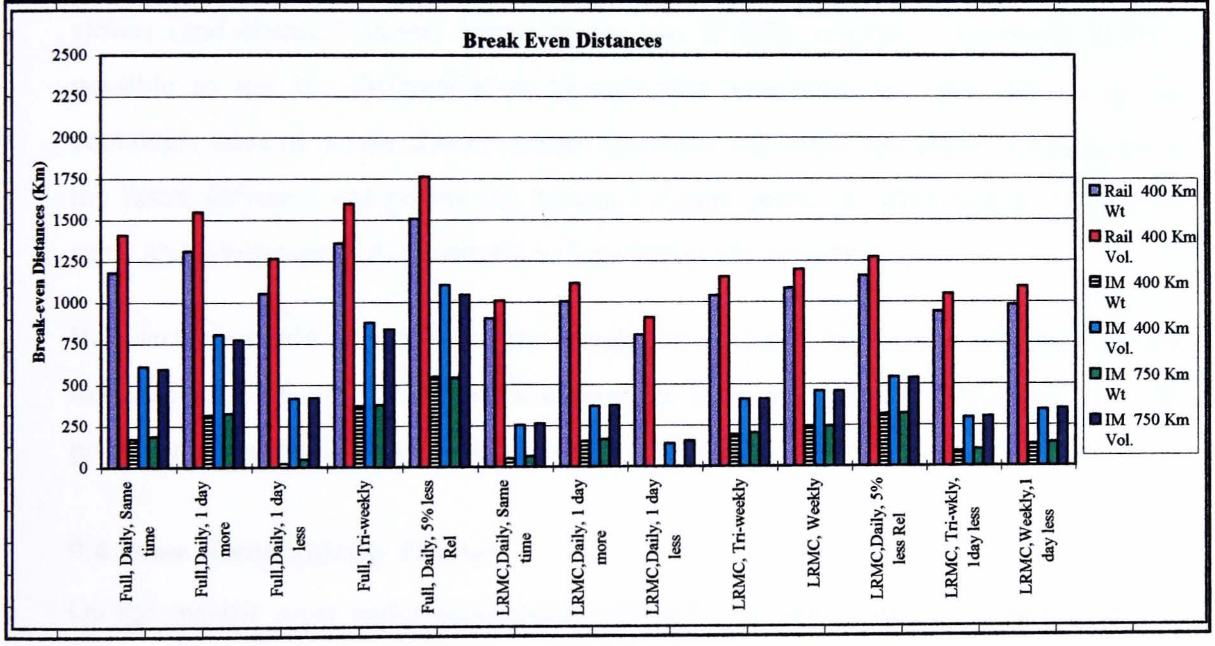


Fig 9.16: Food Products Manufacturers

Mode	Wagon Km/ Wagon Day	Wt/Vol Constrained	Full, Daily, Same time	Full,Daily, 1 day more	Full,Daily, 1 day less	Full, Tri-weekly	Full, Daily, 5% less Rel	LRMC,Daily, Same time	LRMC,Daily, 1 day more	LRMC,Daily, 1 day less	LRMC, Tri-weekly	LRMC, Weekly	LRMC,Daily, 5% less Rel	LRMC, Tri-wkly, 1day less	LRMC,Weekly ,1 day less
			(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Rail	400 Km	Wt	1181	1309	1053	1356	1508	902	1002	801	1039	1082	1158	939	982
Rail	400 Km	Vol.	1407	1547	1267	1598	1764	1009	1113	905	1151	1195	1273	1047	1091
IM	400 Km	Wt	170	317	22	371	546	50	155	-55	193	238	317	89	133
IM	400 Km	Vol.	611	805	417	876	1106	253	366	140	408	456	541	295	343
IM	750 Km	Wt	185	325	46	376	541	64	165	-38	202	245	321	101	144
IM	750 Km	Vol.	596	771	420	836	1043	262	370	155	409	455	536	302	348



However, in case of both the firms covered, the flows were bulk movements to central warehouses, so factors like frequency and transit time did not have that much importance. This may not necessarily be the case with non-bulk flows.

9.3 A Summary of the Results

From the foregoing discussion it appears that intermodal services, based on the use of high speed wagons, can be very profitable on fully allocated basis (besides for the exports cargo) for high value commodities like electronics items, auto parts, food products and chemical products even if they are run twice/thrice a week. Viable tri-weekly services can also be run using the conventional (BFK) wagons for these sectors though they would have to be priced at lower levels, still covering fully allocated costs.

This also opens up the possibility of price differentiation as it should be possible to have a higher priced and faster service based on the use of the high speed wagons and a slower (and cheaper) service based on the use of BFK wagons. It should then be possible to use the differentiation to maximise utilisation of stock (by using the containers booked on the slower service to ensure full loads and timely movement on the faster services) and profits (by having a higher price for firms willing to pay the same and a lower price for firms not willing to pay the higher price)

Rail services could be viable for the freight forwarders, chemicals manufacturers and manufacturers of low value electrical products like cables etc. but would need to be priced on a marginal cost basis and run 2 or 3 days a week.

9.4 Some Route Specific Factors

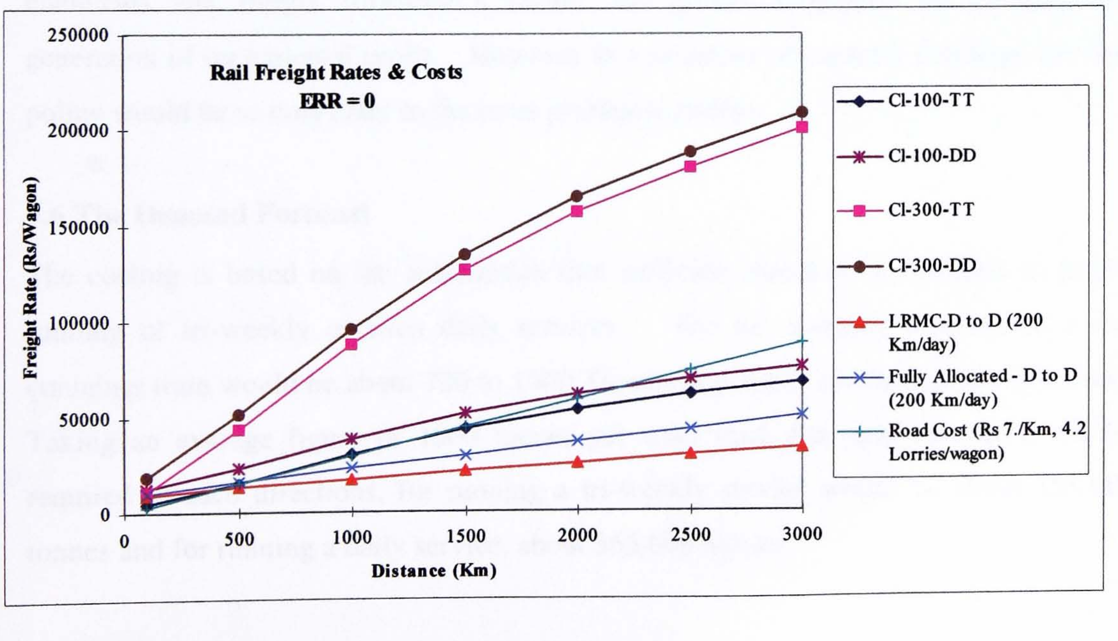
On the specific route under consideration, there is also some amount of empty running of containers in the Bombay to Delhi direction (about one train a day though it is decreasing). At the same time, in case of road traffic (CES 1993) the main direction of movement is Bombay to Delhi for the greater part of the year and correspondingly the road freight rates are higher in this direction. In case the empty running is utilised by offering discounted rates, in the long run this could change the balance of flow thus causing the road rates to go down in the Bombay - Delhi directions with a corresponding increase in the Delhi - Bombay direction (as we have seen this market is operating very close to cost and needs to recover round trip costs). This in turn could make the container services from Delhi to Bombay more competitive.

9.5 Comparison of Rail freight rates with the costs of road and rail movements

We have attempted to compare the existing rail freight rates (as of April 1998) with the costs of rail movement and the Vehicle Operating Costs (VOC) for road movement (April 1998) as worked out earlier in chapter 8. The freight rate structure, existing on IR, has already been described in Chapter 2.

In Figure 9.17, we have shown the freight rates for distances of 100, 500, 1000, 1500, 2000, 2500, 3000 Km for class 100 and class 300. These have also been converted to door to door rates by adding Rupees 4000 at either end for the additional handling and road collection & delivery. To avoid confusion we will subsequently refer to the Class 100 Door to Door rates as 'Cl-100-DD' and the Class 100 terminal to terminal rates (i.e. rail portion only) as 'Cl-100-TT' and similarly for class 300 as 'Cl-300-DD' and 'Cl-300-TT' respectively. These rates are compared with the costs of rail haul, on LRMC basis as well as fully distributed basis (a wagon utilisation of 200 Km/day - is taken as the worst case scenario and higher utilisation would only bring rail costs lower). From this figure we can see that Cl-100-TT rates are almost same as the road costs for distances upto 1500 Km. However the Cl-100-DD rates are initially higher than the road cost and break-even with road costs at about 2200 Km.

Figure 9.17: Rail and Road Freight Rates and Costs



In case of class 300 the rates are much higher than road costs for all distances. It also needs to be noted here that we have not considered the cost of damage/loss, due to the additional handling, into our calculations (though the cost of the additional operations is included). The cost of this damage is usually covered by insurance but even then it entails an inconvenience which is not quantified.

If we compare the rail costs (fully allocated) with the rail freight rates we find that the fully distributed cost is higher than the Cl-100-TT rate but lower than the Cl-100-DD rate for distances below 500 Km. For distances above 500 Km the fully distributed cost is lower than Cl-100-TT rates as well.

Table 9.2: Classification of Commodities

Commodity	Classification	Equivalent Class (loadability adjusted)
Chemicals	90 - 110	90-110
Electrical Appliances	240	100
Auto Parts	240	100
Freight Forwarders	150	

Table 9.2 shows the classification, for charging of rail freight, of some of the commodities studied by us. If we take the loadability factor and consider the equivalent freight rate, it appears that most of these commodities are charged above the fully allocated costs.

In case of availability of rolling stock and track capacity, we would have a case for pricing to cover fully allocated costs or even marginal cost basis for commodities like chemicals and freight forwarder's traffic, for greater utilisation of capacity and generation of incremental profit. However in a situation of capacity shortage, the best policy would be to only cater to the most profitable traffic.

9.6 The Demand Forecast

The costing is based on the assumption that sufficient demand is available to justify running of tri-weekly or even daily services. The net carrying capacity of a full container train would be about 700 to 1500 Tonnes depending on the nature of the load. Taking an average figure of 1000 tonnes per train load, the total volume of traffic required in each directions, for running a tri-weekly service would be about 155,000 tonnes and for running a daily service, about 365,000 tonnes.

RFFC 1993 have projected traffic from Delhi to Bombay to be between 1 to 2 million tonnes per annum and between 2 to 4 million tonnes in the reverse direction for the year 2000-2001, with over half of this being of containerisable nature (see Chapter 6). RITES 1996 estimated total traffic on the corridor to be 44 million tonnes (in 1996-97) with an average length of haul of 1000 Km (RITES 1996). The vast difference between the two sets of figures is probably due to the first set of figures covering only traffic originating/terminating within the cities themselves and the second set taking into account all traffic originating/terminating further North of Delhi or South of Bombay and travelling on this route. Both Delhi and Bombay are surrounded by important industrial belts as such we could easily take double of the RFFC 1993 estimates for traffic originating/terminating within 50 Km of either city. The actual hinterland of a intermodal terminal is likely to be much large but we are, at the moment, looking at the simplest case only. Doubling the RFFC 1993 estimates, we have a total of about 9 million tonnes of freight per annum in both directions originating/terminating within 50 Km of Delhi and Bombay. RFFC 1993 has estimated that over half of all traffic travelling on this route is containerisable and this would give us a figure of almost 4.5 million tonnes of containerisable traffic available. The quantum of traffic required for full utilisation of a tri-weekly service would be about 310,000 tonnes and for a daily service about 730,000 tonnes (total for both directions). As such less than 10% of the available freight would need to be captured to establish a regular tri-weekly service.

The suggested method of obtaining actual forecasts would be as follows:-

1) Obtain sectorwise details of the flows available (from surveys of road traffic).

2) Carry out a similar survey, for a representative sample of firms for the sector under considerations.

3) Use the survey data to obtain a similar demand model as derived in section 7.8, for the sector under consideration

4) Establish a logit curve representing the mode choice probability for the sector, using the attribute levels and the corresponding ratings given by the respondents, for each iteration in the survey.

5) Calculate the difference in generalised costs, between the services under consideration.

6) The probability on the logit curve corresponding to this difference in generalised costs represents the percentage of the total volume that is likely to be captured in the long run.

9.7 The Build Up of Demand

It needs to be remembered, however, that the demand forecasts so obtained would actually represent a steady state condition, which is not likely to be achieved from day one. The actual build up of demand will itself depend on the level of services provided as well as the advertising effort made.

In fact the build up of demand for new services and the provision of adequate services form a self full-filling prophecy to some extent. Swanson et.al. (1997) have pointed out that 'Transport mode choice models assume that consumers have full information about all the alternatives available to them and use all this information to make a rational choice. They are unable to say anything about how long it will take for this state of affairs to arrive.' Swanson et.al. (1997) have also presented a simulation model for forecasting demand for build up for the Eurostar services, though, for reasons of commercial confidentiality details are not given by them. More detailed discussions of factors affecting demand build up and the methodology for modelling the same, are available in marketing literature (Keaveny 1995, Urban et.al. 1993 and Midgley 1977). It is not possible to go into the details of modelling build up of demand in the scope of this work, however, this would be an important area for further research.

9.8 Conclusion

In this chapter, we have studied the comparative costs of movement by rail, road and intermodal services. We have found that, on cost basis alone, both rail and intermodal services become competitive for distances between 500 to 1000 Km as compared to road, even on fully allocated basis. However when we take the service quality into consideration (in the form of generalised costs) the picture changes quite dramatically. Rail service, which previously appeared most viable, now becomes the least viable in many sectors and break-even below 1500 Km against road, only in very few of the situations examined by us. Intermodal services still stay very competitive due to the better perception of the service offered and breakeven below 1500 Km against road, in a large number of the situations. They become even more profitable if we consider the use of, the newly introduced, high-speed wagons which result in faster door to door times than the current road services and in such situations the breakeven comes to between 500 to 1500 Km. We find that highly profitable intermodal services can be operated, besides the international traffic, for the high value cargo like Electrical & Electronic appliances, Autoparts, certain Chemicals etc. It is possible to run profitable services, even based on the use of conventional (BFK) flat wagons, but with lower prices though still covering fully allocated costs.

In both the cases, it is possible to have services running 2 to 3 times a week, to start with, and then go on to daily services which can be really profitable. This also gives rise to the possibility of price & service differentiation. The existing level of road traffic would appear to justify the running of regular frequency intermodal door to door services. However, the build up of demand can take some time and would be dependent on the frequency of services offered and the methods employed for promotion of the services.

On comparing rail freight rates, with the costs, we find that in case of many of the commodities considered, the freight rates (after taking the loadability factor into account) are above the fully allocated levels. Our findings indicate that for sectors like Electrical & Electronic appliances, there is very little possibility of attracting traffic to rail. However for sectors like Chemicals and Freight Forwarder traffic, if service levels (frequency & time) can be improved to match those for road services, or prices reduced to fully allocated cost or marginal cost levels, there is a possibility of running viable services. Here the question would essentially boil down to whether capacity is available to warrant running of such services.

Chapter 10: CONCLUSIONS AND RECOMMENDATIONS

We have successfully used adaptive SP methods for the modelling of demand for freight services in India. We have developed a cost model for costing of rail, road and intermodal services. We have then developed a methodology combining the cost model with the demand model for identifying the segments for which intermodal services can be viable and the price and service levels required for running viable services for these segments.

In this chapter we sum up the findings of our work. In section 10.1 we look at the demand model - the theoretical findings as well as the empirical findings. In section 10.2 we discuss the cost model developed and in section 10.3 we discuss the viability of the services on the basis of the combined model. In section 10.4 we discuss the policy implication of our findings for Indian Railways and CONCOR and finally in section 10.5 we look at the requirements for further work.

10.1 The Demand Model

In this section we will look at the theoretical findings and empirical results of our demand modelling work.

10.1.1 Theoretical Issues

10.1.1.1 Experimental Design

We have used a laptop computer based Adaptive SP design due to non availability of RP data as well as any previous work on the attribute valuations we could expect to find in the different sectors being covered by us.

We have carried out a pilot survey in India. We have successfully modified the Leeds Adaptive Stated Preference (LASP) software and developed a suitable Windows based design, for our main survey, on the basis of the results of the pilot survey. We have tested the design for recoverability of underlying values.

10.1.1.2 Analysis Issues

We have studied three main issues as regards the analysis: -

1) The advantage of using individual level models and aggregating the same using weighted averages as opposed to the use of models based on pooled data. In case of the use of pooled data. We have examined the alternative approaches based on regression models using OLS, WLS and RCM models on survey data as well as simulated data. As expected, the OLS and WLS approaches yielded much poorer results than the RCM model using pooled data and the aggregated individual firm models.

   We have found that the individual firm model approach is more robust and gives consistently better results than the Random Components Model using pooled data, in the presence of rating behaviour and some amount of randomness in ratings (as expected in a real life situation). The weighting scheme used for the aggregating the individual firm models appears to make a significant contribution to the superiority of the individual firm model approach.

   As an additional benefit, this approach permits estimation of models using virtually any statistical software such as SPSS or SAS. The RCM regression model was only available in the Limdep 7.0 econometric software.

2) The next issue explored, was the format for conversion of rating data into pair-wise choice probabilities. In this case, we examined various forms of exploding the data such as explosion into three pairs, six pairs and twelve pairs. We found that, in our design, the explosion into three pairs gives the best results in terms of recoverability of values for simulated data and the stability of results for survey data. This also eliminates the problem of adjusting the 't' values to reflect the fact that we have only three degrees of freedom available.

3) The final issue explored was the actual weights to be used for the WLS regression to obtain the maximum information from our rating data. We are, finally, using a weighting function which gives maximum weight to ratings near 100, as our experiment is designed to compare the alternative modes with the base mode which is rated as 100. In this case, the respondents are likely to put greater thought in giving ratings close to 100 (say 105 as compared to 110), as compared to ratings away from 100 (say 15 as compared to 25 where both are basically not acceptable or 200 as compared to 205 where both are highly preferred). This weighting function

gave good recoverability of values for simulated data and stability of results for survey data.

10.1.2 Empirical Analysis Results

We appear to have derived fairly sensible results from our demand model. We have aggregated these for each sector, however there is a significant level of variation within the sectors themselves and that needs to be kept in mind while making any forecasts based on these results. The results for each sector are discussed below.

1) In case of the Exports sector, the ASC (Intermodal Services) ranges between Rupees 1000 to 5000 (favourable) for all firms contacted except one who had a negative ASC of Rupees 800 (this was a firm exporting rice in break bulk). The aggregate estimate for the whole group was Rupees 1450. This reflected the fact that the firms were finally shipping the cargo in containers and hence would prefer to despatch in containers from the factory itself. The ASC for road based container services was also favourable but smaller (aggregate Rupees 1000 for 3 firms). Rail services were viewed very adversely with most of the firms even refusing to consider them at all.

   Lower frequency services were also not liked with tri-weekly services requiring discounts ranging between Rupees 3000 to 9000 (aggregate Rupees 5200) and weekly services requiring discounts ranging between Rupees 8,000 to 42,000 (the upper figure representing firms who were not willing to use the service at all) with aggregate Rupees 11,400.

   This sector also had some of the highest values of time (ranging from Rupees 1000 to 4000 per day (aggregate Rupees 2000)) and reliability (ranging from 0 to Rupees 1500 per percent change in reliability (aggregate Rupees 5700)).

2) The Freight Forwarders, who consolidate a lot of the piecemeal and parcels traffic, do not appear to see much advantage of Intermodal services with ASC ranging from 0 to Rupees 3200 (adverse) with aggregate Rupees 700. This appears to reflect the fact that their cargo has low loadability (being volume constrained) and also they would still need to utilise own lorries for door to door delivery & collection of the individual parcels. They have an adverse perception

of rail with ASC ranging from Rupees 1900 to 8000 (adverse, aggregate Rupees 2650) as they were handling third party cargo in a very competitive market.

Low frequency services were also viewed adversely with tri-weekly services requiring discounts ranging from Rupees 1800 to 7500 (aggregate Rupees 2300) and weekly services requiring discounts ranging from Rupees 1500 to 7500 (aggregate Rupees 5800). This appeared to reflect the need to store the collected material in their own warehouses, while waiting for the service.

3) The Chemical manufacturers appeared to be indifferent between intermodal services and road services with ASC(IM) ranging between Rupees 300 adverse to 3000 favourable (aggregate not different from 0). This could be due to the fact that these were low value bulk products where intermodal services did not hold any great attractions. They were, however, averse to rail with ASC(Rail) ranging between Rupees 2900 to 8300 (aggregate Rupees 3800). This appeared to reflect the poor perception of the rail mode, since the products appear to be well suited to rail movement.

   This sector was less averse to lower frequency services, than the previous sectors, with frequency discounts varying between Rupees 300 to 4000 (aggregate Rupees 1500) for tri-weekly and Rupees 300 to 16000 (aggregate Rupees 2800) for weekly services. This could reflect the fact that these are intermediate products going into inventory for production. The frequency of despatches is not very high and it is possible to program for a poorer frequency of service.

4) In case of the Electrical & Electronics products manufacturers, the companies manufacturing high value consumer electronic & electrical appliances preferred intermodal services (aggregate ASC of Rupees 765) and were strongly averse to rail services (aggregate ASC of Rupees 12400). On the other hand, the companies manufacturing low value products like cables, which were not prone to damage, did not see any advantage in the use of intermodal services (aggregate ASC of Rupees 1800 adverse). They also did not like rail service but were not so strongly averse (aggregate ASC of Rupees 1800).

In case of low frequency services also the high value product firms required higher discounts at Rupees 6400 and 14000 respectively for tri-weekly and weekly services as compared to the corresponding figures of Rupees 1600 and 5700 for the cable manufacturers. Similarly, the values of time and reliability respectively were also two and three times higher for the high value product firms as compared to the cable manufacturers. These results reflect the fact that the manufacturers of high value products required much higher quality of service than the low value products.

5) In case of the Autoparts industry, we find some preference for intermodal services as compared to road services with a favourable ASC (Intermodal) of Rupees 780 and a strong aversion to rail services with an ASC(Rail) of Rupees 6200. They were somewhat indifferent to tri-weekly services (requiring a discount of only Rupees 440) but did not like weekly services (discount required Rupees 2600). The value of time and reliability were not very high in this case. All this appears to reflect on the fact that some of the components are damageable and of high value and that they are going into inventory for production.

6) In case of the Food Products manufacturers, we find that both favour intermodal services (ASC(Intermodal) of Rupees 2700 & 2200) and against rail services (ASC(Rail) of Rupees 2800 for one and the other refused to even consider a rail service).

10.2 The Cost Model

We have developed door to door costing models for rail wagon services, intermodal services as well as road transport services. In case of the costing for haulage by rail wagons as well as for the rail haul element of the intermodal cost, the cost data available from Indian Railways was not suitable for the current work, as it was based on a fully allocated cost system with system wide average costs. This would not reflect the causality of the costs. We have studied the accounting approach followed by British Rail as well as some of the econometric and engineering models from the American railroads. We have also studied the UIC model for 'costing of movement in transcontainers' and the ESCAP model for 'point to point costing' of freight traffic.

The ESCAP model was found to have been developed in a similar context, for developing country railways, which need to operate in a commercial environment but have traditional fully allocated costing systems, using system wide average cost data. It combines the system wide average cost data with operational performance measures to appropriately reflect the effect of change in operational factors. We have adapted this model for use here and have estimated the cost of movement of rail wagon loads as well as rail haulage of containers with this.

The costs are estimated under two main heads - Long Range Marginal Costs (LRMC) and Fully Allocated Costs. The LRMC includes the cost of crew, fuel, maintenance of rolling stock, variable costs of track & signalling infrastructure maintenance and wagon and loco capital costs. The fully allocated costs include, in addition to the LRMC, the cost of terminal handling and marshalling facilities (which are put into place for the size of the terminal and are unlikely to vary with the introduction of this traffic, which is likely to be only a small part of the total traffic handled by the terminal), fixed element of infrastructure maintenance, train signalling staff and the general overheads of IR.

The LRMC represents the level of costs that any service must recover and the fully allocated costs represent the level of costs that the organisation as a whole must recover. We have tested the sensitivity of the model to assumptions regarding the operational efficiency and evaluated the effect of slower transit times as well as some empty running of wagons. We find that, in case of the rail wagon movement, if the transit time was to double it would result in a 11% increase in the fully allocated cost and a 13 % increase in the LRMC. We have also tested the sensitivity to financing costs and found that a 20% change in the interest rate (i.e. a 2 percent point change) results in a 2% change in the fully allocated costs and a 3% change in the LRMC. Finally, we have evaluated the effect on costs, of the use of the newly acquired high-speed wagons. It was found that the effect of the increased capital cost was made up for by the gain due to faster turnaround. The demand side aspects of the faster service are discussed separately.

In case of intermodal traffic, we have also taken the cost of handling of containers at the terminals as well as the collection and delivery by road. It appears that the terminal handling, collection and delivery costs, for distances of 30 km at either end, constitute more than half of the marginal cost and more than a third of the fully allocated cost of door to door movement over a distance of 1500 Km. As such, any improvement in the drayage operation could have a very significant effect in the overall competitiveness of the service. The main problem here is that at present a tractor-trailer unit is only able to perform one collection or delivery operation in a day even on such short distances (primarily due to restrictions on daytime entry into city areas).

In case of rail wagon movement, the collection and delivery charges at either end come to about a third of fully allocated and 45% of the marginal cost of door to door haulage by rail.

The vehicle operating costs, for road transport, have been obtained during the survey and have also been estimated from an Indian statistical cost model. Comparison of these costs, with the round trip revenues indicates that the road transport industry is operating on a very competitive basis and there is, at best, a very narrow margin between the costs and revenues. The prices are quoted taking the availability of traffic in the return direction into account. In case of movement, to areas where return traffic is not likely to be available, the cost of moving to the nearest point where return traffic can normally be picked up, is also taken into account.

We find that, on cost basis, door to door intermodal as well as rail services are very competitive compared to road services. Rail services break even for distances less than 500 km on LRMC basis and less than 800 Km, on fully allocated basis, for both weight & volume constrained commodities. In case of intermodal services, the break-even distance, on marginal cost basis, for weight constrained commodities, is about 500 Km and for volume constrained commodities at about 800 Km. On the fully allocated basis the corresponding figures are 800 Km and 1500 km.

10.3 The Combined Model

When we look at the generalised costs, taking into account the attribute valuations, we find that rail services can only be viable for some of the sectors considered like Freight Forwarders, Chemicals industry and low value Electrical products such as cables etc. Even here, these services would need to run at least thrice a week and preferably daily. The former would need to be priced on marginal cost basis and the latter can be priced to cover fully allocated costs as well.

Intermodal services can be highly competitive, besides the international traffic, for high value and damage prone commodities like Electronics & Electrical equipment, Autoparts, Food products, Chemicals etc. Faster services (than present road services) using the new wagons can be profitable, after covering fully allocated costs, even if offered 2-3 days a week. In case of use of older flat wagons, it is still possible to run services matching the current road times, on a profitable basis though at a lower price. This gives rise to the possibility of differentiating services on the basis of transit time and obtaining maximum utilisation of the wagon fleet and of catering to different segments of the market with different service and price requirements.

10.4 Policy Implications

1) We find that highly profitable intermodal services can be operated for this route of 1500-Km length, for high value and damageable cargo such as electrical & electronic products, Autoparts and certain chemicals.

2) The larger firms have a poorer perception of road traffic, than smaller firms, and are more in favour of door to door intermodal services. They are, therefore, more likely to take up the use of these services, than smaller firms.

3) The finding regarding the level of collection/delivery charges, as compared to the cost of haulage of containers on the main leg of the journey, seems to indicate that this is an area to concentrate on. If we look at the current pattern of domestic traffic, the phenomenon of terminal to terminal movement by containers and local collection and delivery by lorry, is caused by the cost of door delivery/collection of containers being higher than the cost of the additional unloading + loading as well as road movement by lorry. This could also be partially attributed to CONCOR having rates for collection and delivery, which include a profit element for CONCOR. It appears that this policy needs to be looked at closely to ensure that the policy is performing as it is designed to.

4) The policy of replacement of rail speed link services by intermodal services, as attempted by IR, suffers from having the disadvantages of container use (poor volume to weight capacity ratio as compared to rail as well as road). At the same time, door to door movement does not offer any advantages to the freight forwarders

who are aggregating smalls traffic, since they have to establish their own infrastructure for collection and delivery of individual consignments in any case.

5) The comparison of the costs of rail transport with the existing rates and classification, for the sectors being considered, appears to indicate that currently rail freight services are being priced above the fully distributed cost levels. These services can only be competitive at better service levels or alternately pricing has to be done on marginal cost basis. This implies that careful thought needs to go into deciding if capacity is available to carry this traffic or if additional capacity could be profitably installed for higher projected volumes based on lower prices.

10.5 Further Work

1) It would also be useful to carry out a similar survey using a different route to evaluate the effect of route specific factors and permit wider application of the model. This becomes important as some of the interviewees also indicated that their choice/preference might change if the route was different in terms of the characteristics of the road and the greater proneness of certain routes to theft and pilferage.

2) We also need to cover a range of distances to get a relationship between distance and the model parameters.

3) For the purpose of our exercise, the respondents were asked to consider similar variations in transit time for each of the alternatives. In real life, however, there is considerable variation between the modes. A consignment sent by road is unlikely to be late by more than 2-3 days. However in case of rail, a consignment which gets delayed could even be delayed by weeks in case a wagon becomes defective enroute or is mis-despatched.

   In our survey, reliability has been defined as the percentage of consignments reaching late and we have assumed that a 5 percent point drop in the reliability will effectively result in an increase of 1 day in average transit time. It would however, be useful to examine the effect of the difference in the actual (or perception of actual) distribution of 'lateness' by different modes on the mode choice.

4) After carrying out the survey, it was realised that there are some commodities having a significant quantities of traffic moving by all the three modes considered (road, container, wagon) such as cement and fertilisers. These however, are on different routes from the one taken for the present exercise. Even though most of this movement is not door to door but is from factory sidings to freight terminals and as such is actually wagon load traffic, it could still be useful to study these sectors as it may be possible to obtain mixed SP-RP models for these segments which could perhaps be used to validate the model developed here.

5) During the course of the interviews, it was found that some firms were utilising more than one mode of transport due to reasons not covered in the present research. Some of these were :-

Risk Spreading Behaviour: some firms with large volumes of cargo were using more than one mode to ensure that the operations did not suffer on account of seasonal shortages of lorries or rail wagons. This was true of a Zinc manufacturing firm which was located away from the main transport centres and hence faced a shortage of lorries. They were using container services even though these services were taking longer time and were costlier (20 to 30 %) as well. Loss/damages were also not a major concern as the cargo was fully insured against losses and not a damageable item. They faced seasonal shortages where the lorry rates would become prohibitive if they had no other mode available.

Another factor was the presence of unions of lorry operators in some areas. In these cases the unions tried to force the firms to use lorries operated by their own members and not outside lorries. In cases where the firm had its own siding, it was able to escape from this by sending material by rail/container. In another case the firm was using the union lorries for the short haul of about 250-Km to the Delhi container depot and then stuffing into containers at the depot for further dispatch.

It would, therefore, be useful to understand how the risk spreading aspect and the other aspects like lorry unions change the decisions that would have been made in the absence of such factors.

6) The existing costing system of IR is not designed for supporting commercial decision making and there is a need to look at possibilities of modifying this system to be able to calculate the marginal costs of specific traffics. Since this is based on system wide average costs, it does not take any account of the volume of traffic on a particular route. Consequently, this is reflected in our calculations as well. It would be useful to study the effect of volume of traffic on the costs.

7) The model used by us, does not take into consideration the process of 'build-up' of demand. Therefore, we can only say that a service appears viable and forecast that it will be taken up in the long run. However, we do not say anything about how the demand will build up over time. It would be important to attempt to model the pattern of build up and the effect of the service levels and the promotion methods on the same.

10.6 Summing Up

To sum up: -

1) Our research has proved the feasibility of using Adaptive Stated Preference methods for modelling demand for transport services in a developing country like India.

2) We find that the use of individual firm models, aggregated using weighted averages, provides more robust results than analysis of pooled data using Random Components Model.

3) Factors like frequency of service, transit time and previous experience/impressions of rail based services play a vital role in determining mode choice. The reliability of transit time does not appear to be so important, within the range used for the survey.

4) We find that it is possible to run profitable door to door intermodal services for many of the sectors covered.

5) There seems to be a case for price and service quality differentiation for improved utilisation and overall profitability of services.

6) Emphasis needs to be placed on improving the efficiency of the drayage operation for improving the viability of intermodal services.

7) Rail services would not be viable at all for most sectors and need to be of improved quality (than at present) and priced lower (than at present) to be viable for other segments where they can still yield a contribution after covering marginal costs.

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Appendix A : 'CONVENTIONAL SP DESIGN PREPARED FOR THE SURVEY

Section -A : Background Information

Personal Details : Please fill in your details below :-

1)	**Name :**		
2)	**Designation:**		
3)	**Name of Company:**		
4)	**Address (Office):**		
5)	**Phone No:**		6) **Fax No:**
7)	**email :**		

Company Details

8) What is the main Business of your Company ?

9) What is the Total Quantity of Goods that you need to transport per Month for distances over 250 Km (In case of international traffic please only consider the movement within India). (tons)

10) Of this roughly how much is carried by each of the following modes :-
ROAD RAIL CONTAINER

11) What are the places between which you need to transport the largest quantity of goods out of the quantity indicated in (9) above (Only approximate figures are required. In case you do not wish to reveal some details you are welcome to leave that particular column blank):-

	From	To	Commodity	Quantity/ Month	Value of Goods (Rs/ tonne)	Mode used (Road/Rail/ Container)	Transport cost (Rs/ tonne)	Total time taken
a)								
b)								
c)								

12) Some attributes of a transport service are listed below. Please rank these attributes in the order of their importance from '1' to '5' where '1' is the most important.

Attribute	Description	**Rank (1-5)**
Time taken	(from loading to delivery at destination)	
Cost		
Reliability	(i.e.: percentage of consignments arriving within time)	
Frequency of Service	(for rail & Container Services)	
Safety of cargo		

13) Please list any other attributes which would be important for a freight transport service.
a) b) c)

<u>Section B : Hypothetical Situations</u>

Five hypothetical situations are given below. In each of these situations four services are described using the attributes of Time, Cost and Reliability (some of these may not necessarily correspond to any existing service).

⇒ The first service (Road Service-A) is the existing road service.

⇒ The second (Road Service-B) is a slower road service due to increasing congestion.

⇒ The third is a door to door container service.

⇒ The fourth is a Speed link railway service with a guaranteed delivery time.

Some of the services may appear unrealistic but for the purpose of this research you are requested to consider them as they have been shown.

For each situation you are requested to rank the services from '1' to '4' keeping in mind your requirements for the stream of traffic selected by you

<u>Terms Used</u>

Cost in all the cases is a **<u>door to door cost</u> for one full truckload consignment** and is given in form of an index with the existing road cost being taken as 100. In case of rail this includes the cost of handling at the rail terminals and road delivery at both ends. Similarly in case of container service again it is the door to door delivery cost.

Time is also the time for **door to door** movement i.e. when referring to **Rail & Container services** the time **includes** handling and road movement at either end for door to door delivery.

Time is given in terms of the existing time taken by road. 'As now' refers to the existing time taken by road. 'Road Service(A) + two days' would mean two days more than the present time taken by road transport.

Reliability refers to the percentage of consignments arriving in time. The following table gives the extra time likely to be taken (in addition to the normal time) for all (100 %)of the consignments to arrive:-

Reliability (%)	**100%**	**90%**	**85%**	**80%**
% of Consignments Arriving within **Scheduled Time**	100	90	85	80
100% of the consignments arrive within	on time	3 days late	4 days late	5 days late

14) Please consider one of your firm's major goods flows being moved by road for a distance greater than 1000 Km (it can be a stream already listed in question (11) or a different one) and enter the following details :-

From	To	Commodity
Quantity/month (Tons)	Transport cost (Rs/Ton)	Cost of Goods (Rs/Ton)
Distance (Km)	**Normal Time** taken from door to door	% of consignments arriving wi the **normal time**.

15) Please use the stream selected above to rank the following options from 1 to 4 in order of your preference ('1' would be the option you like best)

Option	**Cost Index (100 = Now)**	**Time**	**Reliability (%)**	**Rank** (1 - 4)
Road Service (A)	100	As Now	90	
Road Service (B)	70	Half day more	90	
Container Service	95	Same as Road (A)	90	
Rail Service	95	Same as Road (A)	90	

16) Now please rank the options in each of the following situations in the same way. **Please do not consider the responses given in the previous question when ranking the next set.**

Option	**Cost Index (100 = Now)**	**Time**	**Reliability (%)**	**Rank** (1 - 4)
Road Service (A)	100	As Now	90	
Road Service (B)	40	Same as Road (A)	85	
Container Service	75	Same as Road (A)	90	
Rail Service	70	Same as Road (A)	90	

17)

Option	**Cost Index (100 = Now)**	**Time**	**Reliability (%)**	**Rank** (1 - 4)
Road Service (A)	100	As Now	90	
Road Service (B)	65	Two Days More	90	
Container Service	60	Two Days More	90	
Rail Service	55	Two Days More	90	

18)

Option	**Cost Index (100 = Now)**	**Time**	**Reliability (%)**	**Rank** (1 - 4)
Road Service (A)	100	As Now	90	
Road Service (B)	50	Same as Road (A)	80	
Container Service	80	Same as Road (A)	80	
Rail Service	45	Same as Road (A)	80	

19)

Option	**Cost Index (100 = Now)**	**Time**	**Reliability (%)**	**Rank** (1 - 4)
Road Service (A)	100	As Now	90	
Road Service (B)	65	Half day more	80	
Container Service	50	Half day more	90	
Rail Service	35	Same as Road (A)	80	

20) In case any part of the questionnaire was not clear or if you have any comments about this questionnaire, the research or transport services in general - please write them below :-

Please Return the completed questionnaire, in the prepaid envelope provided, to :-

Nalin Shinghal
Institute for Transport Studies
University of Leeds
Leeds LS2 9NA, UK

FAX: **0044-113-2335334**

Appendix B : Breakeven Analysis Rail Vs Intermodal – Freight Forwarders & Transport Operators

Figure B.1: Weight Constrained (LRMC)

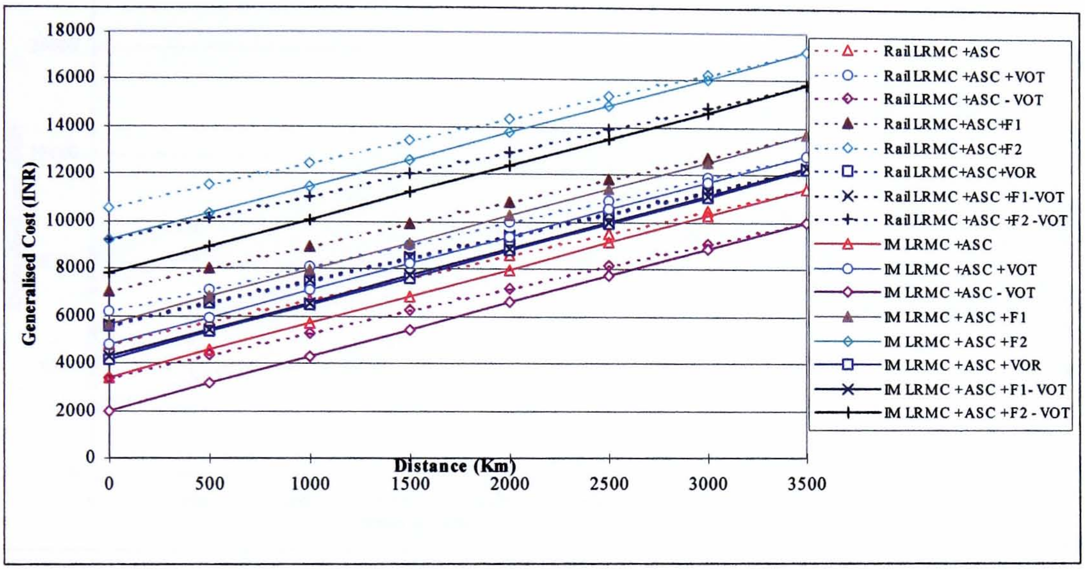


Figure B.2: Weight Constrained (Fully Allocated)

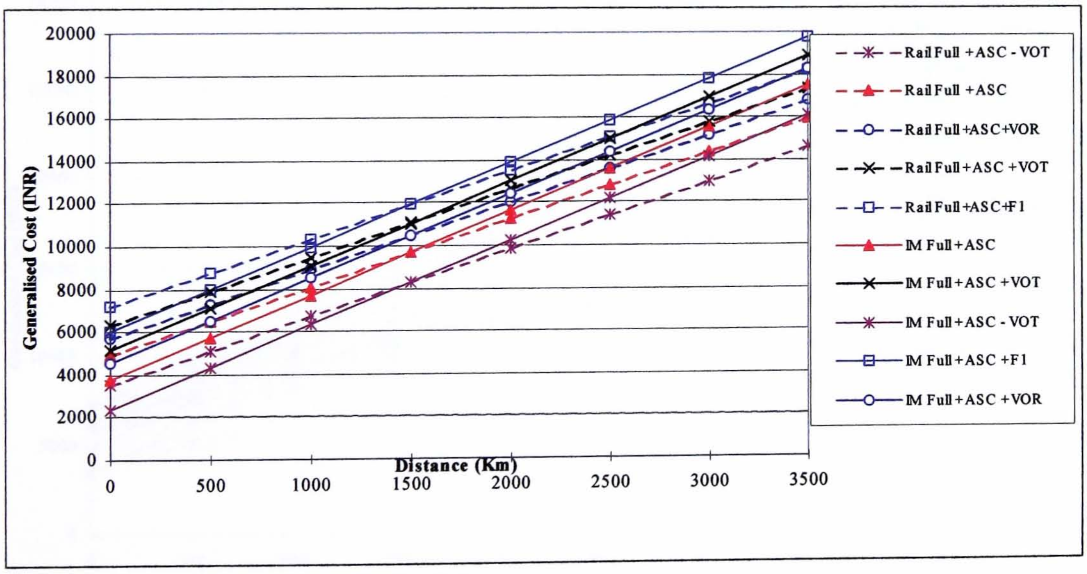


Figure B.3: Volume Constrained (LRMC)

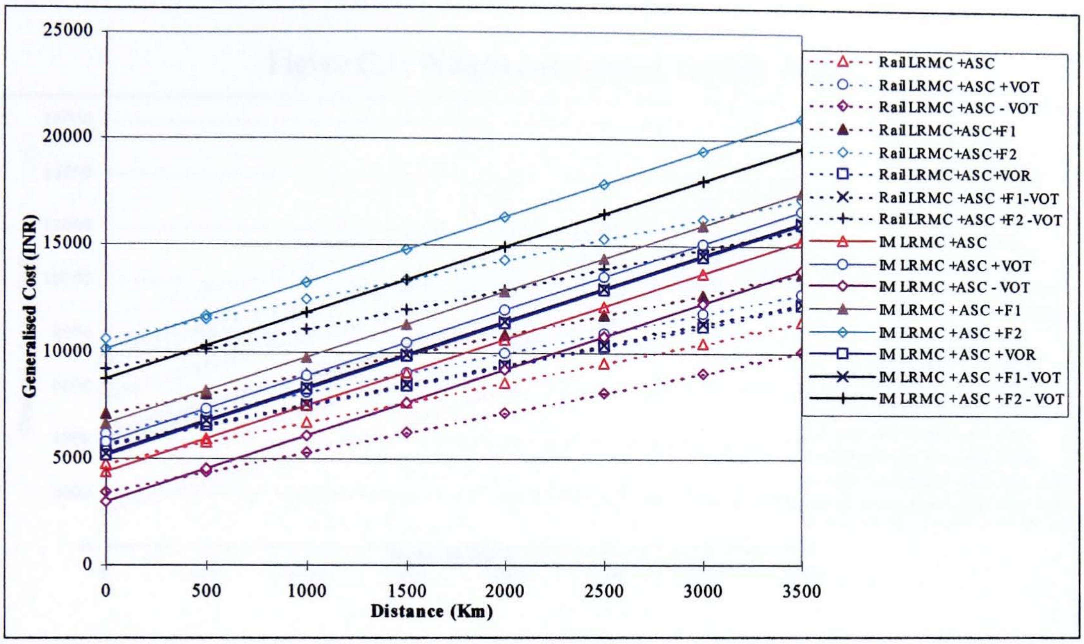
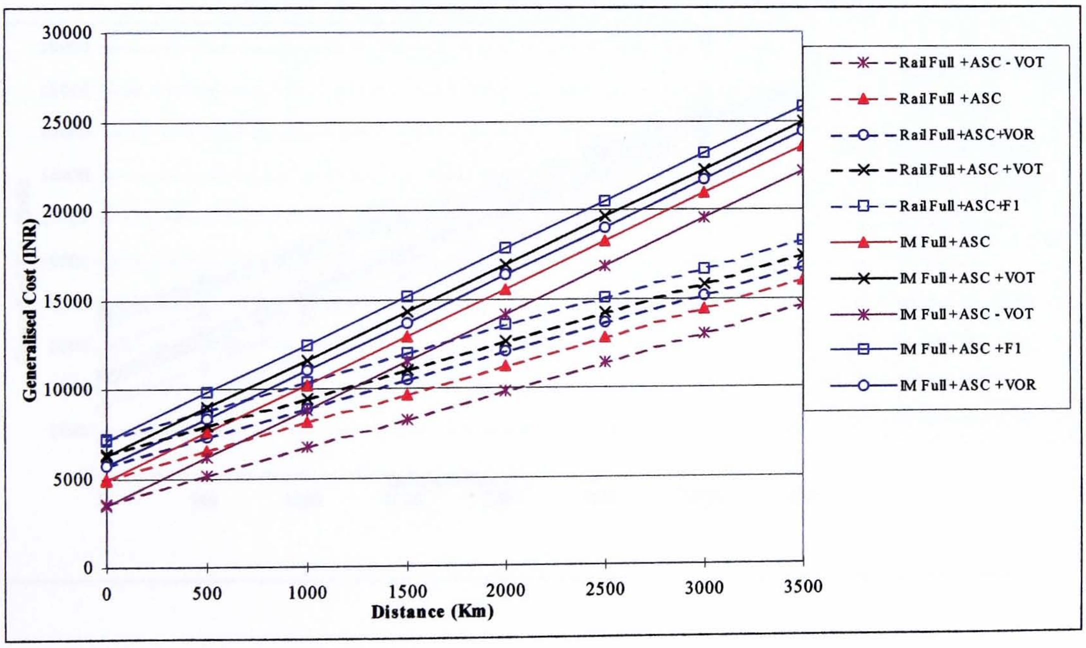


Figure B.4: Volume Constrained (Fully Allocated)



Appendix C : Breakeven Analysis Rail Vs Intermodal – Chemicals Industry

Figure C.1: Weight constrained (LRMC basis)

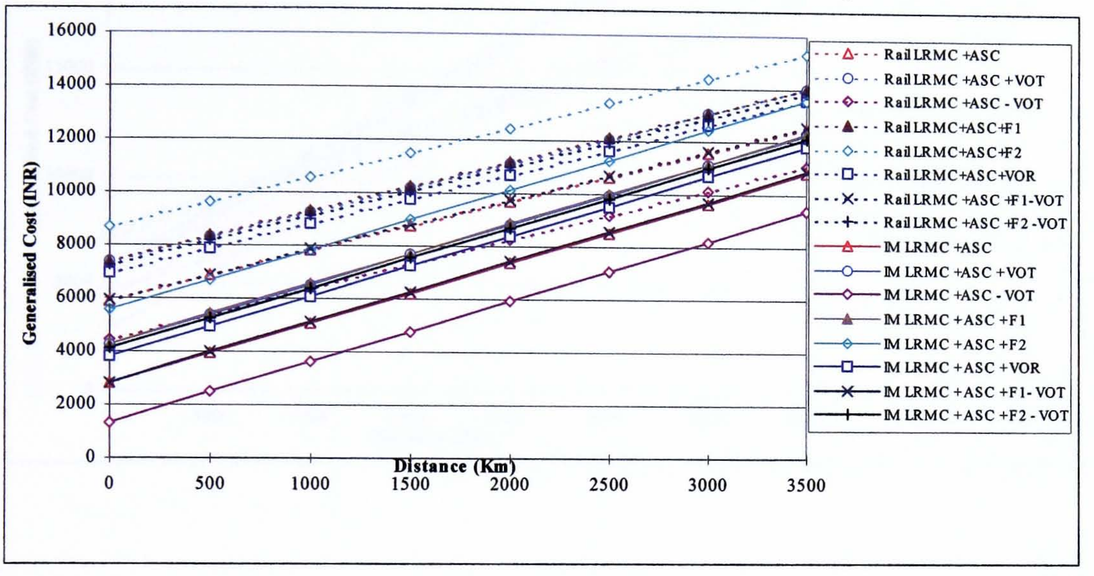


Figure C.2: weight constrained (Fully Allocated basis)

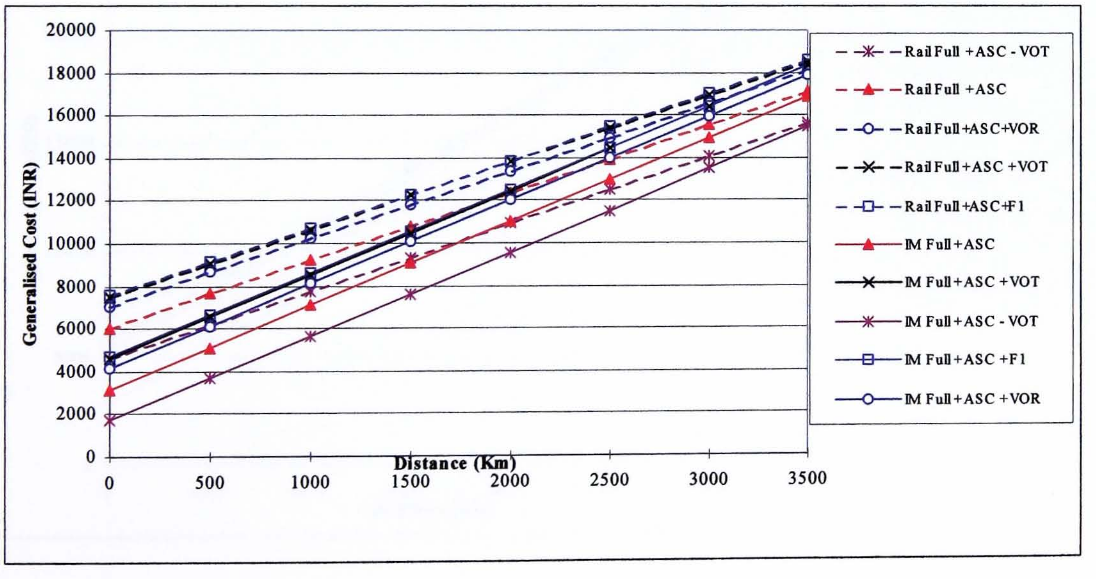


Figure C.3: Volume constrained (LRMC basis)

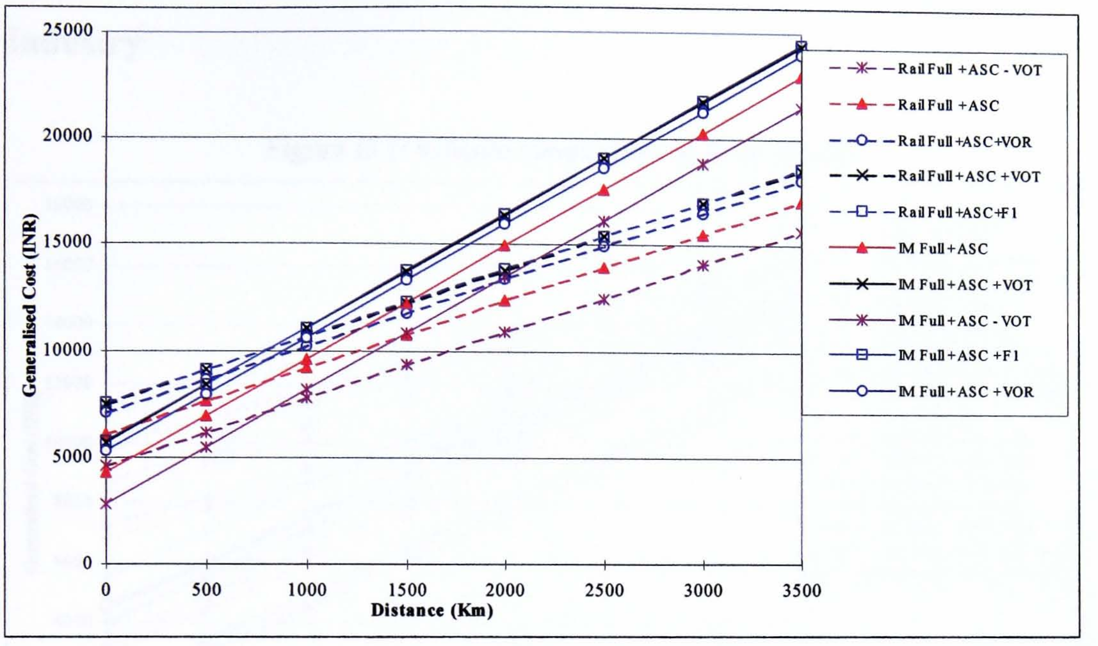
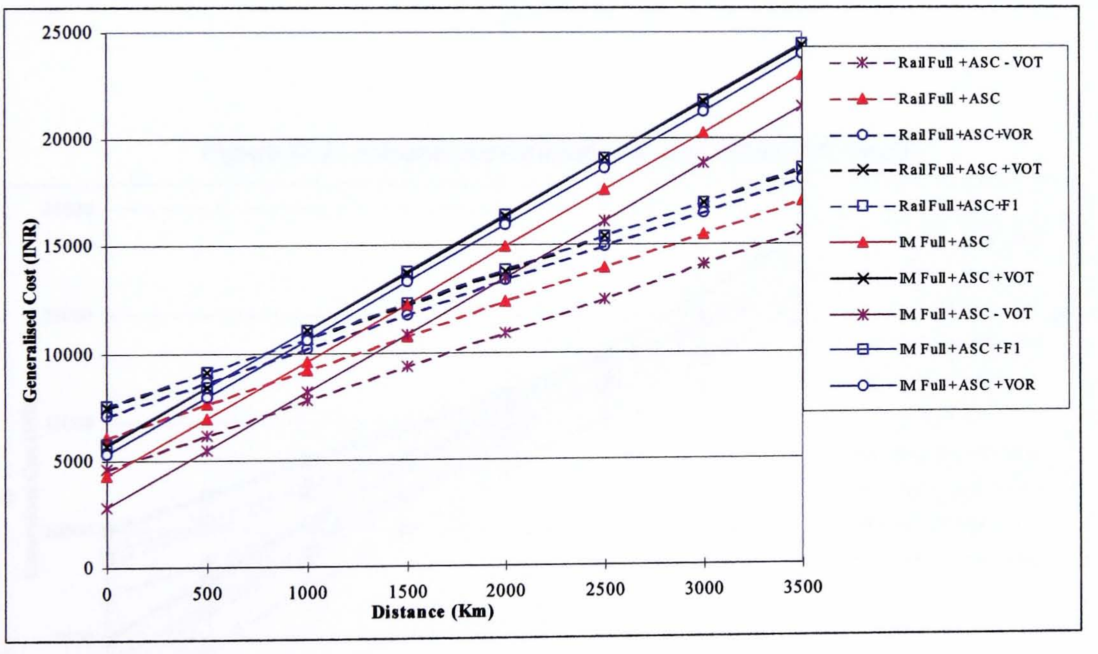


Figure C.4: Volume constrained (Fully Allocated basis)



Appendix D Breakeven Analysis Rail Vs Intermodal – Autoparts Industry

Figure D.1: volume constrained (LRMC basis)

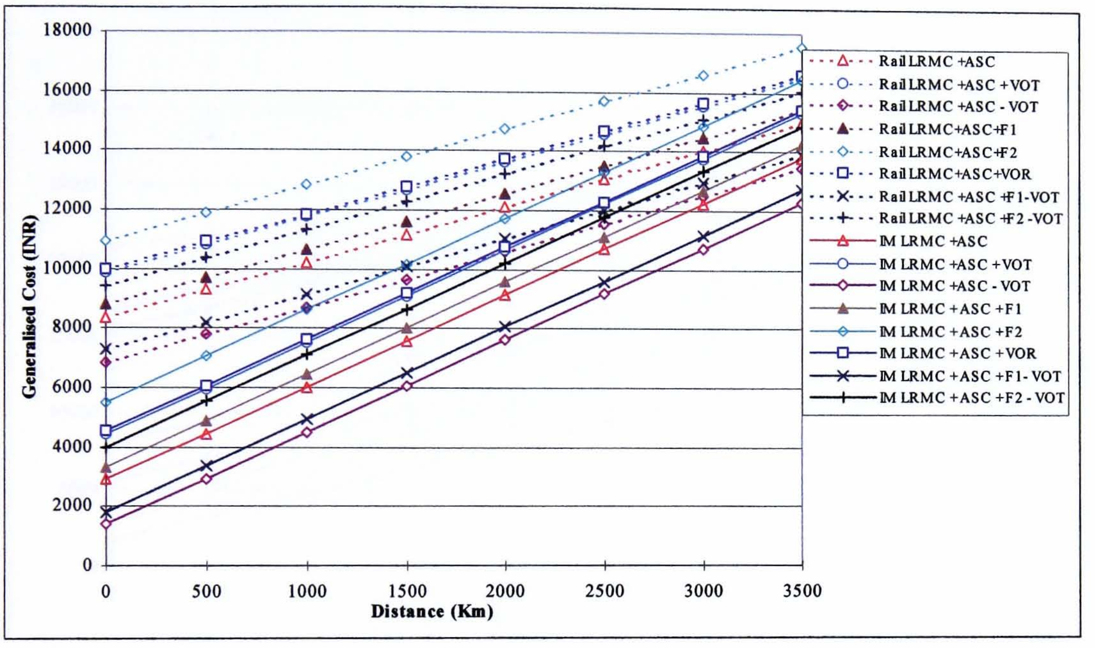
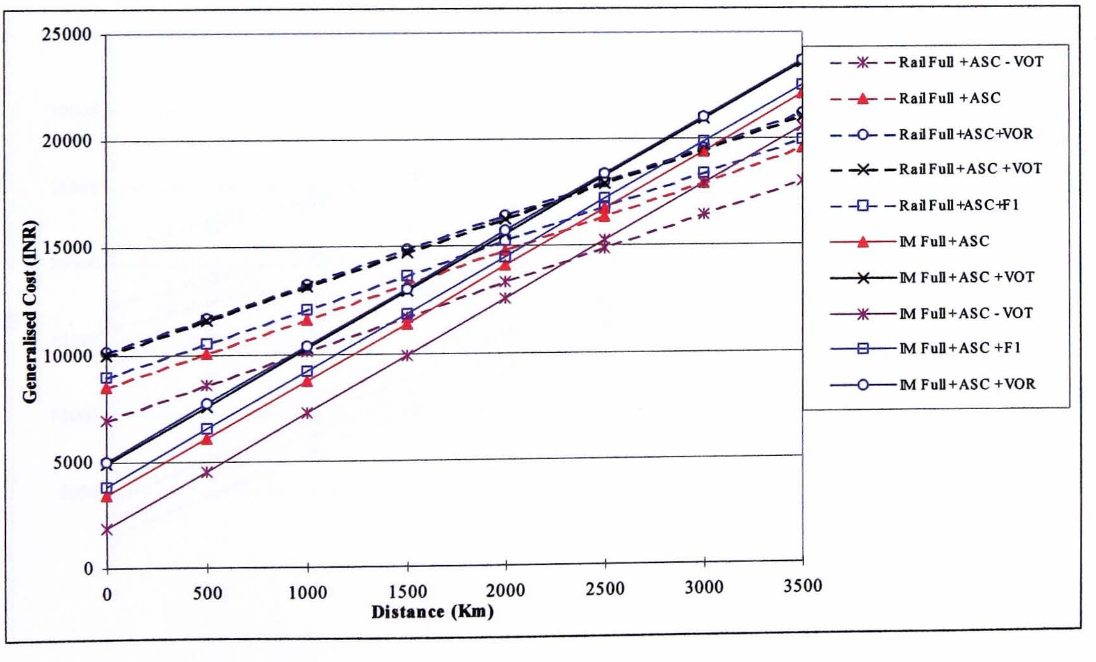


Figure D.2: volume constrained – (Fully Allocated basis)



Appendix E Breakeven Analysis Rail Vs Intermodal – Electrical & Electronics (Hi value products)

Figure E.1: volume Constrained (LRMC basis)

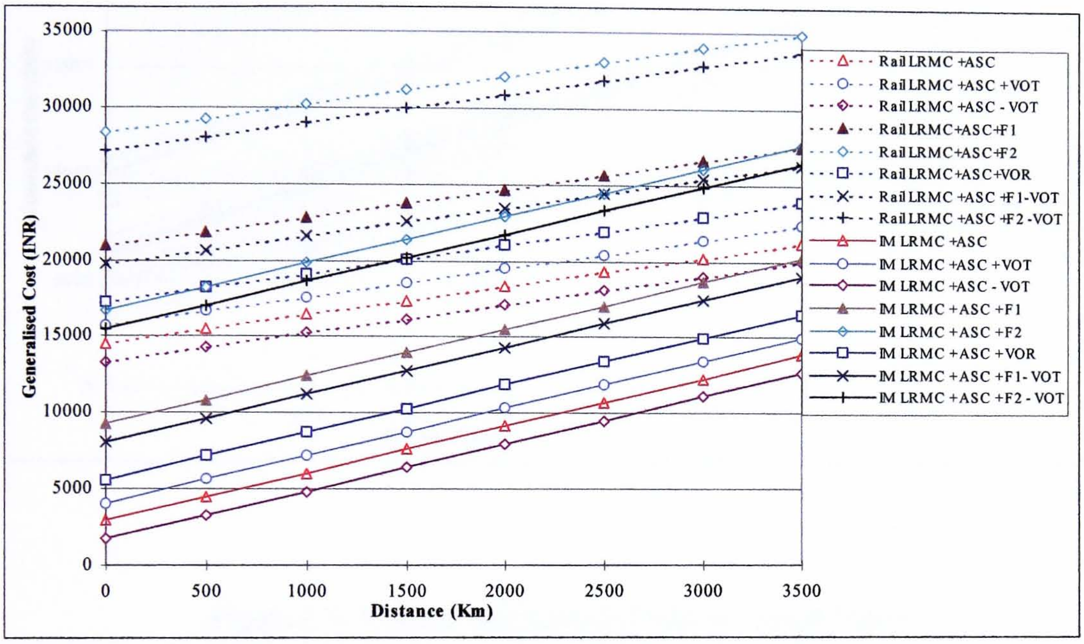


Figure E.2: Volume Constrained (Fully Allocated basis)

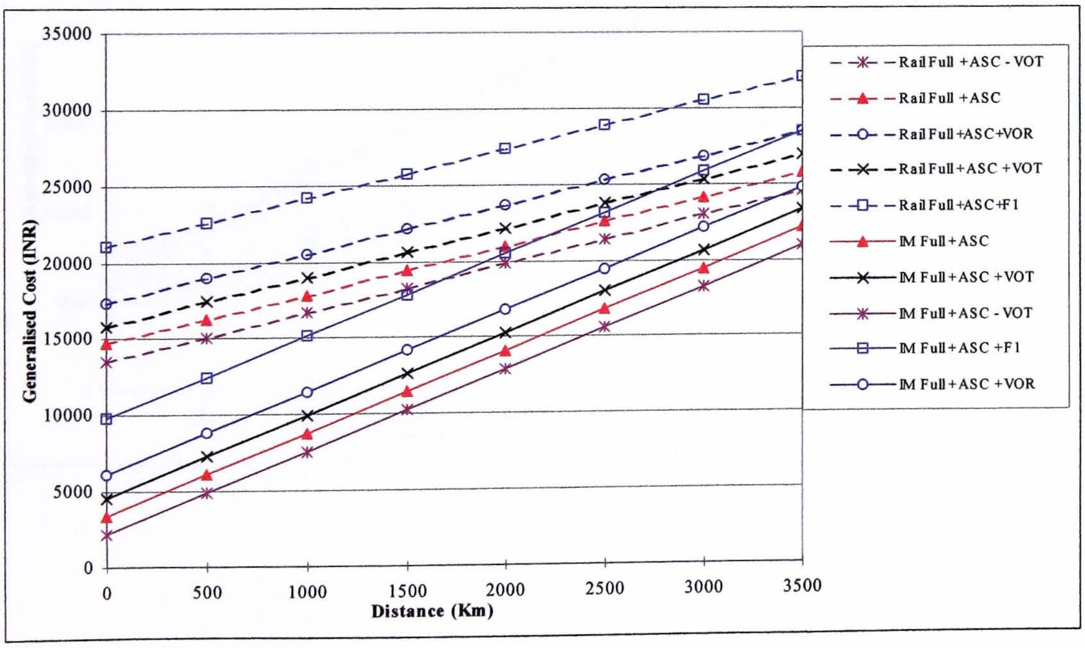


Figure E.3: Volume constrained (LRMC basis)

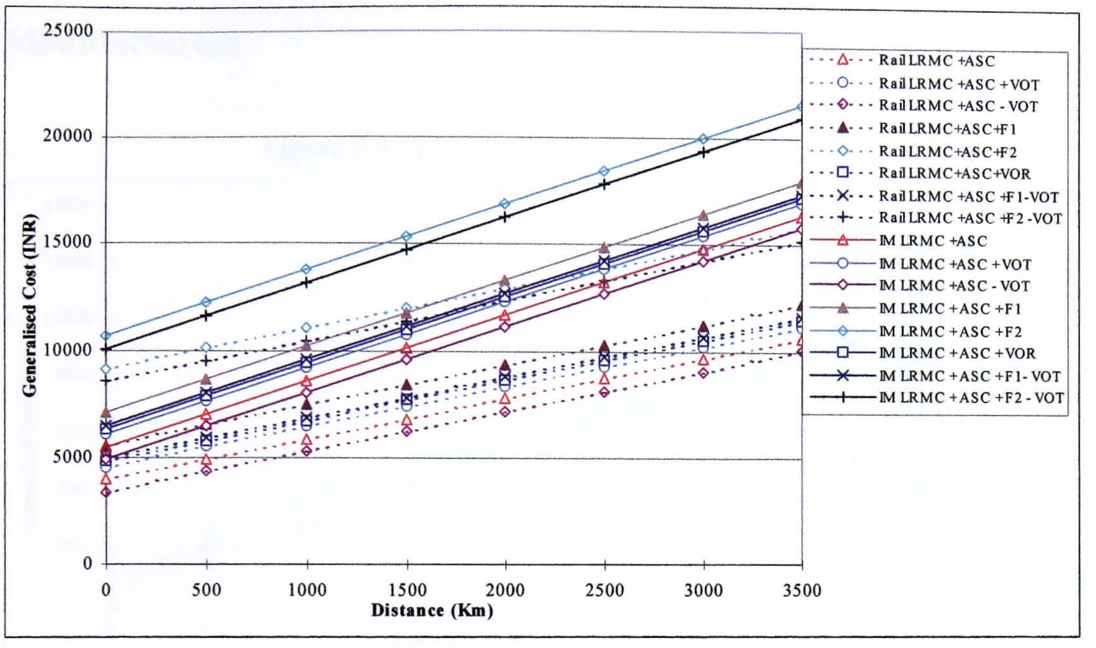
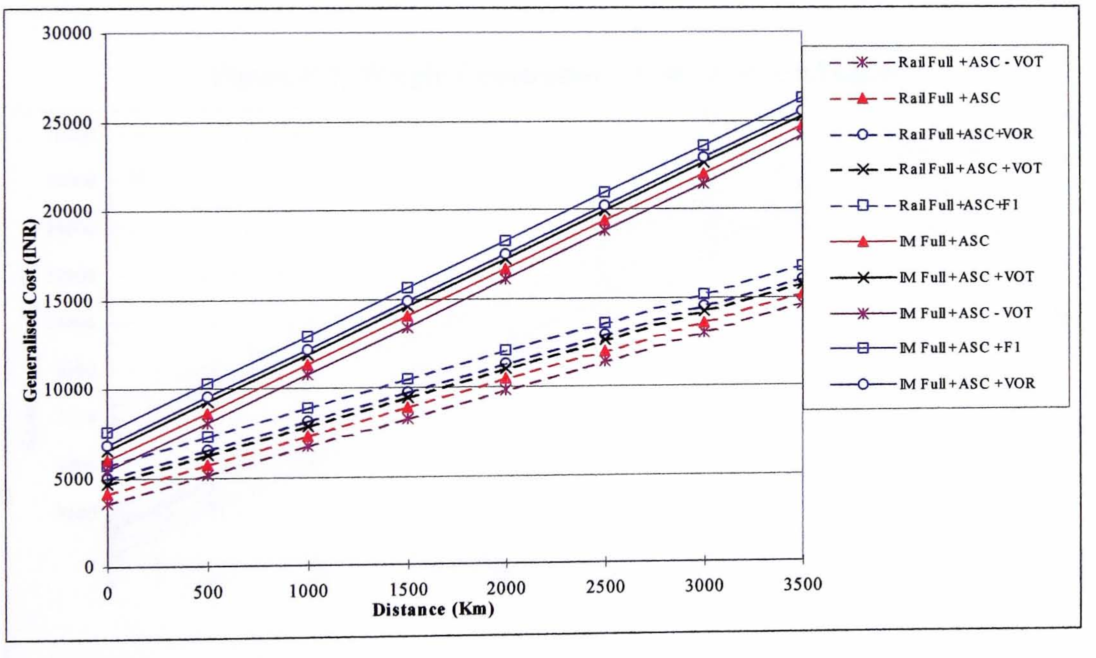


Figure E.4: Volume constrained (Fully Allocated basis)



Appendix F : Breakeven Analysis Rail Vs Intermodal – Food Products Manufacturers

Figure F.1: Weight Constrained (LRMC basis)

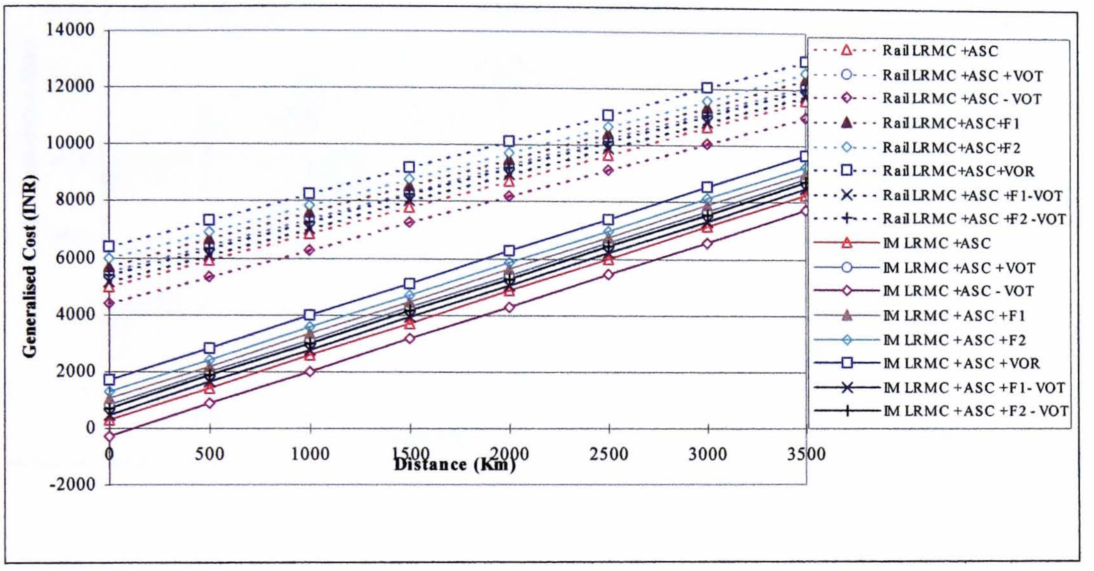


Figure F.2: Weight Constrained (Fully Allocated basis)

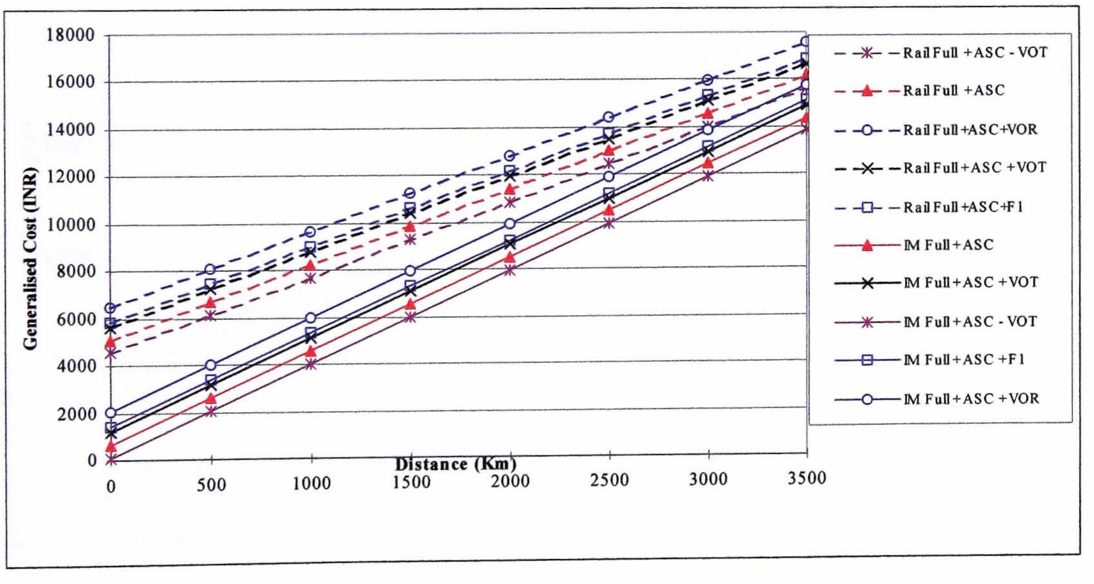


Figure F.3: Volume Constrained (LRMC basis)

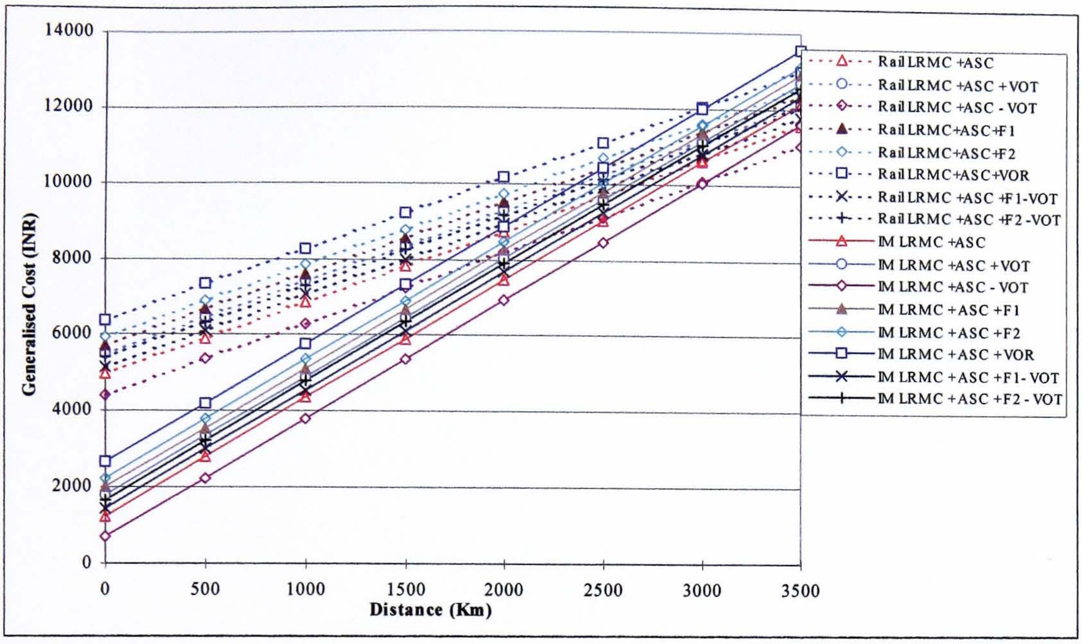


Figure F.4: Volume Constrained (Fully Allocated basis)