Published paper

Fowkes, A.S., Johnson, D. and Whiteing, A.E. (2004) The Development of the LEFT2 Model. Institute of Transport Studies, University of Leeds, Working Paper 582

UNIVERSITY OF LEEDS
Institute for Transport Studies

ITS Working Paper 582

October 2004

The Development of the LEFT2 Model

Anthony Fowkes, Daniel Johnson and Anthony Whiteing

Institute for Transport Studies
University Of Leeds

The Development of the LEFT2 Model

Document Control Information

Authors	:	Dr A S Fowkes, D Johnson, Dr A E Whiteing
Reference Number	:	442579-2
Version Number	:	1
Date	:	October 2004
Distribution	:	Unrestricted
Authorised	:	Dr A S Fowkes

The Development of the LEFT2 Model

A.S. FOWKES, D. JOHNSON and A.E.WHITEING

INSTITUTE FOR TRANSPORT STUDIES
UNIVERSITY OF LEEDS

October 2004

1. INTRODUCTION

Construction of the LEeds Freight Transport Model (LEFT) series was begun as part of the ITeLS project, although other funding has helped and will take forward its development. The initial version, now referred to by us as LEFT1, was a simple mode split model intended to give a rough idea of the magnitudes of the effects of various scenarios, possibly as a way of filtering which scenarios might be investigated using more detailed models. Besides being limited to mode split, LEFT1 suffered from a range of minor defects and deficiencies which led to its abandonment in favour of its successor, LEFT2.

LEFT2 was constructed in 2004 as part of the Engineering and Physical Sciences Research Council LINK FIT project, ITeLS, funded by the Department for Transport (DfT). We acknowledge here the help and useful comments from many persons associated with that project. Besides mode split effects, LEFT2 allows scenarios to alter the total size of the (road plus rail) market. Its purpose is to provide instantaneous ballpark estimates of road and rail freight tonne kilometres under various 'scenarios'. At its base is a desire that the scenarios should not affect the sum of tonnes moved by both road and rail modes. This was because we felt that our scenarios should be viewed as having a neutral macroeconomic effect. For example, if taxes on lorry usage were increased, we would expect other taxes to be lower than otherwise (or government spending to increase) so that total demand in the economy would not change. Consumers might buy their goods from closer sources than hitherto, but they would not be expected to consume less in total. For example, if prices of some goods rose slightly due to higher road user charges, the consumer would have more to spend due to offsetting reduced income tax (or whatever) and much the same total quantity would be bought. Similarly, industrialists as a whole might find input prices increasing slightly, but will find they can charge slightly more for their outputs.

In summary, LEFT2 provides an instantaneous estimate of the effect of macroeconomically neutral scenarios on mode split (road, trainload and wagonload), average length of haul and total market size.

LEFT2 does not load the traffic onto vehicles, and so does not produce magnitudes of HGV vehicle kilometres, for instance. Consequently it does not produce estimates of emissions or other nuisances. It is hoped that a future version of LEFT can incorporate these elements and revisit the other matters that have had to be 'parked' for the present. LEFT2 gives a quick idea of the magnitudes of the effects of any policies that might be considered and should help to provide a first sift where many policies are being considered.

This report describes the basic LEFT Methodology in Section 2. Emphasis is given to that methodology actually embodied in LEFT2, but there is also some discussion of rejected methodologies, and some that have had to be held over for later versions of LEFT. Section 3 presents additional data that was needed by the LEFT2 model. Section 4 describes the scenarios chosen for testing in the ITeLS project, while section 5 gives the first results from using the LEFT2 model, for those scenarios.

2. METHODOLOGY

LEFT2 works at a very aggregated level, for instance ignoring all geography. It was influenced by the 2001/2 DfT/HA/SRA/TfL Review of Freight Modelling (ME&P-WSP et al, 2002), which reviewed currently available models and likely future needs. Currently the Great Britain Freight Model (GBFM) (Newton and Wright, 2003) forms part of the DfT's National Model Suite and ITS has contributed to that model's methodology. GBFM does have geography, but is essentially a mode choice model, with any change to the size of the market having to be inputted exogenously. As an example of the potential problems that might arise, consider the case of whether increased long distance journeys brought about by falling road haulage costs would switch to rail if road haulage costs then rose. A model with a fixed OD matrix (for a particular year) might well re-allocate the traffic to rail, while a model incorporating length of haul effects would more likely reduce the average length of haul. LEFT2 addresses this problem.

Disaggregation within LEFT2 is by the following dimensions:

i) The base total market is split as regards whether it is suitable for trainload rail operations or not.
ii) The base data is split over 7 commodity groups (see section 2.3)
iii) The base data is split over 9 (road) distance bands, (see section 2.3)

Before discussing these we derive cost relationships for road (section 2.1) and rail (section 2.2)

2.1 Road Transport Cost Functions

This section starts by considering cost data, which comes to us in a variety of forms and must be related to our year 2000 base. We then move on to discuss calibration and projection of our base to the year 2010. We follow the conventional approach of splitting standing and operating costs.

2.1.1 Lorry Standing Costs

Standing costs do not vary with tonnage or length of haul and are usually taken to consist of the following:

- *Overheads*

These are indirect as they do not relate directly to a vehicle but are costs borne by the whole fleet. *Fleet overhead* costs consist of costs of all the backup or reserve equipment needed to run an efficient fleet. Main resources are spare tractors, trailers and drivers. *Business overheads* can be subdivided into transport department and company administrative overheads. *Transport department overheads* cannot be directly related to any one vehicle (ie salaries and wages, cars and expenses, telephone, rent and rates). *Administrative overheads* are those costs that are central to the running of a business and which have to be apportioned between all the different company departments, including directors' fees, legal fees, bad debts and bank charges.

- *Licence costs*

There are two main licences to be costed against a vehicle. These are Vehicle Excise Duty (based on max gross vehicle weight of HGVs and number of axles) and an operator's licence, which is a legal requirement for the operator to run his business.

- *Insurance*

The actual amounts of insurance required can vary depending on region, fleet size, type and value of loads, but only vary loosely with distance run.

- *Depreciation*

It is necessary to take account of the cost of the vehicle over the period of its expected life. This is known as depreciation. There are two possibilities for calculating depreciation:

1. Straight line method
2. Reducing balance method.

The straight line method is simple, requiring initial cost of the vehicle, resale or residual value of the vehicle and expected life of the vehicle in years. Annual depreciation is calculated by subtracting the resale value from the original purchase price and dividing the result by the expected life of the vehicle.

The reducing balance method assumes depreciation is greater in the early years of a vehicle's life, and becomes less severe in later years. This approach mirrors the fact that repairs tend to be few and inexpensive and tend to increase as the vehicle ages.

A vehicle typically lasts 5-8 years, depending on type of work it has to do. It will typically run between 20-100,000 kilometres per year.

- *Finance*

Interest on capital is accrued from either the cost of borrowing money or the (opportunity) cost of forgoing interest on a company's own capital.

- *Wages*

Most companies treat drivers' basic wages as a fixed cost as wages are payable regardless of whether a driver is actually 'on the road'. Basic wages are a fixed cost, but bonuses and overtime are classified as operating costs, as will the wages of drivers hired in to meet demand peaks.

2.1.2 Lorry Operating Costs

The operating cost is directly related to the mileage run by the vehicle. Whereas standing costs are analogous to fixed costs, running costs can be considered as analogous to variable costs. However, for operating costs we only consider variability which is mileage related. On that basis, operating costs are usually taken to include the following:

- *Fuel*

This is normally the largest of all the variable or running costs.

- *Engine oil and lubricant costs*

These are typically very small relative to fuel costs.

- *Tyres*

Tyres are classified as a running cost as tyre usage is linked to mileage.

- *Repairs and maintenance costs*

These costs tend to be the second highest operating cost again related to mileage. Three factors make up these costs: labour, spare parts and workshop/ garage costs.

In some cases the distinction between standing and operating costs is unclear, eg wages as discussed above.

Please note, however, that there are many different ways of categorising elements of road transport cost. It should be noted that the most important categories of cost appear to be wages and fuel, but that depends to some extent on how individual categories are combined.

Table 2.1 shows a breakdown of typical transport costs for a 38 tonne articulated lorry, taken from Road Haulage Association (RHA) figures. It is clear from the figures that the major components of costs are the fuel and wages costs.

Table 2.1: Annual transport costs for a 38 Tonne, GVW Artic, 4*2 axle tractor + Tri axle trailer (£).

Standing costs	**£**	**% of total**
Wages (inc NI)	21700	23.4
Insurance	5150	5.6
Overhead per vehicle	14650	15.8
Licences	1200	1.3
Interest on capital	1750	1.9
Depreciation	8350	9.0
Sub-total	**52800**	**57.1**
Running costs		
Fuel	26082	28.2
Maintenance	2553	2.8
Tyres	11109	12.0
Sub-total	**39744**	**42.9**
TOTAL Cost	**92544**	**100.0**

Source: RHA (2003).

2.1.3 Derivation of Lorry Cost Functions

Table 2.2 compares percentage breakdowns of standing, running and employment costs from four different sources, but with all vehicles running approximately 100,000 kilometres per annum. The UK based sources, ie Freight Transport Association (FTA), RHA and Commercial Motor, all have broadly similar proportions of costs between the three categories. The Commercial Motor figures are from 1996, bounding our 2000 base and suggesting the proportion of running costs has increased somewhat in recent years. The Italian figures from La Rivista Dell'autotrasporto show that standing costs are a much lower proportion of the overall cost. This is due to road tolls levied abroad which increase running costs, and slightly higher wages.

Table 2.2: Comparison of road transport costs from various sources (% of total cost)

Source	La rivista dell'autotrasporto, (2003)	FTA, (2003)	RHA, (2003)	Commercial Motor (1996)
Lorry Type	Autoarticolato	33T Artic GVW	33T gross 4*2 combination	32t combination
Standing cost	21	31	35	34
Running costs	52	38	36	33
Employment cost	28	31	29	32

Sources: RHA (2003), FTA (2003), Commercial Motor (1996), La Rivista Dell'autotrasporto (2003).

For the derivation of the lorry cost functions used in LEFT2, we focussed on four vehicle types using supporting lorry cost data from Transport Engineer (2004), and additional information from Motor Transport (2002). Details of these figures are provided in Table 3.3.

At 40km, we take the cost to be equal to half a day's standing cost. For unscheduled journeys there is no reduction on this for shorter distances. For journeys below 40km which are part of a scheduled set of short distance movements, efficiencies can be made allowing cost to fall below the unscheduled minimum. For these scheduled movements we allow a further fall in costs until at zero distance, cost is equal to one quarter of a day's standing cost. We have chosen to set the intercept at about 50% of the 40km cost, with the remainder related linearly to distance.

For one-way (non-stop) journeys over 40km, the cost of the journey will encompass the remaining share of standing cost, calculated on a continuum of a minimum of half day standing cost up to a full day's standing cost, depending on the distance travelled in km. Added to this is a day's running cost, also related to distance, to give total transport cost for a (typical) day.

The data we have provides us with necessary information on 'half day standing' and 'full day standing and operating' costs which give us two points on our cost function. The cost function is likely to be non-linear in nature, as costs not only increase with distance (from operating costs), but time (from standing costs). From these two data points and the assumptions about the form of non-linearity, we were able to construct a cost function for each vehicle type of the following form for journeys >40km:

$$C(\pounds) = \frac{k_1 D}{\ln(k_2 D)} \tag{2.1.1}$$

Where C is transport cost
D is one way distance (km)
k_1 and k_2 are parameters.

We now turn to calibrating our function, starting with journeys over 40km, for which we need k_1 and k_2 for equation 2.1.1

17T Rigids
From Transport Engineer, we found half a day's standing cost to be £70 and a full day's cost (assuming 560km as the maximum two-way daily haul) to be £300.
This gave us two pairs of values for D and C

$D = 40: C = 70;$
$D = 280: C = 300.$

Re-arranging (2.1.1) in terms of k_2 gives

$$ln(k_2) = (k_1D/C) - lnD \tag{2.1.2}$$

Substituting the two pairs of distances and costs gives:

$ln(k_2) = k_1 * 40/70 - ln(40) = k_1*280/300-ln(280)$

Grouping k_1 terms gives

$k_1\ (28/30-4/7) = ln(280)-ln(40)$

which gives

$\boldsymbol{k_1 = 5.38}$

Substituting this back into (2.1.2)

$ln(k_2) = -0.617$
$\boldsymbol{k_2 = 0.539}$

Below D=40, for unscheduled journeys, C equals half a day's standing cost, £70, while for scheduled journeys it is a quarter day's standing cost at D=0, rising to £70 at D=40.

The above approximates to the following function:

$C = \dfrac{5.4D}{\ln(0.54D)}$	$D>40$	
$C = 70$	$D<=40$	Unscheduled
$C = 40 + 0.75\ D$	$D<=40$	Scheduled.

32T Rigid
From Transport Engineer, we found half a day's standing cost to be £85 and a full day's cost (assuming 320km as the typical two-way daily haul) to be £234. This gave us two pairs of values for D and C:

$D = 40$: $C = 85$;
$D = 160$: $C = 234$.

Applying the same method as above we derived the following values:

$\boldsymbol{k_1 = 6.48}$
$\boldsymbol{k_2 = 0.525}$.

We approximate this by the following function:

$C = \dfrac{6.5D}{\ln(0.54D)}$	$D>40$	
$C= 85$	$D<=40$	Unscheduled
$C= 45+D$	$D<=40$	Scheduled

44T Artics, tankers and tippers.

From data presented by Fowkes, Firmin, Tweddle and Whiteing (2004), we found half a day's standing cost to be £110 and a full day's cost (assuming 722km as the two-way daily haul) to be £343. This gave us two pairs of values for D and C:

D=40: C=110
D=361: C=343

Applying the same method as outlined above we derived the following values:

$\boldsymbol{k_1 = 3.19}$
$\boldsymbol{k_2 = 0.08}$

We approximate by the following function:

$$C = \frac{3.2D}{\ln(0.08D)} \qquad D>40$$

$C = 110$ $\quad D<=40$ $\quad$ Unscheduled
$C = 50 + 1.5D$ $\quad D<=40$ $\quad$ Scheduled

For a 44T tanker and tipper, following guidelines from Motor Transport (2002), we add roughly 10% to the 44T artic costs giving:

$$C = \frac{3.5D}{\ln(0.08D)} \qquad D>40$$

$C = 120$ $\quad D<=40$ $\quad$ Unscheduled
$C = 60 + 1.5D$ $\quad D<=40$ $\quad$ Scheduled

Table 2.3 summarises the resulting cost functions.

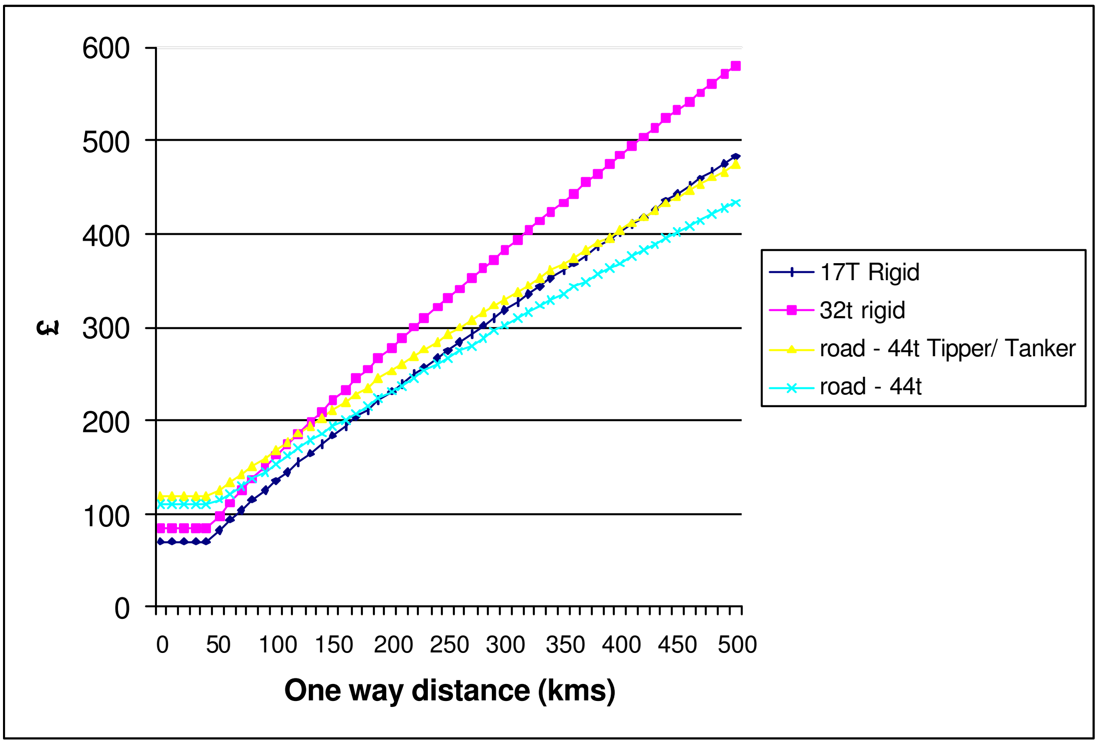
Table 2.3: Cost functions for representative vehicle types.

One way distance D km	17T Rigid	32T Tipper	44T Artic	44T Tipper/ Tanker
D>40	5.4D/ln(0.54D)	6.5D/ln(0.54D)	3.2D/ln(0.08D)	3.5D/ln(0.08D)
D<=40 Unscheduled	70	85	110	120
D<=40 Scheduled	40+0.75D	45+D	50+1.5D	60+1.5D

Currently, LEFT2 assumes that journeys less than 40km are unscheduled. This is because many of the short distance road trips are either feeder trips for rail which are difficult to schedule, or are not relevant to the mode choice, as rail is only competitive over longer distances.

Figure 1 plots these functions over a range of one way distance kms.

Figure 1: Road costs by distance and vehicle type



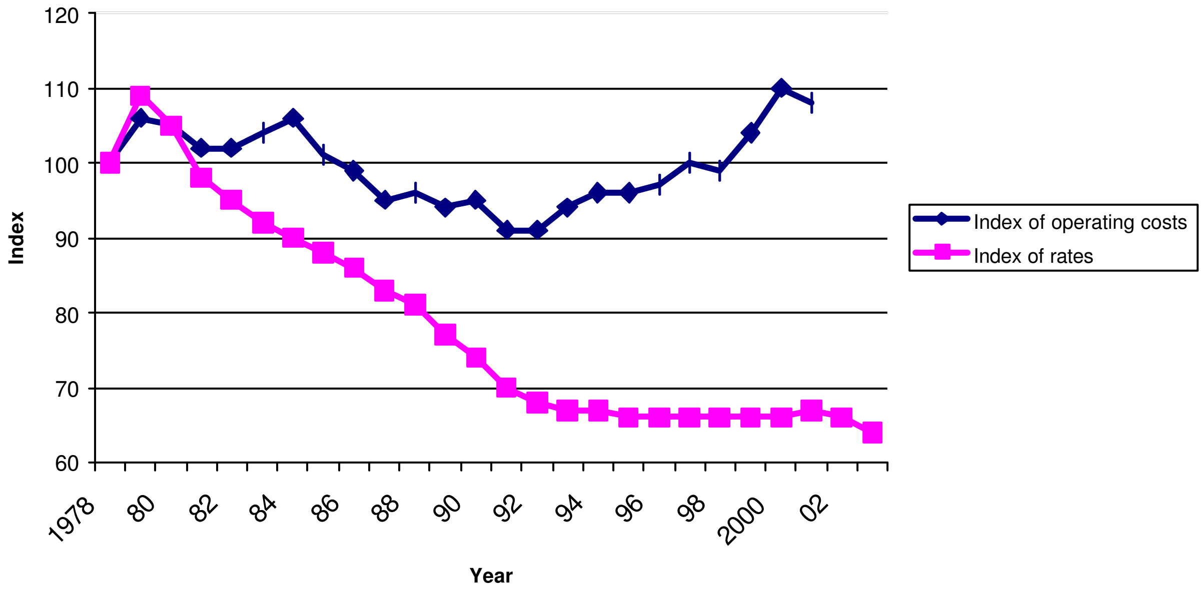
Source: ITS calculations.

2.1.4 Operating costs and rates over time

The Survey of Freight Transport Including Cost Comparison for Europe (SOFTICE, 1999) examined the interactions between production costs, transport costs and transport demand for freight, and the benefits of harmonized freight transport costs. SOFTICE reports that during the previous two decades the UK fleet of articulated vehicles increased by a little more than half, whereas the freight moved (in tonne km) more than doubled. Working with FTA data, presented in Figure 2, it was shown that operating costs drifted down in real terms until the early 1990s, after which there were increases mainly related to the Fuel Duty Escalator. We have used FTA(2003) data and similar, to extend the series.

Because of other factors, such as less empty running and increased competition, operators have reduced the rates charged in real terms. For its 2000 base, LEFT2 has assumed no change in real operating costs and charges for road transport.

Figure 2: Real Operating Costs and Rates over time (1978=100)



Source: SOFTICE (1999) & FTA (2003).

There are already some signs that this price stability may end:

- congestion is beginning to have an impact on journey times and hours of operation;
- fuel prices are increasing, although this is being mitigated by tax reductions; and
- the Working Time Directive is likely to increase drivers' costs.

On the other hand, technological change continues to improve fuel consumption and reduce maintenance costs, and operators are improving the utilisation of their fleets through techniques such as back loading and shared loading.

2.2 Rail transport cost functions

Analysis of rail is less straightforward than road. LEFT2 splits traffic according to whether or not it is suitable for trainload rail or wagon loads. The former have low movement costs but require high volumes. The latter are typically multimodal operations with higher costs associated with road collection/delivery legs, but the traffic volumes need not be large.

Rail freight costs are more complicated than road costs, and we cannot apply a simple rule of thumb methodology. Costs vary significantly due to a number of factors, as outlined in the South and West Yorkshire Multi-Modal Study (SWYMMS, 2001):

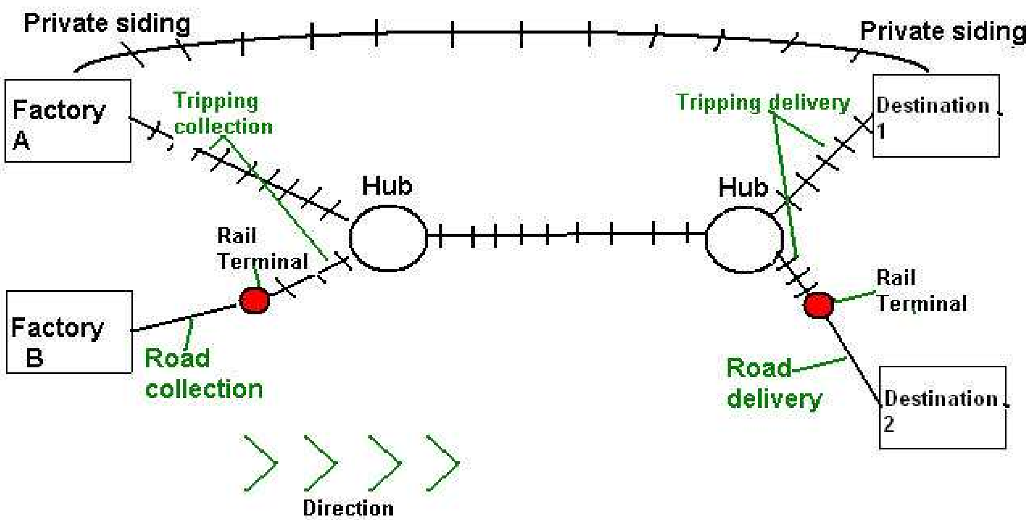
- The cost of loading freight on to the train, either at collection, delivery or transfer points;

- Whether the goods can be moved in trainload quantities, wagon/lorry load quantities or less than wagon/ lorry load quantities;
- The efficiency of the route being operated, i.e. overall distance of journey, distance from rail hubs and efficiency of the terminal operations;
- How wagons are loaded; typically rail wagons can carry more weight but have lower volume capacity than the equivalent road vehicle;
- The kind of goods being transported. Bulk freight (mainly industrial materials such as aggregates and petrochemicals) often benefits from direct access to rail, as opposed to non-bulk freight (mainly manufactured and packaged goods), which have to pass through rail terminals.

2.2.1 Rail Journey Components

Figure 3 illustrates the possible permutations of multimodality and other sources of cost involved in a freight rail journey.

Figure 3: Different Types of Rail Journey



A typical rail journey consists of some or all of the components described below.

Road collection and delivery legs

Where there is no direct access to rail, there are extra costs incurred through transhipment and road collection/delivery. Such short road collection/delivery legs can be disproportionately expensive. Bulk products typically benefit from direct access to rail, but this is rarely now the case for non-bulk products. There will also be scenarios where there is a rail connected facility at one end of the journey, with just a collection or delivery road journey at the other end. There is no scope for scheduling these journeys as freight train movements are sparse, with road collection/delivery movements all required at the same time.

Transfer to/from rail wagon
For bulk products, transhipment methods, such as a hopper, are relatively straightforward. Most non bulk products on the other hand will need to be transferred by fork lift or crane, which, according to the SWYMMS study is at a cost of at least £1.50 per tonne (SWYMMS, 2001). Intermodal freight terminal costs will vary considerably, depending on utilisation. According to Whiteing (2003), they could vary from £15 - £100 per container transfer.

Rail trip leg to / from rail marshalling yard
Rail tripping can occur at either or both ends of the trunk haul and can prove relatively expensive due to poor utilisation of tripping locomotives.

Marshalling at rail yard/ hub
Marshalling costs can be incurred for transfer of tripped wagons to trunk train services and vice versa. Clearly, partially filled wagons will still require the same amount of marshalling as a full wagon, so we treat this element as a fixed cost per wagon.

Trunk rail journey
This is the hub to hub leg shown in Figure 3. This is typically the cheapest part of the journey per kilometre, although it will often be the longest.

2.2.2 Rail Standing and Operating Costs

We employed cost functions of the same form as the road cost functions, ie we assume costs are comprised of fixed costs and distance related costs. To calculate standing costs we used figures from GBFM (Newton and Wright 2003), included in Table 2.4 and, with more detail, in Table 3.4.

Table 2.4: Indicative rail costs (2000)

Rail Access (loco) costs	£2.1 - £2.4 per 1000 tonne km
Rail Access (wagon) costs	£1.1 (general) - £2.4 (bulk) per 1000 tonne km
Wagon cost (wagon with 24 tonne payload)	£37.5 per day
Trunk loco cost	£1700 per day + £1 per km
Marshalling cost	£45 per train per marshalling
Lifting	£20 per container transfer
Collection/Delivery (short distance artic)	£110 at each end

Source: Newton and Wright (2003) and Office of the Rail Regulator (2003).

Operating costs consist of traction costs and track access costs.

Traction costs
These are taken from GBFM to be £1 per km, including fuel and maintenance costs.

Track access costs
For each commodity type a representative wagon type (detailed in Table 3.6) and loco type (Class 66) is assumed, with associated access costs, weights and capacities taken from figures published by the Office of the Rail Regulator as shown in the Table 3.6. Broadly,

locomotive access costs vary between £2.1- £2.4 per 1000 gross tonne km and wagon costs between £1.1 and £2.4 per 1000 gross tonne km.

Additional to these costs we have the following, incurred by wagon load operations

- Marshalling cost; £45 per marshalling
- Lifting cost; £20 per lift
- Collection/delivery; £110 (short distance artic movement)

We assume that each rail tripping distance is 30 km and the trunk rail distance is overall road distance minus 20km.

2.2.3 Derivation of Train Cost Functions

For our train cost functions we are looking at the whole train set, ie the locomotive and wagons. The half day standing costs can be derived from Table 3.4. These standing costs cover the fixed costs of wagons, the locomotive and terminal operations. We assumed that the train set typically travels 500 km in one day. Total standing costs were then calculated on a continuum of a minimum of half day standing cost upto a full day's standing cost, depending on the distance travelled in km, ie

$$\textit{Total standing cost} = 0.5sc * (1 + (d / 500))$$

Where:
sc is one day's standing cost;
d is the distance in km

Operating costs were then calculated by adding traction cost to locomotive and wagon access costs, which were calculated in the following way:

$$\textit{Traction cost} = tc * d * ls$$
$$\textit{Loco access cost} = la * d * (lw/1000) * ls$$
$$\textit{Wagon access cost} = wa * d * (ww/1000) * W$$

Where:
tc is the traction cost per km;
la is the locomotive access charge per 1000 gross tonne km;
ls is proportion of the full train taken up by the wagons for our movement;
lw is locomotive weight, assumed to be 126 tonnes;
wa is the wagon access charge per 1000 gross tonne km;
ww is wagon weight is in tonnes and varies by commodity and;
W is the number of wagons.

All valuations for access charges and appropriate wagon weights are detailed in Table 3.6.

For wagonload rail we also added in appropriate marshalling, lifting and road collection/delivery costs.

2.3 Representative Vehicles and Commodities

Seven commodity groups are used in the model based on the categories provided in the Continuing Survey of Road Goods Transport (CSRGT) data (DETR, 1999):

A. Food, Drink and Agricultural Products
B. Coal, Coke and related items
C. Petroleum and Petroleum Products
D. Metals and Ores
E. Aggregates and Construction
F. Chemicals and Fertilisers
GHI. Other, including manufactures, miscellaneous, containerised, and international.

Nine distance bands are used in the model, again based on breakdowns in the CSRGT data (DETR, 1999):

1. 1-25 km
2. 25-50 km
3. 50-100 km
4. 100-150 km
5. 150-200 km
6. 200-300 km
7. 300-400 km
8. 400-500 km
9. Over 500 km

Traffic (in tonne-km.) was first split according to whether it was suitable for movement by trainload rail (TLS) or not (NTLS). For the former, movement costs are quite low. Generalised Costs per tonne are required for each of the TLS-NTLS/ commodity/ distance cells.

Representative road vehicle types
For each commodity/distance band we have assigned a representative road vehicle type to reflect differences in costs of different vehicles usage. These are based on the four vehicle types for which we have constructed cost functions.

This is estimated on the basis of:
- Rigid vehicles are only a majority of tonnes lifted in lowest 2 distance bands in CSRGT;
- Building materials, crude minerals and other products are the most significant commodities in the lowest two distance bands.

Table 2.5: 'Typical' Lorry type and payload, by distance and commodity type

	Lorry type		Payload (tonnes per lorry)	
Commodity	**0-50km**	**51+km**	**0-50km**	**51+km**
Food, drink & agriculture	Artic44	Artic44	25	25
Coal & coke	A44Tipper	A44Tipper	28	28
Petroleum	A44Tanker	A44Tanker	30	30
Metals & ores	Artic44	Artic44	31	31
Construction	Rigid 32T Tipper	A44Tipper	20	31
Chemicals	A44Tanker	A44Tanker	28	28
Others	Rigid 17T (possibly with drawbar trailer)	Artic44	25	28

Building materials, other crude minerals, ores, crude materials and other products are the most significant users of rigid vehicles. Mostly these are heavy rigid vehicles. For most of these commodities, these will be large (8 wheel) tippers (for minerals) or flatbeds (eg steel). But for the other products, they are probably drawbar combinations, (rigid vehicles).

Each of these vehicle types has different payload capacities, as shown in Table 2.5. This data is necessary to calculate costs per tonne.

Representative rail vehicle type

The wagon types in Table 2.6 were chosen as being most representative of the various commodities.

Table 2.6: 'Typical' Wagon type and payload by commodity type

Commodity	Wagon Type	TOPS Code	Payload (tonnes per wagon)
Food, drink & agriculture	Van	VGA	24
Coal & coke	Coal wagon	HHA	64
Petroleum	Tanker	TEA	70
Metals & ores	Bolster	BAA	70
Construction	Hopper	PHA	75
Chemicals	Tanker	TUA	35
Others	Intermodal	IFA/2	48 per pair

As can be seen, each of these wagon types have different payload capacities. The above (as with so many of the preceding assumptions) is clearly a gross simplification, but (together with the other assumptions used) is thought to be reasonably representative.

2.4 Generalised cost functions

In addition to the financial cost of road and rail transport, modelling should include other attributes such as time and delay costs as well as a mode specific constant. This is a penalty (expressed as a percentage of the road costs) for using rail as opposed to road, implemented by adding to rail cost (see Table 3.11). The scheduled journey times and delay times require an appropriate valuation of time to convert the time measures into financial cost. These are then summed with financial cost to give a Generalised Cost (GC).

2.4.1 Journey time costs

To convert journey times into a monetary measure we applied a value of journey time to average journey times for each distance/commodity category. In order to derive average journey times, we assumed typical road and rail speeds by distance. In the case of rail, speeds vary due to the different wagon types used.

Longer distance road traffic will use a higher proportion of trunk and motorway routes, and will spend lower proportions of time in congested urban areas, so will achieve higher speeds.

These speeds were then applied to each distance band to derive an average journey time by distance. To turn these journey times into costs, we needed an appropriate value of journey time. ITS has long experience in this area, and our estimates are shown in Table 3.11. The resulting journey time costs estimates are shown in Tables 3.12 and 3.13.

2.4.2 Delay time costs

In order to construct a measure of delay costs we need measures of delay and an appropriate value of delay time. Coupled with travel costs, an accurate representation of transport costs must consider costs of time spent waiting, loading and unloading. The values of delays are used based on LASP interviews undertaken by Tony Whiteing and Geoff Tweddle in 2003-2004 and shown in Table 3.10.

These figures were applied to each commodity specific values of delay time taken from Fowkes et al (2004) to yield commodity specific valuations of delay time per tonne (see Tables 3.11, 3.14 and 3.15).

2.4.3 Backloading

A backload factor tells us the proportion of loads which are backloads. A loaded return leg will typically add an extra fuel and wage element to costs depending on the extra time and distance. Typically an A to B outward (prime) leg will not find a B to A return leg, but hauliers will try to find a load close to B wishing to go in the general direction of A. Obtaining this load will involve some administrative effort, extra travel time, waiting time and fuel usage. In practice these elements will vary enormously from case to case. In return for fitting in with the haulier’s schedule, the backload movement might only be charged as little as half of the normal rate. The availability of backloads can also be reflected in the rate for the outbound movement.

It is our belief that profitability in the road haulage industry is such that our formula reflects well underlying costs if that term is taken to include normal profit. In the absence of more detailed data, we propose to take the usual rule of thumb of adding 50% to the one-way rates and costs for a journey loaded in both directions. Hence a journey from A to B and loaded in both directions would have a cost of 150% of that obtained from our formula.

The data we have is purely based on tonnes lifted by distance and commodity groups. This tells us nothing about which of these loads are backloaded. In order to incorporate the cost efficiencies arising from backloading we had to assume backload factors. These assumptions were based on our estimates of empty running of vehicles for the different commodities. We found a relationship between empty running (E, which can be between 0 and 1) and the backload factor (B, between 0 and 1) shown below.

If all loads are backloaded, B=1, and correspondingly, E=0

If half outbound loads have backloads:

50% of all lorries on road are loaded and on an outward leg
25% of all lorries on road are running a backload
25% of all lorries on road are running empty.

This means that of the loaded lorries, 66% have loads in both directions.

More generally, if out of 10 outward trips, y are loaded back

$$E = (10 - y) / 20 \quad (2.4.1)$$

$$B = 2y / (10 + y) \quad (2.4.2)$$

Re-arranging (2.4.1) in terms of y gives

$$Y = 10 - 20E \quad (2.4.3)$$

Substituting (2.4.3) into (2.4.2) gives

$$B = (20 - 40E) / (20 - 20E)$$

ie

$$B = (1 - 2E) / (1 - E) \quad (2.4.4)$$

Re-arranging this in terms of E gives

$$E = (1 - B) / (2 - B) \quad (2.4.5)$$

We assumed the backload factors for each commodity shown in Tables 2.7 and 2.8. From these we derived the proportion of journeys containing a backloaded leg which were used in conjunction with our cost function to derive the average financial cost per tonne lifted by commodity.

Table 2.7: Assumed road backload factors

Commodities	Proportion of outward trips with backloads	Backload factor B	Proportion of empty running E
Food, drink & agriculture	0.82	0.90	0.09
Coal & coke	0.21	0.35	0.39
Petroleum	0.18	0.30	0.41
Metals & ores	0.82	0.90	0.09
Construction	0.43	0.60	0.29
Chemicals	0.43	0.60	0.29
Others	0.82	0.90	0.09

Table 2.8: Assumed rail backload factors

Commodities	Proportion of outward trips with backloads	Backload factor B	Proportion of empty running E
Food, drink & agriculture	0.00	0.00	0.50
Coal & coke	0.00	0.00	0.50
Petroleum	0.00	0.00	0.50
Metals & ores	0.10	0.17	0.45
Construction	0.00	0.00	0.50
Chemicals	0.00	0.00	0.50
Others	0.75	0.86	0.13

2.5 Model Calibration

The mode split procedure was as follows. Two logit models were estimated, one for trainload suitable traffic, and then another for non-trainload suitable traffic. The required trainload/wagonload split was done by judgement, taking all current rail trainload traffic as suitable, plus a little of the road traffic, particularly in commodity groups with existing large amounts of rail trainload traffic. The percentage of all tonnes lifted, by distance bands, judged to be suitable for trainload rail is shown in Table 2.9.

Table 2.9: Traffic suitable for trainload rail (% of all tonnes lifted by commodity and distance in km)

Commodities	0-25	26-50	51-100	101-150	151-200	201-300	301-400	401-500	>500
Food, Drink & Ag	0.1	0.1	0.1	0.1	0.1	1.0	2.0	4.0	10.0
Coal & Coke	37.3	67.1	65.3	49.9	69.9	67.1	99.8	99.8	99.8
Petroleum	2.1	0.1	1.1	15.1	27.3	27.3	56.5	99.8	50.0
Metals & Ores	20.5	32.8	30.9	25.9	26.9	30.9	35.6	34.6	34.5
Construction	20.1	23.0	24.7	30.9	42.2	43.3	30.9	40.0	52.0
Chemicals	1.0	3.0	5.0	5.1	5.2	5.4	6.0	7.3	5.0
Others	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

After splitting the data into trainload and wagon load suitable, a proportion of traffic in each distance band/ commodity/ rail type cell was nominated as captive to road. These road captive proportions are in Table 2.10.

Table 2.10: Assumed road captive proportions (by commodity and distance in km)

	0-25	26-50	51-100	101-150	151-200	201-300	301-400	401-500	>500
Road captive proportion (trainload rail)									
Food, Drink & Ag	0.900	0.900	0.900	0.500	0.880	0.896	0.131	0.600	0.838
Coal & Coke	0.106	0.000	0.000	0.031	0.001	0.000	0.000	0.000	0.000
Petroleum	0.020	0.700	0.050	0.000	0.000	0.000	0.000	0.000	0.000
Metals & Ores	0.947	0.331	0.401	0.770	0.753	0.569	0.481	0.661	0.850
Construction	0.991	0.875	0.836	0.639	0.338	0.380	0.860	0.621	0.397
Chemicals	0.980	0.999	0.999	0.957	0.929	0.902	0.800	0.621	0.999
Others	0.780	0.770	0.800	0.800	0.950	0.806	0.780	0.813	0.780
Road captive proportion (non trainload rail)									
Food, Drink & Ag	0.600	0.600	0.620	0.621	0.598	0.610	0.599	0.589	0.429
Coal & Coke	0.900	0.900	0.903	0.900	0.900	0.974	0.000	0.000	0.000
Petroleum	0.950	0.960	0.960	0.950	0.950	0.997	0.996	0.050	0.500
Metals & Ores	0.041	0.000	0.000	0.100	0.501	0.350	0.350	0.680	0.900
Construction	0.610	0.600	0.589	0.398	0.400	0.399	0.370	0.340	0.300
Chemicals	0.957	0.980	0.990	0.900	0.920	0.930	0.950	0.900	0.999
Others	0.996	0.920	0.800	0.700	0.599	0.399	0.001	0.000	0.002

A simple Binary Logit, using the Generalised Costs derived in section 2.4, was used to give mode splits of tonne kilometres. Adjustments were made to closely match the base splits with the model, for the purpose of reproducing the base data, by means of

(i) adjusting the scaling parameter of the Binary Logit model;
(ii) adjusting the proportion of traffic taken as captive to road; and
(iii) specifying a proportion of traffic captive to rail.

Rail captive proportions were used for just wagonload Ores and Metals. These took the value of 0.2 for 26-50km and 0.11 for 51-100km. All other commodities and distances had a zero value for rail captivity.

Close attention was paid to the composite generalised costs so generated, to check that they were not implausibly far below actual generalised costs. The mode share of rail was estimated in the following way for each distance band/ commodity/ rail type group:

$$MS_{rail} = (1 - cap_{road} - cap_{rail})*Exp(\lambda GC_{rail}) / (Exp(\lambda GC_{rail}) + Exp(\lambda GC_{road})) + cap_{rail}$$

where:

MS_{rail}	is the market share of tonne kms for rail
$capt_{road}$	is the road captive proportion
cap_{rail}	is the rail captive proportion
λ	is the scale parameter
GC_{road}	is the road generalised cost
GC_{rail}	is the rail generalised cost

It was recognised that aggregation bias is a risk but dealing with that was shelved for a later generation of LEFT.

2.6 Deriving base 2010 projections

In order to derive estimates of 2010 'do nothing' projections, ie a continuation of current trends, the following procedures were used. It is important to note that the 2010 estimates are not a forecast of what will actually happen in 2010. In particular, it is assumed in LEFT2 that 2010 will be on trend, rather than a boom or slump year.

Firstly, projections, made in 2000 for 2003 from extrapolating data from 1974 to 1998, were compared to actual 2003 data:

- Where extrapolations of 1998 figures match 2003 actual figures, growth rates of tonnes lifted and tonne kilometres moved for each commodity are retained for our 2010 projections.
- Where 2003 projections do not yield close matches with 2003 data but the growth rates still look sensible, the growth path is shifted (ie rebased), but maintaining predicted growth rates giving new 2010 projections.
- Where the 2003 data bears no relation to the 2003 projections, the 1998 to 2003 actual growth rate is applied to 2003 to 2010, new 2010 projections resulting.

LEFT2 could easily be amended to project to other future years.

2.7 Predicting effect of policy changes

After calibrating the base 2000 figures and producing the 2010 base projections the model is ready to forecast the effect of input changes. Currently forecasts are based on changes in variable or fixed cost components of road transport costs only. These can be implemented through the following ways:

1. Percentage change in operating cost component. In order to implement this, LEFT2 needs to know what proportion of total operating cost this cost component forms. For example, if we are forecasting the effect of a 10% increase in fuel prices the cost function needs to know that fuel prices are 75% of total variable cost. In this way the operating cost component will correspondingly increase by 7.5%.
2. Absolute change in operating cost component (£ per km). For example, a road user charge could increase operating costs by say 15 pence per km. Then this increase in cost will be added to the existing operating cost per km.
3. Absolute change in standing cost (£ per day). For example, an increase in driving costs through working hours restrictions may increase standing costs per day by say £36. This will be added on to the existing standing charge for each lorry per day.

LEFT2 will then calculate the new Generalised Costs per tonne (for road, rail trainload and rail wagonload) based on these cost changes. These are applied to the Market Share estimation along with the calibrated parameters to generate a new mode share of tonne kilometres for each distance band/commodity/rail type group. New tonne kilometres are forecast by applying the new mode shares to the original tonne kilometre figures.

Because of the neutral macro-economic effect, which leaves overall tonnes lifted constant, changes in tonne kilometres are driven by changes in average length of haul. While that might seem straightforward for a model with no distance bands, in LEFT2 it proved very tricky. It is achieved by moving tonnages into different distance bands in a sensible and systematic way such that we can retrieve the predicted tonne kilometres. We needed to move exactly the right number of tonnes between bands (i) where distance bands have differing widths, and (ii) without wiping out all traffic in the short distance bands (which we expected to continue to serve many needs into the future). In fact, mathematically there were an infinite number of solutions. The new distribution of tonnes is derived in LEFT2 from a weighted combination of high (roughly double), medium (base 2000 figures) and low (roughly half) distributions of tonne kms, each of which keep tonnes lifted constant. These reference points were derived iteratively, applying restriction (ii) in each iteration. We therefore sought to locate our solutions on a pathway from roughly half to roughly twice base tonne-km, moving smoothly and paying heed to restriction (ii). Cost changes that yield forecasts outside that range are heavily censored by LEFT2, as though these possibilities were not to be believed.

The base 2010 figures were chosen to conform to the 2010 projections (by commodity). The breakdown by trainload suitability was by reference to the 2000 split. The breakdown by distance band was by the same iterative method referred to above. Again, Low and High reference points were constructed, censoring tonnages. Forecasts (for all distances) were then related to this continuum.

The 'output' worksheet of the LEFT2 model presents the results in the following format:

- Change in generalised cost by commodity for rail train and wagon load and road.
- Base, new and %change in Tonnes lifted, tonne kms and average length of haul by commodity.

The effect of scenarios on tonne-km was determined by an elasticity to generalised cost, calculated from a published elasticity (-0.08) of road tonne-km to monetary cost (Cooper, Black & Peters, 1998). Unfortunately, separate elasticities by commodity were not available, and so that issue was 'parked'. Nevertheless, differing splits between monetary and non-monetary elements in generalised costs (by commodity and distance band) do work to give a range of generalised cost elasticities. The methodology used was to first subtract that proportion of the total change to road traffic accounted for by mode switch, which was found to be three quarters, ie -0.06, and deem the rest to be due to a change in the total market size, ie -0.02 (in terms of tonne-km.).

One complication that we have also 'parked', and so will refer to here and then ignore, is that a switch from road to wagonload rail should really increase tonnages by road, since we have assumed at least one road collection or delivery for each rail wagonload movement. In our view, our base road data does contain such collection and delivery movements, though they are fairly trivial in magnitude compared to main mode road traffic. Since we particularly wanted to hold tonnages constant, making adjustments for this point would have led to confusion. Tonne-km would also be affected, not only for wagonload, but also for trainload if the rail journey was less of a straight line than road, such that total tonne-km increased just because of the switch. Since the methodology of LEFT2 determines total tonne-km before mode split, an iterative process might have been necessary. In any event, we felt that dealing with these points would have overcomplicated the interpretation of model outputs. Consequently a switch of traffic between Road and Rail is assumed in LEFT2 not, in itself, to alter total tonnages or tonne-km, and so our results must be interpreted in that light.

3. DATA

The data used was collected from a variety of sources. For road, the primary source has been the Continuing Survey of Road Goods Transport (DETR, 1999). For rail we have used Transport Statistics Great Britain (DfT, annual). In recent years the data for rail has become difficult to obtain, and gaps have been filled by our own best estimates and some discussion with the SRA personnel. The full data set is commercially confidential. The base data represents a year sometime around 2000.

The data used in the model covers two modes, Road and Rail. Some data was available for Water and Pipeline, but there are difficulties, particularly with recent data. Furthermore, Water and Pipeline are only relevant for a limited number of specialised traffics and movements, largely those of oil. The degree of mode switch from and to these modes under our scenarios was assessed to be minimal, and so the complication of including more than two modes was avoided.

3.1 Base Data on Tonnes Lifted

The distance bands also allow the calculation of tonne kilometres by distance band, by multiplying tonnes lifted by the mid point of each distance band. We assumed the midpoint of the 500+ distance band to be 550 km.

Table 3.1: Road Tonnes Lifted 1998 (millions)

Commodities	0-25 km	26-50 km	51-100 km	101-150 km	151-200 km	201-300 km	301-400 km	401-500 km	>500 km	TOTAL
Food, Drink, Ag	64	65	91	56	39	44	22	7	6	394
Coal & Coke	8	7	5	2	1	2	0	0	0	25
Petroleum	10	15	19	9	4	4	1	0	0	62
Metals & Ores	18	11	11	9	8	9	4	1	1	72
Construction	244	109	79	24	11	12	6	1	1	487
Chemicals	12	8	10	8	6	10	5	2	1	62
Others	199	74	74	51	37	51	27	10	6	529

Source: DETR (1999).

Table 3.2: Rail Tonnes Lifted 1998 (millions)

Commodities	0-25 km	26-50 km	51-100 km	101-150 km	151-200 km	201-300 km	301-400 km	401-500 km	>500 km	TOTAL
Food, Drink, Ag	0	0	0	1	1	1	1	0	0	4
Coal & Coke	4	12	8	2	2	4	2	4	0	37
Petroleum	0	0	0	2	2	2	1	0	0	6
Metals & Ores	0	8	5	1	1	3	2	0	0	20
Construction	0	3	3	3	4	5	0	0	1	20
Chemicals	0	0	0	0	0	0	0	0	0	1
Others	0	0	1	2	1	4	5	2	2	16

Source: Sinclair Knight Merz, AEA Technology Rail and ITS Leeds (2001).

3.2 Cost Data

The following table summarises the road cost information used to construct the cost functions.

Table 3.3: Standing and Running costs used to estimate Road Cost Function.

Vehicle Type		17 T Rigid	32 T Rigid	44 T Artic	44 T Tipper
Source		**TE 2002**	**TE 2002**	**TE 2002**	**MT 2002**
Annual mileage	miles	60000	100000	100000	100000
Annual kms	kms	96558	160930	160930	160930
Annual standing costs	£	35469	42619	53733	54050
Running costs per mile	£	0.31	0.62	0.43	0.47
Running costs per km	£	0.19	0.38	0.27	0.29
Total cost per km	£	0.56	0.65	0.60	0.63
Total cost per half day	£	71	85	107	108
Total cost per day (540 kms)	£	302	350	326	339

Source: Transport Engineer (TE), (2002), Motor Transport (MT), (2002).

The following table summarises the rail standing cost information used to estimate rail fixed operating costs.

Table 3.4: Standing costs for Bulk and Non-Bulk Trainsets.

	Bulk	**£**	**Non Bulk**	**£**
	Class 66 Loco		**Class 66 Loco**	
Depreciation	Over 25 Years (20% Residual)	51200	Over 25 Years (20% Residual)	51200
Interest	7% Per Annum	112000	7% Per Annum	112000
Crew	3 @ £35000	105000	3 @ £35000	105000
Fixed Maintenance		50000		50000
Insurance	Assume 2% of Capital Cost	32000	Assume 2% of Capital Cost	32000
Overheads		52530		52530
Total cost		402730		402730
Cost per day	Assuming 250 days per year	**1611**	Assuming 250 days per year	**1611**
	Wagon	**£**	**Wagon**	**£**
Capital Cost	**Bulk Wagon**	70000	**Megafret Wagon**	70000
Depreciation	Over 20 Years (10% Residual)	3150	Over 20 Years (10% Residual)	3150
Interest	7% Per Annum	4900	7% Per Annum	4900
Maintenance	2 Bogies*0.5p*160000km	1600	4 Bogies*0.5p*160000km	3200
Total cost	Per Annum	9650	Per Annum	11250
Cost per day	Assuming 250 days per year	**39**	Assuming 300 days per year	**38**
	Terminal		**Terminal**	
	1400 Tonnes @ 0.75 Per tonne	**1050**	33*2 FEUs at 23.55 Per lift	**1554**
Fixed cost per trainset per day	Assuming 20 Wagons	**3433**	Assuming 20 Wagons	**3915**

Source: Newton and Wright (2003)

Table 3.5: Running costs for rail

Fuel	£0.85 per km
Variable maintenance	£0.15 per km

Source: Newton and Wright (2003)

Table 3.6: Rail track access costs (2002/03)

Commodity	Wagon type	TOPS code	£/1000 gtkm			Tare weight of wagon (Tonnes)
			Loco access charge	Empty wagon access charge	Full wagon access charge	
Food, Drink & Agriculture	Van	VGA	2.38	1.25	1.79	17
Coal & Coke	Coal wagon	HHA	2.38	1.16	2.30	27
Petroleum	Tanker	TEA	2.10	1.01	1.41	27
Metals & Ores	Bolster	BAA	2.10	0.89	1.56	25
Construction	Hopper	PHA	2.10	1.06	2.34	21
Chemicals	Tanker	TUA	2.10	1.13	1.73	13
Other	Intermodal	IFA/2	2.44	0.77	1.13	18

Source: ORR (2003).

Table 3.7: Additional wagonload rail costs

Marshalling cost	£45 per marshalling
Lifting	£20 per container transfer
Collection /Delivery (short distance artic)	£110 from road short distance formula at each affected end

Source: ITS estimates.

3.3 Journey time and delay time data

Rail and road speed information is required in order to calculate journey times for each distance/ commodity/ mode group.

Table 3.8: Typical Road Speeds (km/h) by distance (km)

Distance	0-500	>500
Speed	72.4	80.5

Source: ITS estimates.

Table 3.9: Typical Rail Speeds (km/h) by distance (km)

	0-300 km	301-400 km	401-500 km	>500 km
Food, Drink & Agriculture	48.3	56.3	64.4	72.4
Coal & Coke	48.3	56.3	64.4	64.4
Petroleum	48.3	56.3	64.4	72.4
Metals & Ores	48.3	56.3	64.4	72.4
Construction	48.3	56.3	64.4	72.4
Chemicals	48.3	56.3	64.4	72.4
Others	48.3	56.3	64.4	72.4

Source: SKM, AEA Technology Rail and ITS Leeds (2001).

The following values arise from LASP work undertaken by Tony Whiteing and Geoff Tweddle in 2003-2004.

Table 3.10: Average delay times (hours) by distance (km)

	0-150 km	151-300km	301-500km	>500 km
Road	0.5	1.0	1.5	2.0
Trainload rail	1.0	1.0	1.0	1.0
Wagonload rail	1.0	1.0	1.0	2.0

Source: ITS estimates.

To convert the journey times and delay times into costs we need appropriate values of time.

Table 3.11: Values of journey and delay time (pence/min/tonne) by commodity and rail penalty (% of road cost)

Commodity	Value of scheduled journey time	Value of delay time	Rail penalty %
Food, Drink & Ag	1.0	1.0	30
Coal & Coke	0.2	0.2	-50
Petroleum	0.7	0.7	-50
Metals & Ores	0.1	0.1	-1
Construction	0.1	0.5	-5
Chemicals	0.7	0.7	-50
Others	2.0	2.0	0

Source: ITS estimates.

Applying the values of time to average journey times yielded the following costs.

Table 3.12: Road journey time cost by distance/commodity (£/tonne)

Commodity	0-25 km	26-50 km	51-100 km	101-150 km	151-200 km	201-300 km	301-400 km	401-500 km	>500 km
Food, Drink & Ag	0.10	0.31	0.62	1.04	1.45	2.07	2.90	3.73	4.10
Coal & Coke	0.02	0.06	0.12	0.21	0.29	0.41	0.58	0.75	0.82
Petroleum	0.07	0.22	0.44	0.73	1.02	1.45	2.03	2.61	2.87
Metals & Ores	0.01	0.02	0.03	0.05	0.07	0.10	0.15	0.19	0.20
Construction	0.01	0.03	0.06	0.10	0.15	0.21	0.29	0.37	0.41
Chemicals	0.07	0.22	0.44	0.73	1.02	1.45	2.03	2.61	2.87
Others	0.21	0.62	1.24	2.07	2.90	4.14	5.80	7.46	8.20

Table 3.13: Rail journey time cost by distance/commodity (£/tonne)

Commodity	0-25 km	26-50 km	51-100 km	101-150 km	151-200 km	201-300 km	301-400 km	401-500 km	>500 km
Food, Drink & Ag	0.2	0.5	0.9	1.6	2.2	3.1	3.7	4.2	4.6
Coal & Coke	0.0	0.1	0.2	0.3	0.4	0.6	0.7	0.8	1.0
Petroleum	0.1	0.3	0.7	1.1	1.5	2.2	2.6	2.9	3.2
Metals & Ores	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2
Construction	0.0	0.0	0.1	0.2	0.2	0.3	0.4	0.4	0.5
Chemicals	0.1	0.3	0.7	1.1	1.5	2.2	2.6	2.9	3.2
Others	0.3	0.9	1.9	3.1	4.3	6.2	7.5	8.4	9.1

Applying the value of delay time to the delay times yielded the following costs:

Table 3.14: Road delay costs by distance/commodity (£/tonne)

Commodity	0-150 km	151-300 km	301-500 km	500+ km
Food, Drink & Agriculture	0.3	0.6	0.9	1.2
Coal & Coke	0.1	0.1	0.2	0.2
Petroleum	0.2	0.4	0.6	0.8
Metals & Ores	0.0	0.1	0.1	0.1
Construction	0.2	0.3	0.5	0.6
Chemicals	0.2	0.4	0.6	0.8
Others	0.6	1.2	1.8	2.4

Table 3.15: Rail delay costs by distance/commodity (£/tonne)

	Trainload		Wagonload	
Commodity	0-500 km	500+ km	0-500 km	500+ km
Food, Drink & Agriculture	0.6	0.6	0.60	1.20
Coal & Coke	0.12	0.12	0.12	0.24
Petroleum	0.42	0.42	0.42	0.84
Metals & Ores	0.06	0.06	0.06	0.12
Construction	0.3	0.3	0.30	0.60
Chemicals	0.42	0.42	0.42	0.84
Others	1.2	1.2	1.20	2.40

4. SCENARIOS

Following consideration within the ITeLS project, we decided to test five scenarios relative to a base 'no change' scenario. Our base data is representative of the position around the year 2000. We have also made use of a projection to the year 2010. In both cases we have considered the effect of the scenario relative to the base forecast of that year. It should be stressed that the base figures are in no way a prediction, merely something to compare the scenarios against.

Scenario 0 No change

Scenario 0 assumes merely that past trends will continue as far as the total market size is concerned, but with the real costs of transport held constant as far as the mode split calculation is concerned. It is implicitly assumed that journey times and delay times remain constant for each mode. Consideration was given to testing a scenario with increased road congestion, but congestion is highly location specific and much freight can avoid congestion by travelling at night. We felt that any results could be highly misleading and could work to undermine faith in the other scenarios, and so no attempt has yet been made at testing a congestion scenario with LEFT2.

This scenario serves two purposes. Firstly, in the 2000 base it checks that the calibration data is recovered at the level of aggregation presented in the tables. That means that any changes in the 2000 base as the result of other scenarios can be safely interpreted as due to the scenario being tested, and not due to any divergence between the model and the data in the 2000 base. Secondly, it shows how our base assumptions for 2010 differ from our 2000 base, in the absence of any scenario changes.

Scenario 1 Working Time Directive (WTD)

The UK Regulations on working hours will be in force by 23 March 2005 and will cover mobile workers who are participating in road transport activities that are covered by EU drivers' hours rules. The main provisions under the regulations are:

- Working time is limited to an average 48 hour week over a 4 month reference period.
- Up to 60 hours working time can be performed during a single week, providing the average working time does not exceed 48 hours during the reference period.
- Working time at night is limited to 10 hours in any 24 hour period.
- Workers cannot work more than 6 consecutive hours without taking a break. If working between 6-9 hours, a break of at least 30 minutes is required. If working over 9 hours, breaks totalling 45 minutes are required.
- Derogations are available that would permit an extension to the 4 month reference period, and allow night workers to work longer than 10 hours.

Unlike preceding legislation on working time, individuals cannot choose to "opt-out" of the average 48 hour week. However, any time classified as a break, rest, or a "period of availability" does not count towards any of the working time limits. These periods are not defined as working time under the RTD.

Scenario 1 assumes that the effect of the implementation of the Working Time Directive in the UK is such that the effect is equivalent to an increase of £36 per day in the standing costs of running an HGV. This was based on an average reduction of working hours from 12 to 9.6 per day.

Scenario 2 Road User Charging (revenue neutral)

This scenario supposes that the government has introduced a distance-based system of road user charging for HGVs, but has set rates such that the total tax take has remained unchanged. While this is similar to current stated government policy, it should be noted that it is suggested officially that the government would reduce fuel tax whereas we have assumed that the vehicle excise duty (VED) would be reduced. The net effect of our assumptions is that the variable cost of running an HGV increases by £0.01264 per kilometre whilst the standing cost falls by £4.80 per vehicle per day.

Scenario 3 Road User Charging (revenue raising)

This scenario supposes that the government uses its road user charging system to raise revenue, either for the revenue *per se* (which may or may not be hypothecated for transport uses) or in order to reflect the marginal social costs of freight haulage in line with EU directives. We have assumed that VED is still reduced by £4.80 per vehicle per day but that variable costs have been increased by £0.15 per kilometre, this being a rough doubling of the variable cost presently due to fuel duty. Readers can interpolate or extrapolate to get an approximation for other levels.

Scenario 4 The SRA Company Neutral Revenue Support Scheme

SRA (2004) describes a scheme introduced in 2004 which replaces previous Track Access Grant support to Freightliners Limited. This new scheme, called the Company Neutral Revenue Support Scheme is open, on a non-discriminatory basis, to any individual operator moving containers by rail. Rates are published in that document although no guarantee is given that sufficient budget will be available to accommodate all bids. Our scenario has assumed that these rates apply to all non-trainload suitable traffic in the food, drink and agriculture commodity group and the miscellaneous commodity group, but not to bulks. No budget limit has been applied.

Scenario 5 Increased efficiency of road goods vehicle operations

The definition of this scenario is that development of good practice, such as is exemplified in other Work Modules of ITeLS, plus governmental efforts to spread best practice in road fleet utilisation, has resulted in a 4% fall in the both the fixed and variable cost of road movements.

The initial motivation for this scenario came from looking at efficiencies in freight operations of Tesco. Associated with the fall in road costs in this sector, another part of the scenario was to assume that this would have been derived from an increase in the utilisation of vehicles. To the extent that this results from a reduced need for vehicles, this would be a reason to expect the fall in fixed costs assumed above. To the extent that it results from the better loading of vehicles, this will be a reason to expect the variable cost to fall as was assumed above. The major manifestation of better loading of vehicles, however, would be a reduction in vehicle kilometres on the roads, and LEFT2 is not able to produce those figures. Results from an ITeLS case study of Tesco movements from factory to Distribution Centre showed the possibility of worthwhile gains in this area (Potter et al, 2004). The scale of such gains will depend on the extent to which they can be emulated by other supermarket chains and the extent to which similar situations arise elsewhere. The figure of 4% has merely been chosen as illustrative, bearing in mind other results within ITeLS.

The government has recently announced that in future bids for funding to deliver such efficiency gains will be considered alongside revenue support grants for rail freight of the type considered in Scenario 4.

Possible effects of these scenarios are set out in Table 4.1.

Table 4.1: Possible Effects of Scenarios on the Logistics Chain

Scenarios	Impacts on Logistics Chain
1) Working Time Directive	- increases road haulage costs, by an amount per vehicle (i.e. raises standing costs), thereby favouring long distance traffic over short distance but reducing road traffic with some switch to rail - probable switch from LGVs to HGVs to minimise driver requirement - increases road collection and delivery cost elements for non-trainload rail traffic.
2) Road User Charging (revenue neutral)	- increases the variable cost element whilst reducing the fixed cost element to an overall equivalent extent - will favour short distance traffic relative to long distance traffic - will reduce road collection and delivery cost elements for non-trainload rail traffic - should switch some longer distance traffic to rail.
3) Road User Charging (revenue raising)	- greatly increases the variable cost element whilst reducing the fixed cost element to a relatively trivial extent - will favour short distance traffic relative to longer distance traffic - should switch significant amounts of long distance traffic to rail. - should reduce the average road length of haul - reduction in the physical length of the logistics chain - potential switch to LGVs from HGVs, with consequent increase in number of deliveries
4) SRA Company Neutral Revenue Support Scheme	- modal shift from road to rail
5) Increased efficiency of road goods vehicle operations	- reduced road vehicle-kilometres - possible switch from rail to road.

5. RESULTS

5.1 Scenario 0: No change

It can be calculated from Table 5.1 that there are forecast growths of 7.5% in total tonnes lifted, 20.3% in total tonne kilometres moved, and 11.9% in the overall average length of haul between 2000 and 2010. Within the totals, rail's share of (road + rail) tonne-km rises from 0.108 to 0.121 between 2000 and 2010. Within rail, the percentage of tonne-km moved in trainloads falls from 57.9% to 55.1%, as overall rail traffic growth is biased towards commodities less suitable for movement in trainloads. The trainload percentage of tonnes lifted is higher, falling from 68.5% to 66.7% since trainload traffic is moving shorter distances than average. Note that 'trainload' has been defined as a trainload of goods destined for only one customer

Without having considered congestion, and with Scenario 0 not including cost increases to road, or subsidies to rail, the growth in rail tonne-km is predicted to be only 34.3%, rather than the 80% that was, until recently, the government target. Some of the following scenarios suggest ways in which rail traffic might be increased further.

5.2 Scenario 1: Working Time Directive

This scenario does not have a dramatic effect. Road generalised costs are raised by some 10 to 15 per cent, but collection and delivery costs for wagonload rail rise and so wagonload rail generalised costs rise by some 5 to 10 per cent, keeping the modal switch to rail down to a 0.25% increase in rail's share (of tonne-km).

Total market size, in tonne-km, falls by about 0.25%. The largest effects are for Coal & Coke and (particularly) Ores & Metals, where trainload rail captures around 3% of base road traffic. The percentage of rail traffic moving by trainload rises slightly. The 2010 results have the same message. Rail traffic moved in 2010 is some 38% higher than in the 2000 base, some 4% of that being due to the scenario.

5.3 Scenario 2: Road User Charging – revenue neutral

Again, this scenario does not have a dramatic effect. Long distance road generalised costs rise by about 1%, with a similar reduction in short distance road costs. This latter also gives a 1% reduction in wagonload rail generalised costs.

The total market size in tonne-km is unaffected, Rail tonne-km rise by just over 1%, balanced by a fall in road tonne-km of 0.13%. Ores & Metals and Miscellaneous traffic are most affected, the former by a large percentage change to a small quantity and the latter by a smallish change to a large quantity. The percentage of rail freight moved by trainload falls by half a percentage point. The 2010 results show the same picture. Rail traffic moved in 2010 is some 36% higher than in the 2000 base, some 2% of that being due to the scenario.

5.4 Scenario 3: Road User Charging – revenue raising

This highly contentious scenario was included to benchmark the effect of increasing the variable costs of road goods haulage. The same reduction in VED as in Scenario 2 was assumed, but with a much larger increase in variable costs (of road). We have attempted to double the variable taxation. Very short distance road movements (say 10km) have only a 1 or 2 per cent increase in generalised costs, but those for long distance (say 500km) rise by some 30%. With rail costs constant there is substantial mode shift to rail.

Total market size, in tonne-km, falls by 0.4%, with rail raising its tonne-km by some 18%. The biggest reduction for road is 10% for Ores & Metals. The biggest increase for rail is 50% for Food, Drink & Agriculture, from a very small base. The percentage of tonne-km moving by trainload falls from 58 to 51. The 2010 results show rail's share of tonne-km rising to

0.146; rail tonne-km being some 61% above the 2000 base figure, 27% being due to the scenario.

Within rail, tonnages of Food, Drink & Agriculture, and Chemicals, were both increased by over 40% due to the scenario, with the former practically doubled compared to the base, and the latter up over 60%. As these commodities presently only have small tonnages on rail, there is no worry that rail might not be able to cope. More difficult would be the 75% predicted increases in the rail tonnes of Miscellaneous items. The percentage of rail tonne-km moving in trainloads falls from 58% in the base to 48% in 2010 as new wagonload traffics are attracted to rail.

5.5 Scenario 4: SRA Company Neutral Revenue Support Scheme

This scenario assumes that all non-bulk traffic is effectively offered the revenue support, at currently published rates in real terms, if that is sufficient to switch the traffic to (possibly intermodal) rail movement. The only generalised costs affected are rail wagonload costs for Food, Drink & Agriculture, and Miscellaneous. There is virtually no change to the total tonne-kms moved, and hence to average length of haul. Road loses some 0.7% of its tonne-km to rail, which consequently increases its share by almost 6%. The 2010 results show a 42% increase of rail tonne-km over the 2000 base, with 8% due to the scenaraio. If implemented together with Scenarios 1 and 3, the increase in rail tonne-km in 2010 would be some 75% above the base, and so very close to meeting the recent governmental objective.

5.6 Scenario 5: Increased efficiency of road goods vehicle operations

Regarding tonnes lifted, the total is as usual fixed, but road gains 130 thousand tonnes from rail in 2010 compared to 2000. The total market size in terms of tonne-km rises by 0.08%, with road gaining 0.18% and rail losing 3% of its traffic in this commodity group (ie a fall of 60 million tonne kilometres). This highlights just how sensitive the small rail tonnages in this sector are to even quite small improvements in road costs.

Table 5.1 shows some further detail for scenarios 0 to 5 for all sectors taken together. Section 5.7 presents results by commodity sector.

Table 5.1 Detailed Scenario Results

MILL. TONNES		2000 Road: Road	2000 Road: Diff. from as now (%)	2000 Road: Propn of total traffic	2000 Rail: Rail	2000 Rail: Diff. from as now (%)	2000 Rail: Propn of total traffic	2000 Rail: % Rail by train load	2010 Road: Road	2010 Road: Diff. from as now (%)	2010 Road: Propn of total traffic	2010 Rail: Rail	2010 Rail: Diff. from as now (%)	2010 Rail: Propn of total traffic	2010 Rail: % Rail by train load
AS NOW	**0**	**1630.99**		**0.940**	**104.32**		**0.060**	**68.51**	**1749.78**		**0.938**	**116.00**		**0.062**	**66.68**
WTD	1	1628.68	-0.14	0.939	106.62	2.20	0.061	69.07	1747.12	-0.15	0.936	118.66	2.29	0.064	67.15
RUC NEU	2	1630.37	-0.04	0.940	104.94	0.59	0.060	68.01	1748.94	-0.05	0.937	116.84	0.72	0.063	66.13
RUC HIGH	3	1619.06	-0.73	0.933	116.24	11.43	0.067	63.47	1734.46	-0.88	0.930	131.32	13.21	0.070	60.94
CNRS	4	1626.84	-0.25	0.937	108.46	3.97	0.063	65.89	1744.75	-0.29	0.935	121.03	4.34	0.065	63.91
VEFF	5	1632.04	0.06	**0.940**	103.26	-1.01	**0.060**	68.45	1750.98	0.07	**0.938**	114.80	-1.03	**0.062**	66.68

BILL. TONNE-KM		2000 Road: Total	2000 Road: Diff. from as now (%)	2000 Road: Propn of total traffic	2000 Rail: Total	2000 Rail: Diff. from as now (%)	2000 Rail: Propn of total traffic	2000 Rail: % Rail by train load	2000 Road & Rail: Total	2000 Road & Rail: Diff. from as now (%)	2010 Road: Total	2010 Road: Diff. from as now (%)	2010 Road: Propn of total traffic	2010 Rail: Total	2010 Rail: Diff. from as now (%)	2010 Rail: Propn of total traffic	2010 Rail: % Rail by train load	2010 Road & Rail: Total	2010 Road & Rail: Diff. from as now (%)
AS NOW	**0**	**151.32**		**0.892**	**18.37**		**0.108**	**57.89**	**169.69**		**179.42**		**0.879**	**24.67**		**0.121**	**55.05**	**204.09**	
WTD	1	150.43	-0.59	0.889	18.83	2.50	0.111	57.96	169.26	-0.25	178.26	-0.65	0.876	25.32	2.63	0.124	55.12	203.58	-0.25
RUC NEU	2	151.12	-0.13	0.891	18.57	1.09	0.109	57.28	169.69	0.00	179.11	-0.17	0.878	24.98	1.26	0.122	54.43	204.09	0.00
RUC HIGH	3	147.32	-2.64	0.872	21.71	18.18	0.128	51.00	169.03	-0.39	173.63	-3.23	0.854	29.64	20.15	0.146	47.93	203.27	-0.40
CNRS	4	150.28	-0.69	0.886	19.42	5.72	0.114	54.75	169.70	0.01	178.02	-0.78	0.872	26.08	5.72	0.128	52.09	204.10	0.00
VEFF	5	151.66	0.22	**0.892**	18.16	-1.14	**0.108**	58.06	169.82	0.08	179.86	0.25	**0.879**	24.38	-1.18	**0.121**	55.26	204.09	

Length of Haul. (km)		2000 Road: Road	2000 Road: Diff. from as now (%)	2000 Rail: Rail	2000 Rail: Diff. from as now (%)	2010 Road: Road	2010 Road: Diff. from as now (%)	2010 Rail: Rail	2010 Rail: Diff. from as now (%)
AS NOW	**0**	**92.78**		**176.09**		**102.54**		**212.67**	
WTD	1	92.36	-0.45	176.61	0.29	102.03	-0.50	213.38	0.33
RUC NEU	2	92.69	-0.09	176.96	0.49	102.41	-0.12	213.80	0.53
RUC HIGH	3	90.99	-1.93	186.77	6.06	100.11	-2.37	225.71	6.13
CNRS	4	92.38	-0.43	179.05	1.68	102.03	-0.49	215.48	1.32
VEFF	5	92.93	0.16	175.89	-0.12	102.72	0.18	212.39	-0.13

5.7 Results by Sector

5.7.1 Food, Drink and Agriculture

Table 5.2: Food Drink and Agriculture Results

Food, Drink & Agriculture	Road			Rail			TOTAL		
	Average length of haul (km)	Tonne km		Average length of haul (km)	Tonne km		Average length of haul (km)	Tonne km	
		(Billions)	% Change on base		(Billions)	% Change on base		(Billions)	% Change on base
Base 2000	124.5	49.04		279.3	1.20		126.1	50.24	
Base 2010	163.0	58.24		337.1	1.95		165.8	60.19	
WTD	162.1	57.84	-0.69	346.5	2.19	12.57	165.3	60.04	-0.26
RUC-NEU	162.9	58.18	-0.10	337.6	2.00	2.69	165.8	60.18	-0.01
RUC-HI	160.5	56.91	-2.29	350.4	2.99	53.45	165.0	59.90	-0.49
CNRS	162.7	57.95	-0.50	322.6	2.24	15.10	165.8	60.19	0.00
VEFF	163.2	58.35	0.18	334.6	1.89	-2.92	165.9	60.24	0.08

This sector shows the largest growth in tonne kms of all sectors, of over 30% between 2000 and 2010. Average length of haul is predicted to increase by 31.5%.

The Working Time Directive switches traffic from road to rail to give rail a 12% increase in its traffic in 2010. The higher overall cost of transport leads to a reduction in the overall tonne kilometres of 0.26%.

The revenue neutral Road User Charge increases rail share by 3%, but has very little effect overall. The higher, revenue raising Road User Charge reduces the average length of haul of road, and leads to an increase in rail's market share of 53% by 2010, albeit from a low base. This could be due to supermarkets taking up the relatively cheaper rail alternative.

Food drink and agriculture is eligible under our assumptions for the Company Neutral Revenue Support (CNRS) scheme. This leads to an increase in rail market share of 15%, by increasing the amount of medium distance traffic which can compete with road.

The increase in vehicle efficiency knocks 3% off rail's market share, and the overall freight market increases, as longer distances are now affordable by road.

5.7.2 Coal and Coke

Table 5.3: Coal and Coke Results

Coal & Coke	Road			Rail			TOTAL		
	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base
Base 2000	66.5	1.66		137.4	5.04		108.7	6.7	
Base 2010	56.9	1.57		153.8	5.93		113.3	7.5	
WTD	56.5	1.52	-3.41	152.0	5.98	0.84	113.3	7.5	-0.05
RUC-NEU	56.8	1.57	0.03	154.0	5.93	-0.01	113.3	7.5	0.00
RUC-HI	55.6	1.51	-4.27	153.1	5.99	1.05	113.3	7.5	-0.06
CNRS	-	-	-	-	-	-	-	-	-
VEFF	57.1	1.59	1.43	154.4	5.91	-0.36	113.4	7.5	0.02

In the 2010 base, LEFT forecasts an increase in the overall length of haul, due to the increase in rail distances. With the continuing decline of the UK's coal industry, inland coal and coke runs longer distances, and more traffic originates from ports, so until coal-fired power stations are built nearer port facilities, longer lengths of haul will be required.

The Working Time Directive switches traffic from road to rail to give a 1% increase in tonne kilometres at the expense of 3% of road.

The revenue neutral Road User Charge has very little effect. The revenue raising Road User Charge increases coal and coke rail traffic by 1% and reduces road by 4%.

The CNRS scheme is not applicable in the case of coal and coke.

The increase in vehicle efficiency leads to an increase in road haulage distances, and 1.5% extra traffic for road, with 0.5% lost on rail.

5.7.3 Petroleum

Table 5.4: Petroleum Results

Petroleum	Road			Rail			TOTAL		
	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base
Base 2000	85.29	5.29		211.59	1.36		97.11	6.64	
Base 2010	104.65	5.32		242.32	2.01		123.92	7.33	
WTD	104.42	5.31	-0.23	242.03	2.00	-0.08	123.69	7.32	-0.19
RUC-NEU	104.64	5.32	-0.02	242.33	2.01	0.04	123.92	7.33	0.00
RUC-HI	104.24	5.30	-0.48	241.68	2.01	0.26	123.58	7.31	-0.28
CNRS	-	-	-	-	-	-	-	-	-
VEFF	104.73	5.33	0.08	242.46	2.01	0.00	124.00	7.33	0.06

The large increase in tonne kilometres forecast in the 2010 base is mainly due to an increase in rail haulage at the longer distances.

The Working Time Directive and the revenue neutral Road User Charge have virtually no effect. The revenue raising Road User Charge reduces road's tonne kilometres by 0.5%, the overall market by 0.25%, and increases rail by 0.25%.

The CNRS scheme is not applicable in the case of petroleum.

The change in vehicle efficiency also has a small effect, increasing the overall market by 0.06%.

5.7.4 Metals and Ores

Table 5.5: Metals and Ores Results

Metals &Ores	Road			Rail			TOTAL		
	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base
Base 2000	119.97	8.64		128.32	2.61		121.8	11.24	
Base 2010	127.20	8.40		150.56	2.53		131.94	10.93	
WTD	125.42	8.16	-2.86	154.45	2.75	8.56	131.66	10.91	-0.22
RUC-NEU	126.83	8.36	-0.51	151.79	2.57	1.66	131.94	10.93	0.00
RUC-HI	120.24	7.54	-10.27	166.47	3.36	32.61	131.49	10.89	-0.34
CNRS	-	-	-	-	-	-	-	-	-
VEFF	127.84	8.49	1.08	148.94	2.45	-3.29	132.03	10.94	0.07

There is only a small forecast change in tonne kilometres upto 2010 in this sector.

The Working Time Directive causes a small reduction (0.2%) of the overall market, increasing rail's market share by 8.6% at the expense of road, which falls by 2.9%. This large effect is due to the high proportion of ores and metals which are suitable for train and road transport, and hence this market is competitive.

The revenue neutral Road User Charge knocks 0.5% off road and 1.5% onto rail, but there is no overall effect on the market size.

The revenue raising Road User Charge knocks 0.3% off the total market share, reducing road's market share by over 10% and rail up by nearly 33%. Rail length of haul increases, suggesting rail is picking up more long distance traffic, as the Road User Charge makes longer road distances less competitive.

The CNRS scheme is not applicable in the case of ores and metals.

Vehicle efficiency improvements increase road market share by just over 1% and reduce rail by 3.3%, with little effect on overall tonne kilometres.

5.7.5 Construction

Table 5.6: Construction Results

Construction	**Road**			**Rail**			**TOTAL**		
	Average length of haul (km)	**Tonne km (Billions)**	**Tonne km % Change on base**	**Average length of haul (km)**	**Tonne km (Billions)**	**Tonne km % Change on base**	**Average length of haul (km)**	**Tonne km (Billions)**	**Tonne km % Change on base**
Base 2000	49.46	24.09		157.63	3.15		53.73	27.24	
Base 2010	55.38	29.22		193.96	4.69		61.46	33.91	
WTD	55.17	29.09	-0.44	193.28	4.73	0.91	61.3	33.82	-0.25
RUC-NEU	55.33	29.18	-0.11	194.47	4.73	0.76	61.46	33.91	0.01
RUC-HI	54.28	28.52	-2.38	200.95	5.29	12.65	61.27	33.81	-0.3
CNRS	-	-	-	-	-	-	-	-	-
VEFF	55.48	29.28	0.21	193.98	4.65	-0.82	61.5	33.93	0.07

By 2010, there is a large increase in tonne kilometres, mainly due to the growth in road traffic.

The Working Time Directive reduces overall tonne kilometres by 0.25%, with 0.25% off road and an increase in rail tonne kilometres of 1%

The revenue neutral Road User Charge has no effect on total tonne kms but increases rail tonne kms by 0.75%. The revenue raising Road User Charge reduces the overall market by 0.25%, with 2% off road and 13% onto rail, and increases rail length of hauls.

The CNRS scheme is not applicable in the case of construction.
The increase in vehicle efficiency has very little effect, with an increase in road tonne km of .2% and a reduction in rail tonne kms of -0.8%.

5.7.6 Chemicals

Table 5.7: Chemicals Results

Chemicals	Road			Rail			TOTAL		
	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base
Base 2000	144.35	8.95		268.29	0.24		146.13	9.19	
Base 2010	156.25	9.63		287.38	0.30		158.42	9.93	
WTD	155.68	9.58	-0.52	286.74	0.33	8.97	158.05	9.91	-0.23
RUC-NEU	156.20	9.62	-0.07	287.09	0.30	1.89	158.41	9.93	-0.01
RUC-HI	154.74	9.47	-1.67	280.47	0.41	38.58	157.7	9.88	-0.46
CNRS	-	-	-	-	-	-	-	-	-
VEFF	156.46	9.65	0.20	287.55	0.29	-3.61	158.55	9.94	0.08

There is a small increase in predicted tonne kms for chemicals to 2010. The increase is mainly for road traffic, with rail having a low market share, in part due to the prohibitive safety regulations of rail travel.

The Working Time Directive knocks off 0.25% the total market, with 0.5% off road and an additional 9% onto rail.

The revenue neutral Road User Charge has no effect on total tonnes lifted, but 0.5% of road tonne kms is replaced by an increase in rail tonne kms of 2%.

The revenue raising Road User Charge leads to a reduction of 0.5% of the total market, with 1.5% off road and an increase of almost 40% of rail tonnes kilometres.

The CNRS scheme is not applicable in the case of construction.

The increase in vehicle efficiency slightly increases road tonne kms (0.2%) at the expense of a reduction of over 3.5% of rail's already small amount of tonne kms.

5.7.7 Others

Table 5.8: Others Results

Others	Road			Rail			TOTAL		
	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base	Average length of haul (km)	Tonne km (Billions)	Tonne km % Change on base
Base 2000	101.44	53.66		303.84	4.77		107.28	58.43	
Base 2010	101.76	67.03		340.49	7.27		109.25	74.30	
WTD	101.35	66.76	-0.40	344.42	7.34	0.95	108.96	74.10	-0.27
RUC-NEU	101.57	66.86	-0.25	340.87	7.44	2.30	109.25	74.30	0.00
RUC-HI	98.66	64.40	-3.93	350.03	9.59	31.89	108.79	73.98	-0.43
CNRS	100.68	65.93	-1.64	332.43	8.38	15.27	109.27	74.31	0.01
VEFF	101.94	67.17	0.20	339.2	7.19	-1.10	109.34	74.36	0.08

This sector is forecast to have a large increase in growth of tonne kms of over 27%, due to the continuing increase in imports of miscellaneous manufacturing goods.

The effect of the Working Time Directive is to knock 0.25% off the total market size, with 0.5% off road, and an extra 1% of rails tonne kms.

The revenue neutral Road User Charge has no overall effect but switches 0.25% of road's traffic to rail, increasing rail's tonne kms by 2.3%.

The revenue raising Road User Charge leads to a reduction of 0.5% of the total market size, with 4% off road and a dramatic increase in rail tonne kms of 32%. There is a corresponding fall in rail's average length of haul as rail becomes more competitive at shorter distances.

The CNRS scheme increases rail tonne kms by over 15% at the expense of a reduction in road tonne kms of 1.5%.

The increase in vehicle efficiency does not have much effect on the overall market size, but shifts 1% of rail's traffic to increase road tonne kms by 0.25%.

6 CONCLUSIONS

This report has sought to document the work undertaken to develop the LEFT2 model, illustrated by its application to a set of test scenarios. It must be stressed that the model is merely a strategic sifting model giving ballpark estimates. No weight should be attached to the minutiae of the results. Equally valid assumptions would yield different results.

We are engaged in training the model to behave properly. By setting the model tasks to do we can get results that we can use to judge the adequacy of the model's behaviour.

Any comments from readers of this note will be welcomed.

It is currently planned to incorporate a range of improvements in a LEFT3 model which will also have expanded scope to forecast vehicle kilometres and thereby emissions levels. The success of that venture will depend to an unknown extent on identifying weaknesses with LEFT2 that can be remedied in a cost effective manner.

7. REFERENCES

Commercial Motor (1996), Tables of Operating Cost Tables. Reed Business Publishing.

Cooper J., Black, I. & Peters, M. (1998), Creating the Sustainable Supply Chain: Modelling the Key Relationships. Chapter 9 in Banister, D. (ed.), *Transport Policy and the Environment*. E&FN Spon, London.

Department for Transport (annual), *Transport Statistics Great Britain*.

Department of Environment, Transport and the Regions, (May 1999), Transport of Goods by Road in Great Britain, 1998. *Annual Report of the Continuing Survey of Road Goods Transport*.

Fowkes A. S., Nash C. A. and Tweddle G. (1991) Investigating the market for inter-modal freight technologies, *Transportation Research A*, vol 25A, pp161-172.

Fowkes, A. S., Firmin, P. E., Tweddle, G. and Whiteing, A. E., (2004) How Highly Does The Freight Transport Industry Value Journey Time Reliability And For What Reasons? *International Journal of Logistics: Research and Applications,* Vol. 7 No. 1, March 2004, pp 33-43.

FTA (2003) Freight Vehicle Operating Costs, Freight magazine, January.

La Rivista Dell'Autotrasporto (2003), March edition.

ME&P-WSP, Katalysis Ltd, Oxford Systematics, Parsons Brinckerhoff, Imperial College, University of Westminster, ITS-University of Leeds, Rand Europe, MDS-Transmodal (2002), Review of Freight Modelling. Final Report to DfT/SRA/HA/TfL.

Motor Transport (2002), February Edition.

Newton, S. and Wright, C. (2003), GBFM *Methodology*, The Great Britain Freight Model Documentation Project, MDS Transmodal.

Office of the Rail Regulator (2003), www.rail-reg.gov.uk/upload/xls/freightusage.xls

Potter, A., Lalwani, C., Disney, S. and Velho, H. (2003), Modelling the Impact of Factory Gate Pricing on Transport and Logistics. Proceedings of the 8th International Symposium on Logistics, pp625-630.

RHA (2003), Goods Vehicle Costs. Road Haulage Association, Weybridge.

Sinclair Knight Merz (SKM), AEA Technology Rail and ITS Leeds (2001). *Additional Freight Model*.

South and West Yorkshire Multi-Modal Study, SWYMMS, (2001), Working Paper 7.3d, Freight Interventions, Prepared for Government Office for Yorkshire and the Humber.

SRA (2004), *Company Neutral Revenue Support (CNRS)*, Strategic Rail Authority, London.

Survey on Freight Transport including a cost-comparison for Europe (1999), (SOFTICE), *Final report*, European Commission.

Transport Engineer (2004), January Edition.

Whiteing, A.E (2003), *Multimodal Freight Transport in Great Britain*. Institute of Logistics and Transport, Corby.