SHORT-RUN AND LONG-RUN IMPACTS OF A MAJOR TRANSPORT INFRASTRUCTURE: THE CHANNEL TUNNEL

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Abstract

Many claims are made about the way in which major new transport infrastructures affect both traffic patterns and the economies of surrounding regions. This paper presents an assessment of the impact of the Channel Tunnel on cross-Channel freight traffic over the first three years of operation and examines the way in which such changes lead to longer term changes in the organisation of logistics and the locations of users. The paper outlines the complexity of the market, the difficulties of forecasting traffic, the way the market has evolved, and some preliminary findings from an in-depth survey of users. This shows the importance of separating short term traffic generation and distribution effects from these longer term changes.

INTRODUCTION

The construction of an entirely new mode of transport, or the completion of a new link in a transport network poses difficult problems for traffic modelling and forecasting. This problem is compounded when the link in question is an international one, requiring the reconciliation of data from sources in different countries, and when the existing operators of routes which may see traffic divert to the new link are themselves in competition with one another. To justify major links proposers also make strong claims for the wider economic development effects which the completion of the link will have, either to secure public sector support, or to underwrite the supposed traffic generation claims

All of these factors arose in the case of the Channel Tunnel. The Tunnel is a 50 kilometre long system between Folkestone (England) and Calais (France) (see Figure 1). The system has two rail tunnels and a smaller service tunnel. The rail tunnels carry both through passenger and freight trains between the British and French rail systems and special shuttle trains which carry road passenger and freight vehicles between the two national highway systems. The tunnel is the only "fixed link" between the British Isles and continental Europe and is in competition with a wide range of ferry services and with airlines (see Holliday *et al*, 1991; Vickerman, 1995, for more detailed background).

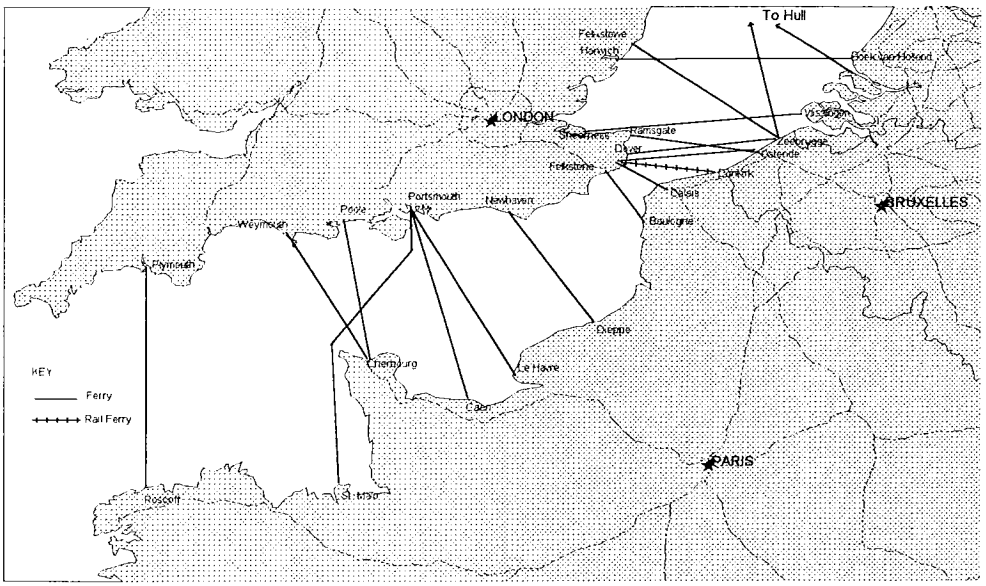

Figure 1 Cross -Channel Ferry Routes

In this paper we discuss the impact which the tunnel has had on the development of freight flows between the UK and continental Europe. We distinguish, in particular, the difference between the

short term effects of changing competition which has led to a considerable increase in traffic on the corridor and the more fundamental longer term impacts on the development of traffic by mode and the secondary effects on the pattern of logistics and the location of logistics operations. The paper is divided into four main sections. Section 2 discusses briefly a theoretical framework identifying these short and long run responses. Section 3 considers the forecasting problems this framework poses, what we might hope to observe and when. Section 4 discusses evidence on cross channel freight traffic trends, from available data. Section 5 presents some initial results from an in-depth interview study of users and potential users.

FREIGHT TRAFFIC RESPONSES TO NEW INFRASTRUCTURE

New infrastructure creates new transport opportunities by removing capacity constraint bottlenecks within transport corridors and by increasing the competitive pressure on existing transport operators. This has the effect of reducing the real price of transport and we expect to see price elasticity induced increases in transport demand. Some of this increase will be due to substitution, of mode and of route, some will be due to the generation of new traffic as a result of transport users being able to penetrate new markets. These are essentially short run responses. In the longer run firms can relocate both their logistics centres (warehouses, distribution points etc.) and their production centres because of the substitution of relatively cheaper transport for other inputs.

However, this can also be argued to be a too simplistic view of the way infrastructure operates in the freight transport market. Transport costs are a small and falling share of total costs for most manufacturing industry, other factors are much more important as determinants of total volumes of sales, market share, and location decisions. This counter view is that there is likely to be a relatively small impact of new infrastructure on longer term economic factors and in the short run the main effect of the lower prices is increased profits to users at the expense of operators through rent seeking behaviour.

We explore these arguments in more detail for both the short run (transport market) and longer run (economic impact) effects.

Short run transport market impacts

Short run impacts are traditionally assessed by use of demand forecasting models. There are several reasons why conventional freight models cannot fully answer some of the questions posed by the opening of the Channel Tunnel. In the following discussion, aggregate and disaggregate freight models are considered separately.

Aggregate Freight Models

The majority of freight models are aggregate in nature. They take the form of the conventional four-stage transport model with some adaptation. The aggregate approach ignores some factors which are particularly important in international freight movements dealing with trade. Significant amongst these are the type of product, the value to bulk ratio and the proportion which transport costs represent of total production costs, which affect acceptable distances and/or transit times, the number of production and distribution sites and the choice of mode.

Aggregate models tend also to be based on average transport costs, whereas the effect of improvements to international transport, and especially from new infrastructure, is typically to reduce the variance in such costs due to the uncertainty caused by congestion at frontiers or in other

disruptions to service. Again the key factor is that such changes may lead to longer run changes in the organisation of logistic operations which a short run model cannot predict.

Disaggregate Freight Models

Disaggregate, discrete choice models look not at total flows, but rather at individual consignments, with the shipper taking a number of transport related decisions from a discrete set of alternatives. This enables a number of the problems identified with aggregate models to be handled, including:

- characteristics of transport services, such as tariffs, times, reliability, minimum load, damage and loss, etc.
- attributes of the goods being transported, such as product type, volume and value/weight ratios, ownership, perishability, etc.
- market characteristics, such as relative prices, general infrastructure facilities, loading/unloading facilities, availability, firm size, etc.
- attributes of the shipping firm, such as policy on storage, plant location, prices, available infrastructure facilities, etc.

However, models tend not be used in a fully recursive way in which the transport attributes of the shipper model are fed back into the location and production decisions of the producer. The spatial structure of demand and supply for each product is assumed constant and this is a limitation on assessing the longer run effects of transport change. Whilst full revealed preference modelling has enormous data requirements, some success has been obtained with the use of stated preference techniques for examining a new refrigerated container service for international maritime cargo (Ortuzar, 1989) and cross Channel services (Tweddle *et al*, 1996).

The main problem identified is that freight flows represent only part of an overall logistics process, and therefore a model predicting a certain level of flows does not adequately reflect the whole picture. An observed increase in freight flows may be due to an overall reduction in the level of stocks held, or because business activity has increased. Simply viewing the flows would not show the cause of any change.

Longer-run Logistics Impacts

In this section we turn to look at the ways that an major improvement to transport infrastructure can affect companies' longer-term strategic planning, remembering that transport is only one element in this decision process. We need to distinguish product logistics and transport logistics as complementary and interacting parts of the overall logistics process, as illustrated by Ruijgrok and Bus (1997). Product logistics is defined as the control of goods from basic products/materials, through the inventory and intermediate production processes and on to the physical distribution of the final products to the customers. Transport logistics involves ensuring that the organisation of freight flows results in as efficient a use of transport as possible while considering quality factors such as speed, security and reliability. Burmeister and Colletis-Wahl (1998) make a similar distinction, although they refer to product logistics as transformation activities and transport logistics as transfer or circulation activities.

Evidence from a survey of the logistics decisions of firms in Scotland (McKinnon & Woodburn, 1996) suggests that firms do not respond at the margin to changes in transport costs, but that the cumulative effects of transport changes can build up a degree of inertia which then leads to a more substantial set of relocation or other changes to the production process.

The way goods are produced in response to customer demand has changed radically in recent years. The point in the logistical process when production for stock becomes production to order (which Ruijgrok and Bus, 1997, refer to as the customer decoupling point) can greatly affect the nature of transport flows, and this point has moved back along the logistics chain. Many companies strive to produce products/services in direct response to customer demand rather than as stock in response to sales forecasts, requiring "Just-In-Time" delivery of both components and finished products. The resulting reduction in stock levels together with the need for more frequent and above all reliable deliveries has radically changed companies' longer-term logistics strategies. This could be either independent of, or induced by, transport infrastructure changes.

Advancements in technology have also been a major factor in influencing companies strategies. Communication technology has allowed all the stages in the logistics process to become transparent, so raw materials, semi-finished and finished goods can be located in both space and time. Improvements in handling and transportation technology allow companies to centralise warehousing and distribution operations thereby reducing the number of depots required e.g. a survey of 10 major food manufacturers in 1990 showed a reduction in the aggregate number of stockholding depots of 44% over the previous 12 years (McKinnon & Woodburn 1993).

One disadvantage of a fully centralised (i.e. one warehouse) approach is the ever increasing problem of congestion on much of Europe's road network. There is increasing reluctance simply to continue expanding capacity in the face of increased demand. However, structural reshaping of distribution and transport networks and operations can mean more efficient use of limited infrastructure capacity. Indeed, the advancement of logistics, which increases efficiency in vehicle utilisation, may be more important than investment in road and railway infrastructure (Wandel and Ruijgrok 1993).

Many logistics decisions are market driven, especially in the retail industry where customers are demanding an ever wider and fresher range of products. On a global scale, many Japanese companies have moved final assembly of products for the European market to Europe in order to improve access to this market. The Single European Market has in itself been a major influence on many companies logistical strategies. The removal of trade and customs barriers has increased the ease and speed with which companies can access markets within Europe, and the opening of Central and Eastern European markets has further enhanced this trend. Companies can serve a wider area of Europe from a particular depot and therefore have the opportunity to reduce the number of depots needed.

There is therefore a set of complex influences, with important implications for the use of transport in the total logistics process, which needs to be understood properly if the impact of any changes in transport opportunities on total freight transport flows are to be properly forecast.

PROBLEMS IN DEMAND FORECASTING

We identified in the previous section some of the issues which make modelling the impact of transport change on the demand for freight transport a difficult procedure. We turn in this section to some of the more practical difficulties faced.

Data Problems

The problem of obtaining the required data for freight modelling is more problematic than for passenger modelling. Data required for disaggregate approaches faces confidentiality and reliability

problems, and even aggregate approaches require a much greater data collection effort (and, therefore, expense) than for passenger movements due to the dispersion of firms, daily and seasonal variation, etc. Counting and recording individual pieces of freight at a port or freight terminal is almost impossible. Many shippers will not know precisely the contents of an individual container or trailer since various goods will be consolidated into load units determined by weight rather than number of items. The opportunities for collecting in-depth data at the roadside are very limited, except perhaps where long delays are unavoidable e.g. when vehicles are waiting for a ferry.
Simple counts of traffic do not provide us with sufficient evidence to draw firm conclusions about the behavioural response of users, so in connection with the Channel Tunnel project specific origin and destination surveys were conducted by the UK Department of Transport in 1986 and 1991 (Department of Transport, 1989, 1993). The sampling frame used was the customs records of the major ports and operators, and a sample of consignments was drawn to enable identification of specific origins and destinations within the UK and the near continent. The data identified precise mode, not just on the ferry crossing, but also means of access to and from the ports, including accompanied or unaccompanied freight trailers, and details of product group and consignment value.

In order to update the situation and examine the true effects of both diversion and traffic creation, after the opening of the Channel Tunnel, it was desirable to undertake a further detailed study in 1996-97. It is, however, now more difficult to obtain an accurate sampling frame since, due to the provisions of the Single European Market, full customs data is no longer available. The new survey had to be based on a survey of shipping companies and agents who were to provide a 1 in 200 sample of shipments. These shipments were followed up by further questionnaires to individual traders in order to obtain detailed information on origins, destinations, nature and weight of goods. The initial response rate has been much lower than hoped for and a full comparison with earlier studies on the most disaggregated level needed for this analysis has not been possible.

Problems of Modelling Choice

Even with good data, modelling and forecasting cross-Channel traffic flows presents some inherently difficult problems. There is an extremely complex choice position facing potential users or shippers. Before the Tunnel traffic could use either truck or rail (via a minimal train ferry service). Truck traffic could choose between short or long distance ferry routes (see Figure 1) or, for some high value/low bulk traffic, use air. With the tunnel in operation, traffic can either remain with its existing mode or can switch to one of the two available tunnel modes. Moreover, given changes in infrastructure, especially roads, on both sides of the Channel linking to the tunnel, there is also an incentive for ferry traffic to switch between longer sea routes and the short sea routes. This trend will be limited by increasing congestion on some of the access routes to the ports.

As Blanquier (1997) has shown, this leads to various problems in the forecasting of traffic:

- the underlying growth of traffic is closely related to economic growth, but not just in one economy; allowance has to be made for differential growth in the economies of the major trading partners;
- the changing commodity composition of trade, reflecting both the differential economic growth factors and the changing costs of transport;
- the need to relate trade flows, measured in values, to traffic, measured in tonnes, allowing also for changing efficiency in the use of transport due to the completion of a single market in transport in the European Union;
- a potential for both mode and route shift, and the recognition that different origins and destinations change as the location of industries and markets change;

- the competitive response of other operators, since, unlike many other new fixed link infrastructures, the Channel Tunnel has not replaced the existing ferry links. Moreover, there is not just one ferry company in operation, indeed the number of operators on the Dover Straits has actually increased since the tunnel was announced, although the two major operators on the Dover-Calais service have been allowed to merge their operations from 1998;
- the creation of a completely new mode, through rail, which gives shippers a choice not just of switching their existing trailers from ferry to the Eurotunnel shuttle service, but also of using rail from one of several new regional rail termini in the UK (although most of these have to be accessed by road). An earlier study using adaptive stated preference methods, Tweddle *et al* (1996) suggested that the degree of complete mode switching would be limited, though this result did reflect a considerable degree of ignorance of levels of service and fears concerning the reliability of the new mode.

In this paper, however, we want to go beyond even this degree of complexity in order to be able to identify the way that potential users start taking into account new transport facilities and opportunities as they plan longer term investment strategies for the development of their business. We report on our approach to this in Section 5, but before tackling this issue we look briefly at what has actually happened during the first three years of Eurotunnel operation.

THE DEVELOPMENT OF CROSS-CHANNEL FREIGHT TRAFFIC

Underlying Trends in Traffic

We need to set the development of the cross-Channel freight market, the short run response to the opening of the tunnel, against the background of the developments in this market over a rather longer period. Figures 2 and 3 summarise the development of UK-continental Europe unitised freight traffic over the past decade. It is this traffic which is relevant to the market for the Tunnel, both for through rail and for the shuttle service. Two types of road traffic are identified, roll on-roll off (ro-ro) traffic of powered vehicles, and unaccompanied trailers. The latter are more common on longer distance ferry routes where the dead time for the tractor unit and driver is more significant. The data is shown for three groups of services Straits of Dover (those services through the ports of Dover, Ramsgate and Folkestone), the English Channel (those services through ports to the west of the Dover Straits, and the North Sea (through those ports to the north of the Dover Straits) (see Figure 1 for details).

It can be seen clearly that the major growth over this period has been in ro-ro traffic through the Dover Straits ports. Although there has been some growth in unaccompanied trailer traffic this has less pronounced over the last few years and has been mainly concentrated on the longer North Sea routes. Despite some growth in ro-ro traffic on the western Channel routes, this has been limited and there is evidence of a reduction from the opening of the Channel Tunnel in 1994. Whilst Figures 2 and 3 represent total flows through the ports, they hide any changes in the origins and destinations of goods each side of the Channel and changes in the type of goods carried.

Comparison of the detailed 1986 and 1991 survey data suggests major changes in patterns of freight flows which confirm some of the anticipated difficulty in predicting market changes from a major change in service provision such as that implied by the Channel Tunnel. The tonnage carried by trailer via the Channel, Dover Straits and North Sea Ports increased by 50% in the period 1986-1991, whilst container traffic shrank by 12% and conventional traffic by 18%. The Dover Straits ports increased their share of this trailer traffic from 47% in 1986 to 50% in 1991, but also increased their share of container traffic from 4% to 7% (a 58% increase in tonnage). Meanwhile

conventional traffic fell by a much larger percentage (50%), but this only constituted a 3% share of the market in 1986. Just concentrating on trailer traffic, the pattern of commodity composition of this traffic changed somewhat, with big increases in manufactured goods and falls in beverages etc. and crude materials. The Dover Straits ports had a larger market share of commodity groups such as beverages and tobacco (70%) and miscellaneous manufactures (63%) and a rather smaller share of crude materials and goods manufactured from materials. This implies a larger share of commodities which are more likely to be time sensitive. The pattern of growth by commodity through the Dover Straits ports was however similar to that for these ports as a whole.

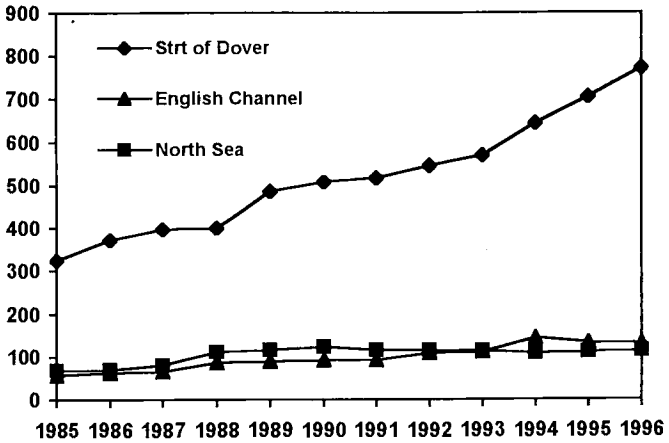

Figure 2 Ro-Ro Ferry Traffic UK-Continental Europe (000)

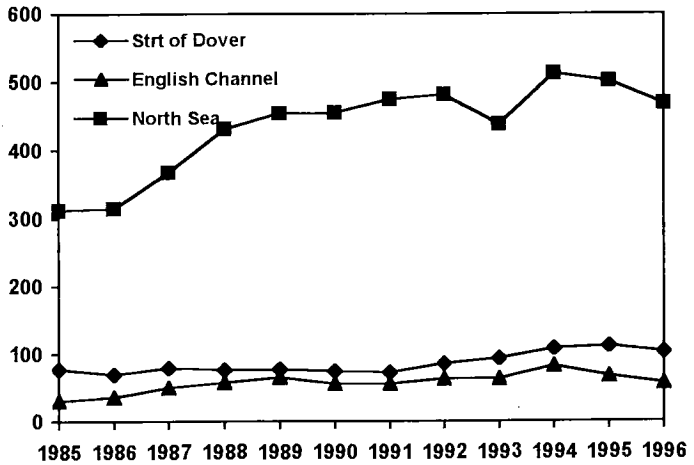

Figure 3 Unaccompanied Trailers, UK-Continental Europe (000)

Problems with the 1996-97 data when disaggregated by commodity and route have prevented a full assessment of the overall impact of the tunnel on the volume and pattern of cross channel traffic in a manner which can be compared with the earlier 1986 and 1991 studies.

The Impact of the Channel Tunnel

The tunnel opened for traffic in July 1994. Traffic built up rapidly (Figure 4) and although this was at the expense of the ferry industry to some extent, there is clear evidence of a substantial growth in traffic across the Dover Straits routes, and ultimately a continuing growth in ferry traffic. This confirms the view that the tunnel has led to a concentration of traffic on this overall route, partly because of better surface links to the ports, but also because of the intense price competition which has prevailed on these routes.

It is not possible to undertake an easy analysis of prices since there is heavy discounting of published tariffs and most major freight operators have contracts with all the main ferry operators and Eurotunnel. It is known that for passenger traffic there can be differences of 10 times or more in the published fares according to time of year, time of day and length of stay, but discounts through package holidays etc. can lead to even greater implied differences in the fare actually paid.

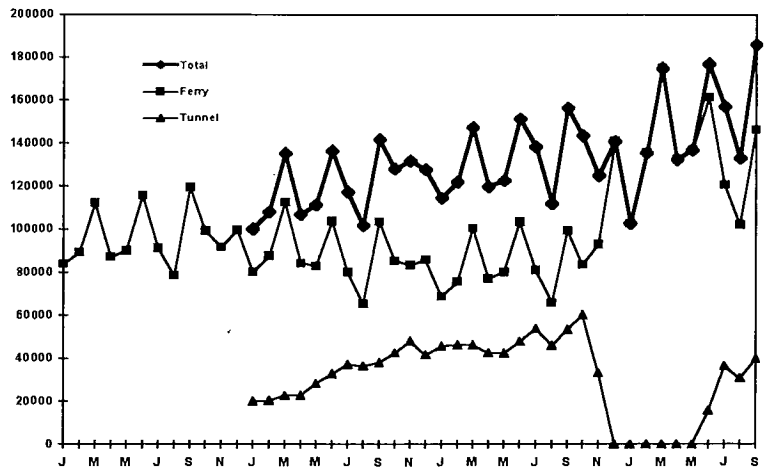

Figure 4 Dover Ferry and Tunnel Lorry Traffic 1994-97

As Figure 4 shows, traffic levels built up steadily during 1995 and 1996. The Tunnel achieved a 41 per cent share of the Dover Straits road freight vehicle traffic in 1996, whilst the Dover/Folkestone-Calais route in total increased its share of the target market from 48% in 1994 to 66% in 1996 (Table 1). This stopped abruptly on 18 November 1996, however, with a disastrous fire on board a freight shuttle train. This led to severe damage to the tunnel fabric which restricted operations for seven months, but more seriously led to a suspension of freight shuttle services until a new safety case was established for the carriage of freight vehicles.

Table 1 - Evolution of Eurotunnel Traffic and Market Shares

	1994	1995	1996	1997
HGV (000)				
Target Market	1,777	1,898	1,953	n.a.
Dover-Calais (% Market)	853 (48%)	1,094 (58%)	1,280 (66%)	1,498
Le Shuttle (% Dover-Calais)	65 (8%)	391 (36%)	519 (41%)	267 (18%)
Freight Market (mn tonnes)				
Target Market	48.4	52.4	54.7	n.a.
Ro-Ro accompanied (% market)	21.8(45.0%)	24.2(46.2%)	25.2(46.1%)	n.a.
Through rail freight (% total market)	1.1 (2.3%)	1.9 (3.6%)	2.4 (4.4%)	2.8

Source: Eurotunnel (1997/8)

The freight shuttle service only started again in mid-June 1997. There was a rapid build up of tunnel carryings again, and advance date for 1998 shows this back to the market share of mid 1996. Note (Figure 4) that during the closure of the tunnel the ferries not only carried diverted trucks, but continued to build the total market on the Dover Straits service. The closure has provided us with an opportunity for an additional dimension to the research since we have been able to examine the behavioural response of users who had gained experience of a service, which was then removed and subsequently restarted. This provides a better test of the value of the service than either the ex ante approaches or simple ex post approaches. We return to this in Section 5.

Through rail freight services were only temporarily disrupted by the fire of November 1996. However, despite initial forecasts that the market for through rail freight would more than treble from under 2 million tonnes a year to at least 6 million, carryings have remained stubbornly low. From 0.2 million tonnes in 1994 this increased to 1.3 million tonnes in 1995, the first full year of operation and 2.4 million tonnes in 1996. Further progress has been made during 1997 and 1998 but is still short of the 6 million tonnes level. This would seem to be a major unexploited market, though such poor responses were foreseen by Tweddle *et al* (1996) and there has been continuing criticism of both the levels of service provided by rail operators and Eurotunnel's charges.

The basic conclusions from the analysis of the available data are that the immediate impact of the tunnel has been:

- to lead to an overall growth in the cross-Channel freight market;
- to cause an increasing concentration of this traffic on a single corridor;
- to be vulnerable to reliability problems caused by the suspension of services;
- to reinforce the dominance of road freight, despite the Tunnel's particular advantage to through rail services.

This simple analysis of the data still leaves many questions which we now turn to answer by looking in depth at the way firms intend to plan and change their transport needs over the coming years.

STUDYING THE RESPONSES OF USERS AND POTENTIAL USERS

In order to explore in more detail the longer term logistics changes planned by a variety of transport firms and their users, and to what extent these changes can be attributed to the opening of the Channel Tunnel, we have been undertaken a series of in-depth interviews. Three groups of companies have been identified with different needs and responses: those offering full logistics services for third parties, those providing direct contract logistics services for specific customers and those carrying out logistics operations for their own needs. A total sample of 30 firms has been achieved, all members of the Freight Transport Association, the leading British association for those involved in the transport of goods by all modes.

The Survey

The survey took the form of an in-depth interview lasting about 45 minutes on average with a member of senior management of the company. Given the considerable variations in size of companies in each of the three sectors it was difficult to ensure that individuals with the same overall planning responsibilities were to be interviewed in each case, but initial approaches tried to ensure that the respondent was someone with a key role in longer term planning of activities for the company.

The questionnaire was divided into 3 sections:

1. *Background Information.* A description of the main products handled, perishable/non-perishable, time critical/non-time critical, finished/semi-finished or raw materials, since these can influence some aspects of the logistics systems used. Whether the products were exported to, or imported from, the near continent, defined as Belgium, France, The Netherlands and Germany. Whether the companies have a high proportion of products handled moving between these countries and the UK since i) these firms may have an extra incentive for using the Channel Tunnel, and ii) they may have located manufacturing/distribution sites close to the Dover-Calais cross channel corridor regardless of the opening of the Channel Tunnel. Other information asked for concerned the use of EDI in the production/logistics process, and whether a JIT service is provided for any products/customers.

2. *Past and Present*: Changes that have occurred since 1994, including markets served (contracted or expanded), standard of service offered to markets, changes in the supplier base, and standard of service offered by suppliers. Changes in the logistics organisation were also detailed in terms of changes in: manufacturing centres, distribution centres, modal choice, vehicle utilisation, facility utilisation, route choice, information systems and use of a third party transport/logistics provider. Respondents were also asked if there were any plans to make changes in these areas in the near future and to give reasons for any changes that may have occurred since 1994 and their implications, particularly in connection with the influence of the Channel Tunnel.

3. *Future*: Respondents were asked to consider the future number and/or location of their company's manufacturing and distribution centres. If changes were planned, the respondent was asked the reasons and whether the Channel Tunnel was a significant influence. Finally, respondents were asked what factors would make the existence of the Channel Tunnel a more significant influence on logistics decisions, and what responses would be to road transport costs rising sharply due to the internalisation of external costs of transport through higher taxes or tolls.

Results

The results, based on a wider set of potential users including major high street retailers, third party logistics providers, and third party intermodal service providers, suggest that the longer term changes in the way firms operate may indeed be more profound than that identified in the earlier Tweddle *et al* (1996) survey.

There is no significant difference in freight logistics between the three groups of respondent. The differences that have been identified are much more related to differences in products and are not necessarily due to the nature of the core business involved. It is the characteristic requirements of the products in terms of delivery times etc. which is more important than whether the company is a third party service provider, a manufacturer of the product or a retailer of the product.

Overall Logistics Changes

Most respondents indicated that the main themes of their longer-term logistics strategies would have been the same had the Channel Tunnel not been built, since other, non transport, factors combined were a greater influence. However, the Tunnel has allowed some logistical changes to be

realised more effectively e.g. a desire to use rail could be easier and more cost effective. Important factors influencing changes in companies' logistics activities included:

- increases in market share - a major influence on logistics strategy is the growth strategy. Logistical operations can have a significant influence on market share through i) increased efficiency/reduced cost allowing products to be sold at a more competitive price, and ii) improved service levels.

- demands from customers for higher service levels - many firms have been forced to improve their logistical operations due to pressure from customers.

- continuing advancements in technology in both communications and materials handling - this has made it possible for companies to monitor and control product and vehicle movements in ways that were not previously possible, allowing automatic communication with suppliers, customers and logistics service providers, resulting in lower stock levels, shorter supply and delivery lead times and increased scope for product customisation to individual customer requirements. The handling and storage of products has also become much more efficient through improved equipment technology, again increasing competitiveness.

- the Single European Market - the unification of European markets has brought with it the increased potential for market increases and easier access to alternative suppliers through elimination of border controls, reduced bureaucracy, and elimination of trade barriers.

- Central and Eastern Europe - the opening up of these countries is seen by many companies as both new markets and suppliers of cheaper raw materials, semi-finished and finished goods. These new markets may significantly influence companies' logistics operations.

Since longer-term strategies are being considered, it should be remembered that the Channel Tunnel has only been available as an option for the movement of freight for a relatively short time. It is possible that the influence on decision making will take several years to be fully realised.

The Role of Rail Transport

One of the more surprising themes to emerge, given the lack of growth of this mode to date, is companies' expressed willingness to increase their use of rail. Proximity to a rail head would be an important influence on the location of future distribution centres. Reasons for this include:

- road congestion, which is seriously affecting the ability to guarantee delivery times, as well as increasing costs/reducing efficiency;
- environmental considerations, leading to a rethinking of the reliance on road as the prime mover of goods. Companies realise that they need to plan for higher taxation on road vehicles, tolls and route restrictions, and are keen to switch at least some of their transport requirements to rail. Established rail users hope to be in a better position to exploit and control the potential cost and efficiency gains provided by rail and perceive a significant marketing advantage in being seen to be 'green' by using more rail transport.

This appears to run counter to the findings of Tweddle *et al* (1996) who found that companies interviewed were generally resistant to using rail and sceptical that it could offer reliability comparable with road. However, those stating they would like to increase rail use often identified certain problems:

- difficulty/inability of rail companies to provide suitable rolling stock e.g. refrigerated wagons;
- non availability of rolling stock for lease;
- lack of reliability - although one company interviewed had found reliability to be high (though not as high as they would like), others still perceived problems in this area;
- problems with other European railways - one company suggested that there was a general lack of enthusiasm for through rail freight services (e.g. UK to Germany)

Our conclusion is that in the longer term there may be substantial reorganisation of locations, market areas, logistics and transport use. It is not claimed that this is simply a direct result of the construction of the Channel Tunnel, but, together with its associated infrastructure, it has made possible more substantial changes, not least because of the enormous increase in capacity which has had significant effects on prices. The in-depth interviews confirm the view that understanding the changing pattern of transport activity requires a fuller understanding of this wider range of influence on firms' total logistics before we can predict detailed freight flows.

CONCLUSIONS

The discussion above has identified some of the difficulties both in predicting the freight traffic flows arising from a major change in transport infrastructure such as the Channel Tunnel and in understanding the causes of changes which have been observed. We have noted from the flow data that there are complex changes of generation, mode and route which are difficult to model. However, we have also produced some initial evidence which demonstrates some significant longer term changes which could have substantial effects on the wider economic significance of the project.

It is capturing these in a modelling framework which is a difficult exercise. This has particular significance where private sector funding has been used. If the longer term effects are substantial, these could be vital in validating the project. Where this could, for example, encourage greater use of rail or intermodal transport, this could justify government assistance in the short run. It is particularly important therefore to be able to predict how the traffic figures will develop in the longer term, not just as total flows or revenues, but in greater, disaggregated, detail.

For government authorities, the increasing domination of one main transport corridor poses problems for the provision of adequate connecting road and rail infrastructure. Congestion on access routes, both road and rail, arises from the short term route diversion effect. The development of a new mode has led to increases for existing modes where sustained price competition has become more important than hitherto.

What has been shown in this paper is that there is a substantial behavioural response which conventional freight forecasting models do not fully include. What is not yet known is whether the long term effects lead to greater or lesser traffic levels than forecast by conventional models. The restructuring of logistics and locations may however be about improving the quality of the transport service such that if lower volumes of traffic result, they are nevertheless associated with higher revenue potential. We have clearly identified an area for continuing investigation here, the next stage is to use this in the further development of freight models.

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