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Analysis of Transport Schemes: Economic Impact Studies

David Simmonds Consultancy

Report to The Standing Advisory Committee on Trunk Road Assessment

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Introduction

1.1 Background and Brief

This Report has been prepared by David Simmonds Consultancy in response to a Brief issued by the Department of Transport, on behalf of the Standing Advisory Committee on Trunk Road Assessment (SACTRA) in May 1997.

The Brief referred to the existence of a large literature on the indirect economic impacts of transport infrastructure projects, as indicated by variables such as employment, output, land-use, etc, and called for a review of the studies that are currently carried out to consider such impacts, focused on a small set of "Case Studies". In particular it called for:

- a commentary on the state of the art with regard to the methods used to assess the indirect economic impacts of transport schemes;
- a critical evaluation of the different aspects of the methodologies used;
- a basis upon which to assess the quality of other similar studies.

To fulfil this brief, SACTRA have commissioned this Report from David Simmonds Consultancy, following an initial study by National Economic Research Associates (NERA). The NERA document is referred to at various points in the present Report.

1.2 Structure of the Report

Chapters 2 to 8 concentrate on presenting the range of methods and models which we have considered. Chapter 2 describes how we have approached our analysis of the chosen Case Study methods. Chapters 3 to 7 inclusive present the Case Studies, in turn. Chapter 8 provides a wider methodological context for these by summarising a number of other methods which we know (from previous reviews or from having developed them) to be available for such studies, but which were not available for consideration as Case Studies.

Chapter 9 then discusses the Case Studies, and where relevant the other models, and seeks to answer as far as possible the questions raised in the Brief. This Chapter incorporates a table which tries to summarise the main characteristics of all the various methods considered. Chapter 9 is relatively self contained, and can be read alone, although it draws from the approach we adopt in Chapter 2.

1.3 Status of the Case Studies

Readers should note that the methods and results of the Case Studies reported in Chapters 3 to 7, and of the other work reported in Chapter 8, may not have been endorsed by the client organizations which commissioned them, and do not necessarily represent the current views of those organizations.

The Case Studies themselves were selected by members of SACTRA.

1.4 Previous interests and involvements

As is common in such specialised fields, those undertaking the present review have previously been involved in some of the work under discussion. In particular, David Simmonds was the initial Project Manager for Marcial Echenique & Partners' A7/A68 study considered in Chapter 7, although he left that consultancy before the project was completed. He has since been involved in a variety of studies, including the European model described in 8.2.6, which simultaneously compete with but intellectually have much in common with the ME&P approach; it is hoped that this, together with various published reviews (in particular, Simmonds, 1994) is sufficient to establish his impartiality in this area.

CHAPTER 2

Approach to the case study reviews

2.1 Identification of the studies

The five case studies chosen by SACTRA related to the following schemes or possibilities:

- the Dearne Towns Link Road;
- Strathclyde Tram;
- Midland Main Line Strategy Study;
- M74 Northern Extension;
- A7/A68 Improvements.

The methods used to assess the possible economic impacts of these are presented in turn in the following Chapters. Note that only the reports mentioned in those Chapters were available to be studied; we have not had access to any other papers relating to the studies, nor have we interviewed the consultants and clients involved. This has had the following implications for our review:

- we have considered only the outputs shown in the reports (other outputs or disaggregations of outputs may have been produced but not published);
- details concerning the resources available to the consultants were not given;
- none of the reports justified the consultants' choice of method (although the MEPLAN study was specifically carried out as a 'test' application of that particular method, so no choice was required).

2.2 Terminology and scope

There is no agreed and consistently used terminology for the different kinds of effects considered in the Case Studies. We have adopted the following for the present Report.

We use the term "economic impacts" to include all effects of a transport change outside the transport system itself. Money savings to transport users, while clearly economic impacts, are not included as an economic impact for this study, but any action taken in response to such money savings are included. Economic impacts can take various forms and be measured in various ways, including changes in employment, output, income, construction, etc.

Direct economic impacts are the immediate economic impacts of the capital and operational expenditure required to build, operate and maintain the scheme.

Indirect economic impacts include all other economic impacts which stem from the scheme. These include:

- multiplier effects of direct economic impacts;
- induced impacts, which are all impacts resulting directly or indirectly from the use (or possible use) of the scheme. Induced impacts may have multiplier effects, which are themselves included under induced impacts. Induced impacts may also include additional construction to accommodate increased demand.

This Report is concerned only with studies of the induced economic impacts of transport schemes. It is not concerned with the *direct* economic impacts or with their multipliers, ie it does not consider the economic consequences of:

- the required spending on construction, vehicles (in the public transport cases) and equipment, and the multiplier effects of this spending;
- the expenditure required to operate the system in question.

Direct impacts and their multipliers are excluded not because they are unimportant, but because their existence and the methods required to estimate them are relatively uncontroversial. Induced impacts, in contrast, are more difficult to identify and to predict. Examples of each type of impact are given in Table 1 below.

Table 1: **Summary of impact categories**

Main category	**Sub-category**	**Examples of impact**
Direct	Direct economic impacts	Additional employment for transport system (e.g. LRT)
Indirect	Multiplier effects of direct impacts	Retail sales to new LRT staff
	Induced effects (the focus of this study)	Firms move location to LRT line, taking advantage of greater accessibility
		Retail and service multipliers from these relocations
		Additional development to accommodate changed demands

Finally, there is the distinction between *impacts* and *benefits*. This distinction is more widely agreed. Impacts are the effects which follow from a particular action; in empirical analysis, one must attempt to trace these through time, whilst in forecasting they can be estimated by comparing "with scheme" and "without scheme" forecasts. Benefits arise from certain impacts which may be seen as desirable (or undesirable, giving negative benefits). One forecast of impacts for a particular scheme may give rise to different assessments of benefits, depending on the objectives of the assessors: for example, the importance they attach to creating jobs in different areas or in different sectors.

2.3 Approach to the reviews

2.3.1 INTRODUCTION

We have attempted to pursue a systematic approach which would apply to all the studies and methods under consideration. This involved a checklist of questions to be answered. This checklist followed the list of key issues outlined in our proposal. It took into account the flow diagram approach proposed by NERA, but had to be modified to reflect the more pragmatic approach taken by several of the studies in this review. A tabular form was devised to summarise the answers to these questions. The checklist was split into four sections, which we consider in Sections 2.3.2 to 2.3.5 below.

In addition, we have tried to formulate a set of characteristics which an economic impact assessment should encompass in order to be suitable for public sector appraisal purposes, as the basis on which to comment on the strengths and weaknesses of the various Case Studies. These characteristics should be defined in general terms, rather than in terms of specific techniques or models. Our suggested characteristics are as follows:

1 The approach used should distinguish induced economic impacts (or at least some sub-set of them) from direct economic impacts and their multiplier effects.

2 There should be a clear view as to why the scheme leads to the induced effects identified, and over whether the analysis intends to consider all (or all significant) effects or only particular effects – and if the latter, why? (A perfectly legitimate answer to this is that the client organization is only interested in certain effects, such as the impact upon their area of responsibility).

3 There should also be a linkage from the nature and scale of the transport scheme to the scale of the induced effects, such that a bigger or better transport scheme would (typically) have greater effects.

4 There should be a clear distinction between impacts and benefits.

5 There should be at least some consideration of the scope for double-counting between transport benefits and the benefits associated with induced economic impacts.

6 There should be consideration of (a) the timescale of impacts and benefits; (b) of the relationship between impacts and other changes (for example, whether impacts will be increased if economic growth accelerates); and (c) of the relationship between impacts and other aspects of public policy, both "active" (requiring public expenditure) and "passive" (eg granting planning permission for private development).

These characteristics could be provided in different ways either by a sophisticated mathematical model or by a comparably sophisticated discussion of the issues involved. To that extent, this list is neutral between approaches. The list is also neutral as to what theory or model should provide the linkage between transport and the induced effects, provided the underlying argument is exposed to scrutiny. This does, however, pose a problem for studies which are based upon seeking the opinions of others (specialists in the subject, or potentially affected firms and individuals in the area) rather than upon original analysis. Those surveyed in such studies may not have a common view as to what the

linkages are or how they would change for different variants of the scheme. This is a criticism of the whole "survey of expert opinion" approach, not just of the way that such surveys are carried out; we have found by experience that it is relatively easy to obtain opinions as to the expected effect of transport change, but difficult to discover the basis for such opinions.

2.3.2 CHECKLIST (1): TRANSPORT IMPACT

This section considered the way in which the transport scheme or strategy was defined, and its direct transport impacts measured (in terms of time savings, cost reductions, etc), *for the purposes of analyzing the induced economic impacts*. In some cases we know or believe that a detailed assessment of transport costs and benefits was carried out, but this did not provide an input to the consideration of economic effects and was therefore not included in the material we have reviewed.

The checklist for this area consists of four questions:

1.1 How is the change in transport defined? (eg as a specified scheme, as a change in transport costs, etc).

1.2 Are direct transport impacts, or the costs and benefits arising within the transport system, considered in the analysis under review?

1.3 Have the predicted transport changes been used in the calculation of indirect economic effects?

An additional question was suggested by NERA: "Is there any evidence that levels of inventory or reliability have been accounted for?". None of the studies considered made any explicit reference to this question in the analysis reviewed, and we have therefore not pursued it any further.

2.3.3 CHECKLIST (2): APPROACH TO INDIRECT ECONOMIC IMPACT ASSESSMENT

The key question here is how the transport change has been linked to the economic assessment, and in particular:

- what the consultants have used as the basis for the relationship between transport change and economic change; and

- what indicators of impact they have produced.

The nature of the relationship between transport change and physical development (new construction or redevelopment) has been the subject of some discussion during the project. Our view is that the direct link from transport change to induced effects acts upon land-using activities rather than directly upon developers, and that the impact upon development is a secondary or less direct effect. Such development effects may come about either through the bespoke developments of businesses responding to the transport change, or through speculative developments as developers act in response to (or in anticipation of) market signals. The causal link is therefore, in our view, from transport to economic

activity, to the demand for buildings and land, to development, but in the temporal sequence observed, development may precede changes in economic activity, and may even precede completion of the transport scheme itself. Because of this, it is probably impossible to achieve an empirical validation of the causal link we have just defined.

We appreciate that choice of method to express the relationship between transport and economy, and the choice of indicators, may well have been influenced by the remit and budget of the study, as well as by the consultants' views of what is appropriate to particular questions. We therefore stress that we have interpreted the various reports as evidence of what has been done in these particular studies, bearing in mind that this is no doubt different to a greater or lesser degree from what the consultants involved would regard as ideal.

The specific questions in the checklist are:

2.1 What are the indicators of induced economic impacts? What explanation is given for the choice of indicator(s)?

2.2 What is the main method used to identify and measure the linkage from transport change to induced economic impact:

- the consultants' judgement;
- a survey;
- a formal model?

2.3 What methods are used for additional analysis of non-transport effects (eg to convert changes in output into changes in employment)?

2.4 What is the timescale over which all these impacts are considered?

2.3.4 CHECKLIST (3): SPATIAL ASPECTS OF THE ANALYSIS

This dealt with spatial detail, spatial scope (ie the area(s) considered in the analysis) and the resulting completeness or otherwise of the analysis:

3.1 Is the approach explicitly spatial, and if so is it:

- a top-down procedure in which overall impacts are allocated to smaller areas; or
- a bottom-up procedure in which total impacts are the sum of results for smaller regions or zones?

3.2 What is the level of spatial disaggregation, if any?

3.3 Is the method (as identified by point 2.2)

- concerned only with local gains; or does it also
- consider redistribution from one area to another (displacement effects)?

2.3.5 CHECKLIST (4): BENEFIT CALCULATIONS AND THEIR INTERPRETATION

This involved asking:

4.1 Is there a measure of benefit associated with the indirect impacts?

4.2 Is this a total benefit, or spatially disaggregated?

4.3 Is the potential problem of double counting (ie counting the same benefit both as a transport benefit and as an indirect economic benefit) raised in the study?

4.4 Do the authors actually claim that the indirect impacts represent additional benefits over and above the direct transport benefits?

2.4 Order of the case studies

The studies are presented in an approximate increasing order of complexity. They can be categorised as follows as shown in Table 2.

Table 2: **Case studies: method categorisation**

Category	Description	Examples
Local economic framework	A set of calculations based upon professional judgement, focusing upon the corridor of the transport improvement.	Dearne Road Strathclyde Tram
Regional economic framework	A set of calculations based upon professional judgement, focusing upon the wider regional implications of the scheme.	MML
Regional framework and supporting economic model	As above, but making use of wider economic growth or input/output models.	M74
Behaviourial modelling	A model representing the location or economic behaviour of firms/households, coupled with supporting economic growth or input/output models.	A7/A68

It is possible to define all these methods as "models" in the broadest sense, in that all of them involve some conceptualisation of how changes in transport will produce changes in one or more aspects of the economy. There are, however, important differences in how they can be used to test variations in transport policy. This depends upon the link between transport and economic activity considered in the checklist (see 2.3.3). In some cases there is a quantified relationship, such that different levels of transport change would lead to different levels of induced impacts. In other cases, there is a "yes/no" linkage – it is the presence or absence of the scheme that is represented, with no account taken of the level of service which the scheme will offer.

The Chapters on individual Case Studies follow, as far as applicable, the structure of the checklist. Answers to the checklist questions are summarised and tabulated in Chapter 9, with 5 for the Case Studies, and 6 for the additional models considered in Chapter 8.

Within each of Chapters 3 to 6 there is a flow diagram of the Case Study method, which attempts (as far as possible) to follow the individual consultants' own description of their method. These diagrams have been standardised between the methods to highlight the qualitative and quantitative aspects of the studies. These are represented by the solid boxes down the left hand side of the diagram, while the fainter boxes off to the right give more details about the methods used. In Chapter 7, where the method is a single model, that model is described in corresponding detail.

CHAPTER 3
Dearne Towns Link Road

3.1 Introduction

This review is based upon The Dearne Towns Link Road Report of Surveys: Volume 3 Industrial/commercial interviews and forecasting, prepared for Barnsley Metropolitan Borough Council by JMP Consultants Ltd, March 1989.

3.2 Aims of the study

This study aimed to collect data on the likely impacts of the Dearne Towns Link road, a proposed single carriageway road linking the A1(M) and the M1 motorway, south of Barnsley. The study was undertaken in the context that the area through which the proposed road was to pass was poorly served by roads, and hence disadvantaged compared to other parts of the region. The main purposes of the study were;

1 to forecast the goods vehicle traffic in the corridor, with and without the link road in place;

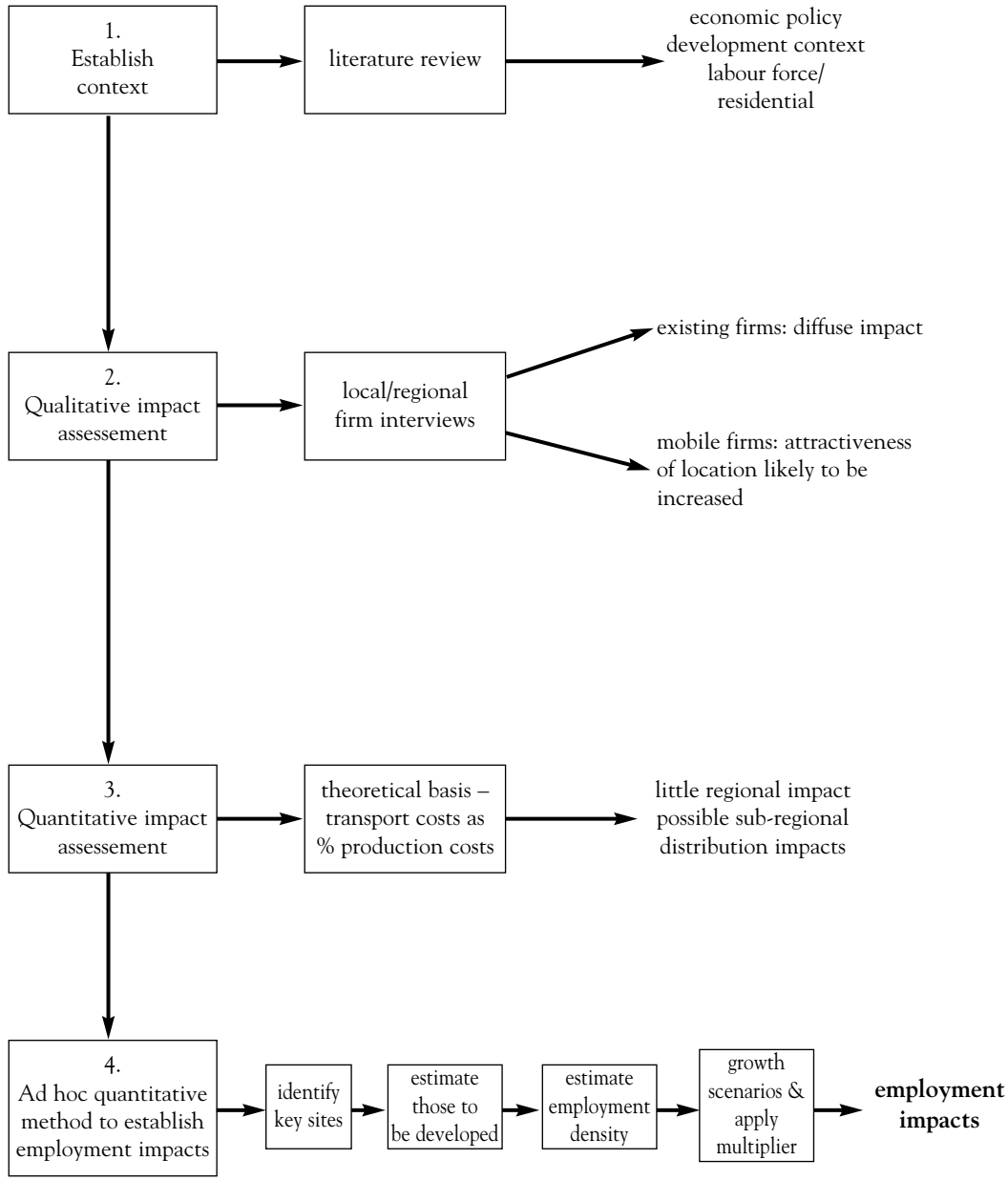
2 to assess the changes in the development potential due to the road (it appears that the consultants decided to confine the impacts to the corridor level, page 86).

The overall methodology followed in the study is given in Figure 1. This shows that the method applied fell into two distinct parts, namely:

- first, a series of interviews with local businesses (local firms, regional firms, and haulage firms); and secondly,

- a local economic framework quantitative approach based upon likely developments, their take-up rates and employment densities.

Figure 1: **Dearne Towns Link Road Impact Study Method**



3.3 Direct transport impacts

The change in transport is defined only by the presence of the new road, with no explicit accessibility index or travel time saving matrix. Given this general definition, there is no direct transport saving measured in this report. Pages 79-81 of the report examine, in qualitative terms, the transport impacts in terms of access onto the strategic highway network, and transport cost savings attributable to the firms sampled (see below). There is no quantitative assessment of transport user benefits. There is no examination of how travel times between origin-destination pairs would have been improved by the scheme. We assume that more detailed analysis of the impact of the scheme on travel patterns on times was undertaken elsewhere in the appraisal, but that it was not used in analysis of indirect impacts.

3.4 Induced impacts: general method

Two quantified indicators of economic impact are examined in the study; new development and employment. In the chain of calculations undertaken, the employment is a function of the available floorspace, and it is employment that is presented in the executive summary, although over what period of time these effects will occur is not explicit.

These indicators are linked to the transport changes by the following methodologies that show how the consultants have defined and examined 'development potential':

1 A qualitative assessment (Figure 1: box 2) focuses on the likely impacts from a series of structured interviews with local businesses. This found that existing firms were unable to quantify the impacts that the road was likely to have upon their business in a way which could be used to calculate employment changes [page 81]. The interviews also covered less tangible issues such as the possible benefits to the labour market, business confidence, and accessibility, finding that the impacts were likely to be small and diffuse.

   From interviews with firms from the wider regional area, the study concluded that the road offered important contributory benefits for mobile firms locating into the area.

2 The quantitative methodology (Figure 1: box 3) focused upon the new physical industrial development that could be associated with the new road. A brief review of the theoretical evidence [page 73] established that while the road was unlikely to have any net regional impact, it may have sub-regional distributional impacts. The subsequent quantitative work is shown in (Figure 1: box 4, with the steps as discussed below:

   1 key sites (either existing but vacant, or planned) were identified and their potential floorspace obtained;

   2 the central assumption was that private sector development at two key sites was dependent upon the proposed road;

   3 high and low scenarios for the take up of the sites were applied;

   4 employment densities (no source is given for these) were applied to the new floorspace to calculate new employment levels.

   5 an average multiplier [estimated on page 77] of 15% was then applied to the employment total, taken to be the average of short-term, long-term and supply linkage multipliers[1].

1 Short term multipliers are defined as additional spending in the local economy and knock-on second round effects. Supply linkage multipliers are defined as additional purchases by incoming firms from existing local firms: this is given as the greatest multiplier. Long term multipliers are result of reduction in employment-led out-migration. No sources are given for the numbers.

Note that in deriving this employment estimate:

- changes in employment to existing firms has been ignored (it was considered that these effects would be negligible [page ii];
- employment from construction has not been included;
- changes in the intensity of use for existing sites has been ignored (this was not mentioned in the report);
- new employment for other (less likely) developments has not been allowed for in the new floorspace growth allocations.
- the timescale considered appears short term, as the study deals with available sites. However, the study itself [page 91] considers the likely timescales over which these sites will be developed to be over the long term. Moreover, the use of 'take-up rates' to give the per annum figures are quoted as if they will continue indefinitely [pages 91, 94].

However, perhaps more importantly,

- there is no explicit link between the size of the transport change, and the potential development estimated. It has been assumed that the presence of the road means that these sites will be developed, otherwise they will not be;
- there is no assessment of the net distributional effects within the region, but outside of the corridor. There is only the comment (page 86) that more general development benefits cannot be measured in any meaningful way.
- there is no theoretical justification for the estimated take up of new sites. Only the empirical fact that if floorspace exists then some of it is likely to be occupied. In other words there is no discussion of the relative attractiveness of the new location relative to other sites in the local area.

This last point may be because the study aimed only to calculate the likely users of the new link, for which the new activities along the road form the secondary transport impacts.

3.5 Indirect impacts: Spatial disaggregation

The study examines the strict corridor only, with no zonal disaggregation, only a process of site identification along the road corridor. However, note that the calculation of the impacts follows a 'bottom-up' methodology, in that the net additions to floorspace are calculated first.

3.6 Indirect impacts: Benefit calculations

There are no benefit calculations. This style of analysis is very informal in its economics, and makes no attempt to argue that the employment impacts are additional to the direct transport benefits. Moreover, the tone of the report is that these are not additional, but relevant to the local decision makers concerned with the distribution of economic growth and employment.

However, these development impacts should be treated with caution. They should not be used in comparison with other schemes without further analysis of development foregone and what the impacts would be on the areas adversely affected.

3.7 Conclusions

The Dearne Towns Link Road Study is entirely concerned with effects in the immediate vicinity of the scheme. It does not offer any theoretical basis for the approach adopted, which appears to assume that developers respond to transport provision and that users respond to development. It is easy to provide a rationale for this – that developers will act in response to or in anticipation of the changes in demand brought about by the possibility of using the Link Road – but this is not explicit in the Study itself.

There is no evidence that the results of the Study would be different if the details of the scheme were different. There might be no difference since, arguably, the impacts considered stem from the release for industrial development of substantial sites with direct access to the main road network, and that any sites in the area which offered these characteristics would have the same effects[2]. There is therefore a case for suggesting that the Study is a good examination of the local employment consequences of permitting industrial development on sites with particular access characteristics, rather than an examination of the induced effects of the improvement in the transport system[3]. This is not by any means a criticism of the Study, only a comment on its relevance to the work of SACTRA.

The Study does not attempt to attach any measure of benefit to the jobs that might be attracted to the sites if developed. Different levels of take-up are considered, but without timescales or reference to other economic changes over time. For some of the sites considered (eg Shortwood Brickworks, p61) requirements for additional infrastructure are mentioned, but it is not clear which of these would require public expenditure before development could take place.

2 See for example paragraph 19 of the Study Summary (page (iii)): "In particular, there is … a dearth of sites available to meet the demand for motorway and near-motorway locations."

3 To some extent, this is because "Firms interviewed in the survey were unable to quantify the likely impact of the road on their business in a way which could provide the basis for estimating benefits of job creation or retention" (Study Summary, paragraph 30, page (vi)).

CHAPTER 4
Strathclyde Tram

4.1 Introduction

This Chapter is based on *Strathclyde Tram: Development Impacts Phase III Report*, prepared for Strathclyde PTE by Halcrow Fox, March 1996.

4.2 Aims of the study

This study examined the likely scale of 'urban and regeneration impacts' [Section 1.1.1] of the proposed Strathclyde tram. The method is shown in Figure 2, showing a methodology similar to the Dearne Road and MML studies, i.e. an initial review, a local survey of relevant actors (planners, developers, firms), and then some quantitative estimates informed by the interview results. Again, of interest is that the consultants have defined 'urban and regeneration impacts' mostly in terms of physical development and associated employment.

4.3 Direct transport impacts

There is no discussion of the direct transport impacts. These may well have been the subject of another part of the study, but any results are not used in this study. Therefore, all the impacts are based upon the presence of the tram, not by its service characteristics.

4.4 Induced impacts: general method

As mentioned above, this study aimed to consider development and urban regeneration impacts. The consultants have taken this to mean the impact of employment within the tram corridor, itself assessed via the new development likely to occur as a result of the tram. This appears to be of relatively limited scope, for example the following are not considered:

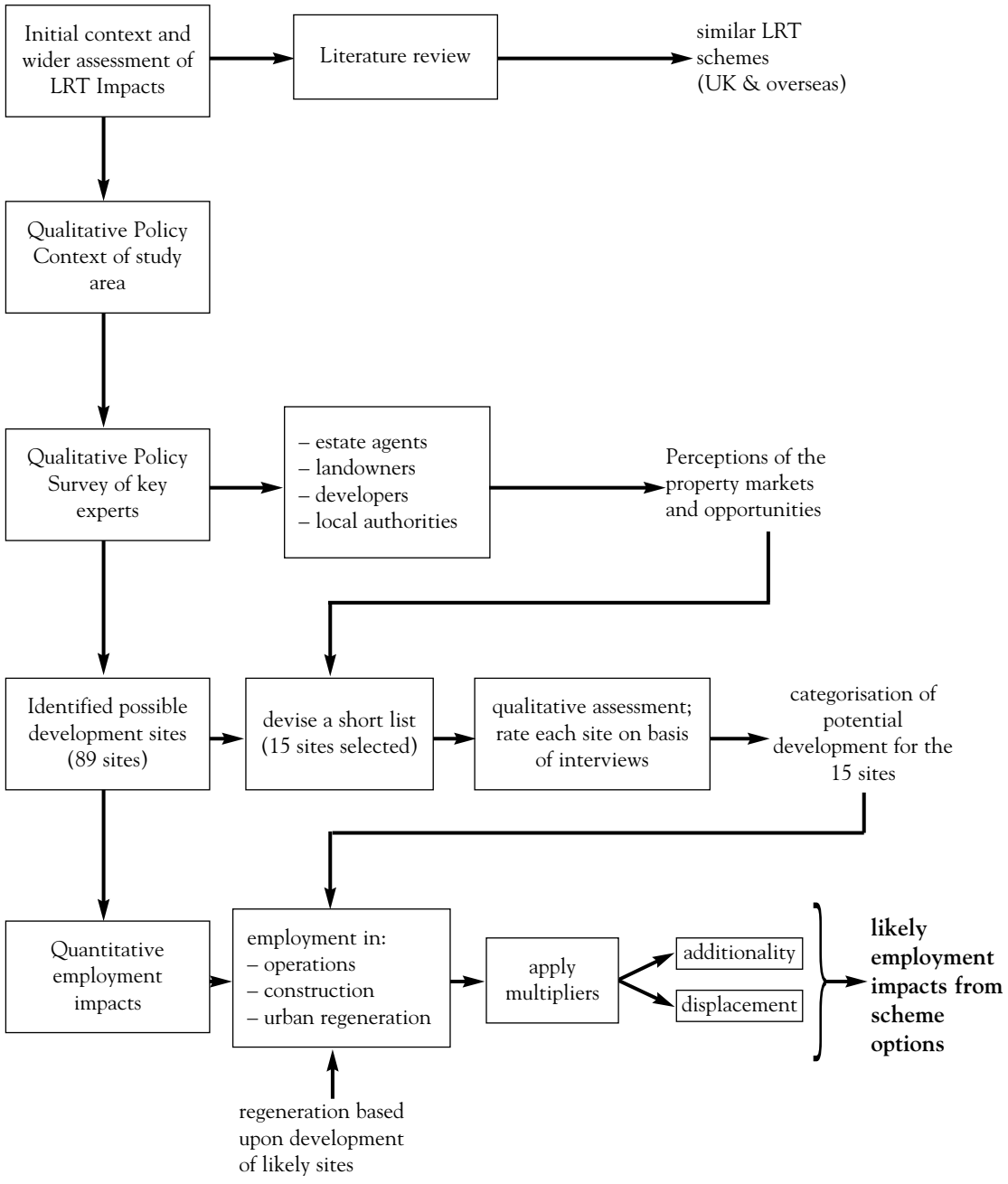
- increases in the intensity of existing land uses;
- changes in employment characteristics of indigenous firms;
- possible service multipliers from increases in households in the corridor.

The method, shown in Figure 2, fell into several parts. Firstly a literature review discussed findings from other light rail studies [Section 3], reaching the conclusions:

- that light rail impacts vary widely from city to city, as accessibility is but one factor of the development decision;

- that there is practically no evidence of negative impacts;
- there are many methodological problems in determining what such impacts are, centring around the other economic factors that influence urban development.

Figure 2: **Strathclyde Tram Impact Study Method**



After setting the policy context, the main quantitative thrust of the research examines the likelihood of development along the corridor. Fifteen sites were shortlisted as being sensitive to the Tram proposals (although details of the derivation are not given, we understand that this was dealt with more thoroughly in a previous report). Each site is then discussed in turn. The consultants drew upon interviews with estate agents, developers, land owners and local authorities to guide their views. Using this to assist, they

categorised each site in terms of the development potential improvement offered by the tram. This was a rating scale "slight – limited – moderate". They concluded that the tram was just one factor affecting the likely development of these sites.

Thus all the regeneration impacts were related to these 15 sites in the tram corridor, with no wider effects, intensification or re-distribution impacts considered.

They then examined the potential labour market impacts, again on a qualitative basis, breaking up the proposed route into 11 zones, and assessing the existing labour market in each. At the end of Section 5, potential employment impacts were assessed, on the basis of:

1 operating staff and construction;

2 indirect and induced employment;

3 regeneration employment.

Impact (2) was estimated on the basis of multipliers, (3) was estimated on the basis of the likely site regeneration from the analysis of available sites. Note that a large share of this employment comes from just one site (Hunter St/Duke St), but it is difficult to trace the site characteristics [from table 4.3] to its employment estimates [in table 5.9]. Average employment densities were used, but their derivation was not discussed. To these jobs, an employment multiplier of 1.3 is applied. Thus there is little discussion of the derivation of either the densities (and how they compare to surrounding employment densities in the study area), or of the multipliers.

The employment estimates were then adjusted for 'additionality' and 'displacement' effects. 'Additionality' is defined as the importance of the public sector in promoting the project. This is set at 25% and means that of the potential regeneration employment, only 25% is likely to proceed. This 25% is justified [Section 5.6.20] on the basis of developments proceeding earlier than without the LRT, being of a higher quality, and having a better image. Section 5.6.22 notes that these estimates do not include any sites other than the key 15 previously selected.

'Displacement' is the geographic redistribution of activities to the corridor due to the scheme. For the regeneration of development employment this is set at what they consider a high level of 60%. However, this still means that 40% of the regeneration employment is considered new, although to what (i.e. the corridor, region, Scotland or UK) is not described.

The timescale considered in this study appears extremely short term. Although time is not explicitly considered, the fact that only existing sites have been considered certainly limits the possible impacts.

The study does not make use of different scenarios of economic growth, despite identifying in the literature review that economic growth can have a marked effect on the impacts.

The links between the tram and economic development are therefore confined to the employment (through operation and construction) multipliers, and the categorisation that sites are more likely to be developed if the tram is built.

4.5 Induced impact: spatial disaggregation

The spatial approach is clear in that the focus is upon the corridor of the tram, with the sites explicitly identified. However, there is no attempt to give the employment impacts by site, although this is implicit within the approach.

The spatial remit is also confined to the corridor level, although the apparently arbitrary value of 60% does consider the regional redistributive impacts. In general it can be concluded that the study has assumed that quantified impacts can only be established for the corridor, and then only in terms of physical development. Note that this study is the only one of the five to include construction jobs (ie direct impacts) as part of the employment total.

4.6 Induced impacts: benefit calculations

There is no attempt at an overall benefit indicator, although the conclusions only give the impacts in terms of employment. They estimate that 600-800 jobs would be created from the regeneration impact, figures largely determined by the displacement variable. As mentioned above, there is no derivation of scenarios for different levels of economic growth.

4.7 Conclusions

Like the Dearne Towns Link Road (DTLR) Study, this analysis concentrates on development-led effects. The implicit basis for this is no doubt the same: that improved transport will increase demand for space at particular locations (whether additional and/or relocated), and that the analysis attempts to identify how developers will respond to this increase, or to the expectation of it, and assumes that this will control the final outcome. In the DTLR case, this basis for analysis seems reasonable, in that evidence is presented to show that there is a shortage of sites with good access to the main road system; it seems entirely plausible that the DTLR would create more such sites upon which development would take place, to which businesses would be attracted creating new jobs (new, that is, to the Dearne Valley).

In the Strathclyde case, however, it is not evident that the transport scheme would "create" sites in this sense; any change in the characteristics of the sites considered must come about because the LRT would increase accessibility to labour/consumers and to other businesses. This is more directly relevant to the issues being considered by SACTRA, but:

- the focus on development rather than upon demand is less appropriate;
- the absence of any consideration as to the level of improvement in accessibility is a serious omission.

As a consequence of this approach, the study:

- takes a short-term view of impacts which most observers agree to be long-term in nature; and

- ignores the possibility that the transport scheme will have significant impacts on the existing stock of occupied property, for example by increasing demands (and hence rents and possibly the pressure for redevelopment) in some areas whilst reducing them in others.

From a planning point of view, it is also significant that the approach is entirely passive – there is no explicit reference to new development possibilities that might be brought forward by imaginative and positive planning around the transport facilities. We recognize, however, that the consideration of such possibilities can greatly complicate the issues of economic impact analysis.

CHAPTER 5
Midland Main Line Strategy

5.1 Introduction

This Chapter is based on the *Midland Main Line Strategy Study Technical Report*, prepared for a consortium of local authorities by WS Atkins, Steer Davis and Gleave and ECOTEC, March, 1990.

Note that is not the same as the recent "Midland Main Line Study" carried out for the Monopolies and Mergers Commission in connection with the award of the Midland Main Line train operating franchise to the National Express Group, nor is the same as the "A1/M1 Corridor Study" carried out for the Department of Transport, which looked at the potential for road to rail transfer in the same corridor.

5.2 Aims of the study

The key aim of this study was the identification of economic development impacts, focusing upon the economy of the Midland Main Line (MML) catchment area. The catchment area was defined as the district of Sheffield, plus the counties of Derbyshire, Nottinghamshire, Leicestershire and Northamptonshire. Although no rationale is given for this study area size, it is above a corridor level, essentially being the administrative area of the clients.

5.3 Direct transport impacts

The assessment is based upon the 'best case' (i.e. most substantial) package of improvements, including electrification, quality improvements, improved freight handling, through running to Europe. These improvements are quantified in the introduction, in terms of 30-50% increases in frequency, and new freight facilities in the medium term. However, further estimates of the likely impacts on demand of these changes do not feature in this study. The study is a preliminary examination of the potential impacts given the improved services.

5.4 Induced impacts: general methodology

The economic impact indicators used in this study were net employment generated and new development [page 1]. Also considered was how the scheme would fit into local planning policies.

The impact study uses a regional framework in which to assess the impacts, the structure of which is shown in Figure 3. These impact topics were arrived at by an examination of the mechanisms linking the transport improvement to economic activity. First, direct impacts are discussed (although they are not calculated in this report):

a benefits to users through travel time savings, and consumer surplus from improved reliability and comfort to passengers (p.3);

b non user benefits via mode switching to lessen road congestion, and hence reductions in investment in other transport infrastructure.

To this list, they add the following potential indirect benefits:

c to existing industry from efficient transport, ie cheaper transport costs;

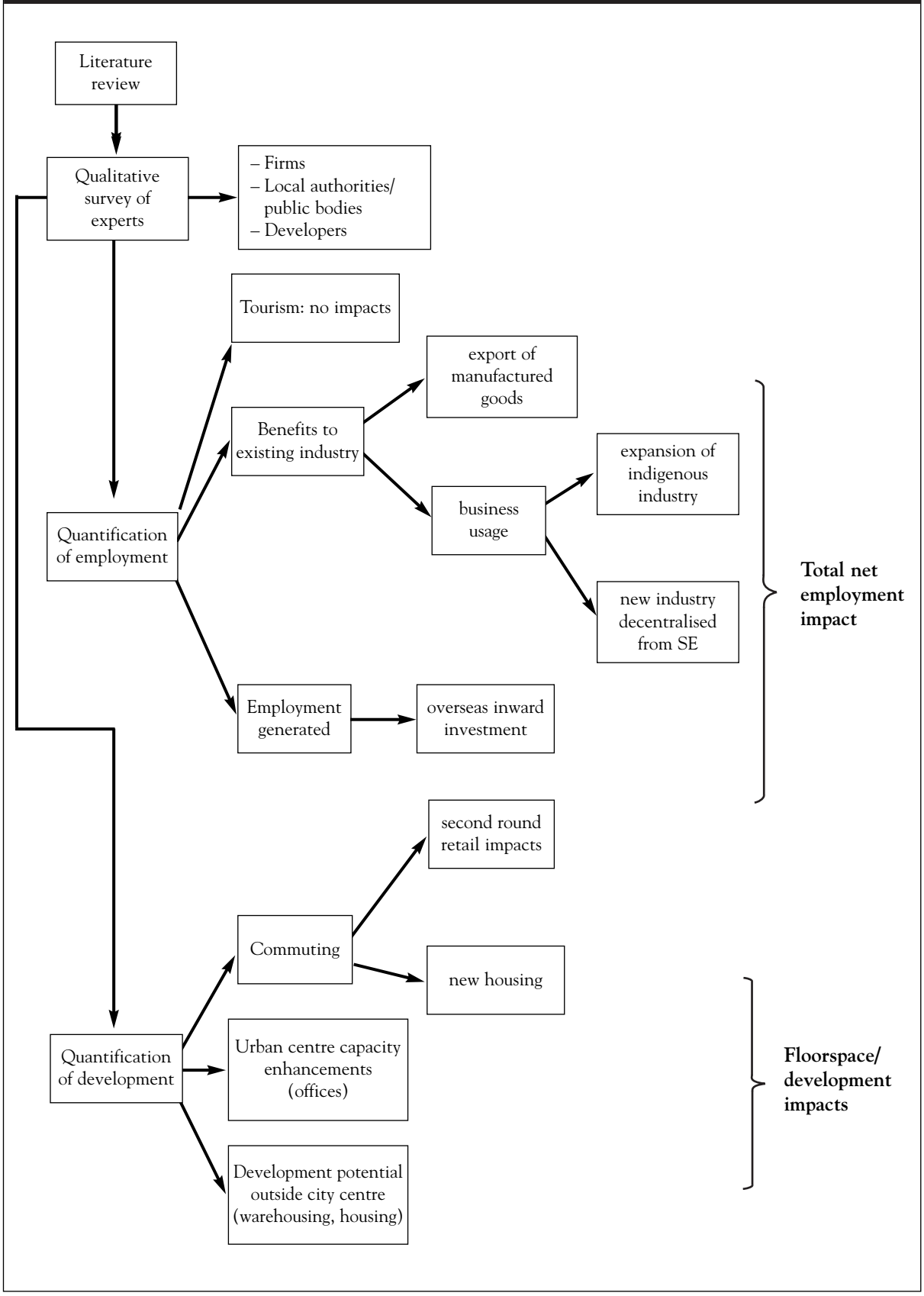
d improving the development potential of vacant, derelict or under used land and enhancing existing development in the corridor;

e through enhancing the capacity of urban centres on the route to accommodate growth in service functions;

f benefits through retaining and generating additional consumer expenditure (retail and tourism) in corridor area;

g employment generation associated with the transport improvements.

Figure 3: **Midland Main Line Strategy Study Method**



As shown in Figure 3, they then estimate the magnitudes of c to g, and sum c, f and g to obtain a total (net) employment growth, and d and e to determine the development impacts. Thus there appears to be an assumption that these benefits are in addition to a and b, but this is not explicitly stated.

They do comment that there is a danger of double counting, but double counting is not then mentioned again until the conclusions. They also comment that the impacts are contingent upon assumptions they have made about external factors including the opening of the Channel Tunnel and the influence of the European Single Market. Finally, they highlight the importance of the distributional impacts of benefits, and say that these can be important, especially where economic and spatial planning objectives are concerned.

The main method was to assess impacts on the basis of:

1 surveys of firms in the area to determine how much they use the MML at present, how much more they would use it if it was improved, and what influences it had on firm's location decisions;

2 surveys of developers (no details given);

3 consultations with local authorities to consider potential benefits;

4 quantitative estimates on the basis of the surveys [page 11] and qualitative judgements.

Taking each impact in 3 in turn, the nature of their impact assumptions becomes clear:

For *generated employment*, they assume, following the literature review, that *inward investment* into the study area from firms overseas will rise [page 12] by 20%, (although the time period is unclear), furthermore;

> *'given the importance of the communications network, and the likely increases in the role of rail services for trade with Europe, it would seem reasonable to assume that in some 20% of inward investment cases the quality of the rail services will be the critical factor in determining the location decision'* [page 13]

Using economic data for Great Britain, they estimate that this would represent 60 jobs per annum, and 500 jobs in the medium term (although what exactly constitutes the 'medium term' is unclear; their calculations would suggest 8-9 years).

For *benefits to existing industry*, they estimate that improving the MML will do little to improve *exports of manufactured goods*, on the basis that only a small percentage of firms (7%) use the MML for freight. However, they undertake some broad calculations, based upon the likely impacts of the Single European Market (completed in 1992). They estimate that 1% of firms could gain from accessibility improvements to Europe caused by the MML and the Channel Tunnel. This is a good example of the use of reasoned but very much *ad hoc* approximations, where they estimate that 1000 jobs could be attributable to the MML [page 15].

Secondly in this category is *business usage*. They comment that their survey of firms showed that 90% of companies employing over 50 people use MML for business purposes. This importance they believe will rise as firms decentralise from the South East. They identify two components to this.

1 *Benefits to existing firms* (expansion of indigenous industry). Their survey covered 84 firms. They used the survey results to categorise firms by their employee numbers, and then indicate what proportion of employment in each band was likely to be affected by MML. The linkages from MML to business decisions were in terms of expansion of company activity and a possible displacement of firms as a consequence of rise in employment in those growing. They make the explicit assumption that employment could be expanded (as consequence of MML) by 1% (based on unspecified 'policy evaluative research' by ECOTEC [page 19]).

   They then reduce this growth for factors such as labour market displacement, leaving a net employment impact of 1500 jobs.

2 Also thought to be an important component for change are *new economic activities*, primarily firms decentralising from the south east. They quote figures from other studies, which say that 5000 jobs p.a. are decentralising from South East. They then come to some assumptions based upon interviews with estate agents and local government representatives. They say that if the MML could improve the proportion of firms that relocate to study area by 20%, this would lead to additional 150 jobs p.a. However, they state that this impact is limited to a short period (just over 3 years) *"as improvements raise the perception of rail quality"*[1] [page 20].

They estimate that the maximum number of expected *commuters relocating* into the study area could double as a result of the MML (from 350 to 700, page 21). Given figures in the household expenditure survey, they estimate that this could lead to £6.8m per annum. Secondary effects could increase the retailing sector by 100 jobs (given that £60,000 of retailing is needed to support one retail job).

When added together these various categories give a total net increase in jobs in the order of 3600 [page 22], over the next decade. The characteristics of this approach are that:

- all calculations undertaken at aggregate study area level;
- simple assumptions for growth and percentages of impacts;
- they attempt in all cases to have a linkage between the MML and the impact suggested. The most formal is the use of comparable consultations for the East Coast Main line (ECML), but more usually the factors are simple *ad hoc* estimates.
- the focus of impacts is upon the 'medium' term, i.e. the next 10 years. Although no explicit reason for this is given, it seems likely that the quantitative estimates are for this period, while some of the qualitative comments deal with the longer term possibilities.

Development impacts are based upon discussions with developers. Various sectors were considered likely to be affected.

1 We are not entirely clear as to the reasoning behind the statement.

1 *City centre office development*: speculative developments are unlikely to be affected. Again, with *ad hoc* calculations they estimate that annual office development in the four largest cities in the study area is approx 60,000m², or £6m of development. Using ECML [page B.41] comparable improvements, they estimate that MML could add 10% to this. They do not add employment generated by this, which would be double counting. Note they have ignored smaller urban centres on the routes.

2 They say that further *warehouse development* is unlikely, and that if it did occur at rail freight facilities, then this would be at the expense of development elsewhere.

3 Housing for the 700 additional residents, as discussed above.

They do not consider increases in the intensity of use of existing developments.

5.5 Induced impacts: spatial disaggregation

The study mostly considers the net economic (employment) impact for the study area as a whole. However, in Section 5, page 26, they also consider impacts on policy objectives. In doing this, they allocate the employment 'benefits' in proportion to the existing distribution of jobs. Thus only implicit account is taken of the changes in the relative attractiveness of locations given the improvements to the MML. However, this raises the question of what other sources of impacts they could have used. Other than the explicit comments about the reductions to benefits for existing firms on the basis of labour market displacements, there is little wider consideration of the net losses outside the study area.

5.6 Induced impacts: benefits calculations

There are no formal benefit calculations, other than quoting the possible jobs and new floorspace generated. However, there does appear to be a strong implicit assumption that the benefits c to g are in addition to any transport benefit.

5.7 Conclusions

This study is clearly concerned with induced economic effects which would be brought about by the possible improvement in services on the Midland Main Line. The induced effects are divided into various categories; some of these (impacts on retail growth) seem to be considered as directly induced by the transport improvement, even though it might be more appropriate to consider them as multiplier effects of other economic impacts. The nature and strength of the relationships between transport change and induced economic effects are not entirely explicit, given that the study relies considerably on surveys of expert opinion and upon the consultants' own judgements. There is no consideration of the way in which the economic impacts would vary with the degree to which rail services might be improved and accelerated. The study area considered is essentially the administrative area of the client bodies, and therefore overlaps with other major rail corridors. This is not in itself a failing or drawback, but we have not found any discussion of how the presence (and possible improvement) of competing rail services might affect the impacts of improving the Midland Main Line.

There is no explicit discussion of the distinction between impacts and benefits: it seems to be assumed that all growth is beneficial. The possibility that counting induced economic change as benefits might double-count transport benefits is considered. There is some reference to other components of economic change, but no analysis of the interaction between such processes and the effects of the proposed improvement.

CHAPTER 6
M74 Northern Extension

6.1 Introduction

This Chapter is based upon *The relationship between economic development and transport links, Stage 2: Economic effects of the M74 Northern Extension*, prepared by Kennedy McTavish, OFTPA and Cambridge Systematics for Glasgow Development Agency, 1993.

6.2 Aims of the study

A previous report examining the potential for economic development as a result of transport infrastructure concluded that a small number of strategic business districts (supporting the main Central Business District) could be viable, situated where land was available on strategic infrastructure routes. However, it found that a key link was missing, namely the M8/M74 link (effectively a bypass for central Glasgow), and this study examines the economic value of that link.

Note that this study was part of a wider programme looking at the implications of the M74. Furthermore, the study has been superseded by more recent work which is examining the implications of the M74 completion both in regional and national Scottish terms, focusing upon industrial profiles and wider economic analysis.

6.3 Direct transport impacts

The direct impacts of the scheme were determined by Strathclyde Regional Council in a NESA analysis. The final benefits from this scheme were fed into the Regional Framework, as outlined below.

6.4 Induced impacts: general method

The key element of this approach is that it adopts a 'Regional Economic Impact Assessment Framework' produced by Cambridge Systematics. It examines '*the impacts throughout the economy of travel time and cost savings, instead of using the cost savings themselves as the full measure of the economic benefit*' [page 11]. The chief indicators used are jobs, value added[1], and development demand (floorspace).

The methodology adopted in this approach is complex. It focuses around the adoption of the Regional Economic Impact Assessment Framework described above, this being the quantitative analysis outlined in Section 3 [pages 25-38]. However, preceding this is an qualitative description of the likely impacts, and proceeding this is discussion, in

1 Value added is the excess of the value of output over the value of the inputs used to create the output.

qualitative terms, of the impacts of 'special development opportunities', (the airport and rail terminal). The quantified methodology is shown in Figure 4, which shows the regional framework method. As such it is similar to but more formalised than that used in the MML study.

Figure 4: **M74 Northern Extension: Study Method**

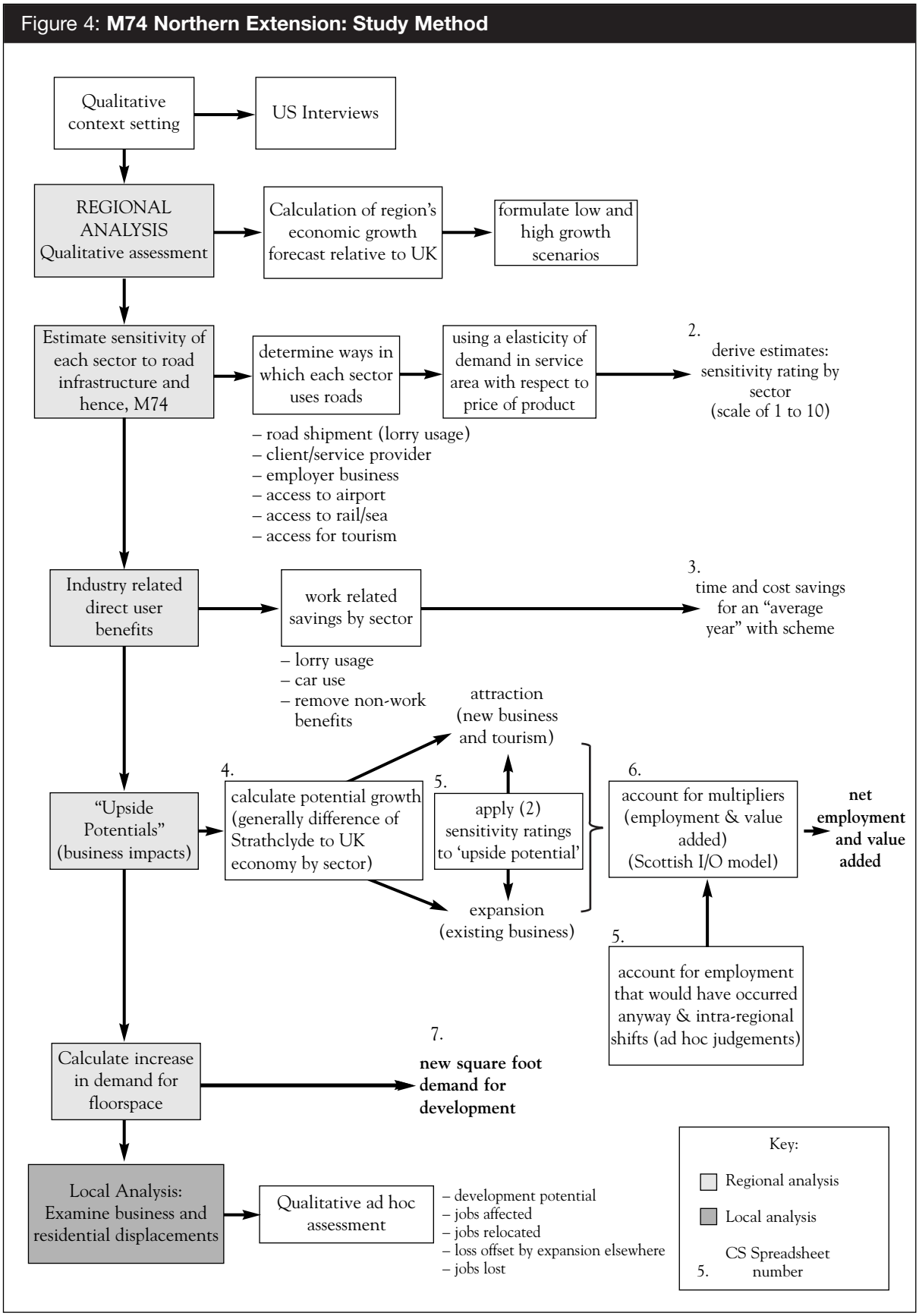


Figure 4 shows the main stages in the method via a series of spreadsheets numbered #1 to #7. These are discussed in turn[2]:

#1 The first step is to determine the projected economic growth of the region, using local economic trends (although clearly an economic growth model could be used here as well).

#2 The sensitivity of each sector to the road improvement is then assessed, the index being a scale from 1 to 10 where 10 implies "totally dependent on the road for business" and 1 means "virtually non dependent on the roadway" [page 27]. This sensitivity (which seems also to be referred to as an elasticity) is dependant upon such factors as the flows of raw materials, sales and capital. It is implied that where available, regional simulation models such as the REMI model[3] are used to derive these sensitivities; in the absence of such a model for Scotland, a mixture of studies and of professional judgement was used.

#3 The transport (user) benefits, are then considered, broken down into the work related cost savings for each sector. The benefits are divided into the industrial sectors on the basis of the size of the industry. Non-work cost savings are excluded (as they do not result in additional income to the economy).

#4 This spreadsheet calculates the potential amount of future growth that the region could achieve. This is taken as the difference between the UK expected growth and Strathclyde's own projection.

#5 "Direct economic impacts" (in their terminology, meaning impacts on sectors directly affected by transport rather than multiplier effects) are then calculated, for jobs and the wider region. This is in two parts.

Firstly the work related transport services (which appears to be the same as the transport user benefits).

Secondly the business expansion and attraction benefits (so called 'additional effects'). Two scenarios are outlined, a 'low' one with just the M74 as an attractor, and a 'high' one with other factors such as the airport expansion, and investment in high tech industries. These factors are calculated by applying the sector sensitivity factors (#2) to the potential growth factors in #4; it is not clear how the differences between the high and low scenarios are introduced.

No more details of the methodology are given. This is unfortunate, especially as it appears that the direct savings are expressed in terms of additional jobs, as well as value added, which requires additional explanation.

2 Note that we have not actually seen the worksheets themselves: the following is based entirely on the descriptions of the worksheets in the text of the consultants' report.

3 The "REMI model" is a package developed by Regional Economic Models Inc for dynamic economic-demographic forecasting; it is designed to create single-area or multi-area models based on available data for groups of US counties and on standard US economic and other relationships (Treyz et al, 1992). The model identifies various categories of transport as economic sectors (see, for exampe, Cassing and Giarratani, 1992, Table 2) but does not (so far as we aware) consider transport itself.

#6 The (#5) direct impacts are then factored using multipliers from the Fraser of Allander Institute.

#7 The approximate demand for new floorspace is thus calculated on the basis of average sq foot per employee figures (from the USA: no local or Scottish data was available).

Some key points to draw from the methodology are that:

- parameters from the USA are used, for example the cost spent on shipments by road [page 28], and business use of air access [page 31];
- both indigenous growth and inward investment are implicitly considered;
- two economic growth scenarios are considered: high and low;
- this study works in the opposite direction compared to the Dearne road study, in that the employment is calculated first, without regard for the available space, and thus a demand for floorspace is produced;
- The initial growth forecasts are calculated to 2005 [page 27], and it appears that the impacts are calculated for an 'average year' within this period (although this is difficult to determine without any tabular results).

Following this, Section 4 of the consultants' report examines the local (corridor) impacts, with some simple *ad hoc* quantification (page 47). This considers both positive and negative impacts. However, these are not additional to the regional impacts, rather it is an examination of how the M74 corridor may gain or lose in the regional context.

6.5 Induced impacts: spatial disaggregation

There is no spatial disaggregation of the benefits calculated, and everything is undertaken at a study area level. However, there is discussion of several key regional sites [pages 38 and 40] in addition to the quantified analysis. In these cases it is the combination of the M74 with other transport infrastructure that is considered relevant. It is assumed that these sites were picked because they are the most likely to experience development benefits from the new road, and hence are case studies, rather than the full range of possible sites.

The local analysis deals with specific sites, but not in a systematic or quantified manner.

6.6 Induced impacts: benefit calculations

It is unclear in this report whether any of the impacts are considered additional to the direct transport benefits. The inferences from page 11 of the case study report suggest that they are not additional. However, the impression is given that the impacts are net additions to the regional economy from the road.

This lack of clarity means that there is a danger of double counting [page 15], as the study states that the scheme already has a good Net Present Value from NESA, but that this does not include wider economic effects. The danger is not because the study itself double counts, but that it can be interpreted as complimentary to the cost benefit analysis.

On the corridor level the situation is clearly stated; none of the impacts are net additions, but redistributions of the regional growth.

6.7 Conclusions

This report is complex to interpret partly because the tables were not included, and partly because it has both quantified impacts (jobs and value added), and site specific development opportunities, but does not make clear whether the former are already in the latter. Study of the report implies that they are already counted, the purpose of the special discussion showing how the M74 contributes to the potential already offered by the air and rail investment. It is also confusing that the net 'spillover' benefits are not distinguished from those benefits already counted as part of the transport benefit.

The study does however have a clear quantified link between transport change and induced economic effects, through the magnitude of the direct transport benefits. It would therefore appear possible to use the method to consider the relative impact of alternative transport schemes. The linkage is from transport to economic activity, ie to the users of property rather than the suppliers of property. As discussed earlier, we find the transport-users link much more convincing than a direct transport-developers link. The study considers economic impacts on the broad assumption, but no specific claim, that positive economic impacts constitute benefits. The potential problem of double-counting is not explicitly considered. The impact of the transport improvement is clearly seen in the context of other economic changes, though the implied relationship between the potential impact of the scheme and the difference between regional and UK forecasts is not fully explained. The study also recognizes that there is a need to consider the role of other policy variables such as the expansion of Glasgow Airport.

CHAPTER 7
A7/A68 Improvements

7.1 Introduction

This Chapter is based upon *Economic impacts of A7/A68 improvements: Final Report*, prepared by Marcial Echenique & Partners for the Scottish Development Department, 1990. This is to some extent taken as an example of a model-based approach, rather than a specific commentary on the MEPLAN package and its application in this particular case. However, given that the evaluation framework is unique to MEPLAN, some specifics must be considered. This is complicated by the fact that whilst a good deal has been written about MEPLAN (eg Hunt and Simmonds, 1993, Echenique 1994), there is much less published commentary concerning the evaluation package, either in general or in the particular form in which it stood in 1990.

7.2 Aims of the study

The study examined separate improvements to the A7 and A68 between the Borders Towns and Edinburgh. At one level the purpose of the work was to provide a wider assessment and appraisal of these proposals; at another level, the work was intended as a test application of the MEPLAN package to such issues.

Given that the study consisted entirely of the application and use of the model, and that the model (in its general, computer-package form) existed before the study, it seems helpful to give an outline of the model before answering the checklist questions about the study.

7.3 The modelling approach

The modelling approach is based upon the integration of:

- a spatial input-output model, which represents the linkages and flows between different sectors of the economy, with;
- a transport model, which represents the linkages and flows between different areas or regions within the economy.

The particular form of spatial input-output model used in turn involves an integration of:

- conventional inter-sectoral input-output modelling with;
- an endogenous household sector (so that population is a function of employment);

- a trade (economic interaction) distribution model (influenced by previous transport costs or disutilities);

- a microeconomic model of the demand of activities for space (floorspace or land).

The relationship between the land-use or economic part of the model and the transport model depends on the correspondence between the economic interactions shown in Table 3 and the transport demands shown in Table 4 (after Echenique, 1994). Note that each kind of interaction or trip shown in these Tables is represented by a spatial production-consumption or origin-destination matrix in the model.

Table 3: **Matrix of trades in a spatial-economic model**

	Industrial consumers	**Household consumers**
Industrial producers	Trades between and within industries (including imports and exports)	Goods and services for personal consumption
Household producers	Labour supplied to employers	Domestic service "Unofficial" economy

Table 4: **Matrix of transport demand generated from trades**

	Industrial destination	**Household destinations**
Industrial origins	Goods haulage Business travel	Travel to shop, to school, etc
Household origins	Journeys to and from work	Journeys to and from work Social travel

This integration has been pursued by a number of research and consultancy teams around the world. The most sophisticated applications to date are probably those of the "Martin Centre Models". These models are applications of two software packages, MEPLAN (Echenique, 1994) and TRANUS (de la Barra, 1989), both of which have their origins in what is now the Martin Centre at the University of Cambridge. Key characteristics of these are that they can take account:

(a) the short-term constraining effects of land or floorspace supply (and the economic implications of such constraints);

(b) certain fixed time-lags and gradual responses;

(c) travel or haulage choices and conditions, including time as well as cost, and hence having the ability to represent congestion.

An outline of the history of such models can be found in Hunt and Simmonds (1993). The present state of their development is (in essence) that they require a significant effort in implementation and calibration, which enables them to reproduce (not necessarily perfectly) the base year situation in terms of land-use, economic activity and transport flows. They can then be run forward over time. In doing so, a wide variety of changes can be introduced, especially:

1 changes in transport supply (opening or closure of infrastructure; changes in fuel prices, fares and tariffs; certain changes in regulation);

2 changes in land and floorspace supply (representing planning policies, or its outcomes – details vary between implementations);

3 certain overall economic changes, such as growth or decline of particular industries, or changes in household incomes.

For each set of inputs, the model will predict a set of results over time including:

- the pattern of land-using activities (typically households and employment);
- the patterns of interactions between these;
- the patterns of travel or freight demand resulting from those interactions;
- use of the network(s), including levels of congestion;
- rents and prices in the economy, which will include the effects of;
- times and costs in the transport system.

The impact of a particular policy is assessed by comparing the results of the policy over time with results from a base or do-minimum run. If the policy involves changes of land or transport supply, without changes in the overall economy, it can be the subject of a cost-benefit analysis which attempts to cover all aspects modelled, ie both the land-use and transport components.

7.4 Direct transport impacts

The A7/A68 study uses a standard "urban" implementation of MEPLAN, with the study area covering South East Scotland divided into 14 coarse zones. The zones range from relatively small but very highly populated (including a single zone for Edinburgh) to large and very sparsely populated. The implementation is "urban" in the sense that it represents typical urban flows of commuters, shoppers, schoolchildren in detail, but freight flows in very little detail. This can be contrasted with "inter-regional" applications of the same modelling framework (eg Williams and Lindberg, 1989) which focus mainly or exclusively on freight flows.

The transport network operates within this zonal structure, with links representing either specific roads or groups of roads. The model was calibrated for the base year (1981) and used to forecast (retrospectively) in three-year steps to 1984 and 1987. The evaluations are based on comparisons of the policy alternatives with the do-minimum for 1984 and 1987.

The report gives user transport benefits directly in terms of the consumer surplus gains to travellers (page 9-7). These are obtained from the generalised cost matrices (which represent the generalised cost of all available modes for each journey) and the numbers of trips. The key point to remember about MEPLAN however is that these benefits come at the end of a chain of calculations, resulting from the trade flows and land-use changes that the model calculates.

7.5 Induced impacts: general method

The MEPLAN package, like many other models, models transport demand at a particular point in time as a function of the pattern of land-uses at that moment. Feedback effects from transport to land-use take place over time, mostly in the next year to be modelled. In the present study, the model was run from 1981 to 1984 to 1987 (and for at least some purposes to 1990 and 1993 – see [8-9]); the transport changes to be assessed were introduced in the transport model run for 1984. They therefore affected the transport results (with unchanged land-use) in 1984; these affected household and employment in 1987. The changed location of households and employment in 1987 have a further effect on transport in that year. A further time period would have allowed the possible effect on housing supply to be modelled, but this was not fully done [p9-6].

The possible improvements were introduced as reductions in journey times between the Border Towns and Lothian, either on the A68 *or* on the A7. The immediate (1984) effect of this is to give time savings to car users and goods vehicle operators whose journeys can use the roads in question, and to some extent to bring about a transfer from bus to car. No instantaneous redistribution is possible. In 1987, MEPLAN recalculates the location of and interactions between households and activities until they are in equilibrium with the changed transport conditions, ie taking into account, into the policy test runs, the reduction in the generalised cost of travel along the A7 or the A68. This gives rise to a new pattern of trip ends and flows which form the travel demand for the 1987 transport model run.

The scale of the land-use effects is very slight: an *increase* (comparing policy with base in 1993) of about 0.5% in the number of households living in the "policy impact area" (the A7/A68 corridor), and an even smaller *decrease* in the number of jobs in that area. The report does not give sufficient detail to support a proper explanation of the signs and sizes of these effects, and indeed we know from other work with similar models that it can be difficult properly to explain the results produced by equilibrium models involving complex simultaneous interactions. However, it seems highly likely that the key effects are:

- an increase in the numbers of people working in Lothian who live in the Borders;
- an increase in the propensity of Borders residents to shop and obtain other services in Lothian.

Note that this is the only recognition in the five Case Study methods of the "two-way" road argument, whereby improved access to a particular area may have negative effects as well as positive effects. The small scale of the effects can be explained by the low base levels of interaction along the corridor, and also by the constraining effect of housing supply, which was not (apparently) allowed to change.

7.6 Induced impacts: spatial basis

All of the calculations in the MEPLAN take place at a zonal or zone-to-zone level, and all other results are obtained by aggregating from this basis.

The cost of labour to basic industries (in £) are given by zone, with constrained study area totals. Likewise the cost of living to the exogenous population is also calculated by zone.

Furthermore, the following spatial variables are also produced [page 9-5]):

- location of employment by sector;
- location of households by socio-economic group;
- rents per room.

Note that the model is self contained within the study area (of which the A7/A68 corridor is only a small part), and does not consider the whole of the Scottish or UK economies.

7.7 Benefit calculations

A key point is that assessment of benefits in MEPLAN depends on its equilibrium assumptions. MEPLAN's land-use model iterates until an equilibrium is established between different land-uses (in quantity and location) and between the demand for and supply of land or floorspace, given those supply characteristics, the overall economic variables and the previous transport pattern. Similarly, though in a much more limited way, the demand for transport is adjusted, in terms of mode and route choice (though not of trip ends and distributions) until an equilibrium with between network characteristics is found. The economic evaluation process therefore depends on:

- identifying which of the modelled economic actors may experience changes in *consumer surplus*, in the land-use or the transport market;
- identifying which of the modelled economic actors may experience changes in *profits*, likewise; and
- identifying and eliminating any double-counting in which a change in the cost (or generalised cost) of transport is also counted in the land-use market.

This gives rise to the evaluation framework shown in Table 5. This categorises impacts by their recipient. Consumers' land use benefits are calculated in the same way as direct transport benefits, i.e. as a consumer surplus relating to the implied demand curve for floorspace relative to cost [see page 9-2]. There is an explicit acknowledgment that in 5 consideration of both land-use and transport effects double counts the transport benefits. To compensate for this, the travel cost (money cost, not generalised cost) savings are subtracted in identifying the total benefits, with account taken of the lags in the model [page 9-6].

Note that the indirect benefits are calculated on the assumption that households maintain their standard of living for a given year, and that businesses whose clients or customers are within the modelled area pass on their costs to their consumers. The formulation of the A7/A68 model is such that only exporting businesses, non-workers and landowners cannot pass on their costs, and hence it is here that the final impacts collect.

Table 5: **MEPLAN evaluation framework**

	Land-use	**Transport**
Consumers	cost savings to unemployed or retired (exogenous population)	user benefits
	(less previous personal travel cost savings)	
Producers	labour cost savings to the basic sector	increase in public transport revenue (bus and rail)
	incomes from housing rents (no split between private and public)	saving in public transport operating costs
		increases in car traffic tolls and charges
Government	none	fuel tax revenue

The evaluation results [Chapter 9] demonstrate that the interplay between transport and land-use can give rise to some fairly complex effects even under the sweeping partial equilibrium assumptions embedded in the Martin Centre models. The general effect of the road improvements is that road users within the study area switch to making faster, but longer and more expensive journeys. The result of this is that they enjoy substantial benefits in the transport market, but that disbenefits arise in the land-use market. These disbenefits accrue to those who ultimately pay for the more expensive journeys (given the model's assumptions about workers' constant standard of living) without enjoying the associated time or other benefits. There is also reference in the commentary on the results [page 9-13] to the more general argument that land rents are generated by spatial mismatch between supply and demand, and that any improvement in transport which facilitates movements reduces such mismatch and leads eventually to a decrease in the total rent paid.

The benefits (including the land use benefits) are discounted against the expected cost of the scheme to give a rate of return on the investment. This provides a rate of return of 6-10% for the A68, which the consultants claim gives a fresh insight into land use impacts of transport policy evaluation.

It should be noted in passing that the details of the evaluation process attached to the MEPLAN package may well have changed since 1990.

7.8 Limitations and weaknesses of the approach

The preceding description of the modelling approach embodied in the MEPLAN package, and of its application to the A7/A68 study, has tended to stress the advantages of the approach in terms of providing an integrated and fairly detailed means of considering the interactions between transport and land-use, of which the induced economic impacts of transport change are one component. This section emphasises some of the corresponding weaknesses. Given the limited amount of detail presented in the A7/A68 report, and the very restricted use which has been made of this particular model, much of what follows about the modelling refers to the approach in general rather than to its Case Study application. It draws upon the critique previously published as Simmonds (1994), to which readers should refer for more detail.

The weaknesses of the approach stem from the fact that it is predominantly cross-sectional and highly synthetic in nature. By cross-sectional, we mean that the majority of the equations in the model describe relationships between different variables at one point in time. By synthetic, we mean that the model uses these relationships to "predict" many variables in the base year on which it is calibrated, rather than taking observed values as input. The synthetic property can be an asset, in that it allows the model itself to estimate variables which may be missing from the observed dataset. However, it also means that the model may start from a base situation which only imperfectly resembles the real base year.

Various techniques have been invented to try to improve the model's ability to reproduce all known aspects of the base year. However, it has also been argued that the cross-sectional equilibrium calculated by the model does not attempt to reproduce exactly the real situation at any particular moment in time. It is therefore not clear whether it is even desirable that the model should exactly reproduce the base situation. If it is not, then clearly one does not expect it to attempt to reproduce any other situation exactly, but only to represent a pattern of change that loosely parallels the real world.

The synthetic nature of the model also means that it is generally difficult to make use of estimation methods applied outside the model, because one cannot guarantee that the model will correctly reproduce the independent variables. For example, it is possible to estimate relationships between (physical) development rates and property prices using observed data, but difficult to use the results if the model system does not correctly reproduce the property prices in each zone. Likewise, because so many variables are calculated by the model, it is difficult to incorporate data on observed changes over time if the real world fails to conform to the model predictions.

A further problem related to the synthetic nature of this and similar models is that transport variables are calculated at the end of a long series of model steps. So far as new transport infrastructure is concerned, this often means that the demand for the new link or system is relatively inaccurate; even if many of the land-use variables accurately reproduce their observed values, the predictions of the interactions between land-uses and of the physical travel demand generated by these interactions are liable to be inaccurate. It is therefore difficult (though the problem continues to be worked upon) to create as accurate a base pattern of transport demand as in a free-standing transport model.

In so far as the model is dynamic, it suffers from the limitation that it assumes activities to reach an equilibrium with the pattern of transport costs and times in the previous time period; there is therefore a fixed time-lag applying to all activities. In the A7/A68 application, this means that it would, in the model results, take three years from the opening of the improved road before any shoppers would divert to different retail centres; any attempt at interpreting the results to assume a faster response will be made very difficult by the relocation of residents and of work within the same time period.

Finally, the model still exhibits the characteristic of the original (1964) Lowry model, that population is a function of employment not only in location but also in number. Any increase in employment in the Study Area will lead to an increase in population (both working and non-working) unless *ad hoc* adjustments are applied to overcome this. This still seems a fundamental drawback to its use in the many cases where the desired economic impact of transport improvement is to reduce unemployment.

In addition to these issues within the method itself, it is of course almost inevitable that a sophisticated method requires more resources than a simple method, and also that the application of a sophisticated new model to the impacts of a particular transport scheme will require a substantial investment in the model and apparently little effort devoted to consideration of the scheme itself. The practical implications of the time and effort required to apply different approaches are not, however, a subject which we are attempting to review in the present Study.

7.9 Applicability of the approach

In discussion of our Draft Report, we were asked to consider the applicability of the MEPLAN approach at different spatial scales.

Applications of the approach have ranged from a small town (Rickaby *et al*, 1992) to the whole of Europe (Rohr and Williams, 1994). As already noted, there have generally been two distinct types of application, one giving more emphasis to the location and interactions of households, and hence dominated by daily passenger travel, and the other emphasising the location and interactions of industries, with much more attention to freight movement and to business and other longer-distance travel. Constraints on the supply of land and buildings, and the rents arising from these constraints, are critical to location patterns in the former, but less important or absent in the latter.

The first requirement for such a model to be applicable is that the area represented should be sufficiently self-contained as to represent a reasonably full choice of possible locations (to live, to shop, to buy and sell goods) for the main economic activities under consideration[1]. Such an area is generally smaller for residents than for commercial transactions; hence the household/passenger models tend to be "urban" and the industrial/freight models tend to be "regional" or multi-regional, though there is an overlap between the largest "urban" and the smallest "regional" applications. The requirement for a reasonably high degree of self-containment and completeness explains why the Case Study application includes areas to the west and north of Edinburgh, as well as the A7/A68 corridor to the south-east and its immediate neighbours.

The degree of self-containment is a function not just of size and spatial scale, but also of the nature of the economy and of the separation between the area under consideration and other urban or regional economies. The other basic requirement for a cross-sectional model such as MEPLAN is that the zonal populations should be large enough that one can expect regular patterns to be observable in variables such as travel to work; alternatively the calibration of the model should explicitly relate to groups of zones. The A7/A68 study was perhaps over optimistic in working with zones so small as to have only a couple of hundred resident households (Table 4.7, page 4-8). In effect, it adopted a more aggregate approach by looking at the net commuting flows between the Border Towns and Lothian (page 5-4), though this was also bedevilled by the imbalance in size between Edinburgh and Midlothian at one end of the corridor and small towns such as Selkirk and Melrose at the other (page 5-5).

The requirement for a fairly self-contained system and the advantage of zones that avoid extremes of size would apply to many other models – perhaps to all models that would aim to represent the system's economy both spatially and comprehensively. The other

1 This criterion is of course equally applicable to many other models.

characteristic of the Martin Centre models which may have a bearing on their applicability at different spatial scales is their equilibrium basis. This means that they are inherently unsuitable for short-term forecasting where the rate of change is critical; it also means that they are unsuitable for use where particular sectors have dynamics of their own which interact with the model variables. The most obvious example of such dynamics is demographic change; as mentioned earlier, the way in which the models produce population from employment, rather than through the more familiar processes, continues to cast doubt over the applicability of "urban" applications of the Martin Centre model to issues in which the level and distribution of unemployment is critical.

7.10 Summary of indirect impact analysis

This Case Study meets most of the characteristics identified in Chapter 2 as desirable for public sector appraisal. The "land-use" effects consist entirely of induced effects (the direct economic impact of expenditure in building and operating the new roads is not considered). The logical link from the transport change to the induced economic impacts is clearly specified, to the point of being implemented as computer code and quantified by parameters, though the complexities of the interactions affected are such that the logic of the impacts may be difficult to trace in practice. There is a clear distinction between the modelling, which deals in impacts, and the evaluation system, which considers costs and benefits. The issue of double-counting is explicitly considered, although the way in which it is dealt with – by obtaining a result in which many effects are double-counted, and then subtracting a correction term – renders interpretation of the results difficult. The approach is dynamic in structure (though much of the detail is not dynamic) and produces outputs which ostensibly represent a sequence of years into the future. The scope for explicit inclusion of other processes of change is generally limited.

The type of model upon which this study was based represents a fully systematic approach to testing the impact of a transport change, in which the different effects of different changes in the network are determined entirely by the calibrated model. Provided that the transport supply changes to be tested can be unambiguously measured as changes to model variables, the execution of the tests is essentially carried out by the model software.

It should be noted that the use of a model of this kind does not in any sense eliminate the use of professional judgement, but applies it in a different way. The approach requires a large measure of judgement in the definition of the model (both at the level of package design and in the choice of how the approach should be applied to a particular study) and in its calibration (which is partly based upon the statistical analysis of local data and partly upon other findings or past experience).

ME&P concluded [page 10-2] that sensitivity testing was required to examine the robustness of their model results. An important characteristic of model-based approaches is that where a study is entirely built around a formal model, it would be possible to undertake systematic testing to investigate sensitivity to the various assumptions, at least in so far as these are expressed as coefficient values. Such testing might also be possible using the approach applied to the M74, but would be limited or impossible in the other Case Studies considered here.

This Case Study is intended to serve not only as an example in itself but also as a more general representative of a fully-fledged "modelling approach" to the impacts under scrutiny. Some alternative models are presented in the following Chapter.

CHAPTER 8
Other approaches of interest

8.1 Introduction

The five case studies selected by SACTRA and summarised in the preceding Chapters are the main focus of this Report. The discussion which follows in the next Chapter would however be artificially limited if we could not refer to other approaches of which we are already aware. The purpose of the present Chapter is therefore to identify these other approaches and to give a very brief outline of each, so that the Case Study approaches can be seen in their methodological context. We believe that all of these have been at least mentioned to the Committee, in evidence submitted or in other work. The following descriptions are all based on published documents or on previous reviews of published documents.

The approaches mentioned are all mathematical models, of varying degrees of sophistication. Rather than carrying out a search for relevant models in the literature, we have looked only at:

- those mentioned in the work carried out by NERA (John Dodgson) for the Committee;
- those which we previously reviewed as part of a study for the European Commission on methods for examining induced traffic effects of major transport infrastructure schemes (at the regional level); and
- the CEBR model.

The three models or groups of models discussed in the NERA report are:

- Dodgson's own model (1974);
- CGE (computable general equilibrium) models;
- macroeconomic models.

The models which we found to be of relevance in the regional induced traffic study were all transport-economic interaction models:

- spatial input-output type models, exemplified by multi-regional applications of the MEPLAN package (Channel Tunnel, Sweden);
- the statistical model developed and applied by SETEC-Economie;
- our own multi-regional model based around the DSCMOD package (Simmonds and Jenkinson, 1993).

In the following sections, we describe each of these very briefly.

8.2 Model summaries

8.2.1 DODGSON MODEL

This study examined the expected effect of the M62, at a time when that motorway was under construction. The analysis involved developing a measure of access costs, using gravity modelling methods, and calculating the change in these costs that the M62 would be expected to produce. A model of employment growth was calibrated, based upon hypotheses about the relationships between the supply and demand for labour, local industrial structure, location and congestion. The resulting equation was used to estimate changes in employment in different areas as a result of the change in access costs.

8.2.2 COMPUTABLE GENERAL EQUILIBRIUM MODELS

Computable general equilibrium (CGE) models are a class of economic models which are "general" in that they represent the economic behaviour of both consumers and producers, and "equilibrium" in that given that behaviour and a number of exogenously determined conditions, they can find the equilibrium state of the whole economy in terms of the quantities and prices of consumption and production (and other related variables).

A multiregional version of a CGE model can include the costs of delivering goods and services from their producers to their consumers. A change in these costs (whether general or specific to particular flows by sector or region) will then affect both the location and the total levels of production and consumption. Roson and Vianelli (1993) give example results from the development of such a model for Italy. [We believe that this work was a contribution to the continuing development of the Italian national transport model].

The main focus of such models is likely to be on freight flows and the effect of exogenously calculated changes in transport cost. There would however seem no reason why in principle they should not:

- include passenger flows in so far as these can be related to economic relationships between producers and consumers;

- treat the transport system as endogenous, so that transport costs reflect levels of congestion which in turn reflect the level of transport demand on a given infrastructure.

These extensions are indeed incorporated in the type of spatial-economic model represented by the Martin Centre packages, which have much in common with the CGE approach. The critical difference, however, is that the CGE models calculate a simultaneous equilibrium, whereas the Martin Centre models operate with an explicitly lagged response to transport costs.

8.2.3 MACROECONOMIC MODELS

Characteristics of macroeconomic models are:

- a series of relationships, at least some of them involving time-lags; which are
- established (in terms both of coefficients and (to some extent) of variables) by statistical analysis of empirical data.

The latter point contrasts with many of the other models considered in this report, whose specifications tend to be pre-determined by their theoretical approach, and for which statistical analysis is more a matter of "fitting" the model to the data than of designing the model.

Macroeconomic models are likely to be estimated only for a complete regional or national economy, without spatial disaggregation, since it is difficult to see how one could estimate relationships between regions in such an approach. The NERA report to SACTRA argues (pp19-20) that such models cannot represent transport costs explicitly, nor can they directly consider expenditure on transport infrastructure, but that they may be able to detect relationships between infrastructure spending in general and subsequent changes in economic activity.

One example of such a model applied at the sub-regional level is that for Merseyside by Minford et al (1994). This was used in an earlier analysis by Minford and Stoney (1991), recently submitted to SACTRA, which attempted to apply the model to analysis of the economic impact of improved transport infrastructure. This application did not however introduce any transport variable into the model itself. Instead, it:

1 calculated the cost savings to manufacturers of a kilometre of new road;

2 argued that these savings would be converted into an increase in wages paid to manufacturing workers on Merseyside; and

3 used the macroeconomic model of Merseyside to examine the consequences of this increase.

The use of the model identifies a range of effects[1], on an explicit timescale of 10 to 20 years, on

- manufacturing and non-manufacturing employment;
- unemployment and the size of the working population;
- wages, total demand and sub-regional GDP.

1 Note that Simulation A in the 1994 paper appears to test exactly the same change – a permanent 1% increase in manufacturing workers' wages – as was examined in the 1991 analysis, and to give more reasonable results, in particular a more stable impact on unemployment. (Page 565 of the 1994 paper indicates that "manufacturing worker" and "manual worker" are taken as synonymous).

The weakness in this approach appears to be in the linkage from the freight costs to wage increases (the steps listed above). It is not clear:

(a) why manufacturers on Merseyside should respond to reduced freight costs by increasing wages and remaining just competitive rather than by reducing their prices and becoming more competitive;

(b) what if anything the analysis says about the reduction in costs for non-Merseyside firms selling goods in the Merseyside market; and most critically

(c) how the analysis considers the incidence of the road improvement. From the paper, confirmed by discussion with one of the authors, it would appear that the analysis assumes that any new road is used by all Merseyside manufacturing both in obtaining supplies and in delivering their production.

Another model which should probably be considered under this heading is the Centre for Economics and Business Research (CEBR) national model, and CEBR's related but subsidiary regional models of London and of the Rest of the South-East (RoSE). There is however no detailed published description of this model; all we know is that it is "a comprehensive economic model of the UK economy that incorporates both monetarist and Keynesian considerations", using inter alia an input-output approach, and that it can produce both quarterly short-term and annual long-term forecasts (CEBR, 1994, p21). From the discussion of results in that reference, it is evident that the model forecasts employment and unemployment, GDP, imports and exports (and hence the balance of payments), tax receipts, benefit payments, house prices, investment, public sector borrowing requirement and inflation.

The CEBR's general approach to modelling the effect of transport investment, as represented in their 1994 study for the British Roads Federation, is broadly the same as that of Minford et al, in that the benefits of the investment (again, road construction) are examined and the resulting cost savings are input to the national or regional model. The basic process is that:

(1) an exogenously chosen level of national road investment for each future year is converted into a length of new road, using a non-linear relationship based on schemes at different levels of priority in the past/present roads programme;

(2) the level of congestion (undefined) in a particular year is determined by the demand for road use (vehicle Km -see (5)) divided by the newly increased total road length;

(3) traffic speed is calculated as a function of congestion;

(4) cost of road use is calculated as a function of speed (and when appropriate of exogenously defined costs intended to restrict demand);

(5) the demand for road use is calculated as a function of GDP and cost of road use (both in the same year).

There are at least two feedback loops possible in this – between congestion (step 2) and demand for road use (step 5), and between these five steps (in which transport costs are influenced by GDP) and the national macroeconomic model (in which GDP is influenced by transport costs). It is not clear how exactly these are dealt with. It is clear that costs are allocated to households and businesses, and that these costs, together with the investment itself, which are input to the macroeconomic model for each year. The macroeconomic model will therefore consider both "direct" and "indirect" economic effects, as defined in the present Study. In addition to tracing these through the economy, the model also incorporates an associated economic policy effect, in the form of an inflation target (p 22). This target is implemented by means of an "economic policy" variable (unspecified, but presumably not acting on the exogenous road investment inputs) which becomes more restrictive if inflation exceeds the target.

The CEBR analysis also calculates monetary values of atmospheric emissions from transport, and of road accidents. The former is clearly an externality; the latter appears to be treated as such, although to some extent it represents real resource costs which could presumably be entered into the model.

8.2.4 SPATIAL INPUT-OUTPUT MODELS

Under this heading we return to the Martin Centre models and in particular to the MEPLAN package. The application used for the A7/A68 study was typical of "urban applications" in that it focused on passengers' daily travel to work, to school, to shop, etc. A different family of applications, typically at a larger spatial level (regional or multiregional) has used the same software and the same economic ideas to focus on the movement of goods between producers and consumers. As already indicated, the economic modelling in this is similar to that of the CGE approach, but with:

- an explicit transport model (which requires, inter alia, a conversion of trade measured in value units to goods measured in physical units);
- explicit time lags, whereby the economy at one point in time is assumed to be in equilibrium with the costs of transport at an earlier point in time (usually five years earlier).

Examples of this approach exist for:

- the European Community (as at 1991, ie 12 countries) (Rohr and Williams, 1994; European Commission, 1996);
- Sweden (Williams and Lindberg, 1989).

These models consider both freight and passenger costs.

8.2.5 SETEC-ECONOMIE MODEL

The consultancy SETEC-Economie has developed a model to estimate the impact of new high-speed rail lines. It calculates changes from the previous employment as a function of the collective time savings due to the opening of the new services. This function involves a coefficient which was originally estimated on observed data related to the TGV Sud Est (Paris-Dijon/Lyon) line, which has to be adjusted for local circumstances such as:

- the size of the region;
- the delay in introduction of the services;
- the possibility of relocation between regions.

This model is of some interest in that:

- it is based on an explicit, calculated measure of the benefits produced by the transport scheme;
- it relates to passengers rather than to freight costs;
- it can apparently be estimated on observed data where an appropriate scheme has been implemented (though so far as we know the estimation has not been published).

However, it is difficult to see what basis can be adopted on which to make the critical adjustments to the coefficient for application in different regions or different circumstances. This being the case, the model is included only for completeness.

8.2.6 ECONOMIC POTENTIAL MODEL

This title covers a range of models which have been developed since the 1950s. Like several other types of models in transport, it began as a physical analogy which has since been found to be mathematically similar to more convincing theories of economic behaviour. It involves the concepts of:

- accessibility, which in this context is a measure of how easily a producer in a particular location can reach all the different markets for his or her product; and
- economic potential, which is the accessibility of a region to the market for a particular sector, times the size (in employment or output) of that sector in that region.

The model is applied to a change in the transport system by:

- calculating the change in accessibility (from every region to each sector's market);
- calculating the associated changes in economic potential;
- predicting changes in economic activity for the sector in each region as a function of the change in its share of total economic potential and of a coefficient for that sector.

Ever et al (1987, 1988) used this approach to estimate the regional impacts of various high speed rail proposals in the Benelux countries and Germany. Rietveld (1989) subsequently identified the way in which the potential model approximates the more sophistiated logit model, and a number of necessary improvements, of which the most important was the need to consider competition between modes. These improvements were implemented by David Simmonds Consultancy in a multi-regional model of Western Europe, successive versions of which have been applied to a variety of transport projects.

8.3 Conclusion

This Chapter has attempted to set the five Case Study methods in context by describing very briefly some of the other relatively formal method available to assess the impact of transport change on economic activity at the regional or higher levels. These descriptions inevitably do even less justice to the approaches and to their authors than has been done in considering the main Case Studies in the previous chapters; however, we hope that the information provided here (and in the summary tables of the next Chapter) will prove helpful in the subsequent discussion.

This Chapter has deliberately been biased towards formal, modelling approaches oth because it draws upon the previous reviews which we undertook, in our Proposal, to revisit, and because it is possible to summarise "what is done" in such methods and to envisage how it could be redone for other schemes or in other places. This kind of transferability does not generally accrue to less formal approaches; an approach based wholly on professional opinions may consider one set of factors in one case, and another set in another case. This may of course be very valuable, and in many cases it will be an essential input, but it is difficult if not impossible to capture in the present kind of review.

CHAPTER 9
Discussion

9.1 Summary of the methods considered

The five Case Study methods can be very briefly summarised as follows: the corresponding responses to the checklist questions are summarised in Figure 5.

A Dearne Towns Link Road Study: uses professional judgements as to the improvement in prospects for development on specific sites, and of the employment that those might accommodate. Impacts are related to the presence of the scheme rather than to the level of improvement provided.

B Strathclyde TRAM: the same as A. Impacts are related to the presence of the scheme rather than to the level of improvement provided.

C Midland Main Line study estimates increases in exports and inward investment, of associated employment, and of increases in population, retail activity, and associated development. All estimates are based on interpretation of surveys of businesses and developers and on additional judgements. Impacts are related to the presence of the scheme rather than to the level of improvement provided.

D M74: conversion of business-related transport cost savings (freight and passenger) into a change in the differential between regional and UK economic growth, taking account of the importance of road transport for each sector. The multiplier effects of these changes, and increased demand for development are also considered.

E A7/A68: spatial input-output model predicting a (slightly) different equilibrium pattern of employment and household location, of labour and service flows, and of demands for housing and commercial floorspace. This is modelled over time, as a result of each alternative transport supply. Location is influenced by time and cost of passenger travel.

The additional methods identified in Chapter 8 can be summarised as follows; the checklist answers are summarised in Figure 6.

F Dodgson M62 analysis: measurement of change in [freight] access costs, used in a model of employment growth by area.

G CGE models: predict a new equilibrium pattern of values of production by sector and region as a function of changes in the cost of moving goods and services between or within regions (no feedback to transport). Focus usually on freight costs only.

Figure 5: **Summary of Case Study methods**

Key:

A – Dearne Towns
B – Strathclyde Tram
C – Midland Main Line
D – M74
E – A7/A68 (MEPLAN)

1.0 DIRECT TRANSPORT IMPACTS

		A	B	C	D	E	
1.1	How is change in transport defined?	✔	✔	✔			specific scheme or services: described
					✔	✔	specific scheme or services: quantified
							as a broad type of project
							increase in infrastructure spending
							specified change in transport costs/times
1.2	Are there direct transport savings or benefit measures?	✔	✔	✔			no quantified measure
						✔	a measured reduction in unit freight costs
						✔	passenger cost savings (private or business)
					✔	✔	transport user cost savings (private or business)
1.3	Have the transport changes been used in the indirect impact calculations?		D	D	✔	✔	(D = used in discussion)

2.0 INDIRECT IMPACTS: GENERAL

		A	B	C	D	E	
2.1	What is the indicator of defined?						income
		✔	✔	✔	✔	✔	employment
		✔	✔	✔	✔		new development/investment
							final goods prices and production
							profitability
						✔	consumer surplus
					✔		value added
2.2	Methodology applied	✔	✔	✔			consultants own qualitative assessment
		✔	✔	✔			interviews with local/topic area experts
					✔	✔	delphi survey
							ad hoc quantified growth assumptions
					✔	✔	micro economic partial equilibrium model
							micro economic general equilibrium model
					✔		macro economic model
							employment growth statistical model
							static land-use/transport model
						✔	dynamic land-use/transport model

Figure 5: **Summary of Case Study methods *(continued)***

		A	B	C	D	E	
2.3	Linkage between transport and economic development based upon…	✔	✔	✔	✔		evidence in literature review
		✔	✔	✔			anecdotal evidence
					✔	✔	economic framework/calibration
2.4	Underlying theory	✔	✔				none
				✔	✔	✔	theoretically plausible
					✔	✔	verifiable
							previously verified
2.5	Timescales over which impacts considered	✗	✗	1	2	1	approximate length of time in decades (✗ implies no explicit horizon forecast year)

3.0 INDIRECT IMPACTS: SPATIAL DISAGGREGATION

		A	B	C	D	E	
3.1	Spatial approach (for calculation of impacts)	✔	✔				none
				✔	✔		top down
				✔		✔	bottom up
3.2	Level of spatial disaggregation						none
		✔	✔	✔	✔		ad hoc site identification
						✔	coarse zoning
							fine zoning
							GIS: no zoning/point based
3.3	Extent of spatial remit (F = full consideration) (S = some consideration)	✔		✔			partial (i.e. only considers local net gains)
			S	S	C	F	complete (i.e. considers wider gain/losses)
							national/international

4.0 INDIRECT BENEFIT CALCULATIONS

		A	B	C	D	E	
4.1	Is there an indirect benefit measure?				✔	✔	(i.e. a strict economic measure of the benefit)
4.2	Is it spatially disaggregated?					P	(P = partial disaggregation)
4.3	Is double counting assessed within the study?			✔			within the indirect benefits
					✔	✔	with the direct user benefits
4.4	Have they claimed additional benefits?			✔		✔	

Figure 6: **Summary of other methods considered**

Note that this summary relates only to the models outlined in Chapter 8; in several cases authors have related models applicable to other spatial scales.

Key:

F – Dodgson M62
G – Roson CGE
H – Minford (Merseyside)
I – MEPLAN
J – SETEC
K – DSCMOD Europe
L – CEBR model

1.0 DIRECT TRANSPORT IMPACTS

		F	G	H	I	J	K	L	
1.1	How is change in transport defined?								specific scheme or services: described
		✔			✔		✔	✔	specific scheme or services: quantified
									as a broad type of project
									increase in infrastructure spending
			✔	✔		✔			specified change in transport costs/times
1.2	Are there direct transport savings or benefit measures?								no quantified measure
									a measured reduction in unit freight costs
									passenger cost savings (private or business)
					✔			✔	transport user cost savings (private or business)
1.3	Have the transport changes been used in the indirect impact calculations?	✔	✔	✔	✔	✔	✔	✔	

2.0 INDIRECT IMPACTS: GENERAL

		F	G	H	I	J	K	L	
2.1	What is the indicator of economic impact?			✔				✔	income
		✔		✔		✔	✔	✔	employment
								✔	new development/investment
			✔					✔	final goods prices and production
									profitability
									consumer surplus
					✔			✔	value added
2.2	Methodology applied								consultants own qualitative assessment
									interviews with local/topic area experts
									delphi survey
									ad hoc quantified growth assumptions
									micro economic partial equilibrium model
			✔						micro economic general equilibrium model
				✔				✔	macro economic model
		✔				✔			employment growth statistical model
							✔		static land-use/transport model
					✔				dynamic land-use/transport model

Figure 6: **Summary of other methods considered *(continued)***

		F	G	H	I	J	K	L	
2.3	Linkage between transport and economic development based upon…						✔		evidence in literature review
									anecdotal evidence
		✔	✔	✔	✔	✔		✔	economic framework/calibration
2.4	Underlying theory								none
		✔	✔	✔	✔	✔	✔	✔	theoretically plausible
									verifiable
									previously verified
2.5	Timescales over which impacts considered	½		2	1			2	approximate length of time in decades

3.0 INDIRECT IMPACTS: SPATIAL DISAGGREGATION

		F	G	H	I	J	K	L	
3.1	Spatial approach (for calculation of impacts)			✔				✔	none
									top down
		✔	✔		✔	✔	✔		bottom up
3.2	Level of spatial disaggregation			✔				✔	none
									ad hoc site identification
		✔	✔		✔	✔	✔		coarse zoning
									fine zoning
									GIS: no zoning/point based
3.3	Extent of spatial remit	✔		✔		✔			partial (i.e. only considers local net gains)
	(F = full consideration)		✔		✔		✔		complete (i.e. considers wider gain/losses)
	(S = some consideration)		✔		✔		✔	✔	national/international

4.0 INDIRECT BENEFIT CALCULATIONS

		F	G	H	I	J	K	L	
4.1	Is there an indirect benefit measure?		✔		✔			✔	(i.e. a strict economic measure of the benefit?)
4.2	Is it spatially disaggregated?		✔		✔				
4.3	Is double counting assessed within the study?								within the indirect benefits
									with the direct user benefits
4.4	Have they claimed additional benefits?				✔				

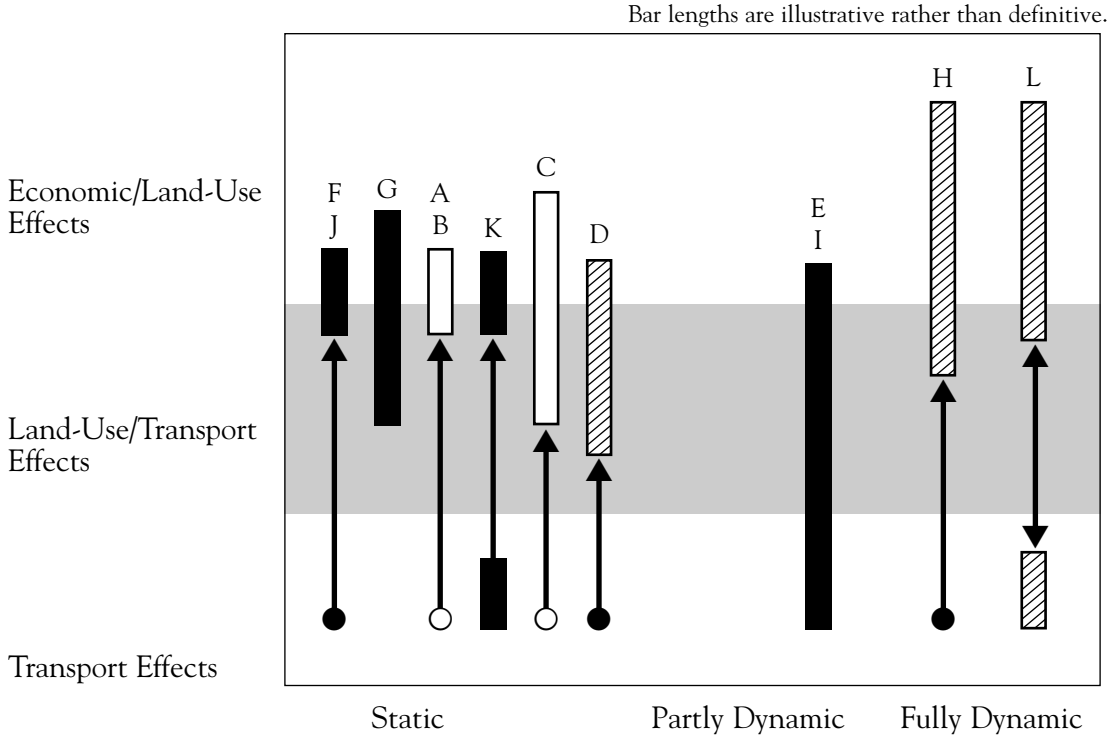
H, Macroeconomic models (including both the Merseyside and CEBR analyses) calculate impacts over time of general changes in total transport costs (freight and possibly passenger) for the regional or national economy concerned, in terms of GDP, employment, etc (with the possibility of feedback to transport demand). They consider only money costs, of all transport or just of freight.

I Regional spatial input-output models: similar to G (CGE models), but with interaction over time between economy and transport (hence also similar to E (MEPLAN), but with more detail of economic sectors and less or no detail of population and of physical land-use). Can consider freight and passengers.

J SETEC model: calculates increased regional employment as a function of the collective time savings enjoyed by residents of a region as the result of a new high-speed train service.

K Economic potential models (as represented by the DSCMOD European application) calculate changes in employment (or of production) by sector and area in response to changing accessibility to markets; accessibility may take into account both passenger and freight movement.

Figure 7: **Comparison of the scope of the methods**



Key to symbols

- Model or other formal calculations: spatially disaggregate
- Model or other formal calculation: spatially aggregate
- Direct judgement or survey result
- Transport model separate from economic impact study
- Description of transport schemes
- Direction of linkage

Key to Case Studies/other models

A – Dearne Towns
B – Strathclyde Tram
C – Midland Main Line
D – M74
E – A7/A68 (MEPLAN)
F – Dodgson M62
G – Rosen CGE
H – Minford (Merseyside)
I – MEPLAN regional
J – SETEC
K – DSCMOD Europe
L – CEBR model

We have attempted to represent the relative scope and sophistication of these in Figure 7. The intention is that the vertical extent of the symbol for each method represents its scope -the variables considered, whilst its horizontal position indicates its sophistication in a coarse categorization from static to dynamic. Where an independent transport model has provided input to the analysis of induced economic effects, this is shown. Unshaded symbols indicate analysis undertaken by surveys of opinions or by the exercise of professional judgement rather than by the use of a model or other chain of calculations. In drawing the diagram we have attempted to identify, without trying to define precisely, three layers of effects:

- at the lowest level of the diagram, "pure" transport effects, such as changes in route;
- in the middle level, land-use/transport (or economic/transport) effects, such as changes in the distribution of goods or trips, which may be regarded as either a transport effect or a land-use/economic effect;
- at the top level, effects such as new property development which are definitely in the realms of economic or land-use change, even if induced through transport change.

All of the methods considered must, by definition, have a component in the top level. Three of them are based on judgements or survey results rather than upon direct calculation; one of these (Midland Main Line [C]) is more extensive in its approach than the other two (Dearne Towns [A] and Strathclyde Tram [B]). Several methods [D,F,H,J] draw upon results from pre-existing or independent transport models which are not part of the analysis under review. Three approaches span all three layers of the diagram: the DSCMOD European model [K], which uses its own transport model to generate measures of accessibility; the MEPLAN package applications [E], which include route choice, mode choice, distribution (as an economic process) and land-use/economic effects; and the CEBR model [L], which takes costs from a spatially aggregate model of transport system performance which [we understand] depends upon GDP as calculated in the macroeconomic model.

Horizontally, the point emphasised by the diagram is that the methods are predominantly static; almost by definition, only the most complex methods, namely MEPLAN and the two macroeconomic models, are towards the right-hand side.

We should stress that:

- our interpretation of effects and of the nature and scope of the models is highly impressionistic – there is no "complexity index" behind the symbol sizes;
- these impressions are based on a mixture of what we have been able to read about the different methods and (especially in the CEBR case) what is claimed for them;
- the diagram refers only to the sample of studies and methods considered in the preceding Chapters, and is clearly not exhaustive;
- the diagram (and the whole Report) would be very different if it concentrated on intra-urban effects rather than upon larger spatial units.

9.2 Introduction to the discussion

The following discussion is structured around the questions raised in paragraph 3 of the Brief. Since the Case Studies considered show a greater diversity of practice than was perhap envisaged when the Brief was written, we have rearranged and adapted these questions as follows:

(a) To what extent is there a common method, or at least common elements in different methods?

(b) What output(s) from transport analysis are used, and how do these influence economic variables, at what spatial scale?

(c) To what extent are the economic impacts contingent upon other actions in transport or other sectors?

(d) How, if at all, are increased employment and other economic impacts valued?

(e) Is there a problem of double-counting between the economic impact benefits (whether explicitly or implicitly valued) and the conventionally measured transport benefits?

(f) How might the prevailing methods be improved?

Preliminary responses to these are considered in turn in the following sections. The discussion of question (a), the degree to which there is a common method, necessarily involves some recapitulation, mainly in tabular form, of the previous material describing the different case studies and other models.

9.3 Commonality of approach

The approaches applied in the five chosen Case Studies have, overall, very little in common. The first two (Dearne Towns and Strathclyde Tram) share the view that developers' direct responses to trasport changes are the main effect of interest, whilst the last two (M74 and A7/A68) share the opposite view that land-users' (ie businesses' and households') responses are the key effect, with an implicit or explicit view that development will follow such demand if planning policy allows.

The Midland Main Line Study steers a middle course between these views, drawing upon both.

It can be argued that the difference between the two pairs of studies contrasted above is that the Dearne Towns and Strathclyd Tram studies have chosen (or been commissioned) to examine whether their respective transport schemes will have an impact on particular sites; they could not achieve this without considering the likely responses of developers (whether speculative or own account), who must act before the sites can be occupied. In contrast, the two Scottish road-related studies are concerned with the potential for employment impact in particular areas, and can assume that there is a certain potential for change without neeing to examine site-specific details of the development mechanism.

This is an appropriate point to mention that studies which depend on assessments of the scope for physical development are subject to the uncertainty inherent in any such assessment. It has been noted that such assessments can vary widely for a given location and time[1]. This uncertainty is most critical to analyses which focus exclusively on the likely direct development impacts, but will also influence, to some extent, modelling approahes such as MEPLAN which may seek to predict development impacts as a function of increased demand from users (residential or other).

The additional methods considered in Chapter 8 have been selected as representative of the range of formal methods and models available in current practice. As such they have by definition more in common with each other, and with the two model-base Case Studies, than with the other Case Studies. There are however very marked differences in approach within these various models; we pick out some key features of these differences in the following section.

9.4 The transport-economy linkage and scale

The linkage between transport and economic change likewise differs widely between the Case Study methods. More surprisingly, it also varies markedly between the alternative models considered in Chapter 8, and it is broadly correct to say that the only thing the latter have in common is that they all quantify the relationship in some way.

At one extreme, the Dearne Towns and Strathclyde Tram studies appear to have assessed the scope for development effects simply from a description of the transport project. At the other extreme, the MEPLAN package used for the A7/A68 study, uses matrices of generalised costs (and of the mone component thereof) by origin, destination and flow type (where "flow type" is a travel purpose or (as in its European model application) a category of freight). The CGE model of Italy uses slightly simpler matrices, of money costs only. Other measures used include:

- an estimate of savings in travel cost made without, or with only indirect reference to, a travel model (Minford et al);
- estimates of the total time savings due to a scheme (SETEC);
- measurements of accessibility (Dodgson, DSC) whic assess the overall ease of reaching a particular market from a specified location (with possibilities of disaggregation by sector, between passengers and freight, etc).

All of the approaches which use quantified measures of transport change could, in principle, be applied to non-infrastructural changes in transport supply, provided that these other changes can be expressed as inputs to the associated transport models. All of the methods which quantify the transport change could, to some extent, take acount of a change in transport costs imposed as a tax or charge. Some can consider other possibilities: for example, the DSC model has been used to consider the effect of European air service liberalisation (Simmonds and Jenkinson, 1995).

1 Hall (1995) reports different estimates of the potential developable floorspace around the proposed Channel Tunnel Rail Link station at Stratford (East London) as varying by factor of at least 2.5 and possibly much more.

It is also relvant, under this heading, to note the differences in the treatment of the economy upon which the transport change has an impact. The critical distinction here is between those in which the economy is treated as static and equilibrium, and those in which here is at least some element of dynamic change in the modelled economy. Table 6 groups the models on this basis.

Table 6: **Categorisation of methods: static/dynamic**

Economy treated as static	**Economy treated as dynamic**
Dodgson	M74
CGE models	MEPLAN
SETEC	Minford et al
DSCMOD	

The choice of a static approach, ignoring the fact that there are always processes of change at work in the economy, may be made simply as a matter of convenience, from an interest in a hypothetical equilibrium condition of the economy, or as an "other things being equal" basis on which to try to isolate a particular effect. The dynamic approaches differ widely among the three examples listed. The Minford macroeconomic model is the most elaborate in that it involves a number of effects which work over time, such that (we believe) it would continue to predict change over time even in the continuing absence of any external stimulus (such as changes in transport costs). The MEPLAN package would behave in this way to some extent, but would typically find a near-equilibrium state (in a way very similar to the spatial CGE model) one time-period after a transport change; other continuing changes (such as the growth or decline of exports from the study area) have to be input by the user. The method applied to the M74 study is only dynamic in so far as its process is driven by the difference between local and national forecasts of growth or decline over time; it is perhaps rather flattering to include it in the "dynamic" column.

There is an interesting contrast between the M74 study and the DSCMOD European application (see David Simmonds Consultancy, 1992). As just noted, the M74 method is dependent upon the difference between local and national forecasts; it argues that bringing the locl forecast closer to the national one depends on transport improvements. The DSCMOD approach uses the economic potential method to assess the impact of transport change on a situation which is otherwise static, and in which different regions are equally sensitive and able to respond to transport change. It is then argued [page 8-22] that the "real" impact of the transport change will depend on the ability of different industries in the various regions to take greater advantage of the transport improvement (or to avoid or absorb the effects of transport worsening). The result is that the benefits of improved accessibility, which may arise both near and at a distance from a particular scheme, will tend to be captured by the more efficient and profitable firms within the area of accessibility improvement. In short, therefore:

- the M74 approach starts from a comparison of the local economy with the national one, identifying the weakness of the former, and assumes that transport improvement will help to ovrcome this weakness;

- the DSCMOD identifies transport improvement as tending to favour some areas and to disfavour others, if other factors are equal; it argues that the weakness or strength of different regional economies will determine how this is coverted into real growth or decline, but does not attempt to estimate this.

How the M74 method works in cases where the local forecast is more optimistic than the national forecast is not entirely clear to us.

9.5 Dependence upon other actions

Except for part of the M74 study, none of the approaches identifies other components of public expenditure as necessary conditions for the impacts it identifies. The role of the other improvements (ie other than the M74) in determining the different scenarios of that study is not clear.

In contrast, all of the approaches assume that greater or lesser amount of private investment, either in development of property or in businesses, will be encouraged into particular locations by the transport schemes they consider. Much of these effects would require public action in the form of planning permission; the Martin Centre models (and other urban land-use/transport models not considered in this report) which represent physical land-use as well as activities can make a helpful distinction between change requiring new development or redevelopment and change which comes about as an intensification of use within existing premises.

9.6 Valuation of economic impacts

The first four of the five Case Studies predict net economic impacts for particular areas, but none of them directly puts a value on that impact. The fifth Case Study method, the MEPLAN package applied to the A7/A68, does not predict a net economic impact, but produces what is intended to be a comprehesive evaluation of the welfare changes induced within the Study Area.

Some of the other models considered in Chapter 8 directly produce other indicators of economic impact in money units, instead of (MEPLAN European model) or as well as (Minford et al) employment impacts.

9.7 Scope for double-counting of benefits

There is discussion in some of the reports about the possibility that consideration of employment impacts, or of both employment and development impacts, may imply a degree of double-couning of effects which have already been counted as transport savings. In the majority of cases, as noted in the previous section, there is no attempt at valuation of the economic impacts, and therefore no need to quantify and cancel out the double-counting effect.

The exception which needs and includes an explicit treatment of double-counting is the MEPLAN application to the A7/A68 study. In this case the double-counting arises from the fact that the land-use equilibrium at one point in time includes th cost changes which have been included, together with other elements of generalised cost, in the consumer surplus calculations for the transport equilibrium at the preceding point in time, some years before. The correction for this (at least as it was applied in 1990) appears simple to carry out, but difficult to interpret. To some extent the difficulty arises from the theoretical sophistication of the economic assumptions in the land-use model, where it is assumed that all monetary benefits are passed on through the chain of transactions to one of three end-of-chain categories:

- exporters (who consume goods and services from within the system, but sell outside, at fixed prices);
- the retired and unemployed (who likewise consume goods and services, but on fixed and exogenous incomes);
- property owners (who receive rents but do not, so far as the model is concerned, consume anything).

The result is that any increases in transport costs are, in the appraisal, charged both to these economic actors and to the actual users of the transport system; the correction for double counting corrects this, but leaves it unclear what, if anything, can be concluded about the incidence of the costs.

9.8 Possibilities for improvement

9.8.1 INTRODUCTION

The Brief requests suggestions as to how "the methodology" could be improved. In the absence of any common method, it is impossible to respond to this invitation in the way that was originally envisaged. Instead, we offer some suggestions as to the characterstics which we believe should be displayed by the methods used in studies of the indirect economic impact of transport change.

Discussion of relevant characteristics naturally tends to focus on the more formal methods under consideration, since only the more formal methods are (or can be) defined clearly enough for us to consider their methodological characteristics. Discussion of formal methods may also help to improve informal approaches, ie the exercise of professional judgement, where these are the only possible or affordable way to consider particular schemes.

9.8.2 RELATIONSHIP OF FORECASTS TO APPRAISAL

We suggest first that the general approach should be first to understand what the indirect impacts of a scheme are likely to be, and then to consider how (if at all) these should be evaluated. This is partly a logical necessity – that one cannot evaluate impacts until one has predicted them - but in addition, impacts may be of interest even though they are not entries in an appraisal framework.

In addition, different impacts may be of significance to different organisations with an interest in the scheme. An analysis may in the near future need to be considered by up to six levels of government (European, United Kingdom, Scottish/Welsh/regional, and up to three layers of local government), in addition to being considered by other public bodies and by the private sector. An approach which can produce results of relevants to several of these, rather than just to one particular body, should mae a greater contribution to an informed and constructive debate about the merits and demerits of the scheme and about the other economic and land-use planning actions that might affect its value.

9.8.3 RELATIONSHIP OF DEMAND AND SUPPLY IN DEVELOPMENT

We suggest that the recommended approach should be to consider the effect of the transport scheme on economic activities (including residents as well as businesses and public services), and from this to consider the effects that may follow on the property market and the development process. This need not ignore the possibility that developers will act in the expectation of effects on demand rather than waiting for them to become evident in prices or rents, nor does it preclude recognition that physical reeneration is an objective of particular agencies. It should however recognize that developers will not respond to changes in the transport system unless they believe them to be of interest to potential purchasers or tenants.

9.8.4 SIGNIFICANCE OF TH TRANSPORT CHANGE

We suggest that any analysis of the indirect impacts of a scheme should incorporate a justifiable measure of the scheme's significance to users, taking account of the present or future relevance of the mode or modes affected and of the destinations to which (or destinations from which) it will give better access. This is an essential step towards justifying any prediction of the scale of the scheme's impact, and to being able to compare the impacts of alternative schemes.

The methods considered illustrate the use of a number of different forms in which the transport significance of the scheme can be measured. The different variables include:

- time savings to passengers (SETEC);
- money savings to manufacturers or to all sectors (Dodgson, Minford, CGE), possibly including the money cost of business travel time (M74);
- both generalised cost and money cost savings (MEPLAN);
- savings in business passenger time and convenience and in freight cost (DSCMOD).

These are passed from transport analysis to economic analysis in different forms:

- at a matrix level by purpose or sector (MEPLAN, CGE);
- as a zonal change in accessibilities or travel times, possibly by sector (Dodgson, DSCMOD, SETEC);
- as an aggregate change for the whole economy under consideration (Minford, M74).

The use of wholly aggregate measures implies that the economic analysis will be for the whole of the single economy considered, and excludes the possibility of looking at the spatial pattern of gains and losses. The use of zonal or zone-by-zone matrices of information from the transport analysis allows such examination of the spatial impact, but requires a model which extends beyond the obvious area of interest in order to do so.

9.8.5 SCOPE FOR BENEITS

We believe that two points need to be recognized about the nature of benefits and the ways in which they may arise.

Firstly, we have already noted that different agencies concerned with a scheme may quite legitimately take different views of what hey regard as its potential benefits. In addition, any particular level of government should be concerned with the distribution of change within its territory. This is particularly true of changes in the distribution of employment. There may very well be a recognizable national benefit in attracting jobs into an area of particularly high unemployment, even if there is reason to believe that most or all of these jobs are diversion of potential growth or even of existing employment away from other regions within the same national economy.

Secondly, we believe that the analysis of benefits needs to take more account of the processes of change, and of the way in which these may magnify or diminish effects and associated benefits. This involves taking ino account:

- that many of the changes of interest come about through investment decisions (or through voluntary or forced disinvestment decisions);
- these are made, even within a single sector, by very different firms in different circumstances;
- that these are not necessarily moving towards any definable equilibrium - for example, because several different firms are all trying to capture the same market;
- that they may place a greater emphasis on transport or accessibility relative to other factors than is indicated by the ratio of conventionally measured transport costs to total costs (see PEIDA, 1984) (or than would be taken into account in a CGE model);
- these processes may interact with other processes, such as the supply of property from the development industry, or the supply of labour as a result of demographic and migratory processes, in ways that create further effects which again are not necessarily converging on any particular equilibrium situation.

Urban modelling of household decisions has some progress in creating workable models of the equivalent processes (see for example Wegener, 1982, or our own more recent DELTA model), but this is admittedly a somewhat easier task because households are far more numerous, and more homogenous, than businesses. Evaluation of benefits has not however been carried out in such models – following the argument in Section 9.8.2 about the importance of establishing impacts first.

We have discussed these processes at slightly greater length in our earlier submission to SACTRA. This is an area in which it is clear that further research and development are needed, and we are not in a position to offer a specific method which would cover all these issues. We nevertheless feel reasonably confident that taking into account the kinds of processes listed above, in addition to points made in preceding sections, would be the appropriate way forward both in discussion and in modelling of the indirect impacts of transport change.

CHAPTER 10
Conclusion

This Report is intended both to provide information about current practice in assessment of the indirect impacts of transport change, and to stimulate discussion about how such practice might be achieved. We hope that it will succeed in both of these aims.

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