USING A LAND-USE / TRANSPORT / ECONOMIC MODEL IN EDINBURGH

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1 INTRODUCTION

This paper describes the modelling undertaken by MVA and David Simmonds Consultancy (DSC) to assess the impacts of the Congestion Charging scheme in Edinburgh. The paper will concentrate on the technical problems and issues generated by the analytical requirements of the various parties involved in the development and assessment of the proposals, and the ways in we attempted to meet these. We will not be describing the pros and cons of the scheme – these are already well documented in the evidence to the 2004 Public Local Inquiry and other articles, but we will try to draw out some of the lessons which have been learnt during the project both about the modelling itself and about the use and presentation of results from such a model in the context of a controversial proposal.

The paper will describe:

- the objectives of the Edinburgh Congestion Charging Scheme;
- the need to explain and therefore measure the impacts which are intrinsically inter-related and would appear at different rates over time;
- the complex tools to undertake the quantification of impacts;
- how these were used, with a summary of the results; and
- some of our observations arising from reactions to the models and the results presented.

2 THE OBJECTIVES OF THE CONGESTION CHARGING SCHEME

The Edinburgh Local Transport Strategy was defined in 2000 and incorporated the following (para-phrased) objectives that subsequently became part of the assessment criteria for the Edinburgh Congestion Charging Scheme:

- reduce congestion on all modes of transport;
- increase the proportion of journeys on foot, by cycle and by public transport;
- reduce the need to travel by car;
- reduce the adverse impacts of travel (accidents and environmental damage);
- maximise the community role of the streets;
- improve the ability of low income and mobility impaired residents to use the transport system; and
- provide a road, foot and cycle network of suitable standard.

In addition, the Council required that the scheme raise sufficient revenues to fund public transport improvements.

The Scottish Executive provided guidance to local authorities wishing to implement congestion charging and demand management schemes which included the following criteria:

- that the scheme will reduce congestion and/or noise and emissions;
- that the net revenues from charging will be additional;
- that there is fair treatment of those who pay the charge (and/or suffer the congestion or environmental problem) and those who benefit from the scheme;
- that a range of public transport improvements are in place before charging is introduced, with further improvements to follow; and
- (added later) that there is clear public support for the scheme.

After a period of testing different configurations, the key features of the final congestion charging scheme itself were:

- two cordons (see Figure 1) – a central area cordon operating 0700 to 1830, and an outer cordon (just inside the trunk road bypass) operating only between 0700 and 1000;
- cordons would only operate inbound on weekdays (not weekends), with only one charge per day of £2 per vehicle, even with multiple cordon crossings;
- exemptions for motorcycles, buses, taxis, blue badge holders, emergency vehicles and blue badge holders – also exemptions from outer cordon charges for City of Edinburgh residents outside the outer cordon;

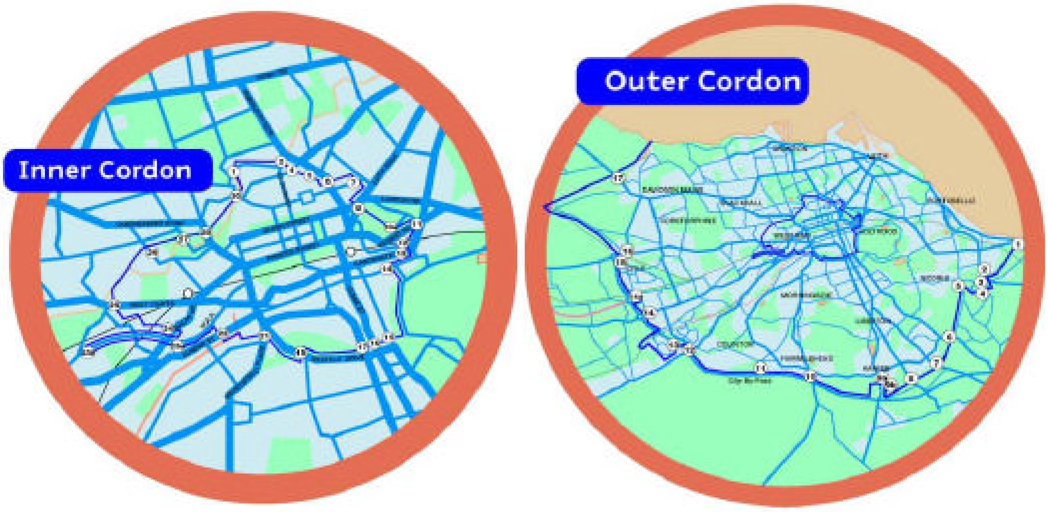

Figure 1 Congestion Charging Cordons

- it was part of a wider transport investment strategy (known as the Integrated Transport Initiative – ITI) that included a Pre-Charging Investment Package and an Additional Investment Package.

3 MEASURING THE IMPACTS

The investment packages that would have accompanied the scheme addressed the last but one of the Scottish Executive's criteria, and the second criterion that net revenues be additional to expected transport investment was reflected in the investment packages and policy decisions by the Council. The added criterion was covered by the referendum. It was therefore left for the analytical work to measure the impacts relating to congestion, noise and emissions assessment criteria, and illuminate the assessment of fair treatment across those who pay and those who benefit.

The key issue was to design a modelling system that could forecast over time the significant changes in travel, and their consequences including economic impacts, by relevant types of traveller across different times of day to meet the requirements of the assessment criteria.

Furthermore, the changes in travel need to take account of all the possible traveller responses to changes in travel costs:

- Car drivers may change route or the search pattern for a parking space;
- Public transport users may change route, or sub-mode (ie between bus, rail or tram);
- Car drivers may change car park (including on-street parking);
- All travellers may change time of day of travel eg to avoid peak period traffic congestion;
- Travellers with a car available may change mode between car and public transport;
- Travellers with no car available may change mode between walk/cycle and public transport;
- All travellers may change their destination within or between urban areas; and
- All travellers on certain non-commuting journey purposes may change the number (frequency) of journeys made.

These responses are all intrinsically inter-related and some, such as destination choice, have impacts into the future. Furthermore given the wide area application of congestion charges, albeit at a relatively low rate, there would be land-use and local economic impacts developing over time as well.

To measure these extensive impacts required a complex set of tools or modelling system that included:

- interactions with land-use modelling to forecast changes in travel demand and local economic impact;
- all traveller demand and their responses across a whole (working) day segmented into time periods;
- strategic and detailed representations of transport supply including parking across all time periods; and
- interaction between supply and demand, and an equilibrium between the two.

4 THE MODELLING SYSTEM

4.1 The Overall Design

The modelling system was developed jointly by MVA and DSC over the period 2001-2003. At the highest level, it consists of:

- a strategic land-use/transport interaction (LUTI) model
- a set of Detailed Assignment Models.

The LUTI model provided the tool for forecasting how transport demands would respond both to changes in the location and intensity of land-uses and to changes in the transport system itself, as well as for considering how changes in transport would affect land-uses and the economy. The Detailed Assignment Models provided the means to obtain more detailed information about network supply performance given the forecast demands for car and public transport travel.

The LUTI modelling system consists of four components:

- the transport model;
- the economic model;
- the urban land-use model; and
- the migration model.

The transport and land-use models represent Lothian in terms of 70 zones, ranging from relatively small zones in Edinburgh City Centre to large zones in the landward districts. Five additional large zones represent Falkirk and South Fife. The 75 zones in Lothian, Falkirk and South Fife match exactly between the transport and land-use models. Outside that area, even larger zones are used in the land-use modelling for a simplified representation of the rest of Scotland; these are not represented in the transport model, and information from other models is used to provide information on transport characteristics outside the TRAM-modelled area. The economic and migration models represent the whole of Scotland in 17 areas, of which Lothian is one. Transport information at area level for the economic model is obtained within DELTA by aggregating from zones to areas.

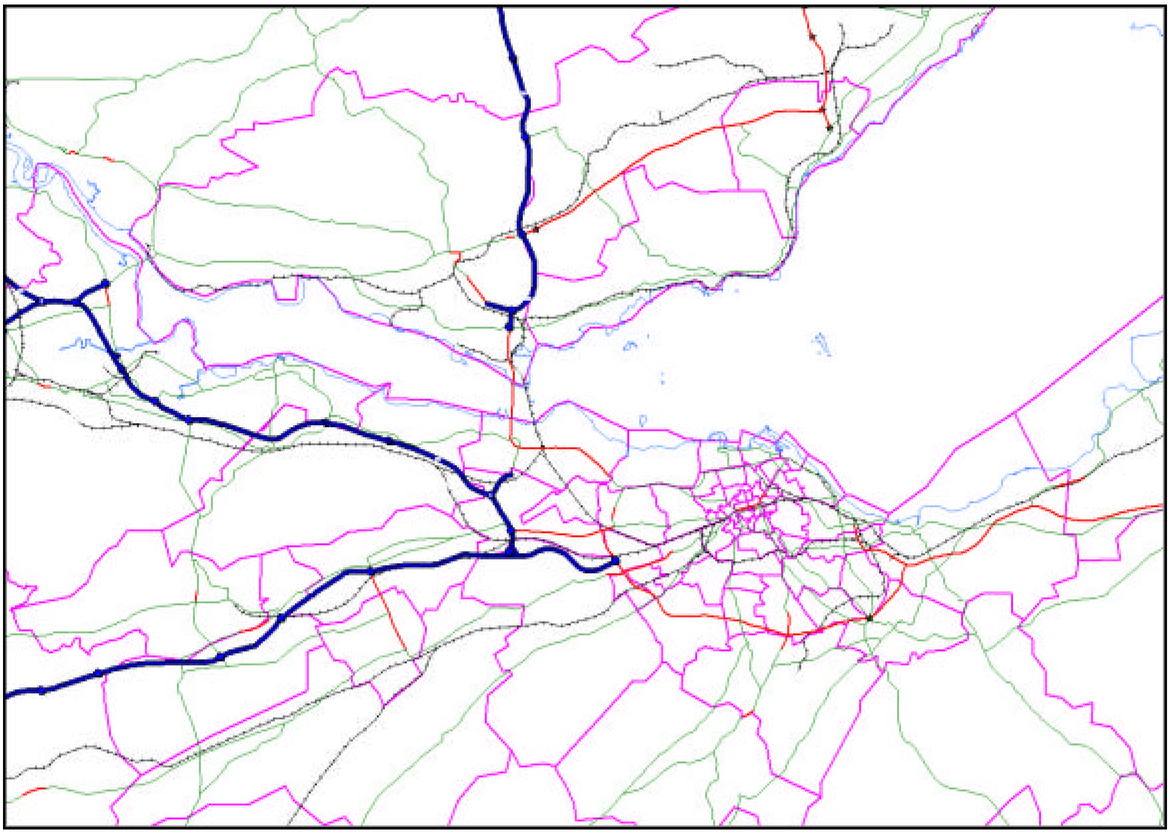

Figure 2 LUTI Zone System

The land-use/economic model forecasts changes in one-year steps. It starts from data prepared by the consultants for the year 2001, and runs forward to 2026. Within this sequence, the transport model is run at five-year intervals, ie in 2001 /06 /11 /16 /21 and /26. Transport changes can only be introduced in these years. Whilst this dynamic system is much more sophisticated than a typical transport model, there are still some limitations on how precisely a proposed sequence of investments or other changes can be represented.

The overall LUTI Model consists of four components described below. The general linkages between them are shown in Figure 3.

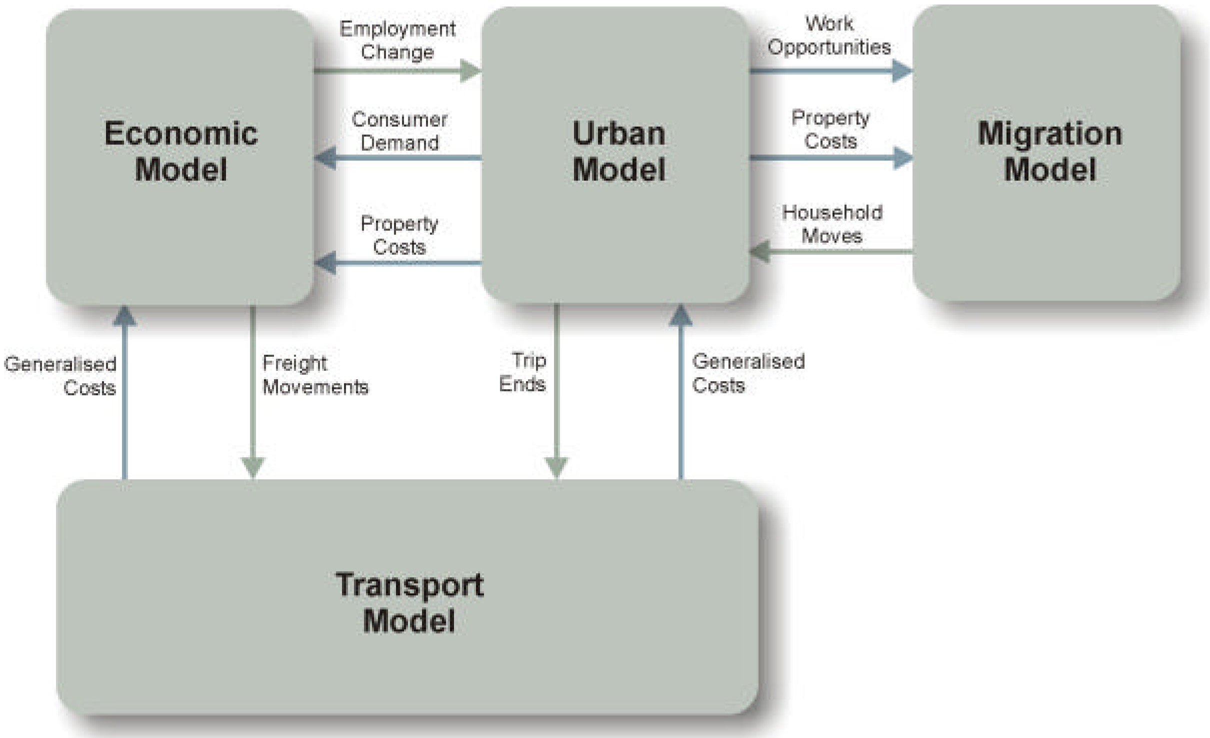

Figure 3 LUTI Model Components

4.2 Transport model

The Transport Model was developed by MVA using its TRAM software (see Bates et al, 1997; Scholefield et al, 1997) - TRAM is an acronym for Traffic Restraint Analysis Model. The software was designed to examine how policies for traffic restraint affect travel in an urban area. The main features of TRAM are:

- multi-modal model (including walk & cycle);
- model is mainly incremental in structure;
- incorporates a comprehensive range of key behavioural responses – frequency, destination, mode (car / pt / walk cycle and pt sub mode), time of day, parking type, and parking location
- uses nine time periods;
- comprises five journey purposes – home base commute, home based shop, home based other, non home based, by car availability (three groups, no car / 1 car / 2 car households), and freight;
- models home-based trips as combined outward & return ‘tours’; and
- contains a detailed parking model.

There are three specific features which made it particularly appropriate for modelling the Edinburgh scheme, and indeed congestion charging schemes in general:

- all home based travel purposes (commute, shop, other) are modelled as 2-way 'tours' where the full tour cost by mode is considered – including outward travel, parking (search time and cost) and return travel. This allows the modelling of 'pay once' tolling , ie there can be multiple cordon crossing during a tour, but the model only records the maximum toll found, hence 'pay once', and also allows 'day ticket' type public transport fares to be incorporated;
- the model comprises eight time periods covering 0700-1900 and one evening time period – this allows effective modelling of time of day switching in response to tolling at different times of the day (by cordon); and
- the parking model allows drivers to choose to park in a zone outside the cordon, continuing to their ultimate destination using PT or walking, ie a car trip to the city centre can become a car plus PT / walk trip in response to congestion charging.

TRAM demand matrices for home based travel purposes comprise of the outbound leg of the trip only – the return leg is determined by the model using a set of return home probabilities. Different demand 'segments' are permitted different time periods in which they can travel, ie the time of day choice is constrained to certain time periods. Base year matrices were derived from 'feeder' models, traffic and public transport count data and use of the Scottish Household Survey Travel Diary. This latter source was also used to establish the set of return home probabilities associated with outward travel at different times of the day.

As a strategic model, the high level of demand segmentation was balanced by an aggregate representation of the transport networks, ie the use of 'spider' links. Fixed paths are input for each of the PT sub-modes – these are derived from the underlying Detailed Assignment Models – see below.

The costs and times for each type of travel are summarised as generalised costs between any pair of zones, by a particular mode, for a particular purpose, including walking. These generalised costs are passed from the transport model to the economic and urban models. Forecast year 'planning' data are then passed back to the transport model and used to derive forecast year demand matrices.

Changes to the transport networks (ie the supply) will change the generalised cost of travel and this can lead to changes in the pattern of travel demand. Conversely, changes in travel demand can lead to changes in the costs of travel on a given route, for example, where increasing traffic congestion reduces vehicle speeds, including buses.

In reality, there is a dynamic, continuously changing imbalance between supply and demand. In the main, however, aside from the short-term impacts of major changes in transport supply, it is normal to assume for appraisal purposes that a balanced state of equilibrium can be reached. TRAM seeks to find a representation of this equilibrium state. It is an iterative procedure in which demand, supply and generalised costs vary until a converged state is reached.

TRAM is one of the few models that represents so comprehensive a range of traveller responses in one integrated and consistent model.

Transport travel costs can change (increase or decrease) in the future through:

- interactions between supply and demand:
  - increased traffic congestion affecting all road users including buses; and
  - increased use of public transport reducing available capacity and increasing pick-up and set-down times; and
- specified interventions:
  - improvements to infrastructure - road capacity and public transport routes (eg trams);
  - improved public transport services – increased bus and train frequencies reducing waiting times;
  - increased public transport fares or car parking charges; and
  - introduction of congestion charging or increased bridge tolls.

Travellers review and revise their travel habits on the basis of these cost changes. This may happen daily for example with a commuter's route choice or over a longer period such as a change in employment location. Some of the responses to change (such as the commuter's route choice) are more sensitive to cost changes than others (such as a change in mode from car to public transport).The range of possible traveller responses leads to the need to define the demand for travel by mode, purpose, time of day and car availability. This in turn leads to a travel choice hierarchy. The travel choice hierarchy used in the Transport Model is shown in Figure 4, below.

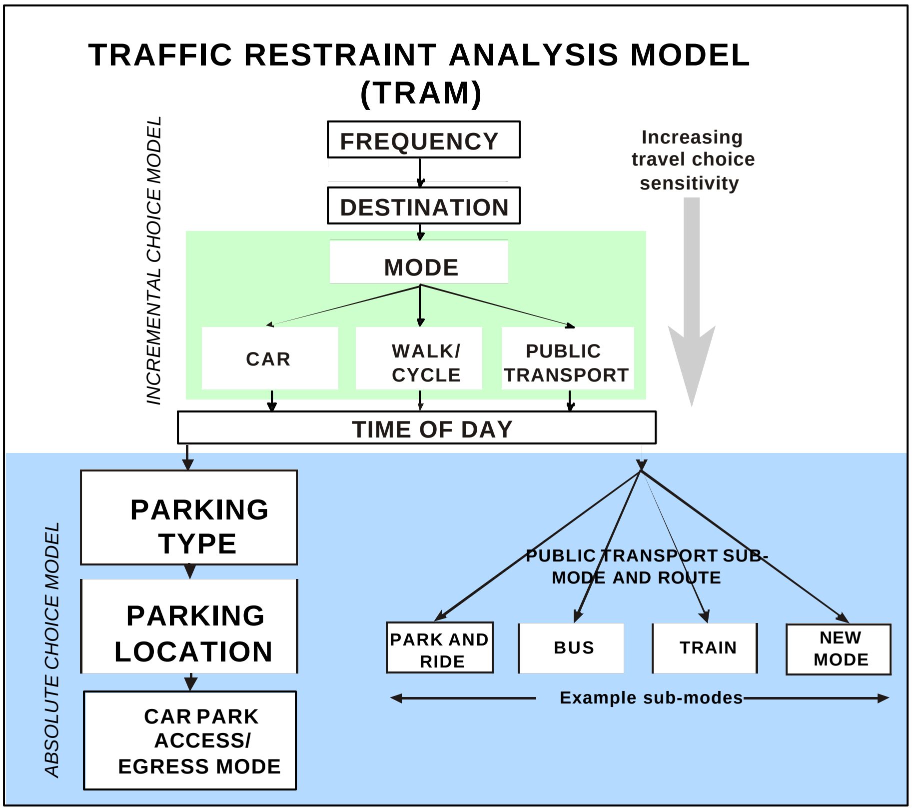

Figure 4 TRAM Model Choice Hierarchy

At the bottom of the figure, are the initial, most likely, responses by travellers to a change in travel cost. In addition, most car drivers' response to increased congestion is firstly to seek an alternative, quicker route. Some will also alter the car park they use, some will shift mode and use a bus or train - especially if no quicker or cheaper car route was available. These possible responses by individuals and businesses continue up the hierarchy until the change in the cost of travel is taken into account when decisions are made on where to travel and how frequently to make certain journeys.

The transport model does not itself forecast changes in the reliability of the transport system, but the outputs of the transport model have been used to estimate such effects and the impact on reliability was incorporated into the testing of the ITI Package.

The transport model is run to represent the transport system in the base year (2001) and for every fifth year of the forecast period, up to 2026. In years for which the transport model is not run, generalised costs are assumed to remain unchanged from the preceding 'transport model year'. For example, the generalised costs for 2011 are used in forecasting land-use and economic change in the years 2012 through to 2016; then the generalised costs for 2016 are used in 2017 through 2021; and so on.

The Detailed Assignment Models

The TRAM model's spider links do not contain sufficient network detail to identify individual roads or junctions, while its PT model cannot be used to give demand forecasts or boarding and alighting profiles for individual PT services. To provide this level of detail, the TRAM / DELTA model has links to two (Highway and PT) TRIPS-based assignment models covering the same geographic area as the main TRAM model but with many more zones, more network detail, and detailed junction modelling. The interface also includes a Park-and-Ride module, which incorporates all formal bus and train based park and ride sites in the modelled area.

The interface between the strategic and detailed models works by calculating the strategic model's forecast growth in car or PT person trips between a Base and Future year, and disaggregating this growth over the more-detailed assignment models zones. This disaggregation is controlled to match the corresponding strategic growth on a TRAM zone to TRAM zone basis but with local variation created by differences in the additional land-use data provided by the user for each detailed model zone. The process therefore allows the user to achieve pro rata growth (so that the existing pattern of trips within a given TRAM zone is maintained) or to vary the existing pattern within particular TRAM zones (for example to model the targeting of development in particular zones within a strategic model sector. The interface has a number of other options for handling green-field developments where there is no existing pattern to draw on.

The assignment models themselves are straightforward network assignment models that for brevity we have not described them here.

However, importantly the Detailed Assignment Models were used to develop details of the scheme design and to calculate much of the appraisal information that was spatially significant. The other role of the PT Detailed Assignment Model is to provide PT route and path inputs to the TRAM model.

Since its application in Edinburgh, the TRAM software has been modified, increasing the size of the models which can be accommodated, and streamlining data inputs. This means that a common network can now be used between the strategic and the Detailed Assignment Models, further simplifying data inputs and achieving greater network accuracy within TRAM. In future applications, Detailed Assignment Models could still be used for junction modelling, modelling of individual PT services and links to microsimulation models.

4.3 Economic model

The economic model is closely integrated with the urban and migration models described below. All of these were developed by DSC using its DELTA software (see Simmonds, 2001; Simmonds and Feldman, 2005).

The economic model forecasts the growth (or decline) of different sectors of the economy in different sub-regions of Scotland. This model takes a number of inputs, including independent forecasts of growth in the Scottish economy as a whole. The economic model itself forecasts the distribution of economic activity within Scotland. The linkages which affect this distribution are shown in the diagram (Figure 2 above). The information used to create these linkages consists of:

- the generalised costs of transport, already mentioned;
- consumers' demands for goods and services, from the urban model; and
- property costs of employment location (rents), likewise from the urban model.

All of these may be directly or indirectly affected by transport changes such as those in the ITI Package.

Within the economic model, two distinct processes are represented. The first process within the economic model deals with:

- where goods and services are produced within Scotland,
- where they are consumed, and
- the resulting trades in goods and services between different parts of Scotland, and to the rest of the world.

These variables respond quickly to changes in the transport system.

The second process within the economic model deals with the pattern of investment in the different sub-regions of Scotland. This process only gradually responds to changes in the transport system.

Both processes will tend to increase investment and production in areas of Scotland which enjoy improving accessibility both internally and to other parts of Scotland. Those increases will be at the expense of other parts of the country.

The key outputs of the economic model are changes in employment by sector and sub-region, and these are passed to the urban model. Data on the demand for freight transport are also passed to the transport model in the appropriate years.

4.4 Urban model

The urban model deals with the location of households and jobs within the Lothian/South Fife areas. The locations of households and jobs are strongly influenced by the supply of housing and commercial floorspace, which in turn is limited by the physical availability of space and by planning policies. The location of households and jobs within the stock of buildings is influenced to some extent by the accessibility of each zone. Different measures of accessibility are calculated and used as influences on different activities. For example, households are influenced by accessibility to workplaces and services, whilst businesses are influenced by accessibility for potential workers and customers.

The urban model calculates the location or relocation of households and jobs, which are critical inputs to the transport model.

The urban model takes account of household budgets, and uses these to calculate the consumer demand for goods and services in each area. As already mentioned, this is an input to the economic model. In doing this, the urban model assumes that households' and businesses' expenditure on new transport costs such as congestion charges is returned to the local economy rather than being lost from the area, ie it assumes that this money is recycled locally through expenditure on operating the charging system and through the application of net revenues to local public transport and other improvements. The urban model also estimates the rent values arising from the competition for different kinds of property in each zone. The resulting costs of location are passed both to the economic model (as an influence on future investment), and to the migration model (as an influence on future migration). The urban model also passes information on job opportunities to the migration model.

4.5 Migration model

The migration model forecasts migration between sub-regions of Scotland. (Movements within sub-regions are forecast in the urban model.) The inputs to this model include job opportunities and housing costs, both from the urban model. Job opportunities are a strong incentive to migration; housing costs are a generally weak disincentive. There is no direct link from transport to migration: better transport does not in itself encourage migration. However, if better transport leads to employment growth, or allows better access to employment, it will tend to encourage migration into the area affected.

4.6 Linkage between sub-models

The overall land-use/transport interaction model thus consists of the four components introduced above. There are complex feedbacks between them. For example, the model takes account of the additional congestion generated by economic growth which may be induced by a transport improvement. Note that multiplier effects, such as additional jobs generated by the expenditure of additional (attracted) population, are included within the model calculations.

The modelling system described above starts from estimates of the 2001 situation in terms of land-uses, transport networks and travel flows in and around Edinburgh, and in terms of the economies of the different areas of Scotland. The 2001 data were estimated because the 2001 Census outputs were not available at the time; indeed the full workplace data from the Census were not available until just before the Congestion Charging Inquiry.

The modelling system also takes as input a range of variables relating to the economic scenario (future growth by sector) and the demographic scenario (future changes in population by age, and in household composition). Both the economic and demographic scenarios are primarily specified for Scotland as a whole. Local adjustments can be introduced as appropriate. From the base data, the scenario inputs and the parameters which describe household, individual, and business behaviour, the model then forecasts the economic development of each area of Scotland and the changes in activities and physical development of each of the zones within Lothian. From these it forecasts the demands for transport between each pair of zones.

4.7 Application of the model system

The model system is generally used by carrying out repeated tests, changing the input characteristics of the transport system, and comparing the results of the tests so as to identify the impacts of the transport interventions examined. It can also be used to examine the implications of different land-use strategies, different economic or demographic scenarios, and so on, and to look at these in combination as well as individually.

The value of this particular model system is that it brings together in one integrated and consistent forecasting method a representation of a wide range of economic, land-use and transport changes and of the interactions between them. It provides a critical assessment of the impact of transport changes on economic and land-use change, avoiding the tendency – common in non-modelling approaches - to assume rather than to demonstrate that proposed transport changes will have desired economic and land-use effects. It includes a wide range of feedback effects. For example, if a particular policy draws extra population and economic activity into a particular area, the model will forecast the additional traffic and congestion which result, and this will tend to counterbalance the positive impact of the policy being considered.

5 use of the model

5.1 The package modelled

The modelling of the ECCS/ITI package had to consider:

- the congestion charging scheme itself;
- new and enhanced bus services, bus priority measures and and park-and-ride facilities;
- new and extended tram lines; and
- urban environmental improvements.

The charges on each cordon were input directly. Adjustments were made so that the charge is levied only once per vehicle per day, and residents of the parts of City of Edinburgh outside the City Bypass were not charged. The public transport improvements involved

- a minimum 10 minute headway on Edinburgh routes, input directly;
- bus priority on radial routes, implemented as minimum bus speeds which are retained even if general traffic speeds drop below this;
- bus services with priority measures on the City Bypass, and other additional city and regional services, input by specifying the new routes
- additional Park-and-Ride spaces at two existing sites, and one new Park-and-Ride site, all input explicitly;

- a new tram line, and the extension of another, over and above the tram schemes assumed in the reference case.

The reductions in traffic in the City Centre are assumed to allow further pedestrianisation resulting in an increase in the quality of the centre, attracting additional shoppers and tourists. The effect on shoppers was modelled as an increase in the attraction factor for the City Centre zones in the distribution of trips. The effect on tourists was modelled as an increase in final demand for relevant sectors of the local economy.

5.2 Transport impacts

The modelling system allows a very wide range of outputs to be examined, including. A summary of some of the main results used in the PLI material is given below:

- Significantly reduced traffic levels within the Inner Cordon (12% down on introduction), with much smaller reductions elsewhere in the city;

- City Centre (inside inner cordon) congestion reduced by 22% on introduction;

- Increased overall travel to the city centre (up by 5%);

- Increase in the total number of walk / cycle trips of around 4%;

- PT trips across the modelled area increased by 15% in 2011, although only by 1.5% in 2006 (ie before implementation of the bulk of the package);

- Car trips across the modelled area were reduced by 1% in 2006 and 3.3% by 2011;

- Car traffic across the inner cordon was reduced by one third with a 7% reduction across the outer cordon (operates AM peak only); and

- Parking revenues were reduced by 4-8%.

The modelling therefore showed that the scheme would achieve many of its objectives, in terms of reduction in congestion and modal shift. The model was also used to produce forecasts of congestion charging revenue which were used in the development of the package of measures funded by congestion charging.

5.3 Land-use/economic impacts

The ITI test was forecast to have a marginally negative impact on the Lothian economy. Employment growth was slowed but not reversed, stabilising after 10 years at some 4500 fewer jobs than in the Reference Case. This represented growth of slightly over 20000 jobs between 2006 and 2016 in the ITI case, compared with growth of slightly under 25000 jobs in the Reference Case.

The local impacts of the ECCS / ITI Package within Lothian were more varied, but key results were that areas outside the city would generally gain additional population and jobs, ie Lothian outside Edinburgh would grow slightly faster than in the Reference Case.

The general conclusion was that the majority of the economic and land-use impacts of the ECCS / ITI Package would be modest or imperceptible. The model has substantial scope for feedback effects, whereby an initial negative effect could lead to further negative impacts; there was no evidence of such vicious circles in the results. We therefore concluded that the ITI Option, considered within the scenario described earlier, would have only very slight effects at the Lothian or Edinburgh total levels, and generally modest impacts locally within Lothian.

It should be emphasised that our work concentrated on economic and land-use impacts, and did not attempt to examine other possible consequences of the ECCS / ITI Package such as accidents, noise and pollution, which were addressed by others.

6 LESSONS LEARNED

This section discusses some of the key points we have learned from the Edinburgh experience and other recent projects, and that we are trying to put into practice in our current work. It focuses on the lessons for the development and use of LUTI models to forecast the impact of land-use and transport interventions; others will be debating the lessons for the introduction of controversial transport planning proposals. It should be emphasised that none of the following is intended as criticism of any particular organizations or individuals in Edinburgh or elsewhere.

6.1 Analysis of complex policies

There has been criticism that the model results are difficult to understand - that it is difficult to see why the impacts forecast follow from the policy that is being tested. This is most likely to occur when the model is being used to test a complex package of interventions whose impacts may well be pulling in different directions. We are strongly of the view that this problem can be overcome by disassembling such packages into their component parts, showing the simpler (intuitively more acceptable) impacts of each of the components, and then building back up to their combined effect (which is generally not the linear sum of the separate effects). On the occasions where we have been able to take this approach we have always been able to provide a better explanation of the overall results.

6.2 Representing planning policies

Planning policies are at present represented fairly crudely in terms of the amounts of development (or occasionally demolition) which will be permitted or imposed, at the zonal level over time. This is typical of current land-use modelling practice, and is not specific to DELTA or to Edinburgh. The analysis of the consequences of planning policies which follows from these inputs is often more sophisticated than that in any other part of the planning system, but it overlooks more subtle aspects of policy, especially those which aim to encourage rather than to limit development. There is a need to enhance the ability of land-use models to reflect planning interventions – though this is an area where further research is badly needed to clarify when, where and how planning policies are effective.

6.3 Forecasting planning policy

Related to the above is the fact that we are often required to run land-use models for years or decades beyond the “horizon” year of existing land-use plans. This is common in UK transport planning practice and probably arises elsewhere, certainly in countries where formal cost-benefit analysis is a major part of transport policy appraisal but not of land-use policy appraisal.

Our preferred approach is to ask local authorities to provide an informal (and if necessary off-the-record) assessment of what they think their spatial development policies will be beyond the time horizon of their formally adopted plans. This is fine providing all the authorities involved are willing to contribute in this way; if not, having information about longer-term expectations in some areas but not others could significantly distort the model results.

One suggestion that has emerged from this is the possibility that for the longer term it would be appropriate to build a model of the “planning system” to generate the quantified planning policy inputs by zone from more basic information about the physical characteristics of each zone and about likely future attitudes to development there. The UK Government has proposed, in response to the Barker (2004) Review of housing supply, that planning authorities should be formally required to adjust their plans for housing development so as to maintain housing prices within a specified level of affordability. Such changes could make it essential to treat medium- and long-term local plans as variable rather than fixed.

6.4 Agreeing or reconciling scenarios

As mentioned earlier, DELTA is designed to work with a fixed economic and demographic scenario for the total modelled area, and to produce forecasts by zone within this context. The total modelled area, such as that for Edinburgh, typically covers a number of local government areas, each of which have their own economic and demographic forecasts upon which their plans and policies are based. The DELTA-based forecasts may well differ from these. One of the simplest points to emerge from our recent modelling practice is the need to compare the different sets of forecasts and to try to reconcile them in terms of the different input assumptions on which they are based.

6.5 Use Of Modelling In Planning

The formal processes of appraising transport proposals tend to require sophisticated model-based analysis only in later stages of the decision-making process. This can cause problems when the results from such modelling indicates that the impacts of the proposal will be significantly different from what was assumed at earlier stages. We would argue that more use should be made of models, especially complex land-use/transport models, to explore the full range of possible scenarios and strategies earlier in the decision-making process, to help the user/client to build up a broader understanding of the problems faced, of possible solutions and of the models themselves. However, we recognise that this may require a commitment to greater levels of resources being required at the earlier preliminary appraisal stages.

7 CONCLUSIONS

The model system we have described provided a sophisticated means of assessing the impacts of a complex package of proposals, in a situation where there was a requirement to assess both the most direct impacts and a wide range of indirect and longer-term effects, many of which were regarded as controversial.

It is well known that the congestion charging proposals were rejected in a referendum of Edinburgh residents earlier this year. The model however has continued to be used to date for further work on other ongoing proposals, notably the development of the Edinburgh tram schemes. We believe that comparable models will be required in other cities in future as increasing attention is given to packages of interventions including parking policies and congestion charging.

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