

## Chapter 1

### **The Evolution of London's Crossrail Scheme and the Development of the Department for Transport's Economic Appraisal Methods**

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#### **Abstract**

Cost-benefit analysis has been used in the United Kingdom for the appraisal of road schemes over the past fifty years. It was less widely used for rail, where most investment was concerned with renewing the existing network. The Central London Rail Study (1988) used cost-benefit analysis to address the problem of overcrowding on London's rail network. The Crossrail scheme proposed in the Study was discontinued because of a recession and because of the priority given the developing links to London's Docklands. Progress on Crossrail was resumed in 2002 at the same time as the Department's appraisal methods were being revised to incorporate wider economic benefits. The quantification of these additional benefits, the resolution of a source of funding and the role of the Mayor all influenced the Government's decision that the scheme should be built. Identification of some of the wider benefits poses problems for transport models that are only partially resolved through the use of land-use transport interaction models. Although the use of a Gross Value Added metric provides an alternative way of estimating the economic impacts of a scheme, it does not replace cost-benefit analysis as a decision aid for government ministers.

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## 1. Introduction

The role of cost-benefit analysis in providing decision-makers with the information that helps them make good choices has always been unclear. In today's environment, with economic growth as a priority, many decision-makers seek evidence of how a scheme affects the real economy, a sentiment which is echoed by land-use planners and others who want to know how it will affect economic activity in their city or region. Research commissioned by the Department for Transport has provided evidence of the wider impacts of transport in terms mainly of agglomeration benefits and effects on the labour supply. These go some way towards bridging the divide between the welfare-based approach and a measure aligned to Gross Value Added, and hence GDP.

It is argued that the use of this additional evidence has been influential in the case of London's Crossrail scheme. It provided new evidence which demonstrated that the scheme would deliver high value for money and helped to make the case for the City's contribution to the scheme. The use of more traditional methods had failed to achieve this when the scheme was first appraised in the 1980s. Alternatives to the welfare-based approach, such as estimating a present value of the cost savings that are measured in terms of GDP or estimating the Gross Value Added by a scheme, have been developed as a means of providing decision-makers with information about the economic impacts of a scheme but both of these measures are of less general application. However, despite the theoretical advantages of the economic welfare method of estimating wider economic impacts, the limited evidence from studies set up to provide an *ex-post* evaluation of these impacts has been unable to identify their existence.

## 2. The Development of London's rail passenger network, 1835-1960

When the main-line railways which linked London with the rest of Great Britain were built in the middle of the eighteenth century, they did not penetrate or cross Central London. Each railway company built its terminus on the fringe of the city. High land prices and engineering constraints made cross-city links unaffordable. Parliament, whose agreement was needed for each project in order to facilitate the purchase of land, remained opposed to any proposal for a railway to enter the city centre. Passengers had to continue their journeys into the central area by foot or by horse-drawn buses. Journeys were slow and the streets congested.

As Central London's employment increased and became more specialised, developing an expertise in financial and business services, the urban area expanded, a process encouraged by increasing household incomes and a demand for more housing space. The population of London increased from 2 to 4 million between 1841 and 1871. By 1911, the population had reached 7 million, with most of the growth by then taking place in the outer urban area. The main-line railways provided commuter services to meet this demand. At the beginning of the twentieth century both electric

tramways and the deep-level underground tube network were being built to provide a means of carrying commuters from the main-line stations to their central London workplaces as well as to provide commuter services in competition with, or in places not well served by, the main-line railway companies. The deep-level underground network was built with tunnels that were narrower than used by main-line trains. This lack of capacity and of interoperability with main-line train services has long imposed costs on London's rail users in terms of interchange and crowding.

The inter-war years showed little expansion of central London's transport network other than the growth of bus transport. Much of the limited investment in new capacity was aimed at serving new housing developments in the suburban area within a 10 to 30-kilometre radius. Most of the new capacity was built by the publicly-owned London Transport Board. The privately-owned, main-line railway companies were more reluctant to build new capacity, with most investment aimed at reducing operating costs and improving service quality through electrification.

In 1944, the UK Government published the Greater London Plan, commonly referred to as the Abercrombie Plan<sup>1</sup>, named after the chairman of the committee responsible for drawing up the plan. While the timing of the preparation of such a plan might seem surprising given the wartime situation, it demonstrated the Government's appreciation of the potential for active intervention in planning land-use and transport. In contrast with the *laissez-faire* attitude of the pre-war period, a post-war government expected to continue to take the leading role in decisions about the use of resources to meet national objectives after the war was over.

The Abercrombie Plan proposed greater co-ordination of land use and transport planning across an area within 60 to 70 kilometres of London, shifting industry and population out of London, where high population densities and lack of open space were seen as unacceptable in a post-war economy. The Plan proposed a "Green Belt" around London, the development of satellite towns and expansion of existing towns in the south-east. The Plan proposed new rail links, which were developed further by the Railway (London Plan) Committee: its 1946 report included several new main-line railways across central London. The planning policies proposed by Abercrombie were generally adopted in the post-war years, with a shift in London's population and manufacturing jobs out of inner London to the growing towns on the outer fringe of the Green Belt. Of the railways proposed in the Abercrombie Plan, only Route C was eventually built and, although the route in the 1944 Plan from Walthamstow in north-east outer London to Victoria in the centre was followed, the scheme developed by London Transport in the 1960s was built as another deep-level underground line rather than as a main-line, high-capacity railway. The failure to fund and build the infrastructure that formed an essential part of the Greater London Plan provides a clear example of Britain's reluctance to engage in high-level national planning.

### 3. Transport appraisal methods in the UK, 1965-2000

#### **The establishment of cost-benefit analysis in transport planning: The Victoria Line and English road schemes**

The Victoria Line provided the first example of the use in Britain of cost-benefit analysis as a means of justifying investment in a public transport scheme which, by providing a more direct route across central London, was expected to reduce overall fare revenues in an era when fares were related to distance travelled. Foster and Beesley's<sup>1</sup> pioneering study showed a positive net present value for the scheme, with benefits restricted to travel time savings for public transport users and reductions in road congestion, on account of some transport users switching from the car.

The analysis was carried out some years after funding for the project was approved by the Government, and thus in this case did not influence the decision to go ahead with the scheme. However, by the late 1960s the approach was being used by the then Ministry of Transport. COBA, as the Ministry's cost-benefit analysis model was named, became established as a means of determining priorities from a long list of schemes for new motorways and road improvements at a time when road traffic was growing rapidly. But COBA's primary use was to help to demonstrate the benefits of the proposal, at the statutory inquiries held to persuade an increasingly sceptical public of the value of the scheme, and of the rationale for the route chosen.

Following a number of hostile public inquiries, the Government set up an Advisory Committee, made up of academics and other experts, to review the Transport Department's methods. The Committee's 1977 report<sup>2</sup> supported the use of cost-benefit analysis as a means of providing decision-makers with the information they needed. But while endorsing the overall method, they recommended that explicit account should be taken of the environmental and other unquantifiable impacts of road schemes. The Committee also advised the Department to adopt road traffic forecasting methods then being developed, which included fuel price and car cost terms, and to show the effects of uncertainty in the information provided to decision-makers.

During an era in which the majority of transport investment was in inter-urban road schemes, there was no incentive for the Department to make radical changes to the objectives of the appraisal process. Its aims were to help ministers in deciding on priorities and hence on the projects that were to be taken to a public inquiry. And it provided the inspector – who adjudicated over this public debate into the merits of the scheme, to be debated within the constraints of the Government's overall transport policy framework – with a process for informing this debate and reaching a decision. The economic welfare framework remained the paradigm and, mainly in response to SACTRA's recommendations, opportunities were taken to extend the impacts covered in response to developing concerns about transport and the environment. While these methods took no explicit account of the Government's economic development objectives, the schemes that ministers approved each year for construction usually included several with low benefit-cost ratios located in regions of high unemployment. Thus, the extent to which the transport infrastructure programme contributed to wider economic development objectives was determined by political judgement rather than by economic analysis.

### **Rail investment – minimising full life costs of operating the railway**

Most of the investment in rail during this period of road building was focused on the replacement of existing assets at minimum cost. Even the initial Thameslink scheme (1987) - which, by re-opening a link previously used by freight trains, provided for the first time a main-line passenger service running north to south through the fringe of the City of London between King's Cross and London Bridge stations – delivered overall cost savings. The scheme made it possible to combine the operations of what had previously been two routes into a single service and to sell the land on which one of the maintenance depots had been located. No cost benefit economic appraisal was required for a project which reduced the overall costs of running the railway and no attempt was made to estimate the impact of the scheme on London's economy.

Investment in electrification of the commuter routes serving the catchment area to the north of London was also undertaken during the 1980s as a cost-saving measure, routes to the south having been electrified during the inter-war period. A consequence of this programme of electrification was to increase very significantly the level of medium- and longer-distance commuting from the north, where house prices were lower and where a large number of new homes were built, since planning consent to develop these sites was more easily obtained than in London's established commuter belt. The central London termini that serve these routes are all located two or three kilometres from the main employment areas and so these new commuters made use of the underground network in the Central Area to access their workplaces, leading to crowding on this network. Outside London, the major urban public transport investment was in six light-rail schemes in cities where there was an opportunity to replace heavy rail lines and provide better access to the city centre. Although significant for the cities which benefitted, the level of such investment in the UK has been much lower than in most other European countries.

## **4. Options for increasing London's rail capacity**

### **A response to the increase in rail commuting and crowding - The Central London Rail Study 1988-89**

The growth in longer-distance commuting and an overall increase in Central London's employment placed greater pressure on the rail network, in particular on the central area underground lines and on the interchanges at main-line termini. Unlike several other European capitals, London lacked an RER or *Stadtbahn* network of through-routes serving the city centre. In 1988, the Government set up the Central London Rail Study (CLRS)<sup>3</sup> to review options for relieving crowding. Working with London Transport, the organisation responsible for planning and operating London's public transport network, and British Rail's Network South-East, responsible for main-line operations, the Study reviewed a number of options.

The analysis carried out for the CLRS was made possible by the development of a detailed, network-based, four-stage transport model that covered the area of interest. The London Transportation Studies model (LTS), developed by the Greater London Council and the Department for Transport, is a model based on household survey data, detailed network information and transport

user cost estimates, combined with origin-destination and route data from interviews of public transport passengers, supplemented and validated through passenger and road traffic counts. Because of weaknesses in the LTS's public transport assignment methods, an additional model, RAILPLAN, was developed to better model passenger choice between alternative rail routes – a key consideration for a study of the case for new rail schemes. Like most models of its time, the LTS made use of exogenous assumptions about the level of employment and its distribution across zones and therefore was not capable of showing the potential development benefits of the scheme. A gap was beginning to appear between the rigorous appraisal and modelling method and the policy-makers' aspirations for the scheme as a means of supporting the growth of economic activity in London.

The analysis set out in the Study's report assumed that a major upgrading programme, to make best use of the existing network, was undertaken. This was a reasonable assumption, as many of the projects were already planned and funded. The options then assessed were, very broadly, between new, deep-level underground lines and the Crossrail schemes, which allowed main-line trains to run underground through the centre of London. The Crossrail schemes included tunnels starting a short distance outside the central area and new stations both beneath the existing main-line termini and at other central-area locations. Schemes to serve East London's Docklands development area were not considered as part of CLRS; they were reviewed as part of the separate East London Rail Study (see below).

The use of cost-benefit analysis as a means of determining investment priorities was well established. The benefit-cost ratios of the schemes were reported in the Study and served as a basis for deciding on the options to be developed in more detail. The benefits were restricted to public transport passenger time savings, including savings in walking and waiting time which were significant in those locations where an interchange was replaced by a through service. Surveys had shown that passengers regarded walking and waiting as more onerous than travel time spent on a train and, on the basis of this evidence, the unit value of in-vehicle time savings was doubled to provide an estimate of the benefits of reductions in each minute of walking and waiting time afforded by new services running directly through Central London. Time spent travelling in crowded conditions was also weighted by an increase in the standard value of time savings. The use of the public transport route assignment model made it possible to estimate changes in crowding levels throughout the network and thus include the benefit to passengers on routes from which users of the new line had diverted. Evidence on the crowding penalty was derived from studies of passengers' willingness to wait for a less crowded, later train rather than board a crowded train.

Further benefits came from a reduction in road congestion as a result of those who switch modes, as estimated through the LTS model, which included a mode choice module. In addition, revenue generated by the additional use of public transport was recorded as a benefit – a measure of passengers' willingness to pay for the improved services. The geographical coverage of the LTS network made it possible to separate the additional revenue generated by Crossrail from transfers of revenue between the different rail operators included in the LTS model.

The Crossrail schemes generally showed higher benefit-to-cost ratios, the indicator used by the Department for prioritising projects, than the options for new deep-level tube lines. They had a higher passenger carrying capacity and reduced the number of interchanges, thus freeing up capacity at main-line termini. In addition, as with the Thameslink scheme, by replacing an operating system which required trains to be turned round at termini with through running, the Crossrail options could be operated at lower cost with less staff and rolling stock. The BCRs of the North-South and East-West Crossrail schemes were estimated at 1.9 and 1.6, respectively, using the 7% real discount rate current at the time.

In common with many transport studies in the UK, the CLRS did not provide the basis for a decision to proceed with the building of a new line. The Study proposed further analysis and refinement of the North-South and East-West Crossrail options. But the main constraint identified in the Study was that of funding. The Government had established a policy whereby the users of public transport schemes were required to pay for the benefits they received from the improvements. The Minister stated in his forward to the Study that there was no case for taxpayers elsewhere in the country to pay for projects that benefitted London's rail passengers. The Study proposed that contributions should also be provided by developers, who benefit through a process of voluntary contributions negotiated by the rail operators. If the increase in revenues from passengers and developer contributions failed to cover the costs of the scheme, the Government would consider making a contribution which did not exceed the value of the external benefits. The economic appraisal did not address options for funding the scheme.

The further work proposed on establishing a means through which transport users might pay for the benefits they would derive from Crossrail was never undertaken. The analysis had assumed that public transport fares would rise in line with the growth in GDP, but no comparison of the impact of an alternative fares assumption, which might serve to fund the scheme, was undertaken. As the further refinements to the route and layout of stations were being completed, Britain slid into economic recession. Central London employment declined and the upward trend in morning peak-period arrivals was reversed. While most of the investment that formed the major upgrading programme, aimed at making the best use of the existing network, was taken forward, the Treasury did not approve any further funding for the Crossrail scheme. A bill, to provide the railway operators with the powers to purchase the land required for the expansion of stations served by East-West Crossrail, was considered by Parliament in 1991. However, because opposition to the line as proposed and because a means of funding it could not be established, the bill did not become law; although the route was safeguarded to ensure that sites required for the scheme would not be redeveloped in a way which would prevent its construction at some future date. The scheme was effectively deferred and little further work was undertaken on developing the East-West Crossrail scheme during the 1990s. Attention shifted to London's Docklands, where a more urgent requirement for additional capacity had been identified.

### **Transport options for London's Docklands – The East London Rail Study**

Plans for the redevelopment of London's Docklands had initially specified relatively low employment densities, locating industries such as printing, warehousing and some lower value-added office support functions in the development area. Access was provided by the Docklands Light Railway, opened in 1987, operating modern, single-vehicle tramcars on a track separated from the road network. Despite an extension to a station in the City at Bank, approved in 1987, and the purchase of two-car vehicles, its capacity was limited.

During the rapid growth in Central London employment during the 1980s, the developers of the Docklands perceived an opportunity to compete with the City of London as an alternative location for the headquarters of firms in financial and business services, a realistic option given the restrictions that the City's land-use planners had imposed on office development within the "Square Mile". While there might have been some aesthetic grounds for this restrictive land-use planning policy, its main consequence was to increase the value of office property in the City.

A number of proposals were made for new public transport links to Docklands to provide both the capacity and the quality of service to serve the density of land use now proposed. A catalyst was provided by the Canadian developers, Olympia & York, who offered the Government a substantial contribution towards a new underground rail link between Waterloo Station and the extensive office



developments in their plans for Canary Wharf, some seven kilometres to the East. Their plans included an option for extending this new line to Greenwich in Southeast London. However, the Government, working with London Transport, decided that this opportunity should be used to link any line serving Canary Wharf with the rest of London's underground network and set up the East London Rail Study to review options for the route. The Study proposed extending the Jubilee Line, thereby linking Westminster, Waterloo, London Bridge, North Greenwich and Stratford with Canary Wharf. The scheme was initially estimated to cost £1 billion and the developers agreed to contribute £400 million in instalments, subject to a number of conditions including a specified date for the line's opening. Work on the scheme started following Parliament's approval of the bill giving London Transport the right to purchase the land needed to construct the scheme in 1992. Out-turn costs amounted to £3.5 billion. Because of delays to the scheme's opening and the financial difficulties encountered by Olympia & York and its successors during the recession of the early 1990s, the out-turn present value of developers' contributions was only 5% of the capital costs.

Forecasting passenger demand for the Jubilee Line Extension tested the capabilities of the LTS model, in particular because the Canary Wharf development, on which the scheme depended, was expected to increase the total number of jobs in the LTS study area, whereas the LTS model had only the capability to assess the effects of redistributing an exogenously determined number of jobs. In addition, the economic appraisal methods then current were restricted to travel time savings, weighted to reflect crowding, walking, waiting and interchange time. The BCR, estimated using the then standard techniques, was around 0.9:1, well below the level at which funding would normally be approved by the Treasury. However, approval was given both because of the substantial developer contributions then expected and because of the further regeneration benefits that were not captured in the measured estimate of the benefits of the project. Unlike the Crossrail scheme, the Jubilee Line Extension provided a scheme which met the Government's objective that the beneficiaries, in this case the developers of Canary Wharf, should contribute substantially to its funding. As delays to the scheme and the developer's financial problems reduced the size of the private sector contribution, the Transport Minister, Steve Norris, made it clear<sup>4</sup> that the unquantified regeneration benefits were a significant factor in the Government's continued support for the scheme.

## 5. Developments in appraisal methods – Widening the scope

### Transport and the economy – issues and recommendations

#### *The SACTRA Report 1999*

After completing its 1977 Report, the Advisory Committee on Trunk Road Assessment was established as a Standing Advisory Committee (SACTRA) and was subsequently asked to report on several topics on which it had expertise, including methods of incorporating the environmental impacts of transport schemes into the appraisal process and into the implications for modelling and appraisal of traffic generation on roads<sup>5</sup>. This latter reference was made in the context of the Department's then current use of a fixed-trip matrix in modelling highway schemes.

In 1996, the Minister responsible for transport agreed with his Treasury colleagues to ask the Committee to provide advice on the relationship between transport and the economy. As the decision

on continuing support for the Jubilee Line Extension to London's Docklands made clear, ministers were aware of the inability of the conventional appraisal methods to capture the regeneration benefits of major new schemes. SACTRA was asked to provide the Department with a better understanding of the increasing body of academic research and of recent developments of land use and other spatial economic models, which offered the prospect of practical application of the theory. The reference required SACTRA to review the Department's well-established cost-benefit appraisal methods and to make recommendations in the event of their needing to be changed to reflect the Committee's findings. In addition, given that road traffic was continuing to increase during the 1990s, the Committee was asked to review the link between economic growth and road traffic and to consider the economic effects of policies aimed at reducing the rate of traffic growth.

SACTRA concluded<sup>6</sup> that there was scope for updating and improving conventional appraisal and modelling methods and recommended that these should be the foundation of the economic appraisal of transport schemes. These conventional methods valued travel time savings, changes in operating costs and in transport operator revenues. SACTRA recommended that transport user benefits should be extended to include the effects of changes in reliability and hence should take account of the reduction in the variability of travel times that resulted from providing more capacity on transport networks. Environmental costs should be valued where good evidence existed. The methods used for forecasting and modelling of business travel and freight traffic should be improved. Where markets were competitive and prices for transport and for the goods and services that use the transport network were set at or close to their marginal costs, conventional cost-benefit analysis, as outlined above and based on the assumption of perfect competition, provided an adequate measure of the scheme's benefits.

SACTRA identified a number of circumstances in which market imperfections were likely to be sufficiently important as to invalidate the estimates from the conventional approach. Among these were imperfections in land and labour markets, as well as conditions in which the prices paid by transport users differed significantly from the marginal costs on account of subsidies or externalities. The Committee suggested that some of the consequences of relaxing the perfect competition assumption effects might be taken into account through developing LUTI or SCGE models. While some LUTI models had been developed for use in Britain, including the MEPLAN and DELTA models, their use had been very limited because of their complexity and because they did not link directly to the Department's appraisal methods. SCGE models were then at an experimental stage and there is still no experience of such a model having been used to inform the business case for a transport scheme. Indeed, SACTRA recognised that SCGE models were more suited to analysis of wide-reaching changes in transport provision or prices rather than enhancing the economic appraisal of even a major British transport scheme.

### ***The Eddington Report 2006***

The Government's quest for a better understanding of the long term links between transport and productivity did not end with the SACTRA Report. In 2005, ministers in the Treasury and Department for Transport commissioned Sir Rod Eddington to review transport's role in sustaining productivity and competitiveness. The Eddington Report<sup>7</sup> recommended that policy should focus on improvements to existing transport networks, prioritising schemes which served congested urban areas, inter-urban corridors and international gateways, since schemes on the most economically significant parts of the network were likely to deliver the greatest economic returns. The report supported the Department's appraisal methods, noting that they were being developed to include Wider Economic Benefits and to provide the more comprehensive indicator of value for money, as discussed below. Further endorsement of the Department's economic appraisal methods was provided by the extensive use of the estimated benefit-cost ratios of a large sample of schemes as evidence of the high returns to transport investment. The Report warned against "*grands projets*", on the grounds that they rarely

delivered the high ratios of benefits to costs that were typical of many smaller schemes and there was little convincing evidence of the claims made on behalf of such projects for transformational benefits. Although no explicit reference to Crossrail was made, the report recognised the case for new urban rail links where these would deepen the labour market.

The Eddington recommendations did not require changes to the economic appraisal adopted or being developed at that time by the Department. Its main influence, apart from emphasizing the role of transport in delivering increases in productivity, was to rationalise the approach to the delivery of transport schemes. The report recommended the identification of strategic priorities followed by an assessment of the problems and the generation of a wide range of possible options using appropriate appraisal methods to determine priorities for the transport budget. It can be argued that, at least to some extent, these recommendations continue to be met through the adoption by the present Government of the Transport Business Case (see p. 44).

## **The Department's response to SACTRA<sup>8</sup>**

### *Updating and improving existing techniques*

The Department's response to SACTRA's recommendations outlined the work it was already undertaking on updating and improving many of the inputs into conventional cost-benefit analysis. A research programme was set up to review and update values of time savings and of reliability changes. New studies were set up, to estimate the key fuel cost elasticity values, which underpinned the estimate of road transport users' responses to changes in generalised cost. While some further research into LUTI models was undertaken, the Department decided against developing an SCGE or I/O model which included transport costs, given the high cost of collecting the data required, the limitations of the data currently available and the uncertain direct benefits. In reality, a decision to proceed with regional economic modelling would have been a cross-government initiative rather than one which might be taken forward by the Department for Transport alone.

### *The Economic Impact Report for regeneration of priority areas*

A further part of the Department's response was the publication of guidance to scheme promoters on the appraisal of the economic regeneration impacts of a transport scheme, with the assessment of regeneration being restricted to areas already identified by the Government as characterised by high local levels of unemployment. Current appraisal guidance requires scheme promoters to provide estimates of the number of residents of a regeneration area that are employed on account of the transport scheme, and a further estimate of the total number of jobs created, whether filled by local residents or by those from outside the regeneration area. The guidance<sup>9</sup> on drawing up a Regeneration Report includes details of the evidence the Department requires in order to demonstrate that these new jobs were dependent on the transport intervention, were additional and would be taken up by those who would otherwise be unemployed. The information is derived from local data on unemployment, surveys of local firms and planning applications and an assessment of the contribution of the scheme to improved accessibility.

### *Wider economic benefits*

Further work was undertaken by the Department in extending its web-based Transport Appraisal Guidance (WebTAG) to incorporate the wider economic benefits of transport schemes. The aim was to develop and enhance the conventional cost benefit approach rather than to switch to a more comprehensive approach, using SCGE or I/O modelling. After reviewing the recommendations of the

SACTRA report and recent academic studies, the main causes of market imperfections that were not part of the current WebTAG based appraisal guidance were identified. The Department published a Discussion Paper<sup>10</sup>, “Transport, Wider Economic Benefits and Impacts on GDP”, which set out methods that could be used by transport scheme promoters to estimate the Wider Economic Benefits (WEBs, later re-named Wider Impacts) of a transport scheme. The Paper also provided an assessment of some of the differences between the components of an economic appraisal based on cost-benefit analysis and social welfare and the elements of this economic appraisal that in one way or another form part of the process of drawing up the National Income Accounts to measure changes in GDP.

The Department’s 2005 paper, identified four sources of market imperfection that had the potential to influence the level of welfare benefit estimated using the then current WebTAG guidance. These were:

- The potential for providing agglomeration externalities by changing the effective density of an urban area and influencing output through the relationship between effective density and productivity;
- The impact of transport projects on increasing competition in the transport using markets;
- Changes in the values put on transport cost savings because of the presence of imperfect competition in transport using industries;
- Effects on labour supply, through changes in the number of people employed in response to changes in the costs of joining the labour market and through existing workers shifting to more productive jobs.

The paper concluded that the transport network in the UK was sufficiently developed to ensure that there was already adequate competition between transport-using firms and, more importantly, that such market failures that existed would not be influenced by transport improvements. While prices for many consumer goods are likely to be higher in the more remote areas, this is generally a consequence of distance from the centres of production which any reasonable transport improvement is unable to offset. It is of note that the appraisal methods used in Scotland<sup>11</sup>, where improving access to remote settlements is a policy priority, includes the option of valuing increased competition.

### **Quantification of wider economic benefits to support transport appraisal**

The Department’s 2005 Paper reviewed recent evidence on agglomeration benefits. It had for long been clear that, despite transport schemes in urban areas generally showing lower benefit to cost ratios than the majority of interurban schemes, decision-makers would approve funding for a number of these apparently less worthwhile projects. Costs were high because of the level of urban land prices and higher construction costs when making changes to busy networks in dense urban areas. Yet these higher costs were in part a result of the higher value that firms and businesses attach to a location in a dense urban area, effects that remained unquantified in the Department’s appraisal guidance.

Research commissioned by the Department<sup>12</sup> defined a measure of effective density and quantified the relationship between effective density and productivity, a relationship that varied by sector and tended, as might be expected, to be greatest in the finance sector and in the sectors of communications, distribution and transport, all of which tend to locate in city centres. For each employment sector and zone, the measure of effective density depends on the proximity of all other

jobs, with proximity measured in terms of the generalised costs derived from the transport model and the level of employment in each zone. The functional form of the relationship is:

$$d_i^{S,k,f} = \sum_{j,m} \frac{E_j^{S,f}}{(g_{i,j}^{S,m,f})^{\alpha^k}}$$

where:

$E_j^{S,f}$  is total employment for all  $k$  sectors in zone  $j$  in the scenario  $S$  in each forecast year  $f$ . If land use is held, fixed employment is the same in both the do-minimum and the with-scheme scenarios.

$g_{i,j}^{S,m,f}$  is the average generalised cost of travel from zone  $i$  to zone  $j$  in the scenario  $S$  by mode  $m$  in the forecast year  $f$ .

$\alpha^k$  is the distance decay parameter, which varies by sector  $k$ .

The effective density of employment is thus a measure which combines all of the levels of employment and the proximity of jobs in a sector of employment in an urban area to all other jobs in the area. In providing a measure of the extent of agglomeration and of changes in this measure, it stands as a proxy for the value of a set of economic benefits that are external to the individual worker or firm and, hence, are additional to the benefits estimated through the reduction in travel time and other generalised cost savings estimated in the conventional methods. The problems encountered in making unbiased estimates of this elasticity of productivity with respect to effective density, and in estimating the parameter on the distance decay function, have been described elsewhere<sup>13</sup>.

The 2005 Paper reviewed the evidence on the existence of imperfect competition in transport-using industries. This showed that, typically, market prices exceed production costs (after following WebTAG guidance on the adjustments to the estimate of the public-sector funding impacts required when expenditure is shifted from a commodity on which VAT or other taxes are paid to an untaxed good, such as public transport fares). The average level of the price/cost mark-up in the UK was around 10% and the 2005 Paper and subsequent draft guidance recommended that all estimates of business travellers' time and cost savings were multiplied by a factor of 1.1 to correct for this market imperfection.

The fourth source of market imperfections, which would result in the underestimation of the welfare effects of urban transport schemes, is that associated with labour supply. The generalised cost of travel to work was assumed to influence the number of people working in much the same way as does the post-tax wage rate. The Department analysed the research on labour supply elasticities with respect to the post-tax wage rate and recommended a value of 0.1. Estimates derived from the transport model of the costs of commuting and the change in these costs attributed to the transport scheme are added to estimates of the average post-tax earnings for new entrants to the labour force. This provides an estimate of the change in the returns from working on account of the scheme, and the elasticity provides the estimate of the extent of the response to this change. A worker's decision to participate in the labour force is determined by the level of post-tax earnings, travel costs and a range of other considerations about the disutility of working that remain unaffected by the transport scheme. However, the productivity of the worker who joins the labour market as a consequence of the new project is measured by pre-tax earnings. The additional tax revenues resulting from higher levels of participation in the labour force count in the WebTAG guidance as an additional welfare benefit, as this effectively allows for a reduction in the taxes paid by all other citizens.

Similar considerations apply to estimating the second labour market impact identified in the guidance, associated with people already in the labour force moving to more productive jobs. Reductions in the cost of working in more urbanised and more productive locations encourage existing workers in less productive locations to transfer to more productive jobs; and access to a larger labour market encourages firms to relocate, contributing to and deriving agglomeration benefits. Although associated with the agglomeration benefits described above, the latter are estimated for existing workers in the urban area that gains benefits from an increase in effective density. The welfare benefits are again restricted to the increase in taxes paid, since it is assumed that, prior to the reduction in transport costs, workers were unwilling to take on the more demanding but more productive roles.

Promoters of major schemes could choose to follow the advice in the 2005 Paper if they perceived that it would help decision-makers understand better the potential magnitude of a source of benefit that had been acknowledged as a point in favour of the scheme but never previously quantified. In 2009, an updated version of the guidance, omitting the discussion of the GDP impacts, was published as a draft section of WebTAG, which included the data sources needed to provide the estimates of each of these Wider Impacts. Even today, six years after the advice was first issued, it has not been made a mandatory part of the Department's requirements for the transport business case. In part, the delay has been due to the new administration's decision to review the previous government's transport decision-making methods and re-cast the economic appraisal process as part of a more comprehensive transport business case.

Present practice in England is to estimate the labour market participation effects, with benefits measured through the additional tax take, and the additional welfare benefits on account of imperfect competition in transport, using product markets for all transport schemes costing more than £20 million. The agglomeration effects are estimated for most of the larger schemes in those locations defined as Functional Urban Areas. The Department has provided a package based on the standard transport user benefit appraisal package (TUBA) to enable these benefits to be estimated directly from the transport model. While this practice is not mandatory, it is generally followed to support the case for the project. The effect of the move to more productive jobs through the redistribution of activity between zones is estimated only for those areas where a suitable LUTI model is available and contribution of this impact is treated as a sensitivity test of the scheme's wider benefits rather than as part of the central estimate. In practice, such models are rarely available and the cost of setting up and implementing a LUTI model generally exceeds the benefits it might provide in terms of additional information.

### **Wider economic benefits and transport modelling**

The full implementation of the Department's draft guidance requires a multi-modal transport model in order to estimate the change in effective density and to estimate the change in overall commuting costs to estimate the labour supply effects. The WebTAG guidance sets out criteria which transport models should meet if outputs from the models are to be used for appraisal purposes. Most, if not all, of those conurbations that are actively promoting major transport schemes all have access to a model which meets the Department's criteria. However, these models, which have been designed for the practical purpose of testing a wide range of transport options, narrowing them down and refining the more promising options, leading to the specification of a preferred choice, focus on travel changes rather than on land use. Labour supply is usually assumed to be fixed and the boundaries of the models are set to coincide with the administrative area of the conurbation. So while the draft appraisal guidance allows for the benefits of increases in the labour supply, these increases in commuting trips are, in most cases, external to the outputs of the transport model. In some cases, the solution to this inconsistency is to allow for the increase in commuting trips to come from zones outside the study

area. Around a third of the journeys to work in Central London by rail start outside the London region and these trips are treated as external to the model, with the forecasts derived from an elasticity-based demand model. In other cases, however, the transport model is formulated to constrain both commuting trip generation and attractions, again leading to an inconsistency between the economic theory of labour supply and its treatment in the appraisal of wider benefits.

The benefit of a shift to more productive jobs is restricted to those who change the location of their workplace and therefore is additional to the agglomeration effect. The Department's guidance advises that a LUTI transport/land-use model is used to estimate how firms and workers will change their locations in response to changes in transport costs. An alternative approach has been to base assumptions about land-use changes and employment on planning development proposals that depend on the project and will gain consent only if the project is approved. There are several examples, including that of Crossrail, of this source of benefit having been estimated and added to the benefits attributed to the scheme. However, the practice of attributing all of these benefits of higher output to the transport scheme is questionable, since they also occur on account of land-use changes, which themselves might have external costs or benefits that should form part of an appraisal which considers both the transport and the land-use effects.

Many rail projects are appraised using single-mode models, because there is often insufficient data to cover the use of all modes for all journey purposes across the extensive transport networks, which are potentially affected by a rail scheme in a typical multi-modal model. It has not been possible to combine several multi-modal models covering the relevant areas, as the specification and design of such models which cover dense urban areas tend to differ from those which cover areas where car trips dominate. The Thameslink Project, which improves rail services over a wide corridor - extending around 250 km from the South Coast of England, through London, to the northern extremities of the London rail commuting market -- stretches across an area covered by several different models. Where a suitable multi-modal model is not available, estimation of the wider benefits of rail projects has required the use of sources of data external to the model.

The redistribution of commuting trips has a further impact on the benefits of a scheme since the shift of trip attractions to urban centres is likely to result in commuters changing their mode of travel as well as their destination, shifting from a shorter-distance car trip to a longer-distance trip by rail. The benefits of the resulting reduction in road congestion contribute to the overall case for the project and, as an externality, provide some grounds for subsidising rail commuting. Estimating the impact of this redistribution of trips and the resulting change in road traffic flows provides a challenge to transport modellers. Approximations have to be made where some of the changes occur outside the geographical area covered by the transport model.

Consistency between the transport model and the economic appraisal has long been a key requirement for a well-executed cost-benefit analysis. The economic appraisal is based on the equilibrium changes in transport user costs that are an output of the model. The models used in Britain for transport schemes do not allow for participation in the labour force to be influenced by changes in the costs of working. Most of the models assume that the level of employment in the zones affected by the scheme remains unchanged by the scheme. LUTI models can help to show the possible effects of relaxing this assumption, although they are not generally used because they are costly to implement and maintain. Even where they are used, the interpretation of the estimate of benefits remains unclear. The change in demand for travel on account of the land-use change is the joint product of the transport scheme and the land-use change and cannot necessarily be attributed in full to the transport scheme. It would seem that, at least in the case of modelling and appraisal as practiced in Britain, there are inconsistencies between the estimation of the wider economic impacts and the representation in a transport model of these effects.

## **The role of the BCR in decision-making - DfT's Value for Money Guidance and the Transport Business Case**

The Department's WebTAG-based transport appraisal guidance identifies several classes of impact, classified in the current guidance as effects on the economy, on the environment, on society and on the public accounts. The guidance reflects the Government's policy objectives and the recommendations made in past SACTRA reports. Most of these impacts were measured and valued in money terms as part of the estimate of the change in economic welfare, including the main transport user benefits and, through the use of estimates of the value of a statistical life, most safety impacts. The BCR of a scheme was derived from the costs and benefits that were valued and defined in money terms. It had long been acknowledged that the BCR was only a very partial measure of the social benefits that a scheme might deliver because the BCR omitted many important effects, including most environmental impacts. WebTAG sets out the requirements on a scheme promoter for estimating such impacts and describing them as part of the table which summarised for decision-makers the case for approving the scheme. For example, the impact of a scheme on bio-diversity is described in terms of any impact on a site of special scientific interest, the extent of any impact in relation to the size and importance of the site and the proposed mitigation of the impact. The aim of providing this information is to enable decision-makers to weigh up both money values and unquantified impacts.

In order to provide decision-makers with a more formal approach to making these trade-offs and to inform stakeholders outside the Department about the decision-making process, the Department published new guidance in 2004 on value for money, since updated<sup>14</sup>. The guidance defines a concept of value for money which covers both the conventional estimate of benefits and the environmental and other effects that fall outside the BCR. In addition, it defines categories of value for money. The paper explains that, as a consequence of both the constraints on public expenditure and the absence of any factor in the Treasury's Green Book on appraisal which takes account of the cost of raising public funds, not all projects whose benefits exceed their costs would be approved. Schemes are classified in terms of their value for money in a two-stage process. The first stage is based on the BCR, with a second stage which reviews the additional costs and benefits that are not expressed in monetary terms and hence are omitted from the BCR. Schemes with BCRs of below 1.0 are defined as "poor" value for money and no such schemes would be approved. Schemes between 1.0 and 1.5 are classified as generally "low" value for money and few if any schemes which delivered only low value for money would be approved. Projects with BCRs of between 1.5 and 2.0 are defined as delivering medium value for money and some of these schemes would be approved, whereas schemes with a BCR in excess of 2.0:1 would generally be approved and funded. While this provisional, initial classification of the value for money is based on the conventional measure of the BCR, analysts and decision-makers then review the extent to which costs and benefits that are not valued in the BCR might change the provisional categorisation of the project and shift it into a lower or higher category, defined in terms of its value for money. This guidance on value for money has since been revised and, in recognition of spending constraints, a new category of "very high vfm" has been added for projects with BCRs in excess of 4.0:1. But the overall concept of classifying a scheme according to its BCR, reviewing the unquantified or other effects omitted from the conventional BCR and deriving from this an estimate of its value for money, remains unchanged.

More recently, the Department has published a note<sup>15</sup> which puts the economic case for a scheme into the context of the Transport Business Case. Decision-makers take into account information on five separate considerations:



The Strategic Case, which determines the need for the investment and the case for change in relation to the Government's policy objectives and the strategic fit of the scheme with the Government's policy objectives;

- The Economic Case, as established through the application of cost-benefit analysis in line with WebTAG;
- The Financial Case, which concentrates on its affordability, the arrangements for funding and accounting considerations;
- The Management Case, which examines the planning, delivery and governance of the scheme, and the allocation and management of risk;
- The Commercial Case, which focuses on the procurement strategy and the commercial viability of the scheme, including the allocation of financial risk under the proposed means of procurement and the engagement of the financial market where private sector funding is an option.

The note was published in April 2011. It is still too early to judge whether it will succeed in overcoming some of the short-comings of concentrating on the economic appraisal without always ensuring that arrangements were being made at the same time to manage and procure the scheme in the most effective way, to provide for its funding and to allocate risks effectively. But the history of Crossrail and of the Jubilee Line Extension provides clear evidence of the need to ensure that a sound economic appraisal is accompanied by a thorough assessment of those other elements of the business case that need to be in place order to ensure that the project is built.

## **6. Wider economic benefits and Crossrail**

### **Crossrail: the revised business case**

The decline in rail commuting to Central London, which provided a reason for halting the Crossrail programme in 1990, was reversed in 1995 (see Annex) and its continuing growth and the resulting increases in crowding led to a review of the Crossrail project in 2002. The Government agreed to setting up Cross-London Rail Links (CLRL), a joint venture between the Strategic Rail Authority - the government-sponsored independent body responsible at that time for rail strategy and planning - and Transport for London. CLRL proposed an East-West scheme along the same route through Central London as in the CLRS proposal, with services extending to Heathrow Airport and Kingston in the West and Shenfield and Ebbsfleet in the East. The modelling, forecasting and appraisal methods adopted in the 1989 CLRS were updated to incorporate network changes, current forecasts of the main exogenous inputs to the LTS model and revisions made by the Department to its appraisal methods to reflect the Government's appraisal policy priorities. Demand assumptions included the plans the Government had announced for the expansion of capacity at Heathrow. CLRL's 2003 business case<sup>16</sup> was restricted to an estimate of the transport user benefits using the conventional approach and the project's BCR was estimated at 1.99:1. The appraisal included an estimate of the

number of jobs likely to be created by the scheme, on the assumption that, without Crossrail, the forecast levels of crowding would constrain Central London employment and that the Greater London Development Plan assumptions could therefore only be realised if Crossrail was built. Estimates were also made of the scheme's impact on the number of jobs created in the regeneration area served by the Ebbsfleet branch, following WebTAG guidance. No economic value was put on these employment-related benefits.

### **Crossrail: the Montague Report**

The Government referred CLRL's Crossrail proposal to an independent expert review group, chaired by Sir Adrian Montague, who had held senior posts in the City and been Chief Executive of the Treasury's Private Finance Initiative Taskforce. The reference can be explained by the Government's reluctance to approve the scheme without taking into account the lessons that might be learnt from the then very recent example of the Jubilee Line Extension, which opened 20 months later than scheduled and for which costs overran by 63% on the budget agreed when work started on the line. This budget was 79% higher than the original estimate made in 1989 on which the economic appraisal was based.

The report<sup>17</sup> made a number of recommendations. It suggested that the procurement and financing strategies should be developed and options for raising alternative sources of funding should be drawn up and consulted on. It suggested that the structure of CLRL, made up of the Strategic Rail Authority and Transport for London, was not a body which would be incentivised to develop and deliver Crossrail in the most efficient way and the governance of the project needed to be changed to set it on a more commercial footing. It made a number of more technical recommendations because the experts on the Review believed that the proposal to operate 24 trains per hour in each direction through the tunnel under Central London would not be feasible. Outside the tunnelled section, Crossrail trains would share tracks and stations with other suburban and main-line services and any disruption to these services would impact upon the reliability of Crossrail trains and hence the capacity of the Central London section.

The Crossrail Bill was introduced into Parliament in 2005 in order to provide Crossrail Limited, the successor to CLRL, with the authority to purchase the land needed on a permanent or a temporary basis to construct the scheme and to take into account the representations made by other parties with an interest in the scheme. The bill was enacted in July 2008 and received royal assent to become the Crossrail Act, a key milestone in the delivery of the scheme. Initial enabling works started later in 2008, with construction works at Canary Wharf in Docklands in 2009.

An important consequence of the Montague Review was the successful introduction in 2007 of a bill into Parliament that would provide London's Mayor with the powers to levy a supplementary business rate on firms in London to fund Crossrail and other projects. The Business Rate Supplement was first levied in 2010 as a two-pence in the pound levy on all larger London businesses. Of Crossrail's total costs of £14.7 billion, £4.7 billion is to be funded through the BRS, with Transport for London providing £7.1 billion, the Government a direct grant of £4.7 billion, Network Rail £2.3 billion and the rest coming from developers gaining specific benefit from the scheme. This funding for Crossrail was confirmed in the Government's 2010 Spending Review. The gap between the case for Crossrail in the appraisal and the requirement funding was finally closed.

## The wider economic impacts of Crossrail

The Montague Review carried out an assessment of the economic case for the project and concluded that the estimated BCR of 1.99:1 was generally sound. The Review concluded that the analysis had followed the Department's guidance. The Review also considered the assessment of the wider benefits that Crossrail was anticipated to provide. The 2003 Business Case reported on the jobs created in Central London as a consequence of removing a constraint on commuting and provided an estimate that these jobs might add between £8-9 billion in present value terms to UK GDP. A provisional estimate of the economic welfare benefits of these additional jobs and of their impact on agglomeration suggested that this effect might add £4.5 billion or around 20% to the benefits of the scheme. In addition, following the WebTAG guidance on the assessment of regeneration, the scheme had the potential to create between 56 000 and 100 000 additional jobs in the Thames Gateway and other regeneration areas with high local unemployment, and where Crossrail would improve accessibility and employment prospects and encourage firms to locate there.

The Review concluded that Crossrail could be expected to contribute to the regeneration of Thames Gateway and help deliver the Greater London Development Plan's objectives. It would also help to maintain London's reputation as the leading location for financial and business services. However, the Review team did not provide a detailed assessment of the methods used by CLRL to estimate the magnitude of the agglomeration benefits and expressed some doubts about the feasibility of deriving a reliable estimate of such impacts.

Crossrail published a revised business case in 2005<sup>18</sup> to incorporate changes in the specification, including the proposals to terminate the Southeastern extension at Abbey Wood in place of Ebbsfleet, some 15 kilometres further to the East and to simplify the operation of Crossrail services to the West of London by terminating at Maidenhead. Estimates of the conventional benefit-cost ratio were updated to take account of new exogenous forecasts and changes made to ensure consistency with the Department's current appraisal guidance. On these new assumptions, Crossrail's BCR was 1.80:1, with the transport user benefits valued at a NPV of £16 billion.

The 2005 Crossrail Economic Appraisal was prepared at the same time as the Department was drawing up the 2005 Discussion Paper on Wider Economic Benefits and the appraisal provided the first opportunity to make practical use of the draft guidance. Indeed, the 2005 Economic Appraisal at times anticipated the guidance and consultants working for TfL provided their own estimates of some of the parameter values that were used in estimating the size of these sources of benefits. The outputs from the transport model used by TfL provided the estimates of the changes in generalised cost between zones and by mode required to estimate the effect of the scheme on effective density and on participation in the labour force. The published Economic Appraisal was consistent with the values in the 2005 paper and included sensitivities using values derived from research conducted for TfL. The benefits of agglomeration using the Department's estimate of the change in productivity with respect to effective density of 0.059 were estimated at £3.1 billion, an addition of 20% to the benefits of the scheme. Using an elasticity of 0.075, as estimated by TfL's consultants, the value increases to £4.5 billion. The increase in labour force participation was estimated using the labour supply elasticity value, wage levels and tax rates set out in the 2005 Paper and estimates of changes in commuting costs derived from the model. A further addition to the benefits from the conventional estimate was the effects of imperfect competition, restricted to changes in travel time for those travelling on business. These two additions made up a further £0.8 billion of benefits.

No suitable LUTI model was available that could be used to estimate the land-use changes that might follow from the responses of firms and workers to the reduction in the costs of access to central London and hence the economic benefits of the move of workers to more productive Central London

jobs. TfL adopted an alternative approach by assessing the extent to which the lack of capacity constrained the growth of employment in Central London and hence how the increase in capacity provided by Crossrail would lift the constraint on the expansion of Central London employment. A forecast of Central London employment to 2026, based broadly on past trends, was established and this forecast was assumed to be unconstrained by the transport network's capacity.

Having established an unconstrained forecast of employment, the next stage of the analysis was to estimate the extent to which prospective commuters would be crowded off the network. Analysis of cordon crossings and of select links on the underground and rail networks showed a clear relationship over time between growth in demand and the level of crowding, with evidence of growth being constrained by crowding. From this it was possible to estimate a constrained growth scenario, and a less constrained alternative with the Crossrail scheme in place. Since the increase in the labour supply had already been estimated using the elasticity-based approach, all of the increase in Central London's employment, attributed to the relaxing of the capacity constraint, was attributed to people moving from other locations to more productive Central London jobs. The 2005 Economic Appraisal estimated benefits of £3.2 billion, accounted for by the shift to more productive jobs, due to the capacity provided by Crossrail using the Department's estimate of a 30% premium on output per job in Central London. TfL's analysis suggested a higher premium, which has been used in subsequent analysis to generate a range of benefits.

The inclusion of these wider impacts increased the overall BCR in the Crossrail 2005 business case from 1.80 to 2.60, with a range of 2.3-3.2 based on different assumptions about the elasticity and other values used in the estimates of these wider benefits. Evidence of the value of Crossrail's wider benefits had the consequence of shifting the project from those defined as delivering medium value for money into the high value-for-money category.

The work undertaken by Crossrail and the project's consultants provided a valuable and practical test of the Department's paper on Wider Economic Impacts. It helped to codify the assumptions that the Department later published in the 2009 WebTAG unit on the Wider Impacts sub-objective to ensure that the methods could be applied and that schemes would be appraised on a consistent basis. It demonstrated the extent of the wider benefits, showing by how much they increased the conventional estimate. But the analysis was more than an exercise aimed at putting into operation a new and untested part of the appraisal guidance. It seems unlikely that a decision to proceed with the next phase a major project such as Crossrail would be made entirely on the basis of a still somewhat untested development of the Department's appraisal methodology. But this evidence of the extent of the wider economic impacts and of the value for money that the scheme would deliver, coming at a crucial stage in the scheme's evolution, was clearly a factor in the decision to go forward with the Crossrail Bill and with legislation to raise a business rate supplement as one source of funding for the project.

The Department's methods and recommended values were subject to critical review, in some instances by those with an interest in strengthening the case for Crossrail and other London schemes. A 2007 paper prepared by consultants on "the Economic Benefits of Crossrail<sup>19</sup>" described the estimate of the wider impacts made in the 2005 business case as "highly conservative". This report challenged the assumption in the Crossrail business case that growth in demand was capped in 2005 at 2026 levels, in line with WebTAG guidance for rail projects. The analysis in this consultants' report, which did not form part of the business case, quantified the effect of an alternative higher estimate of output per head in Central London, which better reflected the specialist nature of the City's financial sector and its role as a location for company headquarters. In addition, the consultants estimated the effects of assuming continuing growth in employment post-2026 on the benefits associated with the move to more productive Central London jobs. Forecasts for Central London employment in the

longer term were based on the current employment densities in certain zones in New York, Paris and Tokyo, each of which is well in excess of current London levels in broadly comparable areas. The higher densities observed in these competitor cities were assumed to be achieved by 2070 in the City, Westminster and Docklands, respectively. The effect of these changes to the assumptions used in the 2005 business case would double the economic benefits of the scheme.

Further updates to the Crossrail economic appraisal were carried out in 2010 and 2011 to reflect changes in scope and design and in the scheduling of works as well as changes to the exogenous inputs to the appraisal and modelling, in particular the reduction in the rate of economic growth forecast for the UK. The 2010 economic appraisal was updated to inform decisions on the future of the scheme in the context of the cuts in public expenditure which were made in the Government's October Spending Review. For this reason, costs already incurred were omitted. The benefit-cost ratio from continuing with the scheme, including wider benefits, ranged between 4.07 and 7.74, with the upper end of the range taking TfL's estimate of the premium on Central London output in the estimate of the benefits of the move to more productive jobs. A second difference between TfL and the Department is in the values put on time savings. But these differences apart, the Crossrail 2011 business case follows the Department's appraisal guidance and this has helped decisionmakers to determine priorities between Crossrail and other projects and reach an understanding about the implications of a decision to proceed with the scheme or to stop it.

### **Crossrail – London as a world city**

The Crossrail scheme is a joint venture between Transport for London and the Department for Transport. It acquired this special status because the main-line suburban railways to be linked by the tunnel through Central London are operated by private-sector train operating companies (TOCs) under franchises let by the Department. The Department specifies the levels of service to be operated and invites TOCs to bid for a franchise, usually of seven years but in some cases for longer. TOCs retain all revenues and so bids are generally for subsidy since most franchises in the London commuting area operate at a loss. The infrastructure outside the tunnel is owned, maintained and managed by Network Rail, the private sector, not-for-profit company that owns all main-line rail infrastructure. London's underground network is owned and operated directly by Transport for London. Transport for London's interest in Crossrail is explained by TfL's exclusive responsibility for public transport within the very congested central area. In addition, Crossrail relieves congestion on several busy TfL underground lines to the East and West of Central London, thus requiring TfL's participation in the planning of Crossrail. TfL is therefore an essential partner in the planning and development of Crossrail.

There is also a strong political dimension behind TfL's participation. There is competition between different regions and conurbations for the limited transport budget. The Greater London Authority (GLA), the administrative body that has responsibility for planning and transport policy in London, with the operation and management of the transport network undertaken by TfL, has, since its establishment in 2000, made a strong case to ministers in central government for their support of Crossrail. The GLA recognises the value of good research as a means of improving the evidence base of the analysis used in the decision-making process, and has been active in commissioning studies to investigate the economic benefits to London's economy of Crossrail and other transport schemes. London is not alone in this initiative; other conurbations have also taken new approaches to demonstrating the value of transport to their economies. Indeed, it might be argued that the setting up of the GLA in 2000 provided one of the catalysts for the continued development of the scheme. The role of a strong and influential champion for Crossrail cannot be underestimated. The proposals put forward in the 1989 Central London Rail Study lacked an organisation which could act as leader for the scheme and as its promoter. The interface between London's transport network and the main-line

railway ensured that neither of the rail operators took on the role at that time, each preferring to see money spent on their own network rather than on one that cut across the two.

The interface between the Department and TfL provided by the Crossrail business case has identified a difference in policy objectives of some analytical interest. Transport projects funded through the grant given by the Department to TfL are appraised by TfL, and the Department has no role in determining priorities on the TfL network. The size of the grant is determined by a number of factors, including operating and maintenance costs and expected revenues on TfL's network. The economic returns to new projects form only a small part of the overall decision. Although TfL generally follows WebTAG appraisal guidance, it uses a value of non-working time savings that is 29.3% higher than the national average value and a value of business time savings 58.0% higher. The Department has for long used a national average value for time savings as a very approximate means of ensuring an element of fairness or equity in the distribution of the national transport budget across the more and less prosperous regions of the country. And there are very real political considerations in the case of a decision to treat one voter's non-working time savings as more valuable than another's. The premium on the national average value adopted by TfL simply reflects the higher average earnings of London residents when compared with the national average. The 2003<sup>20</sup> value-of-time study found a time series income elasticity of 0.8, which is used in WebTAG guidance for forecasting the growth in transport user benefits. The evidence on cross-sectional values is less conclusive.

Moreover, any London-specific value should reflect the characteristics of London Transport users and the extent to which, for example, higher housing costs might limit their willingness to pay a premium on the national average value in line with their higher earnings.

A consequence of this difference in the value put on the time savings and associated benefits of Crossrail is that the 2010 and 2011 Crossrail Business Case Updates provide two separate estimates of scheme benefits, with the lower one based on WebTAG national average values and the other using the London-based value. Although the results are presented with a brief explanation of the reasons for the difference, it is clearly unsatisfactory that a scheme of national importance is presented as having two different central estimates of the size of its benefits.

## **7. Alternative metrics to the welfare approach**

### **The GDP effect of a project**

Despite the theoretical advantages of cost-benefit analysis, many policy-makers remain sceptical of its merits. The outcomes of a scheme appraised using cost-benefit analysis cannot easily be audited to demonstrate whether or not it has delivered all of the expected benefits. Indeed, as discussed below, analysts have found it very difficult to demonstrate, through *ex-post* evaluation of a selection of projects, whether the project has delivered any of the benefits claimed of it. Some policy-makers, often those with a private-sector business background, take issue with the concept that their objective should be to implement projects and policies aimed at maximising net economic welfare subject to a budget constraint. The priority given by governments to raising the rate of economic growth is second only to policies for cutting the budget deficit. Transport ministers want to know how a project will contribute to economic growth, which they see as a relevant indicator of its likely success of being funded by a

hard-pressed Treasury. In current circumstances, a GDP-based measure is likely to be more persuasive than a measure of welfare benefits, described by a transport minister of many years ago as “fairy gold”.

The literature on transport and GDP is extensive and the purpose of this paper is to go no further than to outline its relevance to decisions on Crossrail and other British transport projects. In its response to SACTRA, the Department decided against developing economic models, including input/output and SCGE models, that could, at least in theory, be used to demonstrate the impact of changes in transport costs on GDP and the implications of raising the revenues required to fund these interventions. There were no existing models covering Great Britain that might be updated or adapted for the specific purpose. It would not be possible to construct any such models without extensive new data and this would require winning over other government ministers who had no immediate need of such a model. Although the EU IASON Project had shown the Department’s analysts how a SCGE model might be applied at a strategic EU level, a review of SCGE models commissioned by the Department<sup>21</sup> confirmed the view that development of such a model to meet the Department’s requirements would not be a feasible option.

One objective of the 2005 Discussion Paper “Transport, Wider Economic Benefits and GDP<sup>22</sup>” was to inform the debate about cost-benefit analysis and GDP. The Government’s Transport Innovation Fund, which provided finance for transport schemes and other projects for which local authorities made bids, was set up while the paper was being drafted. Scheme promoters were required to demonstrate how their proposals might promote growth in the local economy and the paper provided advice on how this might be done.

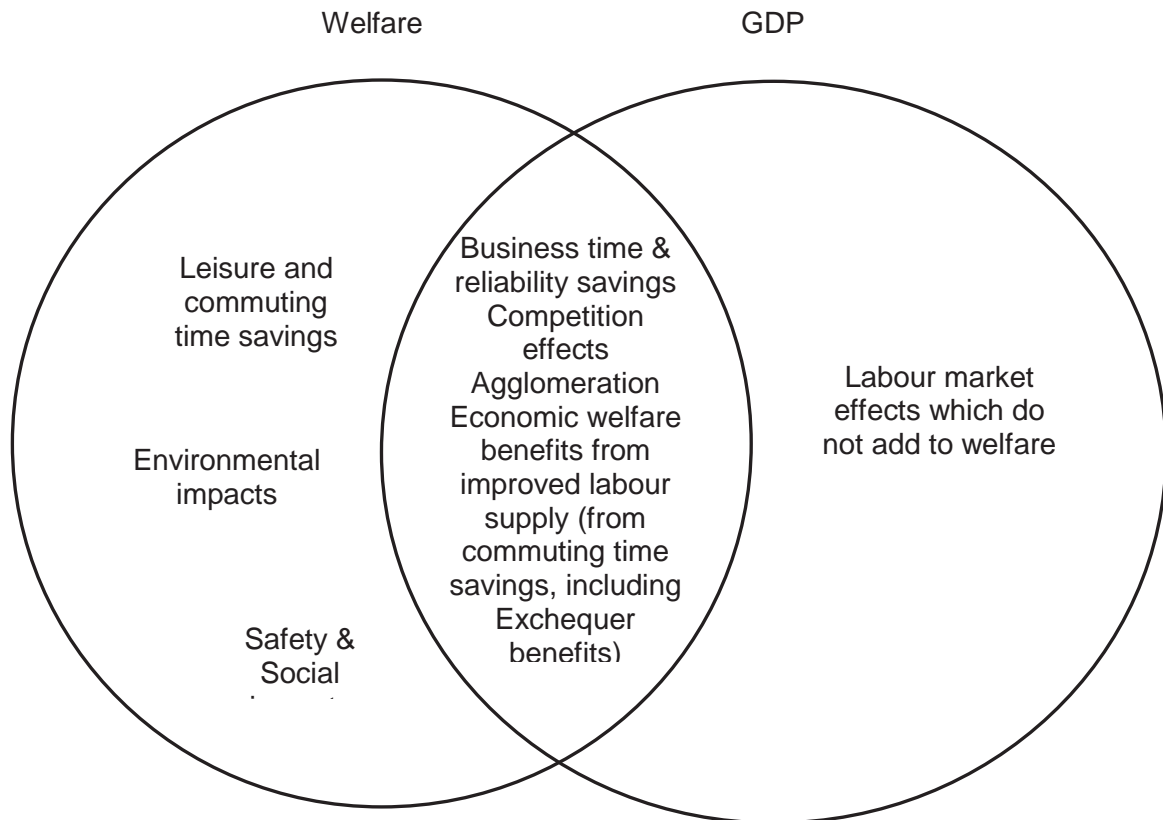
The Venn Diagram, used in the 2005 Paper to distinguish between welfare and GDP-related benefits, is reproduced below. All agglomeration and competition effects, all business time and cost savings and the welfare-related benefits of improved labour supply count in both the economic welfare calculus and contribute through the increase in economic efficiency to GDP. The paper identified labour supply effects that added to GDP but were not part of the increase in economic welfare. All of the additional wages, generated by the transport-induced increase in labour supply, count as a GDP effect. However, the welfare-based measure, assuming a perfect labour market, makes the assumption that those who join the labour market or shift to more productive jobs were always in a position to take these jobs but chose not to do so because of the disutility of work. They were induced to do so because of the reduction in the generalised cost of travel to work, given the rewards from work in terms of the post-tax income. In addition to this source of benefit, estimated conventionally through the rule of a half, there is the additional welfare benefit (which also counts in the GDP effect) of the additional tax on the earnings of these workers.

Additional tax revenue can be regarded as a welfare gain because it allows for the enjoyment of a greater quantity of public goods or a reduction in the overall burden of tax. The tax in this case is additional, generated by the increase in employment and productivity, and is not a transfer.

The 2005 Discussion Paper accepts that the commonly used means of estimating the rate of growth of GDP in successive years, the output gap and changes in the trend rate, are all measured in terms of percentage changes, an approach which is inconsistent with the net present value-based measure provided from the transport-related estimate of GDP effects. A footnote to the paper suggests that “...it is rare but legitimate to describe these (GDP) effects – which are essentially changes to trend GDP – in NPV terms.” Commentators might indeed concur with the Department on the rarity of such descriptions of GDP. Moreover, the absence of any counterfactual, which would show the GDP effects of not proceeding with the scheme and hence of lower public spending, does not form part of the calculus. Despite these limitations on the measure, this measure of the GDP effect per £’s worth of

NPV of spending was persuasive in discussions between transport ministers and the Treasury on the funding of major transport schemes, including the two major London schemes of Thameslink and Crossrail, both of which remained largely unaffected in the Chancellor's 2011 spending decisions.

Figure 1.1. **Distinction between welfare- and GDP-related benefits**



Source: Department for Transport (2005).

### **The increase in Gross Value Added in a conurbation by transport – outline of the method**

The Department's 2005 paper has encouraged alternative approaches to estimating a transport scheme's contribution to the wider economy, especially in the context of the Transport Innovation Fund. The requirement encouraged Greater Manchester to develop an alternative approach which largely focused on the local and regional Gross Value Added rather than providing an estimate of the net national effects. Although the Greater Manchester TIF bid failed, largely because a postal referendum showed that voters did not support peak period road pricing that was part of the transport package, the method for estimating the impact of transport proposals on Manchester's economy have been developed into an operational tool.

The Greater Manchester Passenger Transport Executive (GMPTE), working with the consultants KMPG, developed a means of estimating the impact of a scheme on Gross Value Added within the study area. Thus the metric differed from the DfT's use of a measure of economic welfare and the



BCR as a means of prioritising investment. The GVA-based measure was used to rank options within the package of possible measures, to demonstrate their impacts on the local authorities within the region covered by GMPTE and to indicate to local tax payers and to central government the contribution to the region's economy of the investment package of transport and land-use changes.

The KPMG model relaxes the assumption about fixed land use and provides a means of estimating how firms as well as workers respond to improved accessibility. Improved accessibility encourages more productive firms to replace those which deliver a lower value added. There are many low-value added, low-employment density activities on the fringes of the central areas of large conurbations – car-repair and other workshops, printing and scrapyards, for example. Cross-sectional data showed how the mix of economic activity changes as accessibility increases, and this change in the mix of economic activity results in more productive jobs.

An elasticity of productivity with respect to rail connectivity of 0.11 was estimated and this effect was disaggregated into the change in productivity within sectors (0.9) and the effect on productivity of changes in sectoral mix (0.2). The second contribution to increased GVA was attributed to business location decisions as a result of improved rail connectivity. There is a strong link between the density of employment in terms of jobs per kilometre and rail connectivity, with a 10% increase in the latter, leading to a 13% increase in employment. The elasticity value varies by sector and by region – it is highest for business services and banking. Thus improvements in accessibility increase both output per head and the number of workers in the zones benefiting from the improvements.

The modelling developed for GMPTE does not help to separate those jobs which have relocated from other areas from those which are net additions. Much of the increase in GVA, while of benefit to the study area, is a result of transfers from other less productive locations. The proportion of jobs in each sector that might be described as footloose was identified by defining a minimum number of jobs per resident in each region and sector. The study showed that 14.1% of all jobs in the region were not located so as to serve local residents and firms, and thus defined the overall size of the market that had the potential to relocate in response to changes in accessibility.

A study commissioned by the, now defunct, Northern Way Consortium of local authorities and other interested groups in the North of England from the Spatial Economic Research Centre at the London School of Economics<sup>23</sup>, followed broadly the same approach, using a measure of accessibility based on generalised cost, which distinguished between road and rail in determining economic mass or effective density. The wage equation, linking productivity to economic mass, was derived from micro-data on individuals rather than on aggregate estimates by place and level of economic mass. By controlling for the characteristics of individuals, the SERC method effectively separates the effects of a location being more productive because of agglomeration economies from the consequences for GVA of people who are more productive in any location, and who move to a location that has become more attractive on account of a reduction in transport costs. While this approach has the potential to separate the redistribution effect from the pure agglomeration economies, it does not, of its own, help to show the origin of this redistribution.

### **The increase in Gross Value Added in a conurbation by transport – assessment**

The models outlined above provide an alternative approach to the measure of GDP per £'s worth of public sector cost. It is not a substitute for that metric since it measures changes at an urban or regional level and is not intended to serve as a measure of the net effect on national GVA. It has certain advantages as a metric. For many local decision-makers, GVA is a concept that they feel better able to understand than welfare benefits and for this reason it could be argued that the quality of

decision-making is improved. The method provides some indication of the expected spatial distribution of the changes in economic activity and can help to show where housing developments and other spatial policies are well integrated with the location of employment. It provides the potential for more comprehensive modelling of the effects of a proposal on CO<sub>2</sub> since there is a potential to link the transport-related emissions, derived from the transport model, to the changes in land use using data on the use of energy for domestic and other purposes by residential and commercial density.

However, certain welfare benefits, such as reductions in all travel time other than for trips to and in the course of work, are omitted, despite the contribution of such activities to the overall quality of urban life. Moreover, it could be argued that the model shows the potential increase in GVA rather than a best estimate. The increase follows from a combination of the improvements in accessibility and other programmes of investment, some of which might require a public sector contribution or impose externalities on those who work or live in the urban area and all of which require decision-makers and developers willing to implement plans to change land use to complement the changes in accessibility.

The use of a GVA or GDP per £'s worth of spending metric provides a means of ranking projects and prioritising those to be implemented out of a pre-determined budget. But the metric lacks the essential output from a well-conducted cost-benefit analysis, which is to determine whether the project is worth building in the first place. There is no equivalent of the value-for-money metric which can help to influence the size of the budget. Its merits are in its ability to provide more and different information about schemes that have already met the minimum value-for-money requirements.

A critical assessment of the methods is made difficult by the lack of published papers that provide details of the estimation methods and values used for the elasticities, which relate accessibility to productivity and employment density. The problems of identifying causality in such relationships are well known, as are the difficulties in separating improvements in accessibility from all of the other changes taking place.

## 8. Evidence of wider economic benefits: Ex-post evaluation

Despite the claims made for the ability of transport schemes to transform the economy of urban areas, there are few British studies that provide a conclusive demonstration of the contribution of any specific scheme. Experience has shown that carrying out the “after” part of a “before and after” study is a complex and costly task with limited benefits in terms of improving forecasting and appraisal methods, including the methods used to estimate the wider economic impacts. While most of the earlier British studies focused on highway schemes and their effect on regional development<sup>1</sup>, two recent studies are of more relevance to London rail schemes and their wider impacts.

Transport for London commissioned an extensive Impact Study of the Jubilee Line Extension<sup>2</sup>, which opened in 2000. The modelling and economic appraisal of this scheme was described above in the context of the East London Rail Study. The evaluation study provided extensive data on the use of the line, trends in property prices, employment and rental values and comparisons of the current data on passenger flows with the forecasts made for the ELRS. The increase in land prices was seen as a potential source of funding future schemes. But the study could not provide an assessment of what might have happened in terms of the level and geographical distribution of employment in the absence of the line. The development of Docklands provided a unique opportunity to extend London's financial business district. It concluded that the density of development and levels of employment in Docklands would have been lower without the line but there was no way of quantifying this effect or attributing causation.

More recently, the Department for Transport commissioned a longitudinal study<sup>3</sup> to investigate the relationship between improved accessibility and increased productivity. The study was restricted to road schemes which had been completed between 1998 and 2003. Estimates of the transport cost savings that occurred as a result of these road schemes were linked with a dataset of firms according to their workforce, output, sector and location. The changes in productivity of those firms that had experienced the greatest improvements in accessibility to employment were compared with other firms. The analysis, aimed at investigating the extent of agglomeration benefits, found no significant effect on productivity for these firms of changes in accessibility to employment and hence in effective density. The researchers concluded that this finding did not imply that agglomeration benefits did not exist. They suggested that such effects are difficult to detect because of the small size of the elasticity of agglomeration with respect to productivity – a 10% increase in agglomeration results in a productivity increase of around 0.15. Road schemes increased effective density by an average of 1.8% in the area within 10 km of a road scheme, again suggesting that the effects were too small to identify in the study. The study was restricted to estimating the wider benefits of the transport schemes; it did not address how the transport cost savings which benefit firms that use the new infrastructure influence costs and productivity.

Neither of these evaluations of transport's wider impacts has provided evidence that might improve our understanding of the magnitude of these benefits or the mechanism whereby transport schemes deliver them. In the case of London's Docklands, the Jubilee Line Extension was part of a plan for the complete redevelopment of the area, coupled with a vision for its future as a place where international headquarters would locate. While this vision has been realised, the Study could not separate transport's role from the many other influences that led to the success of Docklands.

## 9. Conclusions

Cost-benefit analysis has been long established in the UK as a means of providing decision-makers and the public with information about the impacts of a transport scheme and about the strength of the business case so as to help determine priorities between schemes and hence allocate the Department's capital budget. The Department for Transport is responsible for providing guidance on the methods to be used by scheme promoters in England and this is done through WebTAG. The methodology, while retaining the paradigm of economic welfare, has been developed to reflect policy priorities. Within this admittedly restrictive framework, transport's impact on the economy is estimated through welfare impacts additional to the conventional cost-benefit analysis. This impact is made up of the benefits from increased agglomeration, the effect on the value put on the benefits on account of imperfect competition in transport using product markets and labour supply effects. The methods remain firmly based on the principles of cost-benefit analysis, a framework used throughout government departments in the UK and which is codified in the Treasury Green Book<sup>1</sup>. These wider impacts are net additions to national economic welfare. The Department has provided guidance on what it has defined as the GDP effects of a transport scheme, based on business cost savings and additional output on account of the response of labour to lower commuting costs and of firms to changes in accessibility, but while these may be of strategic relevance to decision-makers, they remain separate from the economic case for a scheme. Unlike cost-benefit analysis, this approach does not demonstrate whether the benefits of a project exceed its costs by a margin big enough to make it a project which delivers high value for money.

The Crossrail scheme was developed as a solution to the growing problem of crowding on London's commuter rail services. The initial proposal in 1989 was appraised using conventional cost-benefit methods. For a number of reasons, including an economic downturn, the lack of a champion for the scheme and the failure to resolve the decision on the funding of the scheme, the scheme did not then go ahead. When the scheme was revived in 2003, the Department had started to develop its guidance on wider economic benefits and the Greater London Authority, acting as a champion for the project, took up the guidance and enhanced it to reflect the constraints imposed by crowding on the supply of labour to Central London and firms' willingness to locate there. The inclusion of wider economic benefits demonstrated the strength of the economic case for the scheme. With these benefits added, it would deliver high value for money. This analysis also provided evidence on the benefits of Crossrail to business, which may have contributed to the introduction of the Business Rate Supplement which helped to ensure a funding package for Crossrail.

Existing appraisal methods, supplemented by the inclusion of wider economic benefits, have been adequate in the case of Crossrail. Crossrail adds 6% to rail capacity at the Central London cordon. Over this decade, a further 18% is being added through projects to upgrade most of the existing underground lines, rebuild several busy Central London stations and lengthen many main-line commuter trains. Crossrail is already responsible for the redevelopment of offices and other buildings in the vicinity of the stations along the route. But, unlike the Jubilee Line extension to Docklands in the 1990s, Crossrail is not transformational in terms of delivering a step change in capacity to zones which were previously difficult to access. Crossrail stations are all at locations already well served by the London Underground or main-line rail networks.

WebTAG has the advantage of providing estimates of the wider economic impacts which can generally be derived from the transport model and align well with most decision-makers' views about how transport might affect the economy. Estimation of these effects and incorporating them into the analysis used to support the business case for a scheme is not always simple. There are well-documented problems in estimating the relationship between effective density, however measured, and productivity. The treatment of labour force participation in terms of a simple elasticity with respect to a definition of the returns from work conceals the complex interaction between the actions of firms and the decisions of workers in response to changes in transport costs. Because of the cost of implementing and maintaining LUTI models, they are not sufficiently developed and used in England as to provide a standard approach to estimating the effects of the move of workers to more productive jobs and of firms to more productive locations in urban centres. Nor are the existing LUTI models integrated into the economic appraisal process, with the consequence that they fail to provide decision-makers with a full assessment of the costs and benefits of the land-use changes. An added complexity arises when specifying the geographical area to be covered by the model and hence the scale and scope of estimates of these wider effects. The British approach to transport has generally been to make incremental changes rather than one of comprehensive national planning. The last attempt at a national plan, the Ten Year Plan for Transport, published by the Labour Government in 2000, proposed extensive investment in roads, rail and local transport, only parts of which were delivered as proposed, although the Plan's objectives of reducing the growth in traffic congestion have largely been realised by the economic recession and increases in fuel costs. This incremental approach to resolving the country's transport problems further explains the reliance on cost-benefit analysis and the absence of a good case for developing alternative approaches.

These are not grounds for complacency. There is a continuing debate between land-use planners and transport economists about the relevance of transport appraisal methods. The debate has focused on the reliance on time savings as the indicator of the majority of the benefits of any scheme. Critics of the Department's approach have argued that time savings are quickly converted into other benefits, most typically, in the case of urban schemes, the ability of commuters to live further from their place of work and purchase more housing space, while firms relocate to take advantage of increased accessibility. It is clear that decision-makers would find it useful to have more and different information on the wider impacts of transport schemes, and in particular on those very few which are intended to transform the economy in the area served by the scheme. This additional information also enables the promoters of the scheme to make a better case when seeking to obtain funding and consent to build it.

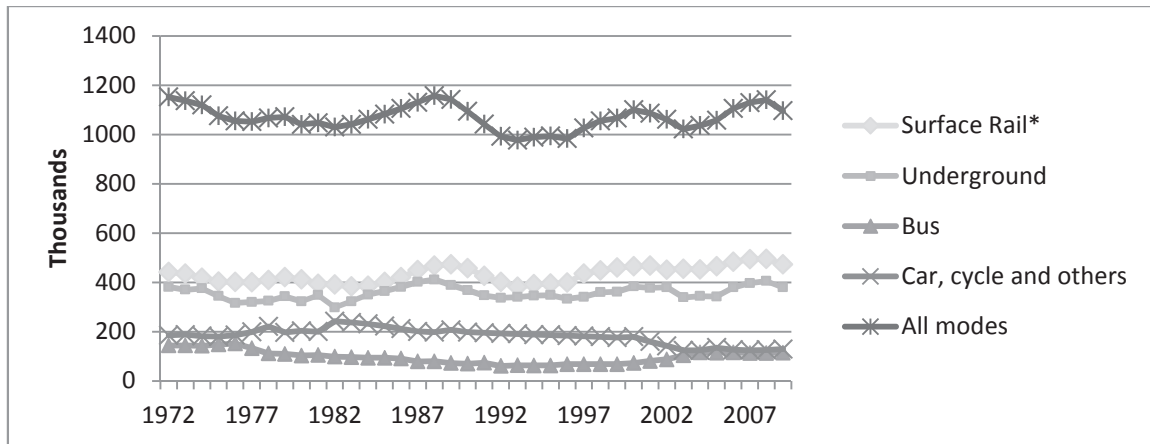
However, there is no consensus on what additional information would be of value to decision-makers other than the mythical crystal ball, which even a hardened politician might be reluctant to uncover. Despite the priority given to economic growth, an indicator of a transport scheme's contribution to raising the trend rate of GDP is not, on its own, a metric that would make for better decisions. While it is clear that a well-defined land-use model, which supplements the transport model, could provide decision-makers with a better understanding of the likely outcomes of a scheme and of its potential to deliver further changes, land-use modelling does not form part of standard practice in England.

There is a good case for a review of the land-use models currently available in the UK to establish the extent to which they might help to provide, either in their existing forms or after some modification, some of the information about the spatial impacts and responses to improvements in accessibility that are omitted from the current appraisal methods. There would also be merit in comparing how these models estimate the redistribution of economic activity with the estimates made in the Crossrail appraisal and in the work for Greater Manchester and the Northern Way. The outcome of such a review would be very uncertain. The restrictive nature of land-use planning policy in

England constrains many of the modelled responses to improved accessibility, thus reducing the benefit of using such a model. Inclusion of the costs and benefits of the land-use changes to complement the transport appraisal raises other challenges, in particular in distinguishing whether the land-use change benefits are additional to those in the transport model. In a world of generous research funding, research into these issues would prove an interesting and challenging task, albeit one with very uncertain outcomes. However, funding for the present programme of research is very restricted and there are many competing priorities.

## Annex 1.A1

Figure 1.A1.1: People entering central London during the morning peak, 1972-2009



\* People transferring from rail to underground or bus at mainline stations in central London are recorded as surface rail passengers.

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