1. WHY DO WE BUILD METROS?

Metro schemes are generally built to serve the centres of large cities. As such they either have to be in deep tunnels with deep stations, or near (or even on) the surface in cut-and-cover trenches. This generally makes them expensive to construct.

Historically railway schemes have rarely, if ever, paid for themselves in fare box revenue. Yet despite this, all ‘world cities’ have metros and generally appear to want more, so what is it that metros do that makes cities desire them and persuades national governments to invest in them?

Traditional cost:benefit analysis tells us whether the monetised benefits to society outweigh the net costs. Metros deliver social benefits in the form of time savings for travellers and improved journey ambience (congestion relief and improved quality). Projects with a positive social benefit:cost ratio are deemed to be economically worthwhile, but this is no guarantee that they will actually be funded by the Treasury, which has to manage the competing demands of different government departments.

Three rail lines implemented in London since the Victoria line in the 1960’s, the Fleet Line (the Jubilee Line), the Docklands Light Railway (DLR), and the Jubilee Line extension (JLE) all had traditional benefit:cost ratios of less than 1:1 at the time of their appraisals. Yet the government funded these schemes and so must have perceived greater benefits than those captured in the traditional cost:benefit analysis.

The UK government’s New Approach to Appraisal (NATA) recognised that traditional transport economic appraisal was not reflecting the full value for money of public transport schemes, nor their contribution to wider policy objectives which could not be monetised within a benefit:cost ratio.

However the problem remained that, despite an appraisal framework that permitted consideration of wider benefits, the mechanisms by which transport schemes generated such benefits were not identified, quantified or most importantly valued. So what is it that metros do for cities that is not captured in traditional transport economic appraisals? To answer this question we need to understand why cities have developed the way they have and what role transport plays in that development.

2. CITIES AND TRANSPORT
A key reason for the existence of cities is that the productivity benefits from undertaking economic activity in high-density areas outweigh the costs of other factors such as paying for the additional transport. Even though businesses have to pay higher rents, wages etc. when they locate in a city centre, they still find it worthwhile to do so.

Why do such productivity benefits come about? Four specific examples can be identified of why clustering enhances productivity. It leads to:

- a larger, deeper, labour market – providing employers with more choice of skills and more competition for jobs;
- more competing and complementary businesses and institutions – providing additional pressure for innovation and efficiency and enabling greater specialisation amongst support services;
- a larger, deeper, client market – London's Finance and Business Services (FBS) sector for instance is a global player attracting business from around the world;
- greater potential for contact and knowledge sharing – both informally via social interaction and more formally via conferences.

This is the theory of agglomeration. Agglomeration is a common process and high degrees of agglomeration exist in major financial centres such as London, New York, Tokyo, Frankfurt and Paris, especially in the Finance and Business Service (FBS) sector. It explains why jobs cluster and hence why cities exist.

As outlined by Venables (2004, *Evaluating urban transport improvements: cost-benefit analysis in the presence of agglomeration*, London School of Economics), transport improvements are an important contributor to agglomeration. The effective density of a city will be improved if links between firms within the city are improved. In addition, overall city employment will be increased if constraints on getting into the centre are relaxed.

So, cities exist (at least in part) because of the link between density and higher productivity, and transport improvements help to increase density in the first place. This is why urban rail schemes generally, and Crossrail in particular, are important for the continued success of the London economy.

3. OBJECTIVES OF CROSSRAIL

The role of Crossrail in supporting the economic growth of London is strongly reflected in the objectives set in 2001 by the project’s shareholders, Transport for London and, at the time, the Strategic Rail Authority. It is interesting to consider these in the light of traditional transport economic appraisal and what
cities do, as discussed in the preceding chapters. They are set out in full below.

“The overall objectives of Cross London Rail Links Ltd (CLRL) are:

• to support the continuing development of London as a World City, and its role as the key financial centre of the UK and Europe

• to support its economic growth and its regeneration areas by tackling the lack of capacity and congestion on the existing network

• to improve rail access into and within London.

Specifically Crossrail needs to:

• support the wider transport, planning, social and environmental objectives of the Government’s current transport strategies, the Major for London’s Strategies for London, and Regional Planning Guidance

• relieve congestion and overcrowding on the existing National Rail and Underground networks and support the development of a network of strategic interchanges

• facilitate the continued development of London’s primary finance and business service activities, which are now located in both the City and Docklands

• facilitate the improvement of London’s international links, including Heathrow

• facilitate the regeneration of priority areas, such as the Thames Gateway and the Lea Valley

• provide improved east-west rail access into and across London from the East and South East regions.

To meet these objectives Crossrail needs to be feasible from both operational and engineering points of view, environmentally acceptable and value for money.”

The primary emphasis of these objectives is on supporting productivity growth, and is well aligned with the concept of agglomeration, even before the approach to valuing agglomeration benefits was determined. There is no explicit mention within the objectives of providing time savings to commuters, or improving journey comfort and ambience, which is what is primarily captured by the traditional transport economic appraisal.

There is a requirement within the objectives to relieve congestion, but this is to support economic growth, i.e. to provide more capacity so that more people can work in central London. The aspect of congestion relief captured within
the traditional appraisal is a reduction in generalised cost. In a crowded-assignment model, such as those used for the Crossrail appraisal, congestion is treated as a generalised time weighting, reflecting its unpleasantness or discomfort, and passengers’ propensities to avoid it. Reducing this is a genuine and valuable benefit, and results in mode shift and redistribution of existing trips (which in turn generates net revenue), but it does not capture the economic growth arising from greater employment densities in the central area.

The generalised cost savings (time savings and improved journey ambience) are what attract passengers to Crossrail, and hence enable the agglomeration benefits. In the extreme, if no passengers were to use the scheme then the agglomeration benefits would be zero. So although the social benefit of passengers being attracted to Crossrail is captured in the conventional appraisal, the true economic consequence of that, which the project’s objectives are most focussed on, is not.

There is a strong emphasis within the CLRL objectives on regeneration, social inclusion and supporting policy objectives. These can be captured through the New Approach to Appraisal’s multi-criteria appraisal framework. The DfT uses this framework to determine value for money. However, although some productivity impacts are included in the conventional appraisal, there was a concern that the potentially significant agglomeration impacts were not being captured. CLRL set out to address this, working closely with the government. The resulting methodology is discussed in the next chapter.

4. DETERMINING THE AGGLOMERATION BENEFITS

Our work on determining agglomeration benefits basically split into two stages:

- A Quantification stage which determined what the potential employment growth could be, whether there was a transport constraint on central London employment growth, whether there were other constraints which would prevent that growth even if additional transport capacity were provided and the extent to which the Crossrail scheme could support employment growth

- A Valuation stage which determined the change in economic performance resulting from the relief of the constraint on central London employment growth

The quantification stage started by developing our understanding of the relationship between crowding and growth in demand on the transport network, since constraints on travel to the city centre will prevent employment in the central area from reaching its potential level.
CLRL investigated the historic relationship between the level of congestion on underground links and the amount of subsequent growth in demand for a number of time periods between 1981 and 2000. The analysis showed that there was a strong, statistically significant, negative relationship between the initial level of crowding on a link and the subsequent average annual growth rate in demand. That relationship held across a variety of time periods and whether overall demand was rising (e.g. 1994 to 2000) or falling (e.g. 1987 to 1994).

Crowding was found to have an impact on growth even at low levels of crowding but became much more marked at levels of crowding above 70% of Planning Guideline Capacity (PGC – a measure of ‘ideal’ capacity provision used by Transport for London that allows for standing passengers at an acceptable density) across the morning peak period. Plotting the relationship between the initial level of crowding in 1987 and the subsequent average annual growth rate in passenger flow over the period 1987 and 2000, and taking a line of best fit, shows that average growth becomes negative at a level of crowding around 75% of PGC over the morning peak period.

There are clearly a number of potential responses contained within this relationship, including reassignment to a new route or mode of travel, changes to travel behaviour (such as peak spreading or working from home), changes to home or employment location and even people who continue to travel because of increases in wages. At an individual link level it is not possible to break down the change between these.

When looking at central London as a whole however, the options for changes to mode and/or route are limited. The average inbound level of crowding across the central cordon is 75% of PGC so there are few opportunities to shift to a less crowded route. The other options all entail real economic costs whether those are changes to the preferred time of travel, higher wages, loss of agglomeration benefits from jobs moving out of the capacity constrained clusters or simply people choosing to work in less productive sectors because they are easier to travel to.

Using cordon data, which shows flows on all rail links passing through cordons around central London, the Isle of Dogs and the City, a ‘crowding off’ function was developed. When crowding on the network increases above a certain level, growth in demand is assumed to be reduced, stopping altogether once crowding is too high. Since Crossrail increases capacity passing through the cordons, there is then less crowding and less of a constraint on growth in demand. Assuming trips equate to jobs, Crossrail therefore allows more growth in employment in the central areas of London.

Both the changes in employment and the changes in accessibility then impact on changes in density. The definition of density used here is ‘effective
density’, which follows guidance that the UK Department for Transport has issued on wider economic benefits. In the modelling process, London is divided into zones. The effective density of a given zone j then depends on the level of employment within the other zones, and the generalised cost of travelling to j from everywhere else. Forecasts of employment are based on the London Plan (and changes in employment between the with / without Crossrail scenarios based on the analysis described above), and generalised costs are already calculated for the conventional transport appraisal.

To translate changes in density into changes in productivity, we then require an ‘agglomeration elasticity’. This is the elasticity of productivity with respect to density. Evidence is available on this from a variety of sources. Venables’ work suggests that it could take a value of between 0.04 and 0.12. In other words, a 100% increase in density could lead to a productivity increase of 4 – 12%. The agglomeration work undertaken for Crossrail has used 7% based on London-wide research undertaken by Volterra Consulting, but not specifically for central London. It may be considered that this is a conservative estimate given that London has a large FBS sector and that FBS is likely to be at the higher end of any ranges estimated.

There are two distinct agglomeration benefits:

i) Move to more productive jobs – this measures the increase in GDP from workers moving to jobs in the city centre where their productivity is higher;

ii) ‘Pure’ agglomeration – this is the increase in productivity for the existing city centre workers. It comes about due to further clustering when extra workers locate in the area.

Data for productivity in individual boroughs of London has been obtained and grown by 1.75% per year to forecast future values. It is assumed that all the zones within an individual borough have the same output per worker.

Differences in employment between zones (or boroughs depending on the level of analysis) are combined with differences in productivity in order to quantify the value of the move to more productive jobs. For the pure agglomeration, changes in effective density are combined with the agglomeration elasticity in order to obtain changes in productivity for the workers already located within that zone / borough.

Both agglomeration benefits are calculated over a 60-year appraisal period and discounted to a base year.

This gives a central value for the increase in GDP that Crossrail enables. However, with the move to more productive jobs only the ‘tax wedge’ element of the increased output should be counted as additional to the welfare appraisal. This is because if the market is in equilibrium, then the rest of the productivity gain should be balanced out by other costs to the workers who
move to central London, such as longer commuting times, longer working hours, greater levels of stress etc. Thus the increase in output is gained at the expense of other “non-pecuniary” costs imposed on workers.

The end result of the analysis is that a substantial amount is added to the existing welfare increase that is calculated in the conventional appraisal, and a truer valuation of the benefits of the scheme can be gained.

5. CONCLUSIONS

The agglomeration approach outlined here gives us a method by which to value the impacts of urban rail schemes on city economic growth. Our view, and the experience from Crossrail, is that these impacts are just as important as the traditional time savings and quality benefits. That view has been reinforced by further work undertaken on other rail projects in and around London by Colin Buchanan.

We believe that decision making on investments in urban rail projects in the UK and elsewhere have typically taken account of the potential for employment growth, but in an ad hoc way without any real analysis to back-up or challenge those views. Agglomeration benefits provide a real improvement and in our view radically change the case for urban rail schemes.

Traditional transport economic appraisal remains an essential element in considering whether a project should go ahead. But equally, in our view, the government also has to consider what a project will do for productivity and economic growth, and agglomeration benefits provide a major step forward in this regard.