

## **Wider economic benefits and private finance in the appraisal of major infrastructure projects: the Crossrail project**

Roger Vickerman  
Centre for European, Regional and Transport Economics  
University of Kent  
Canterbury, CT2 7NP, UK

Tel: +44 1227 823495

Fax: +44 1227 827784 Email: [R.W.Vickerman@kent.ac.uk](mailto:R.W.Vickerman@kent.ac.uk)

### **Abstract**

The Crossrail project is a huge infrastructure project to build a new underground rail line across Central London. A traditional financial appraisal or Cost-benefit Analysis fails to yield an adequate return, but the application of some new results from an analysis of wider economic benefits, particularly potential agglomeration effects, suggests a greater viability. This analysis has been used to justify private sector contributions to the project which were critical in its acceptance by the Government. This is a different approach from a conventional Public-Private Partnership. This paper reviews the project, the rationale for the wider benefits and the likely impact. It suggests that this could be a valuable way of generating both specific funds and justifying specific taxes to raise such additional funding to pay for such wider benefits.

### **Key words:**

Infrastructure investment; wider economic benefits; Cost-benefit analysis; Public-private partnership

**JEL codes:** D61, H44, L51, R42

### **Introduction**

The Crossrail project is a huge infrastructure project to build a new underground rail line across Central London. With a total budget of around £16 billion it will take eight years to complete. It has an unusual form of delivery structure in which the initial work has been done by two public sector agencies representing central and regional government, which will provide guarantees for most of the funding, but a final decision on the project was dependent

on achieving agreement from a variety of public and private sector agents on significant contributions to this funding. This is not therefore a typical PPP structure, the public sector has maintained a controlling interest which is vital during the parliamentary approval process, but is harnessing private sector contributions from the beginning. The decision was based on the recognition of the wider economic benefits not usually captured in a transport cost-benefit analysis. These have been used, not just as a means of justifying the investment, but also of capturing some of those benefits from private sector, developer and other, contributions to the capital cost.

The estimated transport user benefits of the project at £12.8 billion are insufficient to justify the project, but the additional benefits of over £7 billion have enabled the promoters to claim that the project will bring around £20 billion of total benefits to London. Of these additional benefits some £3 billion are ascribed to agglomeration effects on the basis of new research.

The paper provides a critical review of the appraisal methods used to justify the project and assesses the advantages and disadvantages of the delivery method chosen. As with any project of this scale it has a degree of individuality which is not necessarily transferable, but the methods chosen to realise the project do provide interesting pointers to the way future projects could be delivered by identifying wider benefits which can be ascribed to specific private sector interests.

## **The Project**

The project is to construct a main line railway gauge tunnel across Central London in an east-west direction. This will provide a link between existing rail infrastructure at each end and allow a service of up to 24 trains per hour. The current service plan allows for trains to link existing commuter lines to the west and east of London, with a link to serve Heathrow Airport. This will provide four new Central London stations with connections to the

Underground network, giving access to the West End shopping and theatre districts, the City of London and also to the new financial district around Canary Wharf (Isle of Dogs).

The main difficulty of tunnelling through Central London is that the area is already very congested with Underground tunnels and other services, plus a difficult geology which requires extreme care and creates additional cost. Access to the tunnelling sites has been a major issue in the environmental impact assessment. Tunnelling costs are estimated at £1.6 billion and station construction at £2.22 billion out of a total capital cost of £6.886 billion at 2002 prices.

The scheme also provides for automatic train operation and protection in order to achieve such a high density of operation. This is expensive and involves technology as yet untried in situations other than metro operation.

The project is seen as vital to increase the capacity of London's rail system both to alleviate overcrowding and to reinforce the economic capacity of the city. Crossrail affects a huge area of SE England. Potentially it serves an area with a total population of up to 20 million people depending on the precise final arrangement of service patterns and covering an area of up to 25000km<sup>2</sup>. The total area affected includes the three English regions of Greater London, South East England and East of England with a total GDP of around £340 billion. Given the nature of the project it is difficult to estimate more precisely an exact area directly affected, but it is likely to impact on some 10-12 million people, some 12000km<sup>2</sup> and a GDP of £300 billion.

The Greater and Outer London region faces enormous infrastructure challenges. Greater London has a total workforce of about 5.3 million. The largest sector, finance, professional and business services, employs just over 1 million. London also has a large self-employed community of over 455,000 in 2002. However, with an unemployment rate of 7.52% it has

one of the highest rates of unemployment of any UK region. Given the nature of the workforce and the high cost of housing in London the economy is highly dependent on commuting. Over 1 million people enter Central London every day, 45% by rail and a further 32% by Underground. Roads face serious congestion and the Central Area is already subject to a Congestion Charge of £8 per day for road vehicles. Some commuters travel over quite long distances (100km is not unusual) and times (2 hours each way per day is also common).

Despite a good network of Underground services within Greater London, especially to the north of the River Thames, regional rail services terminate at main-line stations on the edge of the Central area requiring most commuters to interchange to Underground services which have become extremely overcrowded and unreliable. The one partial exception is one north-south link, Thameslink, which provides a connection between commuter services to the north and south of the capital. This has been under development for several years and has not yet reached its full potential.

The Crossrail project is designed to provide a similar east-west link and allow commuter rail services direct access to a series of major stations in Central London. This has been seen to be essential to maintain the competitiveness of the City of London as a world financial centre in the face of competition from cities such as Paris or Frankfurt which have heavy rail services serving the centre of the city in the form of the RER or S-Bahn respectively. Earlier schemes have usually failed on the basis of obtaining an adequate return on the capital in the face of severe restrictions on public investment. Hence, the evaluation of wider economic benefits has been a major issue in the decision making process.

### **Project Structure**

Major projects of this type tend only to succeed if there is a clear project champion. Crossrail has been hampered by the lack of such a champion. As a heavy rail project it was essentially the responsibility of British Rail before privatisation in the mid 1990s during a period when

large-scale investment in the rail sector was not well supported by Government. Transport within London also faced difficulties until the reform of local government replaced the fragmented structure of the London Boroughs with an overarching Greater London Authority (GLA) with an elected Mayor which was given strategic responsibility for transport.

This led to the project being re-established as a strategic partnership between the Strategic Rail Authority (SRA, as successor to British Rail) and Transport for London (TfL, as the GLA's delivery authority for transport). However, as indicated above the project has much wider significance than just the GLA area as it will carry services which penetrate into areas outside the GLA area and will also provide key inter-connection services for those travelling from much further afield as it links the two main-line stations of Paddington and Liverpool Street. Since it also provides a connection to Stratford, where there is a proposed additional station on HS1 (the high speed link via the Channel Tunnel to Paris and Brussels) Crossrail can also provide a link into international services (one earlier option routed the line via Kings Cross St Pancras where the new Eurostar terminal is located but this proved difficult in engineering terms and led the line away from one of its main areas of service, The City). There is also an implication for airport services with one branch serving Heathrow Airport and providing direct services into parts of London not currently served by the Heathrow Express and Underground links. Furthermore the relief of congestion at Liverpool Street will enable increased capacity on the Stansted Airport rail service.

In 2002 Cross London Rail Links Ltd (CLRL) was established as a joint venture between the SRA and TfL. The Department for Transport (DfT) provided £154 million towards exploratory studies, but it proved difficult to identify a clear financial rate of return which would meet the normal criteria on the basis of identified user benefits relative to the very high costs of such a complex project. The key to the further progress of the project was to identify other partners who would benefit from the project, but also to identify any wider benefits not be picked up in the standard transport appraisal exercise that could be seen as a possible

payback to joint venture partners. The business case was presented to Government by CLRL in 2003, and the DfT undertook its own review of the business case which was published as the Montague Review in 2004. This led to the Crossrail Bill being deposited in Parliament in 2005, but it then took until October 2007 before the Government finally accepted the commitments of partners, essentially the Corporation of London representing City interests and property developers who would undertake to develop additional stations in return for the development activity this could stimulate as part of a £16 billion funding package. The Bill should pass into law during 2008 allowing construction to begin in 2009 and completion in 2017. The project has been appraised over a 60 year life.

Although the structure of the project thus sounds like a form of Public-Private Partnership, it is an unusual one in that it is not a straightforward concession granted by the public sector to a private consortium with some public sector guarantees. The core partnership is between two public sector bodies the SRA and TfL, representing central and local government respectively, through subsidiary companies with a notional capital. This partnership is CLRL Ltd. This partnership was criticised in the Montague Review as potentially not providing a sufficiently robust development vehicle during the Parliamentary approval process (involving a so-called Hybrid Bill) and construction and consequently it proposed the transfer of responsibility to a project promoter more clearly identified with Government. The revised Partnership is contained in a Heads of Terms published in November 2007. This provides for the transfer of the project to TfL but under the auspices of a joint Board of TfL and DfT. The private sector interests arise through the involvement of the City of London Corporation and the agreement of private sector interests that a special development levy can be exercised over firms within the affected area, plus the specific involvement of property developers for at least one station development project which due to its construction complexity would not otherwise have been able to be included. Thus here the private sector interests are relatively small and specific, but critical to the acceptance of the project.

## Project budget and finance

The Heads of Terms of November 2007 estimates capital cost of £15.9 billion of which DfT will be responsible for £5.639 billion and TfL for £7.738 billion. These are guaranteed amounts, significant parts of these sums will be expected to be raised from various private sector sources through, for example Section 106 Agreements where developers agree to pay for the necessary transport improvements to effect a scheme. Table 1 summarises the sources of funds.

<u>TfL Underwritten</u>	
GLA (NNDR debt)	3.5
TfL – core contribution	2.7
LU Interface savings	0.4
Sales of surplus land and property	0.5
Developer contributions	0.3
London Planning Charge	0.3
	<b>7.7</b>
<u>DfT underwritten</u>	
DfT grant contribution	5.1
BAA/City Corporation	0.5
	<b>5.6</b>
<u>Other</u>	
Network Rail	2.3
Depot	0.5
City Corporation	0.1
Less other residual costs	(0.4)
	<b>2.5</b>
<b>Total</b>	<b>15.9</b>

Source: Secretary of State for Transport and Transport for London (2007)

The DfT share includes £0.5 billion from BAA (as owner of London Heathrow) and the City of London Corporation. £300 million is to be provided by developers including the owners of Canary Wharf to provide the Isle of Dogs station and a proposed contribution from Berkeley Homes to fund the provision of a station box at Woolwich (though not for its fitting out). A further £300 million will be derived from a supplementary business rate on businesses likely to be affected and for a Statutory Planning Charge These would reduce the direct charges falling on TfL and DfT. It will be seen that there is also a commitment by Network Rail, as

owner of the infrastructure over which Crossrail trains will run at the outer limits, to make investment commitments.

This is the first major project in the UK which is relying so heavily, not just on the potential for gains from wider economic benefits, but also in terms of a financial commitment based on the expectation of these by likely beneficiaries, as a major part of its justification.

### **Wider benefits**

The key to this project is in the identification of wider economic benefits from which all the parties will gain. These wider benefits arise from various sources, but the main impact is through the enhanced productivity which arises from agglomeration effects. These arise particularly from the ability to widen and thicken labour markets such that workers can move to more productive jobs as well as the direct enhancements to productivity.

Agglomeration arises because of the extent of linkages in the local economy as these linkages help enlarge the markets not just for final demand activities but for intermediate activities as well (Fujita et al. 1999; Fujita and Thisse, 2002). This means that as activities move towards the larger city costs rise as transport costs within the city will rise because of congestion etc and land rents will rise, but so will market size enabling further exploitation of scale economies. Because markets have grown more activities will be attracted to the city and hence the transport costs embodied in those activities will be reduced as more activities are available locally and do not need to be imported from outside the city.

The critical point to note here is the role of real wages in this process of cumulative causation. Even if wages do not rise because of diminishing marginal productivity of labour, since prices of goods will fall real wages may continue to rise. Thus labour will continue to be attracted to the city and contribute to the rising level of demand which will encourage more investment. Similarly, if transport costs fall because the increased prosperity enables further investment in

the transit system used for commuting, this enlarges the effective labour market and this will reduce the average unit cost of labour even if wages actually increase.

These changes in labour markets arise for three main reasons: changes in participation rates; increased working hours and moves to more productive jobs. Because workers can now access a wider range of jobs more cheaply (at least in terms of generalised cost) they will be more willing to work. If journey times are reduced workers may be more willing to work longer hours, or if they are not they may nevertheless have an impact through increased expenditure in increased leisure time. Most importantly the enlarged labour market will enable workers to move to more productive jobs within the city, more productive because of the increased market size enabling exploitation of further scale economies. Thus the increased size of the commuting area has impacts on productivity and wage differentials (Venables, 2007).

The evidence for these impacts has traditionally been sought in studies which aim to relate productivity to city size. Urban economists have looked at this issue in different ways with similar results to those for the relationship between infrastructure investment and economic performance. The key issue here is whether the evidence points more to urbanisation economies, which are usually measured with respect to total population in the city, or localisation economies, which are measured with respect to industry size (employment). The typical elasticity of productivity with respect to city size is of the order of 0.01 to 0.20 across a range of studies with a typical value of 0.10 suggesting that there is evidence of modest agglomeration economies (see for example, Sveikauskas, 1975; Moomaw, 1981; Nakamura, 1985; Henderson, 1986). Elasticity with respect to industry size is typically a little larger, with values closer to 0.20 (Nakamura, 1985; Henderson, 1986), although a more recent study by Henderson (2003) has a much lower elasticity of 0.03.

Ciccone and Hall (1996) and Ciccone (2002) provide alternative estimates using measures of employment density which are shown to account for most of the variance in productivity. The elasticity with respect to density is of the order of 0.04 to 0.06. A more detailed study incorporating more precise spatial measures at a smaller geographical scale by Rice et al (2006) produces a similar order of elasticity.

Recent work by Graham (2007) for London reaffirms these results for manufacturing industry, but consistently finds elasticities of 0.2 or higher for services. This suggests that for the modern city, highly dependent on skilled labour in financial and business services, there are potentially significant gains which can be generated by changes which enable the labour market to grow.

This work has been used to generate potential impacts for Crossrail. But the wider benefits of a project are not just in the agglomeration benefits of productivity increases. Lower transport costs can lead to increases in competition which will lower prices and contribute to market expansion. Such price effects may not be passed through immediately to consumers in imperfectly competitive industries, but the increased margins may lead to further benefits through the exploitation of internal scale economies. There may also be exchequer benefits as the rising activity levels enhance tax revenues and reduce welfare payments.

The initial economic appraisal of the project by CLRL based on 2002 prices and the project before later modifications suggested a Benefit-Cost Ratio of around 1.6-1.8 on a capital cost of £10.6 billion and a total costs, including maintenance and operating costs, of £13.9 billion. This would be offset by revenues of around £13.6 billion (net revenues after allowing for traffic abstraction of £6.1 billion). Applying the elasticities identified by Graham to Crossrail suggest that wider benefits would increase the BCR to around 2.4-2.6 (Table 2). For this exercise it was assumed that competition benefits would be small, but this may lead to an underestimate.

Table 2 *Estimated Welfare Benefits of Crossrail (£mn)*

<i>Business time savings</i>	<b>4,847</b>
<i>Commuting time savings</i>	<b>4,152</b>
<i>Leisure time savings</i>	<b>3,833</b>
<b>Total transport user benefits</b>	<b>12,832</b>
Agglomeration benefits	3,094
Increased competition	0
Imperfect competition	485
Exchequer consequences of increased GDP	3,580
<b>Additional benefits</b>	<b>7,159</b>
<b>Total</b>	<b>19,991</b>

Source: Department for Transport (2005)

The original CLRL study produced slightly higher transport user benefits (£16 billion against £12.8 billion), but the additional benefits, principally arising from agglomeration effects appear to have a critical impact on the overall appraisal of the project.

### **Conclusions and implications**

It would therefore appear that the ability to identify wider benefits more precisely and show the clear nature of these has been a critical factor both in ensuring the decision to proceed with Crossrail and in securing payments from the private sector. Traditionally such wider benefits have been seen to have an essentially public good nature that would make it difficult to charge them to specific groups. Here however both the sectoral and spatial nature of these benefits has been identified in such a way as to justify both direct payments by developers and a wider tax on specific groups.

Crossrail by its nature is an enormous project with highly specific types of impact, but the method used to quantify wider benefits and then use these to raise additional sources of revenue, may be an interesting model. The contributions are on a relatively small scale comrade with the total cost of the project, but nevertheless may have been critical in securing the decision to proceed.

## References

- Ciccone, A. (2002), 'Agglomeration effects in Europe', *European Economic Review*, **46**, 213-227.
- Ciccone, A. and R. Hall (1996), 'Productivity and the density of economic activity', *American Economic Review*, **86**, 54-70.
- Crossrail (2003) The Crossrail Business Case, Cross London Rail Links Ltd, Strategic Rail Authority, Transport for London
- Crossrail (2005) Economic Appraisal of Crossrail, Cross London Rail Links Ltd,
- Department for Transport (2004) Crossrail Review. Report of a Review Chaired by Adrian Montague)
- Department for Transport (2005) *Transport, Wider Economic Benefits, and Impacts on GDP*, Technical Paper. London: Department for Transport
- Department for Transport (2007) The Government Overview of the Case for Crossrail and its Environmental Impacts (Cm7250) London: The Stationery Office
- Fujita, M., P. Krugman and A.J. Venables (1999) *The Spatial Economy: Cities, Regions and International Trade*, Cambridge, MA: MIT Press.
- Fujita, M. and J.F. Thisse (2002), *Economics of Agglomeration*, Cambridge: Cambridge University Press.
- Graham, D. (2007), 'Agglomeration, productivity and transport investment' *Journal of Transport Economics and Policy*, **41**, 317-343.
- Henderson, J. (1986), 'Efficiency of resource usage and city size'. *Journal of Urban Economics*, **19**, 47-70.
- Henderson, J. V. (2003), 'Marshall's scale economies', *Journal of Urban Economics*, **53**, 1-28.
- Moomaw, R. L. (1981), 'Productivity and city size: a review of the evidence', *Quarterly Journal of Economics*, **96**, 675-688.
- Nakamura, R. (1985). Agglomeration economies in urban manufacturing industries: a case of Japanese cities. *Journal of Urban Economics* **17**, 108-124.
- Rice, P., A. Venables, and E. Patacchini (2006), 'Spatial determinants of productivity: analysis for the regions of Great Britain', *Regional Science and Urban Economics*, **36**, 727-752.
- Sveikauskas, L. (1975), 'The productivity of cities', *Quarterly Journal of Economics*, **89**, 392-413
- Venables, A. J. (2007), 'Evaluating urban transport improvements: cost-benefit analysis in the presence of agglomeration and income taxation'. *Journal of Transport Economics and Policy* **41**, 173-188
- Secretary of State for Transport and Transport for London (2007) Heads of Terms