

5. Route-wide impacts: Agglomeration benefits

5.1 Introduction

5.1.1 One of the key objectives for Crossrail, as published by the CLRL Board, is to facilitate the continued development of London's Finance and Business Service (FBS) activities. The chosen route passes through the West End, the City of London and the Isle of Dogs, the three main FBS clusters not only in London but also in the UK.

5.1.2 The starting point, both for this analysis and the transport impacts is the forecast of future population and employment in London as defined within the London Plan. The London Plan expects an increase in total London employment of 636,000 jobs between 2001 and 2016 and an 800,000 increase in population. These projections are based on the extrapolation of historic trends and have been approved by government following a rigorous examination.

5.1.3 The two key conclusions from the London Plan (for this assessment of the Agglomeration impacts of Crossrail) are that:

- the dominant sector behind future employment growth will be FBS. The FBS sector created a net 750,000 jobs in London between 1971 and 2001 equal to the entire growth in employment (all sectors) over that 30 year period;
- the FBS sector is heavily concentrated within the central area (largely due to the agglomeration benefits of locating there). Of the overall employment growth, roughly half is expected to locate within the central area (including the Isle of Dogs).

5.1.4 The dominance of the FBS sector and its geographic focus on the central area has significant transport implications. Growth will be focussed within those areas that are served by the most congested parts of the rail network and that growth will be almost entirely dependant on public transport (no additional highway capacity is planned and even before congestion charging, commuting by car into the central area was declining).

5.1.5 Growth in the FBS sector within the central area will, therefore, create significant problems for the public transport network. Crossrail's role is to support and enable that growth and there are two reasons why that support is vital for the UK economy as a whole:

- the FBS growth is market led. It is the market that is demanding additional FBS jobs and the market that is demanding that those additional jobs be located within the central area. If that growth were to be constrained there is no guarantee that it would take place elsewhere within London, or the UK.
- employment growth in central London has a significant productivity advantage over employment growth elsewhere. That productivity differential is driven by the agglomeration benefits of locating within one of the three largest FBS clusters in the world (the others being New York and Tokyo).

5.2 Agglomeration

Agglomeration theory

- 5.2.1 There are a variety of definitions of agglomeration, most of them along the lines of “The act or process of collecting in a mass; a heaping together”. Agglomeration is a common process and high degrees of agglomeration of FBS companies exist in major financial centres such as London, New York, Tokyo, Frankfurt and Paris. Cities exist as an agglomeration of economic activities in which the costs of being crowded must be outweighed by the benefits of the location to businesses and indeed residents. Preferences appear to exist over a wide range of locations for co-location of these types of services.
- 5.2.2 The reasons why agglomeration occurs include:
- *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 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.
- 5.2.3 It is possible to conclude that:
- agglomeration effects exist and the extent of FBS clustering suggests that they are of particular importance to this sector;

- agglomeration effects within the FBS sector are largely associated with central London;
- increases in employment density will increase the scale of agglomeration.

5.3 Constraints on future employment growth

- 5.3.1 Given the characteristics of travel to the central area, the heavy dependence on rail to get people to work and the high levels of crowding to and within the central area, it is clear that a lack of public transport capacity can and probably does already, constrain growth. Before addressing the transport constraint in more detail, however, consideration needs to be made of other possible constraints on growth. CLRL have specifically looked at two: the property and labour markets.

The property constraint

- 5.3.2 CLRL investigated whether the property market would be able to deliver the amount of additional office space required to meet projected employment growth. The conclusion was that the property sector would be able to supply sufficient office space to accommodate the expansion predicted within the London Plan forecasts¹³.

The labour market constraint

- 5.3.3 Assuming there was demand from employers to locate within central London and property to accommodate them, would there be sufficient supply of labour to fill those positions? In terms of mobility of labour there should not be a problem, workers will migrate if necessary to fill labour shortages, especially in high wage sectors such as FBS. In addition high population growth is expected within London anyway, driven by the demographic characteristics of the current population. If there is a constraint it is likely to be due to the London housing market. In this respect the role of Crossrail in linking the Thames Gateway to the central area is important by creating new residential locations accessible to the areas of expected employment growth.

The transport constraint

- 5.3.4 The transport constraint is that the level of growth forecast by the London Plan by 2016 cannot be accommodated by the anticipated increase in rail capacity without Crossrail – and future growth beyond 2016 will be even more negatively affected by the transport constraint.

¹³ Drivers Jonas – The Economic Case for Crossrail, June 2002

- 5.3.5 Public transport capacity is a complex technical area with questions over both the definition and measurement of capacity and what passenger responses are to increases in crowding. The base year for Crossrail's modelling work is 2001 and hence that is the comparator for the future year scenarios.
- 5.3.6 Cordon analysis measures the level of supply and demand across individual cordons. CLRL have used three cordons around:
- the central area (roughly equivalent to the zone 1 fares area);
 - the City;
 - the Isle of Dogs.
- 5.3.7 Information is presented in *Table 5.1* for the morning peak period (7am to 10am) although within that period crowding is much worse in the peak hour.

TABLE 5.1: 2001 CORDON ANALYSIS RESULTS

	Demand	Supply	Crowding
Central	897,000	1,220,000	74%
City	324,000	523,000	62%
IOD	51,000	83,000	62%

Notes: Demand = passenger flows inbound across the cordon for AM peak period (7-10)

Supply = Planning Guidance Capacity (PGC) TfL's standard definition of capacity

Crowding = Demand as % of Supply

Cordon analysis excludes InterCity and CTRL services from both supply and demand figures.

- 5.3.8 It should be noted that cordon analysis substantially underestimates average crowding because aggregation of all the individual links ignores the fact that the busiest (most crowded) links carry the most passengers.
- 5.3.9 Select Link Analysis (SLA) provides information on crowding levels to the three main employment centres within London, namely the City, Isle of Dogs and Central London (effectively Fare Zone 1). SLA identifies users of all links crowded in excess of a pre-defined level of crowding and allows their destination zone to be identified. It is, therefore, possible to identify:
- the numbers of passengers experiencing defined levels of crowding according to their destination;
 - the amount of time spent on links crowded in excess of defined levels of crowding, again according to individual destination areas;

- dividing one by the other, the average amount of time spent by passengers to particular areas at each defined level of crowding.

5.3.10 *Table 5.2* shows the amount of time spent by passengers according to the level of crowding experienced. The numbers shown refer to the amount (and proportion) of on-train time rather than total journey time. About one third of all on train time (38% to the central area) is spent in excess of PGC.

TABLE 5.2: AVERAGE MINUTES PER PASSENGER BY CROWDING LEVEL (2001, AM PEAK HOUR)

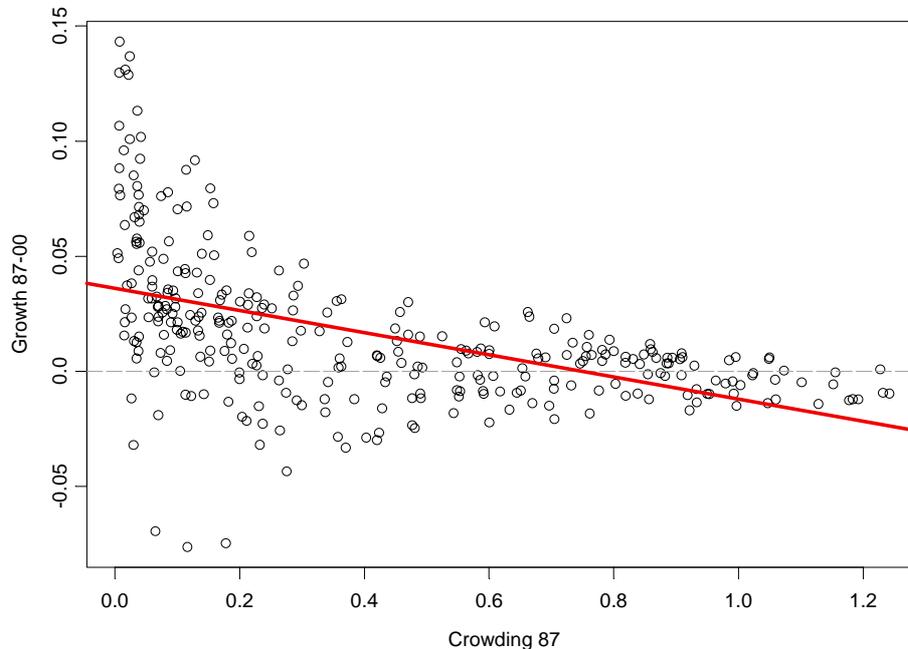
	Total Trip (average)	Crowd > 30% PGC	Crowd > 80% PGC	Crowd > 100% PGC	Crowd > 125% PGC	Crowd > 150% PGC
Isle of Dogs	26.28	25.27	15.60	9.00 (34%)	2.91	0.24 (1%)
City	30.65	28.23	19.60	10.91 (36%)	4.07	0.44 (1%)
Central	28.55	25.98	17.85	10.83 (38%)	4.02	0.31 (1%)

5.4 Crowding and its constraint on growth

5.4.1 CLRL have 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).

5.4.2 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 PGC across the morning peak period. *Figure 5.1* shows the relationship between the initial level of crowding ("crowd 87") and the subsequent average annual growth rate in passenger flow ("growth 87-00") over the period 1987 and 2000. It shows the outcome for each of the individual links considered and the line of best fit which shows that average growth becomes negative at a level of crowding around 75% of PGC over the morning peak period.

FIGURE 5.1: RELATIONSHIP BETWEEN LEVEL OF CROWDING (D/PGC) IN 1987 AND ANNUAL AVERAGE GROWTH RATE IN DEMAND (1987 – 2000)



5.4.3 There is 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.

5.4.4 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% 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.

5.5 Conclusions on constraints

5.5.1 It does not appear that either property or labour supply will provide insurmountable constraints on the future growth of FBS employment in central London. That growth will, however, place

additional demands on an already crowded rail network and a lack of rail capacity could well constrain growth. Analysis of historic trends shows that passengers are averse to crowding and that highly crowded links experience much lower growth than others.

5.6 Future transport conditions and the impact of Crossrail

5.6.1 There are substantial changes expected to occur between the 2001 base year and the 2016 forecast year. The key issues relevant to the central London employment impacts are:

- the London Plan predicts increases in both population and employment. By 2016 population is expected to rise by 800,000 and employment by 636,000;
- due largely to the concentration of employment growth in the central area and minimal increases in highway capacity, this growth results in a disproportionate increase in public transport use. Total morning peak period public transport trips in 2016 are expected to rise by 25%;
- despite the increases in rail capacity assumed in the base scenario (Thameslink 2000, East London Line Extension, CTRL, significant increases on many of the Train Operating Companies (TOCs) and full PPP network growth assumptions for LUL) the overall result, before Crossrail is introduced, is a substantial increase in crowding. That comprises both increases in the highest levels of crowding and a spreading of the locations in which crowding takes place.

2016 base

5.6.2 For comparison with the 2001 cordon figures, *Table 5.3* shows the 2016 results with and without Crossrail.

TABLE 5.3: 2016 WITH AND WITHOUT CROSSRAIL, ALL RAIL MODES EXCLUDING CTRL

	2016 without Crossrail			2016 with Crossrail		
	Demand	Supply	Crowding	Demand	Supply	Crowding
Central Cordon	1,129,000	1,452,000	78%	1,162,000	1,539,000	76%
City Cordon	439,000	649,000	68%	481,000	787,000	61%
Isle of Dogs	113,000	137,000	82%	138,000	212,000	65%

5.6.3 Crossrail reduces average crowding across the City cordon to just below 2001 levels, and to the Isle of Dogs and Central cordons to

somewhere between 2001 and 2016 without-Crossrail levels. Without Crossrail there is a significant increase in crowding across all three cordons. It should be noted that although the City cordon appears less crowded than the central area that is only because the rail services entering the City from the west are less crowded than they were when they crossed the central cordon (having already dropped off passengers in the West End). The Select Link Analysis (*tables 5.4(a) and (b)*) takes account of crowding experienced over the whole journey and shows the City to be the destination which suffers the highest average crowding.

TABLE 5.4(A): SELECT LINK ANALYSIS: 2016 WITHOUT CROSSRAIL

	All Trips	Crowd > 30% PGC	Crowd > 80% PGC	Crowd > 100% PGC	Crowd > 125% PGC	Crowd > 150% PGC
Isle of Dogs	36,000	34,000	34,000	34,000 (94%)	21,000	9,000 (26%)
City	105,000	97,000	95,000	90,000 (85%)	75,000	25,000 (24%)
Central	450,000	400,000	394,000	370,000 (82%)	309,000	110,000 (24%)
All Zones	1,143,000	796,000	717,000	657,000 (57%)	512,000	187,000 (16%)

TABLE 5.4(B): SELECT LINK ANALYSIS: 2016 WITH CROSSRAIL

	All Trips	Crowd > 30% PGC	Crowd > 80% PGC	Crowd > 100% PGC	Crowd > 125% PGC	Crowd > 150% PGC
Isle of Dogs	36,000	34,000	32,000	27,000 (74%)	14,000	7,000 (19%)
City	105,000	97,000	92,000	86,000 (82%)	54,000	19,000 (18%)
Central	450,000	401,000	383,000	355,000 (79%)	232,000	90,000 (20%)
All Zones	1,143,000	814,000	722,000	652,000 (57%)	402,000	149,000 (13%)

5.6.4 *Tables 5.4(a) and (b)* show how crowding increases by 2016 without Crossrail (in comparison with the 2001 results in *Table 5.2*) and then how Crossrail relieves crowding (especially at higher levels of crowding). Comparing *Tables 5.4(b) and 5.4(a)* shows that for crowding levels of 150% of PGC, Crossrail reduces the numbers of passengers affected by between 20% and 30%.

5.7 Quantifying the impact on central London employment

5.7.1 The next stage is to link the reduction in rail crowding provided by Crossrail to the number of additional jobs enabled within the central area. A number of approaches to this have been developed and applied by the Crossrail team and its consultants. Volterra Consulting Ltd (Volterra) and Oxford Economic Forecasting (OEF) have developed mechanisms for forecasting the impact of additional crowding on central area employment growth. These are described below.

The Volterra approach

- 5.7.2 Volterra developed two approaches, one based on the cordon analysis (described above) and the other on the Select Link data. The cordon approach applies a “crowding-out” function, which in essence says that the proportion of “unconstrained” development demand that takes place reduces as crowding across the cordon increases. As crowding increases from current (2001) levels, an increasing percentage of unconstrained development demand is assumed not to occur. The relationship is such that once crowding increases to a level 25% higher than the 2001 base, all future development is stopped (and at, for example, 2.5% higher than 2001 levels, 10% of unconstrained development is stopped).
- 5.7.3 The Select Link data approach looks at the existing distribution of crowding for central area workers and postulates that any increase in crowding beyond that distribution would represent a constraint and gradually reduce growth.
- 5.7.4 Volterra’s approach suggests that by 2016 the transport constraint without Crossrail would have reduced employment within the West End, City and Isle of Dogs by between 5,000 (cordon approach) and 13,000 (Select Link approach). Post 2016, assuming a continuation of the growth trends in demand for those locations and supply to them, the size of the constraint increases to 33,000 and 40,000 jobs by 2027.

The OEF approach

- 5.7.5 OEF used their in-house macro-economic model of the UK, which incorporates spatial and sectoral disaggregation. Into that model they input the impact of Crossrail on the three key central areas (City, West End and Isle of Dogs) with reference to its impact on travel costs. OEF derived that impact on travel costs through their non-linear generalised cost curve. This approximates to the crowding curves used in the Railplan and LTS models at most levels of demand, but implies much higher crowding penalties at high levels of overcrowding (specifically more than 20% over PGC). The curve was designed to overcome the straight-line crowding functions and lack of capacity constraints within the existing models for LUL services in particular.
- 5.7.6 The OEF model then uses the change in generalised travel costs to determine changes in wages required to attract staff, resulting in changes in business efficiency and hence changes in employment by sector and location. Their results are for an equilibrium position, recognising the interactions between changes in employment and changes in crowding.
- 5.7.7 The OEF approach suggests that by 2016 the transport constraint without Crossrail would have reduced employment within the West End, the City of London and the Isle of Dogs by 10,000

compared to the with-Crossrail scenario. The 2016 results do not take full account of the time lags within OEF's model. By 2027 central area employment is reduced by 23,000 without Crossrail.

- 5.7.8 Both approaches forecast a substantial constraint on employment in central London in the no-Crossrail scenario. It is reassuring to note that other transport models, reviewed briefly in the following paragraphs, predict a similar scale of impact of Crossrail on employment in central London.

The LTS model distribution function

- 5.7.9 The LTS model incorporates a Distribution function which predicts changes in the distribution of trip destinations (predominantly employment locations) as a result of changes to the network. Analysis of the LTS demand matrices as a result of the introduction of Crossrail indicates that they show an additional 35,000 trips (all modes) terminating in central London in the morning peak period for the 2016 with-Crossrail scenario. That might reasonably be assumed to equate to an additional 35,000 central area jobs.

The Elasticity approach

- 5.7.10 In the July 2003 Business Case an elasticity approach was adopted rather than the DMS (distribution and mode split) function. This factored up passenger trips in accordance with the percentage reduction in average travel costs derived from the introduction of Crossrail applying an elasticity of -0.6 . The elasticity approach resulted in an overall increase of some 25,000 trips with some 17,000 of them to the central area.

LASER model results

- 5.7.11 LASER is a model which analyses, "economic activities, land use and transport" within London And the South East Region (LASER). LASER explicitly models the interaction between land use, density and transport accessibility. A LASER model test of Crossrail from 2002 (a different scheme from the current one) concluded that without Crossrail "it appears that overcrowding may cause 30-50 thousand jobs not to be sustainable".

Centre for Economics and Business Research (cebr) approach

- 5.7.12 cebr (in work undertaken for the Canary Wharf Group) developed an approach based on changes to accessibility with and without Crossrail. The approach models the relationships between the amount of population and jobs within six defined travel isochrones (15, 30, 45, 60, 75 and 90 generalised minutes). It uses changes in those accessibility indices to predict changes in population and employment within each zone.

- 5.7.13 The conclusions from the cebr work are that as a result of Crossrail there would be 63,000 additional jobs in the City and the Isle of Dogs by 2023, another 85,000 jobs in the Thames Gateway and 33,000 elsewhere in London (including the West End).

5.8 Conclusions

- 5.8.1 This chapter has brought together evidence from a number of sources. The cebr and LASER model references are taken from work undertaken at different times and for other purposes and are, therefore, not strictly comparable. The other approaches are taken directly (or derived) from model outputs and are, therefore, consistent with the transportation analysis of the scheme.
- 5.8.2 There are three potential sources of agglomeration benefits that would result from the implementation of Crossrail. These are:
- the additional jobs that are enabled to locate within the central area as a result of the additional capacity supplied by Crossrail will benefit from an increase in productivity by virtue of being within the agglomeration instead of outside;
 - those jobs that are already located within the central area will also benefit from increased efficiency (agglomeration benefits) derived from the marginal increase in employment density provided by the additional central area jobs;
 - all jobs within the central area will benefit from an increase in the effective density of the central area caused by the improvements made by Crossrail to transport within the central area.
- 5.8.3 Every approach suggests additional central area employment (including the Isle of Dogs) resulting from the implementation of Crossrail and although there are significant differences between the forecasts a central range might be 5,000-13,000 jobs in 2016 and 32,000-40,000 ten years later. This will result in significant GDP growth which will be a significant beneficial impact.