

OXFORD ECONOMICS

The Economic Value of International Connectivity

April 2013

A report for Transport for London



OXFORD
ECONOMICS



York Aviation

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Executive Summary

In February 2013, Transport for London commissioned Oxford Economics and York Aviation to prepare a technical note on the economic value of connectivity by air as part of the Mayor's Aviation Work Programme during 2012-13. This note is intended to inform the on-going consideration of the benefits of additional airport capacity for London.

The primary focus of this research has been a review of the existing literature in this area with a view to:

- establishing the nature and extent of the existing evidence base around the economic value of air service connectivity;
- providing a clear overview and explanation of the paths by which air service connectivity can impact on the economy;
- identifying how the benefits that come with increased air connectivity sit with traditional economic impact and appraisal techniques;
- assessing past approaches to considering the economic value of connectivity and whether these provide either appropriate existing techniques for quantification of these effects or pathways to new techniques in this area;
- initial consideration of some of the key questions that arise around the economic value from the connectivity offered by a new or expanded hub airport for London.

Connectivity is a complex concept to define and measure. However, in terms of air transport it fundamentally relates to the degree to which desired destinations are serviced from convenient airports, along with the nature of the associated air routings (including characteristics such as whether connections are direct or indirect, travel times, service frequencies, service reliability, quality and costs).

This degree of complexity and the fact that connectivity is a concept - and not a defined commodity - means that measuring connectivity is difficult. Any measure will always be an indicator or a proxy for connectivity.

However, at the same time, assessing connectivity is important. The value of connectivity has become central to the debate around assessing the impacts of airport capacity growth in London and the south east. In particular, it is important to establish and define connectivity's role in fuelling direct and wider economic impacts in London and across the UK, especially when London's status as a top tier global city may be at stake.

In the past, a variety of measures including growth accounting and gravity models have been used to measure connectivity. The former of these focusses more broadly on how improved connectivity can improve the economy's overall productivity, while the latter focusses more closely on how links between specific centres of trade and population foster growth. To date however, full application of gravity models has been hampered by a lack of data.

Other measures include the use of index based approaches, although these do not provide econometric results per se. Overall, growth accounting methods have proved most suitable to measuring connectivity effects to date.

Connectivity can be seen to impact on the economy through a variety of channels. These include:

- Foreign Direct Investment;
- Trade;
- Tourism;
- Labour Market; and
- Agglomeration effects.

Several studies have pointed to connectivity proxies or the availability of air services as being important to FDI and business investment and location decisions. Such decisions will be influenced by the need to establish good communication between head and branch offices but will also reflect businesses own global and regional “hub and spoke” operations. “Branch” offices will also require good air connectivity to reach regional markets. Further, because of the long term nature of business investment, organisations will seek to ensure not only that air connectivity is adequate in the present but that future capacity will be adequate to support their own future operations. This is an issue which may be of particular importance given on-going debates over future airport capacity in London and the south east.

Improved connectivity has also been seen as playing an important role in fostering trade, both in terms of goods (freight) and services (represented by business passengers). Past studies by a number of organisations have established relationships between improved connectivity and trade, albeit with caveats over causality in some instances. More fundamentally, surveys and other work connected with such studies have established the importance which businesses place on good air links, air transport’s share of overall trade value and the importance of airport location. For example, Oxford Economics (2012)¹ established that, while making up less than 1% of UK trade by volume, air transport accounted for 22% of its value.

Improved connectivity may also act as a spur to tourism by making new destinations more easily accessible. Both inbound and outbound tourism are important in this respect because, by fostering tourism, improved connectivity reduces trade barriers. Reduction of trade barriers allows the UK (or any other) economy to focus on areas of comparative advantage and allocate resources more efficiently.

Labour market effects are also relevant. Improved connectivity may help support migration between countries, allowing businesses to access a wider pool of

¹ Oxford Economics (2012) *The value of aviation connectivity to the UK – A report for BAA*

labour than would otherwise be the case. Further, there may be spillover – or agglomeration - effects which arise from increases in employment density, though the size of such impacts has not yet been firmly established in the case of air transport.

Finally, it is important to reconcile both theoretical issues and past approaches to connectivity with the practical realities facing London and the south east. It might be argued that a certain level of connectivity is enough or that there are diminishing returns beyond a certain point and therefore that London does not need major changes to its airport infrastructure.

While London remains well connected at present there are evident strains on its links to the outside world. These capacity constraints will only grow over time if nothing is done to address them. It is therefore clear that, for example, simply arguing that London and the south-east currently has “enough” connectivity essentially misses the point. The growth of developed and emerging economies and related development of trading links means that if there is no matching increase in airport capacity, connectivity and therefore economic growth - will suffer.

Likewise, while evidence is limited, there appears to be a “step change” in terms of the connectivity associated with global (or “Alpha”) cities such as London or New York, with such cities requiring a certain absolute level of connectivity. While more needs to be done in this area, to the extent that there is a causal relationship flowing from connectivity to status, the risk is that losing good connectivity could, in time, erode city status - though it is likely other factors would also be important (i.e. good connectivity is necessary but not sufficient to maintain status).

Moreover connectivity is also a relative concept – no one city can “win and take it all”. Rather what is important for London and the south east in particular is that it expands airport capacity in line with likely aviation demand. This will ensure that growth in London, the south-east and the rest of the economy is maintained, and that London retains its competitive edge and its status as a global city.

1 Introduction

In February 2013, Transport for London commissioned Oxford Economics and York Aviation to prepare a technical note on the economic value of connectivity by air as part of the Mayor's Aviation Work Programme during 2012-13. This note is intended to inform the on-going consideration of the benefits of additional airport capacity for London.

The primary focus of this research has been a review of the existing literature in this area with a view to:

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- assessing past approaches to considering the economic value of connectivity and whether these provide either appropriate existing techniques for quantification of these effects or pathways to new techniques in this area;
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1.1 What is Connectivity and How Can it be Measured?

Given the focus of this research, there is clearly an important question to be answered at the outset. What does the term connectivity mean in this context? Ultimately, it should be recognised that connectivity means different things to different people. It is not definable in absolute terms. It is an amorphous concept relating to the ease with which people or goods can be moved between desired origins and destinations.

In terms of air transport this concept of connectivity and ease of movement relates to a wide range of potential factors:

- whether the desired destination is served from a convenient airport or whether an indirect routing is required or potentially whether any routing at all is available. This links clearly to an airport's - or airports' - ability to deliver breadth in network connections and connections to the desired location;
- the time it takes to travel to the airport, transit through that airport, fly to the destination and transit at the other end;

- the frequency of service, which links to whether connections are likely to be convenient to passengers' desired travel patterns and to flexibility in requirements and resilience;
- the quality of service both in terms the choice of products on offer and in terms of the overall experience of travel;
- the reliability and resilience of services, which links to user considerations around waiting times and ultimately choice of destination;
- the costs of travel both in relation to surface access to the airport and in relation to air fares.

It should also be recognised that connectivity is not just about what an individual or group of individuals needs at any given moment or for a particular journey but also about what potentially they might need in the future. This latter point is crucial in terms of considering the economic value of connectivity in relation to air services. Decisions that may have implications in terms of prosperity or growth are made in one time period, based on an impression of the availability of connectivity at that point or in the future. These connections may not have been used at that point and may, potentially, never be used if the need does not arise but are perceived as potentially important. In short, connectivity is not just about what people do but also about what they could do or what they believe will be required. To some extent, connectivity is about creating conditions of confidence to invest, which may require a level of connectedness over and above that which is strictly essential.

A further complication is that, in many ways, connectivity can be considered as being relative rather than absolute. At a most basic level, connectivity could be absolute. A destination can either be reached or not, but in most cases, in reality, it is not that simple. There are usually a number of options or possibilities for reaching the desired destination but some are either easier or cheaper or faster or safer or more reliable or quicker than others. The connectivity offered by one option becomes defined by the connectivity offered by the others. Again, this concept is potentially important in the context of considering the economic value of new airport capacity in London. London is well connected now. However, does new capacity mean that it will be better connected? Similarly, the previous statement could equally have been: London is well connected now compared to its competitors. Would new airport capacity improve its relative position or would the failure to deliver new capacity result in a decline in this relative position.

This degree of complexity and the fact that connectivity is a concept and not a defined commodity means that measuring connectivity is difficult. Any measure will always be an indicator or a proxy for connectivity. A number of approaches have been used in recent years, including methodologies developed by Oxford Economics and York Aviation, and these are discussed later in this report. These have focussed on what might be termed economically advantageous connectivity - air services that support economic prosperity in some form. This fits well with the primary focus of this paper and the interest of TfL.

1.2 Why is it Important?

The issue of the economic value of connectivity has become central to the debate around the expansion of airport capacity in London. Perhaps the main reason behind this is the increasing rebalancing of the debate around the economic importance of air services away from traditional economic impact metrics, such as direct or indirect employment creation, and even to an extent away from economic welfare considerations, which are often poorly understood by non-technical audiences and do not capture all GDP impacts, towards hard evidence of wider economic impacts. Developing new airport capacity in London will be expensive and there are potentially significant environmental costs but equally London's status as one of the world's top two economic centres is also possibly at stake. This status relies on many things but air service connectivity, through the current global hub at Heathrow particularly, may be one of them. There seems little doubt that new airport capacity will be essential in developing future connectivity. Therefore, the role that air service connectivity plays in influencing decisions that have knock on effects to the economy outside of those that are already captured by existing economic appraisal techniques needs to be better explained and understood.

This explanation of the linkages between connectivity and wider impacts in the economy is a central theme for this report, along with the rationale for including such impacts over and above those identified by existing techniques.

1.3 Structure of this Report

The report is structured as follows:

- in Section 2 we analyse some of the past approaches that have been used to consider the issue of measuring connectivity and the link to wider economic impacts. This includes consideration of whether such approaches potentially provide a meaningful way forward in this context;
- in Section 3 we articulate the linkages between connectivity and key channels of wider impact and consider some of the existing evidence of these impacts;
- in Section 4 we examine the links between connectivity and traditional microeconomic approaches and how this fits with GDP growth;
- in Section 5 we consider the implications of this analysis for some of the key questions relating to the expansion of airport capacity in London and the South East.

2 Past and potential approaches

2.1 Growth accounting approaches

Growth accounting approaches constitute one way of measuring the impact of connectivity on economic growth.

A growth accounting approach essentially follows a Cobb-Douglas production function model of the economy. A Cobb Douglas equation typically takes the following functional form.

$$Y = AK^{\alpha}L^{\beta}$$

Expressed in plain English, this expression sees economic growth (Y) as being driven by three major elements:

- The supply of capital (K)
- The supply of labour (L)
- A residual known as “total factor productivity” (or TFP) (A)²

TFP is essentially the “unexplained” component of economic growth – i.e. it is that part of economic growth which occurs beyond simply adding “more of the same” – more capital and/or more labour.

Economists typically denote TFP as being driven by technological improvement but this is only one component of TFP. TFP might arise from a variety of other sources such as improved managerial practices or changes in the configuration of production or a change in the pattern or intensity of resource use.

For example, the construction of a new hub airport might involve the application of new capital and perhaps, to some extent, labour. The application of these factors would be expected to increase capacity. However, beyond this, such an airport might further boost the productivity of the economy. Of course new plant and equipment might be more technologically advanced than older ones and this in itself could be a productivity boost by reducing the marginal cost of operations. However, beyond this, the new capital might not simply be “like for like” but organised and designed with modern transport needs in mind, such that logistical and operational efficiencies are optimised (as opposed to an airport location which simply grew incrementally via “historical accident”). The siting of the new hub might also be superior to previous locations from an air operations point of view, allowing for travel time savings in the air and on the ground and increased reliability of aircraft operations.

Freight will benefit from these improvements as well as passengers, since it will support more reliable and speedier air operations carrying time sensitive goods. This reduces the need for expensive inventory sites and management.

² α and β are the capital and labour shares of income respectively.

These supply side “shocks” (equivalent to a movement of the supply curve to the right under conventional microeconomic analysis) could allow for cheaper and more efficient aircraft operations. This, in turn, could allow airlines to offer new and/or more direct routes to more locations and/or cheaper fares to existing locations. In other words, connectivity will be enhanced – more people and more goods will be induced to travel to and from the UK. And the enhancement in connectivity will reflect the abovementioned supply side improvements.

Further, the enhanced connectivity could allow for other spin-off effects – or “externalities” - such as agglomeration impacts or induced foreign direct investment (FDI).

All of these impacts improve the productive capacity of the economy beyond simple additions to the labour force and capital stock and so could be reflected in TFP. In other words, it is possible to relate the changes in connectivity to TFP (and by extension to GDP). In order to do this a connectivity equation (or set of equations) could be developed to isolate the impact which connectivity has on GDP (typically in the long run)³.

Examples of growth accounting approaches include Oxford Economic Forecasting (1999) Oxford Economic Forecasting (2006) and EUROCONTROL (2005). In a similar vein, Intervistas (2006) used labour productivity as a proxy for TFP to develop a variant of this approach. More recently CBI (2013) has sought to relate connectivity to trade although this would not appear to constitute a growth accounting approach *per se*⁴.

In particular, the model used in Oxford Economic Forecasting (2006) sought to relate TFP (and thereby GDP) to changes in the number of business passengers and freight movements over time. Business passenger and freight volumes were combined into an underlying “business air proxy” for this purpose⁵.

³ Note that, as pointed out by many, including the Davies Commission (*Discussion Paper 2: Aviation Connectivity and the Economy* (2013)) in a technical sense travel itself is a derived demand. It ultimately reflects the attraction of a destination rather than the demand to travel *per se* (cruise ships etc being partial exceptions). For example, business people catch flights not for the sake of catching flights themselves but to undertake activities at their destinations – e.g. meetings, conferences, planning etc. Accordingly improved connectivity (e.g. more people flying to more destinations) can provide a signal of the deeper supply side improvements at work which serve to facilitate travel. This theme is taken up again in the Section discussing microeconomic drivers.

⁴ Oxford Economic Forecasting (1999) *The Contribution of the Aviation Industry to the UK Economy*; Oxford Economic Forecasting (2006) *The Economic Contribution of the Aviation Industry in the UK*; Eurocontrol (2005) *The Economic Catalytic Effects of Air Transport in Europe*; CBI (2013) *Trading Places - Unlocking Export Opportunities Through Better Air Links to New Markets*

⁵ Arguably leisure passenger volumes could also be included as an independent variable. While the direct impacts of increased flows of leisure passengers on GDP are more ambiguous – e.g. a trade deficit may widen if improved airport infrastructure leads to more people taking holidays overseas than foreigners

The advantage of a growth accounting approach is its ability to bundle together many of the potential components of connectivity into a simpler and more comprehensive model. It can also point to more direct linkages between connectivity and economic growth than is immediately obvious from traditional microeconomic approaches. Because it can relate changes in freight and travel movements to TFP and thereby estimate the ultimate impacts on economic growth as a whole, it may, by implication, also point to some factors which impact on growth but which are not well captured by traditional microeconomic approaches (e.g. the potential role of FDI).

The example above explores what happens to connectivity, and thereby GDP, as a result of an infrastructure improvement. Of course, the relationship can run the other way – growth in both the UK and overseas can drive demand for flights and thereby connectivity. Growth in emerging markets – and the potential demand for trade in general and aviation services in particular which it implies – is a particular issue facing the UK at the moment as it seeks to determine the appropriate level of aviation capacity in the South East.

On the one hand it is important to note growth as a driver of connectivity because there is a need to provide infrastructure to meet this demand. However, on the other, if the interest is in connectivity (or what underlies it) as a primary driver of growth itself then it is the “connectivity to growth” relationship that matters. Transport economists are typically interested in the latter relationship as it relates incremental improvements in infrastructure – and the productivity benefits they may entail – to economic performance⁶.

Following on from this, it is also important to note the potential for such simultaneity bias (or endogeneity) in modelling (i.e. GDP driving connectivity as opposed to connectivity driving GDP). This is one potential drawback to growth accounting approaches, albeit one that can be overcome with appropriate model specification.

2.2 Gravity models

An alternative approach to measuring the impact of connectivity is via the use of gravity models, which derive from the literature on international trade and traditional transport economics literature which explores the links between “nodes” (such as cities) and traffic volumes.

taking holidays in the UK – increased tourism and VFR flows open the economy to trade and allow inputs to be better allocated, improving productive efficiency.

⁶ Also note that *not* improving infrastructure in the face of growth driven by rising GDP – in the UK or abroad – may result in constrained demand – analogous to that modelled by DfT (2013) (*UK Aviation Forecasts*) as a part of their most recent round of aviation forecasts. Conversely, if these supply side bottlenecks are removed this potential demand is now freed up.

There are undisputed economic benefits of increased trade. Increased trade allows countries to be more efficient in choosing what to produce, as they can choose to produce and export what they have a comparative advantage in and import other items. This stimulates economic growth. Part of this effect also includes productivity improvements for exporting firms and increased foreign direct investment (inward and outward).

Gravity models may be used to measure the effect of improved airport infrastructure on trade. Better airport infrastructure can reduce the costs of trade, for example, by providing more routes and frequencies of passenger flights on which cargo can be carried, which reduces the time that inventory must be stored. A significant and growing portion by value of the world's trade is carried via flights. This is especially the case for small items such as microchips and diamonds, or for highly perishable items such as fresh vegetables. From 1975-2004, the amount of manufactured goods transported by air increased by 7.4% per annum compared to goods transported by ship, which grew by 4.4% per annum.⁷ Less than 1% of goods by volume are transported by air, but, for example, in value terms, more than a third of imported goods in the US arrive by air.⁸

Behar and Venables (2010) remind us that transport costs include freight charges as well as other costs such as speed and reliability. For these high value goods, uncertainty about delivery time is a key component of transport cost. Nordas and Piermartini (2004)⁹ point out that this uncertainty drives up the amount of inventory that needs to be kept as buffer stock, hence driving up the cost of doing business.

The gravity model predicts bilateral trade flows based on the relative economic sizes (often using GDP measurements) and distance between two countries. All gravity models use the great circle distance between two countries as a variable to proxy transport. This variable, however, can also serve as a proxy for information and familiarity. The elasticities of trade flows to distance are therefore not an appropriate measure of the effects of just transport costs on trade.

Further, transport fees cannot be directly incorporated into a gravity model. This is because bilateral transportation costs are partly endogenous to bilateral trade in the sense that transport infrastructure is built up in response to trade demand. The inclusion of transport costs would therefore bias the estimators. One way around this is to produce an econometric model of transport costs and then use the estimators from that model as an input to a gravity model. This does, however, require finding comprehensive data on transport costs.

⁷ Behar and Venables (2010) *Transport Costs and International Trade*, Economic Working Paper 488, University of Oxford

⁸ *Ibid.*

⁹ Nordås, Hildegunn Kyvik and Piermartini, Roberta (2004), "Infrastructure and Trade", *WTO Staff Working Paper No. ERSD 200404*,

Finding data on transport costs is, in fact, quite difficult, as Nordas and Piermartini (2004) point out. The data that does exist is of poor quality. Limao and Venables (2001)¹⁰ combined several sources of information on transport costs to estimate the effect of transport costs on trade. They found that halving transport costs increases trade five-fold across their sample of countries. Using a cross-sectional econometric model of transport costs, they also find that improving destination infrastructure by 1 standard deviation is the equivalent of reducing distance by 6,500 sea km. Most importantly, they calculated the elasticities of trade flows with respect to transport costs by using results from the gravity model and also from their econometric model of transport costs.¹¹ Their point estimate of the elasticity of trade volumes with respect to transport costs is -2.95. The paper by Limao and Venables, however, does not incorporate air freight data in all the estimation models and it does not explicitly measure the effect of reducing transport costs for air freight because the infrastructure variables included are not directly related to airports.¹²

Nordas and Piermartini (2004) use an augmented gravity model with an index for different types of transport infrastructure in order to separate out the effects by infrastructure type. Although they find that port efficiency has the largest impact on trade flows, they also find that a ten percent improvement in airport efficiency in either exporter or importer countries increases bilateral trade by around 1 percent. In comparison, port efficiency increases trade by over 6 percent.

In short, gravity models can offer some insights into the impact of transport infrastructure – and airport infrastructure in particular. They offer supporting evidence for the fact that transport infrastructure may improve connectivity. Further, by seeking to relate the “density” of connections between different points (or nodes) they have conceptual similarities with the basic ideas underlying connectivity. To date, however, data restrictions have limited their full use as a connectivity measure.

2.3 Other Approaches

The particular difficulties around quantifying the link between air service connectivity and measures of economic growth and prosperity, either GDP related or welfare related, has led to many studies considering these benefits

¹⁰ Limao and Venables (2001) Infrastructure, Geographical Disadvantage, and Transport Costs *The World Bank Economic Review* Vol. 15, No. 3 (2001), pp. 451-479

¹¹ They have been able to do this by using the same explanatory variables in both sets of estimations.

¹² The infrastructure index is constructed as an average of the density of the road network, the paved road network, the rail network, and the number of telephones per person.

through either qualitative analysis or survey evidence or through quantitative indicators designed to articulate the potential extent of connectivity benefits or the relative position of an airport, city, region or country compared to others. Examples of studies using these types of approaches are numerous. They include work for ATAG, ACI EUROPE, the Airport Operators Association, regional and local public sector bodies and individual airports.

One approach that is of particular relevance in considering the economic value of connectivity is the use of the Business Connectivity Index (BCI) developed by York Aviation. The BCI does not seek to quantify the economic value of connectivity in terms of an impact on economic growth or similar metrics but focuses on trying to understand the relative value that different airports or groups of airports can offer to businesses in reaching economically desirable destinations and therefore, by extension, the extent to which they may support the economic benefits associated with enhanced connectivity. The BCI assesses the connectivity value of an airport based on the destinations served, an assessment of the economic importance of the destination city based on research undertaken by the Globalisation and World Cities network, and the level of frequency offered to those destinations. This enables an assessment to be made as to not only whether one airport is better connected than another from the perspective of business users but also how much better connected it is. It can also be used to consider the extent to which developments over time can change the usefulness of an airport's route network over time. A number of similar indices have been developed, including research by IATA, the World Bank and the World Economic Forum. The exact make-up of these indices varies and they are intended to fulfil a variety of functions. The BCI appears to provide the most useful tool for considering the potential economic contribution associated with different air transport connectivity options.

Surveys of key users or potential users can also provide valuable insight in to the economic importance of air service connectivity, shedding light on a range of issues such as the extent to which the availability of air services are a factor in company location and investment decisions, the ability to trade effectively, use of modern supply chain techniques or the ability to access partners, knowledge or specialist services. The purpose and nature of individual surveys can vary significantly. Commonly cited general surveys that are believed to shed light on the influence of air services include the European Cities Monitor produced by Cushman & Wakefield¹³. This annual survey of 500 key European corporate decision makers identifies the best locations for business in Europe and seeks to identify the key factors behind these rankings. Other survey work is more specific, examining issues around aviation specifically. For instance, the 2008 City Aviation Study for the City of London Corporation included a survey of city businesses exploring their views around London's air service offer, it's connectivity, the importance of this connectivity to business and future development options¹⁴.

¹³ <http://www.europeancitiesmonitor.eu/>

¹⁴ City of London Corporation (2008) *Aviation services and the City*

Overall, while these other types of approaches do not quantify the economic benefits associated with air service connectivity, they are an important element in any analysis of potential economic value. They provide an evidence base for the existence of effects and can assist in understanding magnitudes and directions of effect and relative positioning of different options. They may also, ultimately, provide inputs that can assist in the specification of quantitative models using either growth accounting or gravity type models.

2.4 Recommended approaches

The above discussion explores the technical strengths and weaknesses of growth accounting and gravity models. While the gravity modelling approach offers some intriguing potential insights, it suffers from data and development issues. The comprehensive nature of growth accounting approaches are likely to make them more suitable for measurement of connectivity effects at present. We have also considered the use of qualitative approaches which draw upon wider evidence to describe the influence of connectivity on the economy and focus on developing assessments of the direction of effects and the potential magnitude. Clearly, the primary weakness of these approaches is that they do not provide an answer that can be readily understood in terms of a monetary value. However, they do provide valuable insight in to the influence of connectivity and add significantly to the evidence base around the economic value of connectivity.

3 FDI, agglomeration labour markets and related concepts

3.1 Introduction

This Section focuses on demonstrating the linkages between air service connectivity and the economy. It uses logic chains to explain how connectivity influences decisions and behaviours in the wider economy that ultimately impact on GDP and growth. It uses information from a range of existing research to evidence these impacts and consider potential orders of magnitude.

We have considered the following impacts through this process:

- Foreign Direct Investment;
- Trade;
- Tourism;
- Labour Market;
- Agglomeration effects.

While we have examined these impacts separately in terms of their link to connectivity, it should be recognised that many of these are in themselves interrelated and, as such, there is potential for double counting in some areas and underestimation in other areas if effects are considered in isolation. Indeed the existence of these interlinkages has been cited by commentators such as CE Delft as a potential source of double counting. In their view the direct effects cited above are simply all forms of trade.

As suggested above, an advantage of a growth accounting approach is that it should capture all of these elements in a parsimonious modelling framework.

3.2 Foreign Direct Investment

We focus initially on air service connectivity and inward investment. The link between air transport and the attraction or retention of inward FDI has long been suggested and there is a significant amount of evidence to support the existence of this effect. A range of surveys identify connectivity proxies or the availability of air services as being important to investment and location decisions:

- Cushman & Wakefield European Cities Monitor - this annual survey of 500 European corporate decision makers provides significant evidence of the importance of international connectivity in influencing company location decisions. It is one of the most commonly cited pieces of survey evidence in this area. The survey consistently identifies factors such as *transport links with other cities and internationally* and *ease of access to markets, clients and customers* as amongst the most

important factors in company location decisions. There are clear linkages here to the availability of air service connectivity. It is also noticeable that the cities served by Europe's major hub airports commonly feature towards the top of the list in terms of the best places to locate in Europe. In 2011, London was first, followed by Paris, Frankfurt and Amsterdam in order;

- Oxford Economic Forecasting The Economic Contribution of the Aviation Industry to the UK Economy (2006) - research by Oxford Economics in to the contribution of the air transport industry to the UK economy in 2006 identified that a quarter of companies surveyed as part of the research reported that access to air services is important in determining where they locate their operations in the UK. Research undertaken by Oxford Economics for IATA, also in 2006, sought to quantify the link between air connectivity and business investment. The results of this research imply that a 10% increase in connectivity is associated with a 3.5% increase in the level of fixed investment in the long run;
- York Aviation for the City of London Corporation City Aviation Study (2008) - identified that 27% of survey respondents believed they would be very badly or quite badly affected by a failure to expand airport capacity. Significant numbers cited impacts around investment decisions as being potential effects of this failure, such as downgrading of the London office status, movement of corporate functions away from London, less investment in UK operations or relocation of operations to another country;
- Deloitte (2007); *The Heathrow Phenomenon* - this research focused on the economic impact of Heathrow on the economy of London, with a particular focus on West London and the M4 Corridor. It cites research by Think London that identifies that around 50% of foreign owned companies chose London because of its status as an entry point to the UK and to Europe. The report goes on to suggest that the connectivity offered by Heathrow is critical to this effect;
- York Aviation (2004) for ACI Europe, *The Social and Economic Impact of Airports in Europe* - this report examined a wide range research from a range of different sources. This included highlighting studies by Ernst & Young on location decisions in Europe, research by VNO-NCW on the influence of Amsterdam Schiphol Airport on location decisions and by the University of Cologne on the significance of airports for firms. This analysis identified the importance of access to major airports in terms of investment decisions across a range of economic sectors;
- Bel & Fageda in 2008 considered the influence of intercontinental flights on head office location. They found that

the supply of direct intercontinental flights is effectively a major determinant in the location choices of large firms' headquarters. Indeed, a 10% increase in the supply of intercontinental flights involves around a 4% increase in the number of headquarters of large firms located in the corresponding urban area¹⁵;

- Strauss-Kahn, Vanessa and Xavier Vives (2005) *Why and where do headquarters move?*¹⁶ - this research identified that headquarters relocate to metropolitan areas with good airport facilities, low corporate taxes, low average wages, high levels of business services and an agglomeration of headquarters in the same sector of activity;
- a London Chamber of Commerce and Industry survey of London Business Leaders (2008) identified that 94% of respondents believed that Heathrow was very important or important for attracting FDI and tourism to London;
- recent research by the Institute of Directors (2012) identified that almost six in ten (59%) members agree that a lack of spare capacity at Heathrow has a damaging effect on inward investment to the UK, compared to just 17% who disagree. In all regions of the UK, more IoD members agree than disagree with this statement¹⁷.

Similarly, previous research from a wide range of commentators helps to explain how air services influence FDI decisions and why in this context connectivity is important. Essentially, this research establishes a logic chain around the need for travel between corporate head offices and branch locations. This travel facilitates effective management and operation of central administrative functions, allows the transfer of knowledge and technology, enables specialists within the organisation to operate across the full range of locations and allows the local or central delivery of training and development activities. At a most basic level, this establishes the requirement for connectivity between the head office and the branch location.

However, increasingly relationships are more complex than that. Major multinational companies now often organise themselves in a form of hub and spoke model. For instance, a US based multinational may have its headquarters in New York. However, its operations around the world may well then be divided in to world regions, such as Europe, Asia or Latin America. Operations in these individual regions may then be run from a regional

¹⁵ Bel, G. & X. Fageda (2008) "Getting there fast: Globalization, intercontinental flights and location of headquarters", *Journal of Economic Geography*, 8 (4), 471-495.

¹⁶ Strauss-Kahn, Vanessa and Xavier Vives (2005) *Why and where do headquarters move?* CEPR Discussion Paper No. 5070

¹⁷ Institute of Directors (2012) *Flying into the future*

headquarters, for instance in London, Hong Kong or Sao Paulo. There is therefore not only the need for connections between for instance New York and London but also from London to branch locations within Europe. This helps to explain the need for breadth in connectivity and also the need for a balance between long and short haul services. Ultimately, it should also be recognised that the availability of connectivity may also influence the location of an organisation's global headquarters. If the connectivity from the 'home' city is not sufficient to enable effective management of the business, the headquarters itself may well need to move so it can better serve the needs of the organisation over the long term.

The influence of air services on location of the branch site in terms of external functions also needs to be considered. This relates to the function that the site plays. Branch locations that are, for instance, regional sales offices, providing customer service or support may in themselves require air service connectivity for them to reach regional markets for which they are responsible. Again, this suggests the need for breadth in connectivity from a given location to support this type of function.

It is in the context of FDI decisions that the concept of potential connectivity, introduced in Section 1, is perhaps most important. In making location or investment decisions organisations must consider not just the present but also the future. What will they need to be able to operate effectively from a given location over the coming years? In terms of connectivity, this means having knowledge of what their network of locations will look like in the future, where their markets will be and where key partners and suppliers will be. These are clearly subject to uncertainty, especially in the longer term. Location decisions often mean significant investment both in cost and time. Therefore, good general connectivity now and the potential for competitive connectivity in the future is important in providing comfort that their needs can and will be met. This also highlights the importance of flexibility to adapt to changing connectivity requirements over time.

If the available evidence suggests that air connectivity is important in securing inward investment, the next step in the chain of impact is to establish whether such investment is ultimately beneficial to the host economy and why. The research undertaken by NERA for the Department for Transport in relation to international business impacts considered this question in some depth¹⁸. The ultimate conclusion is that, in circumstances in which the investment results in higher technology/more productive approaches being brought to the host country (as opposed to multinationals seeking to exploit cheap labour in the host country or access more advanced technologies held in the host country), there will be a boost to long run productivity (reflected in TFP).

The importance of air services in relation to outward FDI and the potential economic benefits associated with this investment is sometimes forgotten. This

¹⁸ NERA (2010) *Representing International Business Impacts in Transport Appraisal*

perhaps reflects the perception that capital outflow from the UK must be a bad thing. However, just as inward investment is only beneficial in certain circumstances, outward investment is only negative in certain circumstances. If investing outside of the UK represents a more efficient use of an organisation's capital, either by allowing it to access cheaper labour or more advanced technologies or more productive approaches, the impact on the host country's long run productivity will be beneficial.

Equally, in relation to air connectivity and outward FDI, the importance of connectivity remains. It is simply the direction of flow that is reversed. Outward investors need to be able to manage their investments effectively and air travel can be an important part of this process. If they cannot, the investments will not be made and associated productivity gains not achieved. It should also be remembered that an 'outward' investor could also be globally mobile and become an inward investor elsewhere. Therefore, outward investors require locations for their 'home' bases that enable this travel and, again, potential connectivity is a key factor. Investors will not have perfect knowledge of where they are going to have interests in the future. A strong and developing connectivity offer is therefore important in giving comfort that their needs can and will be met.

3.3 Trade

The importance of air travel and air connectivity in increasing levels of trade is again well established. In relation to trade in goods, air cargo is a quick and efficient means of transporting goods around the world, which makes economic sense in relation to the transport of some goods, primarily those that are high-value, low weight or time critical. In this sense, air connectivity enables UK firms to enter overseas export markets effectively. Equally, air cargo enables UK firms to access suppliers overseas that may offer lower priced or better alternative inputs to production processes and it enables UK consumers to import goods from overseas that may again be cheaper or of better quality than those available from domestic suppliers. In essence, trade allows countries to use their comparative advantage to maximise efficiency.

However, passenger connectivity is also important in terms of trade. In relation to the trade in goods, companies need staff to travel to meet potential customers, to secure deals and to provide after sales care. This relates to both exports and imports. Trade in services is also heavily reliant on air passenger connectivity. Again, companies need staff to travel to meet potential customers and secure deals but, in contrast to the trade in goods, they may also need individuals to travel to actually deliver the services being sold.

The existing evidence on the importance of air connectivity to international trade is again extensive:

- CBI Trading Places (2013) established a strong link between the level of air service connectivity and trade between the UK and

the World's eight largest high growth economies¹⁹. It also found similar patterns for the six largest EU economies²⁰. The report went on to estimate that an additional daily service to each of the World's largest high growth economies would result in £1 billion in additional trade;

- Frontier Economics (2011) also established a clear correlation between the level of trade and air connectivity in the UK, albeit causality was not established. Furthermore, the report identified that UK businesses traded 20 times as much with countries where there are at least daily flights compared to those with less frequent or no direct connections. Frontier Economics moved on to estimate that UK trade could be increased by around £1.2 billion per annum if there were sufficient capacity at Heathrow to accommodate viable routes to emerging markets²¹;
- In 2012 Oxford Economics estimated that the manufacture of goods for export by air accounted for around £28 billion to UK GDP. Further, Oxford Economics estimated that, while making up less than 1% of the volume of UK trade, air transport accounted for 22% of the value. The importance of connectivity in this pattern is highlighted by Heathrow handling around 65% of the UK's air freight²²;
- Survey work undertaken by Oxford Economic Forecasting (2006) identified that nearly two-thirds of companies (65%) reported that passenger services were either vital or very important for sales and marketing and a very similar proportion (64%) report that passenger services were either vital or very important for servicing or meeting customers. Of the companies surveyed, around 13% of sales were believed to be reliant on air service connectivity. The survey also highlighted the importance of air services in distant, high growth markets and in supporting UK supply chains²³;
- The 2008 survey by the London Chamber of Commerce and Industry identified that 42% of responding businesses earned at

¹⁹ CBI (2013). *Trading Places: unlocking export opportunities through better air links to new markets* –Page 4.

²⁰ Ibid. Page 7.

²¹ Frontier Economics for Heathrow Airport (2011) *Connecting for Growth: the role of Britain's hub airport in economic recovery* –. Page 11.

²² Oxford Economics (2012) *The value of aviation connectivity to the UK – a report for BAA* –. Page 3 and 9.

²³ Oxford Economic Forecasting (2006) *The economic contribution of the aviation industry in the UK* –. Pages 34 to 39.

least 51% of their revenues from overseas trade and that access to an airport was very important or important for 81% of respondents.

Evidence from broader research on the impact of transport connectivity generally on trade is also helpful in understanding the importance of air connectivity. NERA's research for the DfT on transport and international business impacts summed up the findings of a wide range of research on the link between the sensitivity of trade to transport costs as follows²⁴:

- distance matters – the almost universal conclusion across the research is that the further away and more costly markets are to reach the less bilateral trade will occur;
- distance matters even for digitally-traded goods – even where there is no physical cost to transferring the good or service, it is harder to trade with more distant countries. NERA cites the impact on trade from unfamiliarity bred by distance;
- distance matters more than it used to – NERA cited research by Berthelon and Freund (2008) which suggested that it was becoming easier to source homogenous and high trade cost goods from nearby countries, so relative trade costs are becoming more important.

There are a number of key messages here in terms of the importance of air connectivity to trade. Air connectivity is exceptionally effective at reducing the perceived distance between markets. Good connectivity can dramatically reduce the time it takes to reach some markets, reducing perceived distances and offsetting the impacts of unfamiliarity. There is also the potential for air connectivity to enable firms to spread competition beyond simply price by improving customer service and support, potentially counteracting the final factor in some markets.

If, on this basis, it seems reasonable to suggest that air service connectivity is important in facilitating trade in both goods and services, the question then becomes whether increased trade is likely to bring about greater economic growth and prosperity. Some commentators have suggested that while increased connectivity will be beneficial in terms of UK exports there will be at least an equal impact on UK imports, which will have negative implications in terms of the UK balance of payments. This is, however, a rather simplistic view of the world and ignores the fact that enabling bidirectional international trade will ultimately facilitate economic growth through enabling countries to develop comparative advantage. Exporters will be able to widen the market for their goods and services, enabling them to benefit from economies of scale and increase productivity, while more broadly potentially growing to meet wider market demand and drawing in more labour and capital from economic sectors

²⁴ NERA Economic Consulting (April 2010) *Representing International Business Impacts in Transport Appraisal* –. Pages 15 to 16.

where the UK does not hold a comparative advantage. This structural change within the UK towards more productive activities where there is comparative advantage will need to be compensated for by declines in other domestic sectors but the short fall in production will be met by imports from other countries which hold a comparative advantage in these sectors. Ultimately, this process will result in a more efficient global allocation of resources and increased productivity, which will be reflected ultimately in TFP and economic growth.

3.4 Tourism

The value of air connectivity in terms of tourism is in some ways self evident. In the UK, particularly, inbound tourism is heavily reliant on air transport to enable visitors to reach the country. The Davies Commission discussion paper on aviation connectivity and its contribution to the UK economy highlights that, in 2011, 75% of the 31 million visits made to the UK by overseas residents started at an airport and that 84% of the £18 billion spent by overseas visitors was spent by those arriving by air²⁵. The International Passenger Survey demonstrates that it is only in relation to the UK's closest neighbours that other modes offer any significant competition to air travel (France, Belgium, Germany, Ireland and the Netherlands).

Air services make the UK easier and faster to get to for potential visitors travelling either for business or leisure purposes. However, it should be recognised that while they influence the decisions that visitors make they are not in the great majority of cases why somebody visits the UK. Air connectivity is what might be termed a necessary but not a sufficient condition in attracting tourism to the UK. However, the absence of direct and competitively priced connections could be a substantial impediment to tourist visits. Expanding connectivity has the potential to increase the number of visitors to the UK as it will open up new markets from which new visitors might come if the tourism product is of interest to them or make it easier or cheaper to visit from existing markets.

Perhaps because of the clarity of the link, the evidence base around the influence of air connectivity on tourism is less extensive:

- a London Chamber of Commerce and Industry survey of London Business Leaders (2008) identified that 94% of respondents believed that Heathrow was very important or important for attracting FDI and tourism to London;
- research by Ishutkina and Hansman²⁶ (2008) highlights the vital role that air connectivity plays in relation to tourism in island

²⁵ Airports Commission (2013). *Discussion Paper 02: Aviation Connectivity and the Economy* –Page 21.

²⁶ Ishutkina and Hansman (2008). *Analysis of the interaction between Air Transportation and Economic Activity* –Page 12.

economies with the extreme example of Jamaica. Tourism activities account for around 20% of the country's GDP. The Jamaican government considers tourism so important to the national interest that it until recently maintained the national carrier, Air Jamaica. It still retains a substantial share;

- a range of studies by Oxford Economics have highlighted the value of air services to the tourism economy, noting particularly the role played by Heathrow as the UK's primary international gateway²⁷;
- previous research undertaken by GLA has identified the important role that inbound tourism plays in supporting export revenues. It notes particularly London's role as a generator of inbound trips²⁸;
- York Aviation's research for ACI EUROPE highlighted that, even for major European cities, where other transport modes are more effective competition, air connectivity can account for a third or more of foreign visitors²⁹.

It is, however, important to recognise that air connectivity works both ways. While it clearly enables inbound visitors, it also enables outbound travel, which will have a negative impact in balance of payment terms. For the UK this is particularly pertinent as outbound travel exceeds inbound travel, albeit research by ABTA suggests that the negative impact is substantially reduced once account is taken of the income generated in the UK by UK based travel firms.

Following on from this and assuming that the availability of air connectivity is an influence on inbound and outbound tourism, it is again important to consider how changes in the levels of tourism will impact on the economy and whether these impacts are likely to be positive or negative.

At a basic level the net balance of tourism clearly impacts on the level of consumption in the domestic economy. Inbound tourists clearly increase the level of this expenditure, while outbound tourists reduce it. This impacts on GDP. However, again, this is a relatively unsophisticated view of the world, which fails to take account of a number of issues around outbound tourism in particular:

- it implicitly assumes that outbound passengers would spend the money they spend abroad at home. This is not necessarily true.

²⁷ Oxford Economics (2011) *Economic Benefits from Air Transport in the UK* and Oxford Economics (2012). *The value of aviation connectivity to the UK*

²⁸ GLA (2011) *A new airport for London: Part 2 – the economic benefits of a new hub airport* –Page 39.

²⁹ York Aviation for ACI EUROPE (2004). *The social and economic impact of Airports in Europe* – Page 41.

That money could in fact be spent on another form of import or simply be saved;

- it misses the fact that there is a significant industry in the domestic economy that supports outbound tourism, which would be damaged by reduced demand for outbound travel. This includes the travel trade and indeed a proportion of the economic footprint of the air transport industry;
- the revenues generated by outbound travel are essential in making air service viable, thereby enabling the other beneficial effects from air connectivity we describe;
- it assumes that there is no economic value to outbound tourism. This is patently untrue. It has an important social function in terms of enabling travel for personal business or for visiting friends and relatives and increases our understanding of other cultures. This in turn has knock-on effects in terms of making the home country an attractive place to live and work, with implications in the modern global labour market, and in terms of counteracting unfamiliarity effects that make trade more difficult;
- if you subscribe to the view that tourism is simply another form of trade, then we have described above how increased trade will ultimately lead to improved exploitation of comparative advantage, resulting in a more efficient allocation of resources globally with, ultimately, benefits for all in the long run.

Ultimately, the balance of these different effects on long run economic prosperity and growth is difficult to untangle. Increasing connectivity will lead to more inbound tourism and more outbound tourism. What is important is whether the combined effect, along with the other impacts described, results in an increase in productivity and economic growth.

3.5 Labour Market Effects

An area that is increasingly being identified as one of the channels of impact through which air connectivity operates is its influence on the labour market through its ability to influence individuals' decisions around where and how much labour to supply. This effect can in broad terms be divided into two.

At one level, air connectivity is important for the UK in being able to attract talented individuals to live and work in the country on a permanent basis. Research undertaken in 2009 for the British Chamber of Commerce by Colin Buchanan and Partners on the economic impacts of hub airports identified that there were around 3.8 million overseas born workers in the UK, of which around 2.6 million were from outside the EU³⁰. The report emphasised that for this

³⁰ Colin Buchannan and Partners (2009) *Economic Impact of Hub Airports*

group, while modern communication technologies were extremely important for day to day contact with friends and family overseas, it was not ultimately a substitute for the physical access that air services provide. It emphasizes that if the UK is to retain the economic advantages it has gained by its willingness to recruit skilled people from abroad, it needs to retain the air connectivity needed to support the quality of life of this group.

Air connectivity is also essential in supporting the life style choice of an increasing number of high value added individuals who use air services to commute for short periods or even weekly while living overseas. These individuals often provide specialist or high value services that are part of what enables the UK's competitive advantage. In both cases, the availability of air service connectivity has implications for the long term labour supply for the home economy. The ability to attract skilled migrants to live and work in the country both increases the total amount of labour available to support output and has potential implications for long run productivity in the economy as those with new or higher level skills are attracted to work.

3.6 Agglomeration Effects

The final area we have considered is the way that air service connectivity can impact on the economy through so called agglomeration effects. These effects are productivity benefits that can be achieved by firms located close to each other, perhaps through knowledge spillovers between firms, improved access to suppliers or to larger labour markets. They relate to the concentration of economic activity in an area. In other words the more firms located within an area, the greater the likely agglomeration effects.

NERA in their work on international business impacts for the DfT identified that transport generally can change the level of firm concentration or the effective density experienced by firms by reducing travel times. This can then lead to increased agglomeration benefits.

This concept is well established in terms of the impact of transport schemes within a domestic setting, perhaps because it is easier to see how this might be relevant in relation to a ground transport scheme that improves connectivity across a city. However, the impact in terms of air services is perhaps less well understood. Nevertheless, the theoretical reasoning behind the idea that air connectivity could provide agglomeration benefits is the same.

In the context of air connectivity, it is perhaps helpful to consider potential agglomeration impacts in two ways:

- as a direct impact from the way in which air services can increase effective density across large areas by reducing travel times and increasing the ease with which agglomeration effects may occur across national borders. This is essentially the boost in productivity within firms as air services make the world smaller. By facilitating travel, air services increase interaction between customers and clients, between different offices of the

same firms and at conferences and training events. They enable the development of specialist goods and services by increasing the size of the potential market and they assist in widening the labour market from which firms can draw;

- as an indirect impact relating to the potential impact of air services in terms of influencing FDI decisions, which in turn result in clustering of firms in locations around major airports, again resulting in an increase in effective density and greater agglomeration.

Clearly, there are linkages between these types of effect and some of the other channels of impact that we have described, notably FDI and labour market impacts.

The evidence base around aviation connectivity and agglomeration effects is currently limited, however. NERA's past work evinces some scepticism about agglomeration in the context of air travel, citing DfT guidance and referring to declining impacts with increasing distance. Likewise Graham and Meto (2010) suggest that there will not be major agglomeration impacts from the implementation of HS2 in the UK, though they acknowledge the evidence base is very limited³¹.

However, it is important to distinguish between the concept of agglomeration and the technical specifics of the existing DfT formulae (which were originally intended as a guide to agglomeration due to surface transport improvements within an urban area and its surrounds).

In fact, as suggested above, it is possible to conceive of air travel as offering agglomeration benefits in much the same way as surface travel does. In particular it would be expected to help to promote interactions and the exchange of ideas and knowledge and facilitate knowledge spillovers as workers from different regions/countries learn from each other. Indeed that is, in part, the point of much business travel, intended or otherwise. It may also potentially augment labour market density and encourage specialisation – particularly when work is undertaken on a more regular basis (fly in/fly out) or in the context of major projects³².

³¹ Graham and Meto (2010) *Advice on the Assessment of Wider Economic Impacts: a report for HS2 at* <http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/pgr/rail/pi/highspeedrail/hs2ltd/appraisalmaterial/pdf/widereconomicreport.pdf>

³² Indeed Graham and Meto (2010) also acknowledge this noting that there are no obvious characteristics of the sources or mechanisms of agglomeration that would limit its generation over longer distances. The reasons for the authors findings in respect of HS2 remain somewhat cloudy and maybe related to model specification, particularly in respect of their existing assumptions around employment density impacts and distance decay.

Accordingly, any spillover benefits from such activity arising from business and/or labour market interactions must be positive. Otherwise one would have to argue that for some reason the increase in effective density resulting from air travel is zero, even though such increases are allowed for in the assessment of surface travel modes.

In practice, as suggested above, agglomeration impacts arising from air travel would typically be associated with business trips. More and more business people working within a given area will increase that area's effective density just as regular commuters would. Of course, given that air travel is not an everyday occurrence even for business people one would expect the effects to be much smaller than the opening of a new interurban metro link, for example. Nonetheless they would be present (and could perhaps be measured by examining the fraction of working days spent by business travellers in a given area).

Further, given the volumes moved by international and domestic aviation, the figures could be material.

Moreover, aviation facilitates the back and forth movement of people between centres on a weekday migration basis – e.g. some workers might spend the week in one country and return home on the weekend. These effects should also be noted when assessing the materiality of agglomeration impacts and would be enhanced if improved infrastructure (e.g. opening of a new hub airport) serves to enhance connectivity and reduce costs.

4 Reconciling connectivity with traditional microeconomic approaches: how connectivity drives GDP

The above discussion has focussed on various approaches to the concept of connectivity. While, as noted above, the term connectivity can be useful in public policy debates, the variety of approaches and factors discussed above holds the potential to lead to conceptual confusion about the nature of connectivity and how, exactly, it has the potential to drive economic growth³³.

However the concepts behind connectivity can be clarified by reference to the basic microeconomic framework. This framework forms the starting point of traditional transport economics, and innumerable appraisals of transport schemes as well as underlying WebTag's methodological approach.

Reference to this framework may help explain the relationship between connectivity and the factors behind it these variables such as travel time, fares and other elements of what is known to transport economists as "generalised cost" as well as the ultimate relationship of all of these to GDP.

³³ It is particularly important to stress the microeconomic roots of connectivity given some of the misuses or misunderstandings of the term in recent years. For example CE Delft's (2012) (*Review of the Economic Value of Night Flights at Heathrow*) critique of Oxford Economics (2011) *Economic Value of Night Flights at Heathrow* argued that suboptimal flying times would not impair connectivity as there would be no change in the number of flights as a result. However this is to misunderstand the meaning of connectivity – since what drives connectivity is precisely those factors such as travel times and modal amenities. Presumably as flights become less convenient passengers and freight drop out (while others face higher generalised costs). In the long run flight movements could decline as a consequence.

Likewise in considering how connectivity affects behaviour, Oxera (2010) *Understanding the Theory of International Connectivity* discuss modelling the impact of "new" destinations and discussing whether this should be modelled through a rightward shift in the demand curve. However, this seems to drift from the conceptual basis of transport as a derived demand. Air transport does not create "new" destinations. Rather air transport may lower the generalised cost of travel to/from existing destinations (e.g. via direct flights which cut travel times) and this would result in increased passenger and freight demand. This is typically reflected in a movement downwards along a given demand curve.

Conversely, given that destinations already exist, if there is no change in generalised costs (e.g. no decrease in travel times) then there is no apparent reason why more passengers would travel to them. In such a case. a shift in the demand curve for air transport at a given price would typically be due to an outside ("exogenous") factor – e.g. a change in incomes in emerging markets as discussed below and/or a change in consumer tastes or preferences.

To understand the driving force behind some of the key concepts associated with connectivity it is instructive to consider a “thought experiment”. First, consider the UK as it is with its global aviation connections both domestically and to the rest of the world. This implies a certain level of connectivity both internally and with the outside world. That connectivity could be measured in various ways – e.g. via a connectivity index or using the growth accounting methods or even gravity models.

Next, consider the UK with no domestic or international aviation services whatsoever but with the rest of the world continuing to enjoy such connections. The UK would still be accessible by sea and via a land border through the Republic of Ireland. Clearly, by any measure, the UK’s (air) connectivity would effectively be equivalent to zero. There would be no incoming passengers or cargo to drive growth nor any consequential effects of that growth. One might therefore expect the *total* flow of people and goods between the UK and other countries (and within the UK) to fall, even allowing for modal substitution.

Yet *why* would the flow of people and goods between the UK and other countries (and within the UK) be reduced under the second scenario ? The most immediately obvious answer is that **travel times** would increase. While other modes were available, it would take longer for people and goods to reach the UK and longer for people and goods to leave it.

For example, consider a flight from Beijing to London which under the second scenario would now terminate in Amsterdam. If passengers wanted to continue their journey to the UK they would need to exit their aircraft and choose a new mode for their onward journey. That would add to **in vehicle travel time**. There would be the inconvenience of making the change (**modal interchange costs**), and additional **waiting time** associated taking with the new transport mode. (Both of these effects are often valued at multiples of any “in vehicle” value of time costs.) There may also be issues of **reliability** as modal interchange means more potential for delay on other modes (as any connecting traveller can testify).

It is also likely that overall **fares** to passengers would increase, as the marginal costs to airlines of travelling into London on that route are likely to be smaller than the additional modal interchange costs (i.e. landing in Amsterdam, and then paying train and, possibly, ferry fares is likely to cost more than the additional long haul fare for the London-Amsterdam segment of the trip.)

It is also worth recalling that, while they generally turn up at an airport a considerable period before departure due to structural constraints such as security and check in requirement, potential air travellers may nonetheless value the option of increased flight frequency. Business people in particular may value the fact that there are several flights a day to given destinations, enabling them to structure their working days more efficiently. This **option value** could also be monetised indeed the concept of option value is well recognised in WebTAG (3.6.1) and in other areas such as cultural and environmental economics. Conversely, any such value would be lost with the absence of flights to and from the UK and within the UK.

In essence, then, the total (or generalised) cost of travel would increase. As a result, fewer passengers (both business people and tourists) would make the trip. And those who do make the trip would face higher costs.

Agglomeration effects arising from people meeting, interacting and working closely together would be lessened as there would be fewer trips to the UK. And likewise any **FDI flows** resulting from air travel would also be reduced.

On the producer side, the profits (or **producer surplus**) earned by the UK aviation sector (i.e. airlines *in combination with* airports) would disappear. While some of these might be redirected to other transport modes and industries, this would be a “second best” allocation of resources (as the market had already made a choice to dedicate those resources to aviation services even in the presence of competing modes).

How would all this affect the economy? In a nutshell, economic efficiency would be reduced – i.e. the economy would become less productive. With business people facing higher costs (in time and fares) to access the UK the cost of doing business rises for those who do keep coming, reducing the profitability of any activity. Leisure travel would be reduced, reducing the efficiency of trade flows due to the effective trade barrier created by the loss of flights. Likewise, any FDI flows arising from air travel – either in or out of the UK – would be reduced also meaning that inputs are allocated less efficiently – either via too little investment in the UK or UK investment which could earn higher returns for UK companies overseas. Meanwhile, the loss of the aviation sector would also reduce the efficiency and profitability of the transport sector as a whole, even allowing for the fact that resources are now diverted to “second best” transport and/or other uses.

All of these effects would serve to reduce the UK’s overall productivity and slow economic growth. And, as indicated in Section 2, they should also be picked up under a model linking connectivity with economic growth. The effective absence of air connectivity (due to the supply side constraint of no air travel) implies that the economy functions less efficiently and economic growth is reduced as a consequence.

Now consider the reverse of the above from a microeconomic perspective, with a “supply side change such as the construction of a new hub airport near London. The new hub could reduce or eliminate capacity constraints, potentially decreasing the amount of time spent in the air (as operations become more efficient) and/or in delays or waiting time spent on the ground.

In general the construction of a new hub with more efficient plant and equipment could reduce the per movement costs for passengers and freight. Combined with sufficient “headroom” capacity offered by the new hub, this means that costs per movement would fall. As a consequence, in a competitive market,

fares should fall, dependent on the costs of providing new capacity, even if some of the benefits were retained by the aviation sector³⁴.

As a further consequence, airlines might not only increase frequency on existing routes but could explore new routes which currently seem marginal or higher risk in revenue generation terms, particularly to emerging markets. At least some of these new routes could produce new revenue streams which would not otherwise have arisen. In short, such a hub could allow for an important element driving any investment and ultimately economic growth – the ability to explore new options and generate higher returns than simply sticking to tried and tested ones (“a retreat to certainty”). In contrast, constrained hubs tend to mean that carriers stick to fewer, more familiar routings (e.g. London/New York) which generate more certain returns in the short run but imply constrained growth in the long run.

The increased traffic could also drive the “externalities” of higher levels of leisure travel, increased agglomeration and induced FDI – as the new hub means that with the removal of effective trade constraints/bottlenecks the economy is better able to allocate resources to their most efficient uses.

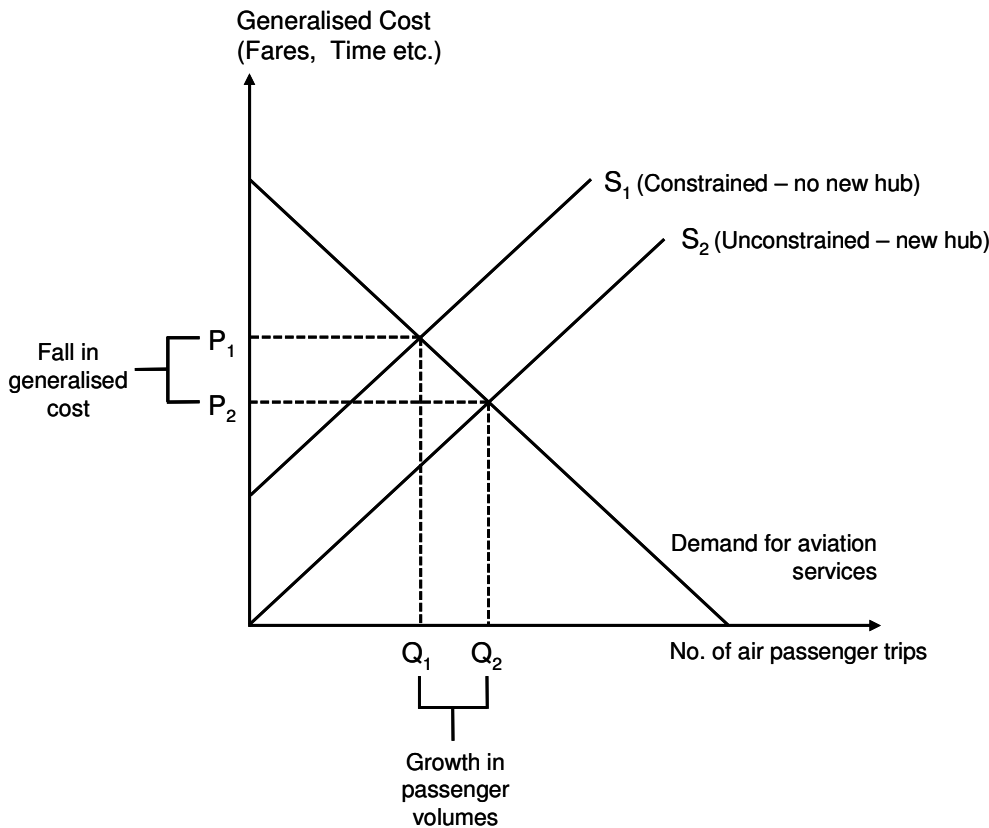
This, again, illustrates the link between the microeconomic model and the concept of connectivity. A fall in supply side costs can result in more offerings/routes on the part of airlines – and that increase in destinations, routes or passengers could be recorded under various forms of connectivity models. And the driver behind it (a fall in supply side costs) would be recorded as a benefit under standard microeconomic models³⁵.

This is shown in figure 5.1 below. The construction of a new hub is reflected in a movement of the supply curve for aviation services from S1 to S2. (Generalised) costs of air travel fall from P1 to P2, spurring an increase in passenger trips (to existing and new destinations) from Q1 to Q2. (The movement from Q1 to Q2 could be picked up by a connectivity model which would record changes in passenger trips.) The movement of the supply curve will generate increased consumer and producer surplus which, in turn, will drive GDP growth. (An analogous curve could be drawn for freight.) “Externalities” not shown on the curve but nonetheless driven by the increase in trips include agglomeration and FDI which will also contribute to GDP growth.

³⁴ Note that in economic terms it is irrelevant who captures this benefit of falling costs per movement. A fall in costs per movement enhances economic efficiency. Some of the fall could be captured by producers (airport operators and/or airlines) and some by consumers. As suggested in a competitive market one would expect that some of the benefits would be passed on to consumers.

³⁵ As previously indicated, in a technical sense connectivity *per se* – i.e. the movement of people and goods to and from destinations – doesn’t drive the growth, as transport is a derived demand. It is what connectivity represents – the underlying economic factors behind it which do so.

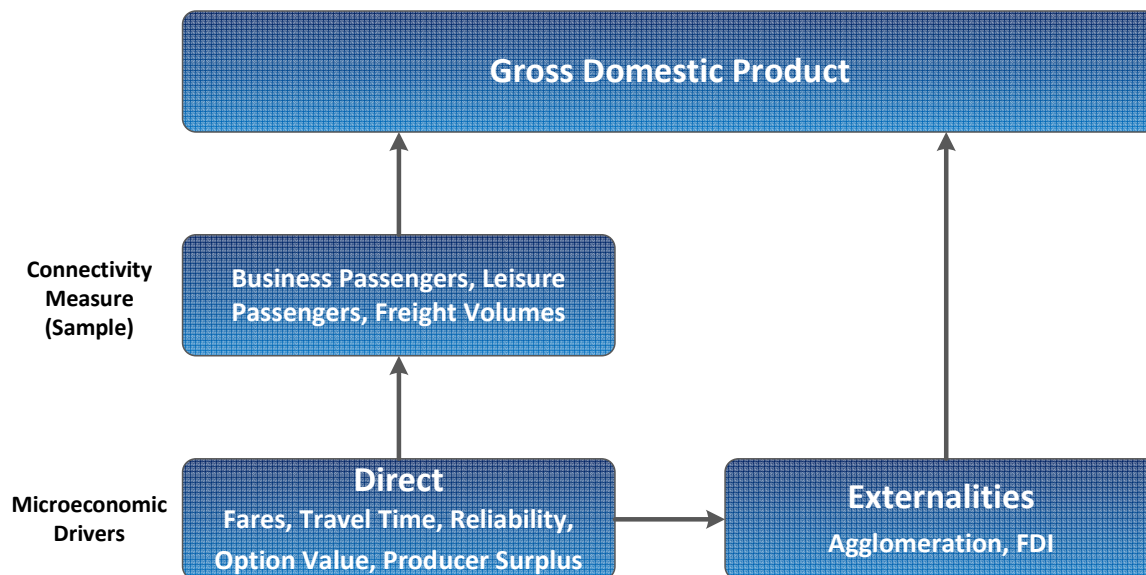
Figure 4.1: Effect of a new hub – basic microeconomic approach



Of course, as previously suggested, it could be that connectivity improves due to a demand side change – e.g. growing GDP/incomes in the UK or overseas markets with a “static” level of UK aviation transport infrastructure. But in such a case this could also be represented in a microeconomic framework through a rightward shift in the demand curve for aviation services. Here again, the supply side becomes relevant – since prices will rise to meet the charged demand in the absence of any changes to the supply side. Ultimately if no infrastructure improvements are undertaken the market could be said to be “constrained” – as per the DfT’s (2013) constrained aviation forecasts. In short, connectivity will have improved in such a scenario but not as much as it could have done due to infrastructure bottlenecks, reducing potential economic growth. This is the situation currently facing the UK in respect of its aviation services infrastructure.

Figure 4.2 indicates the basic linkages between microeconomic drivers, connectivity and economic growth.

Figure 4.2: Link between micro drivers, connectivity and GDP growth



5 Implications for London's/SE airport options

Our analysis of the economic benefits associated with air connectivity and the existing evidence base relating to these effects raises a number of key questions that are pertinent to any consideration of the future direction for airport capacity in London and the South East.

We have set out our initial thinking on some of these issues based on the research undertaken to date below. However, it should be recognised that further research will be being undertaken in the coming months by a range of organisations including ourselves, which may provide further evidence and insight in to these questions.

5.1 How much connectivity is enough?

Much of the evidence base described in this report considers the benefits from connectivity in terms of a relatively simple relationship: more is better. However, it is a legitimate question as to whether there is a point at which a city or an airport can offer 'enough' connectivity. This is a point at which air connectivity supports all the functions it needs to and adding more is simply overkill.

At the outset, it should be said that we do not believe that this is the case. As we have described above, the needs of economic agents change. The economic geography of the world changes, trading markets rise and fall, sources of potential investment change, and peoples' tastes for travel and tourism evolve with time and relative prosperity. In such a world, the connectivity needs of the economy are constantly changing and as a result the air connectivity offered can never be 'enough'. What fits with the needs of the economy one day will not necessarily fit the next day.

The concept of 'enough' connectivity implies that a city or country's airports reach a static level that meets its needs. However, remaining the same in a changing environment will in fact result in stagnation and 'enough' will soon not be 'enough'.

The implication for London and the South East is clear. It is not sufficient for London's airports and specifically Heathrow to remain as they are now. In a constrained environment where they cannot grow and evolve in a properly functioning market, connectivity will stagnate. This is to some degree what has been seen in recent years at Heathrow. Constraint at the airport has led to falling numbers of destinations and a failure to deliver new destinations in emerging markets at the same pace as seen at competitor airports. In the absence of capacity, airlines have retreated to certainty, to high yielding dense markets, rather than taking a risk on emerging markets. Hence, while London remains very well connected now and it could perhaps be suggested that it has 'enough' connectivity now, the needs of the underlying economy are shifting and

airlines are not necessarily reacting to this. Fairly soon, the level of connectivity to the markets required will not be 'enough'.

5.2 What is the nature of the relationship between economic benefits and connectivity?

Following on from questions around whether it is possible to have 'enough' connectivity are questions around what is the nature of the relationship between connectivity and economic benefits. There are potentially a number of possibilities:

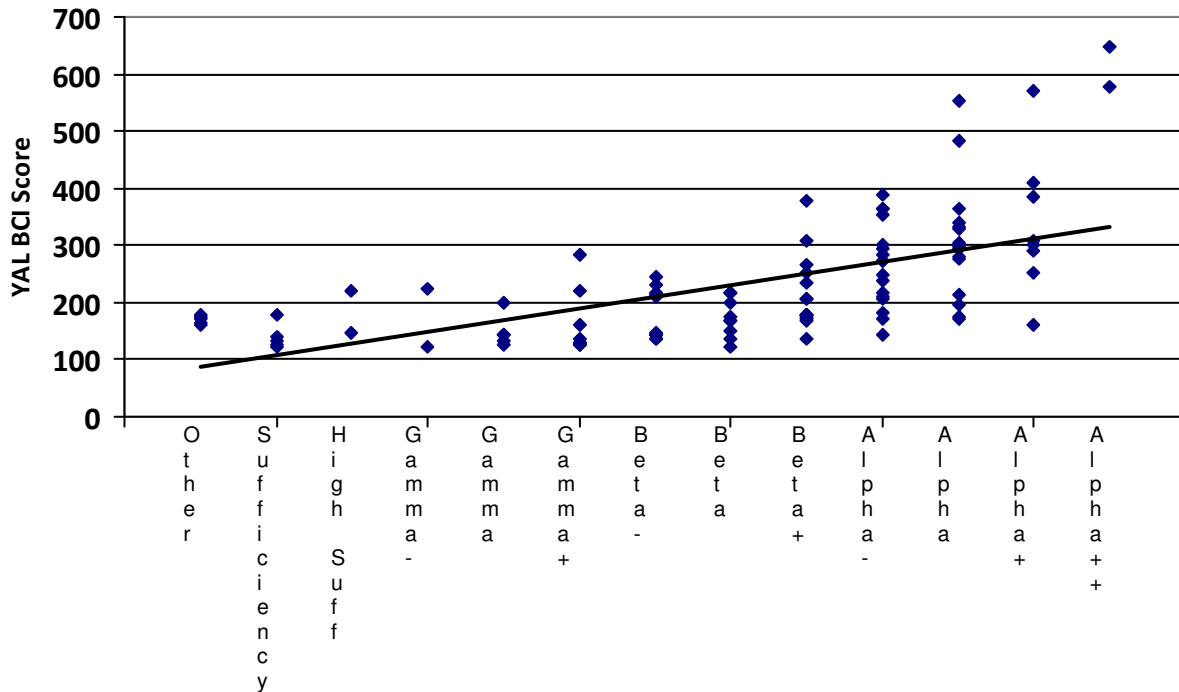
- *Linear* – there is some form of linear relationship by which as connectivity increases the level of economic benefit delivered increases proportionately;
- *Stepped* – this could work in either direction but broadly connectivity might increase in a linear fashion but the economic benefit delivered only increases when particular levels of connectivity are reached, thereby creating a stepped relationship;
- *Diminishing Returns* – initial small increases in connectivity result in large increases in economic benefit but as the absolute level of connectivity grows, the increase in economic benefit associated with a unit increase in connectivity falls;
- *Tipping Point* – again this could be either positive or negative. Is there a point before which the level of connectivity is irrelevant - little or no benefit is delivered but beyond which there are significant benefits ?

Our review is not able to give a definitive answer to this question. There is some evidence to suggest that connectivity is likely to suffer from diminishing returns. This is intuitively sensible. An initial single connection makes trade possible where it was not before with attendant economic benefits. A second connection makes trade easier and will bring benefits but in all likelihood not at the same level as the first connection. This could apply both to frequencies of service or to the balance between direct and indirect connections. Extending this analogy would seem reasonable. In reality the relationship between connectivity and economic impact is highly complex, as we have seen, and there are likely to be elements of all the relationships described above in evidence. This is one of the reasons why effective quantification of the effect is highly challenging.

However, in trying to provide some answers to this question, it is perhaps helpful to look at patterns of connectivity around major world cities and consider what this might tell us about the nature of the relationship. Figure 5.1 below shows the 100 best connected cities in the world based on the York Aviation Business Connectivity Index and their classification within the GaWC ranking of world cities.

There are a number of points to note from this:

Figure 5.1: York Aviation BCI of World Cities vs GaWC Category



- while there is significant variation in terms of the level of connectivity available to individual cities within the different classes identified by GaWC, there is an overall upward trend. More significant world cities tend to have or require greater levels of connectivity. However, the trend is relatively weak and certainly at the upper end the relationship does not come close to explaining the level of connectivity on offer to Alpha ++ world cities such as London and New York or indeed many Alpha group³⁶ cities;
- this preponderance of Alpha cities above the trend line may suggest that there is some sort of step or tipping point at the upper end of this relationship. To be a high end world city potentially requires a significant amount of connectivity and it would certainly appear to be so for Alpha++ world cities;
- for Beta cities and below the relationship between GaWC classification and their BCI score is less strong than for all cities. This reinforces the possibility that connectivity is more important at the upper end of the World City scale.

This analysis does not help consider issues around diminishing returns as it does not consider connectivity over time.

³⁶ Alpha group includes all types of Alpha city.

The implication for the London and the South East from this analysis is that there is potentially a step or tipping point in the relationship between connectivity and London's position as one of the world's leading cities. The relationship is not precise and further work might be able to define this step more clearly as there are also other factors at play. However, there is evidence to suggest that maintaining a strong connectivity offer is important is remaining at the top end of the scale. Capacity constraints ultimately threaten the ability of the City's airports to deliver the connectivity it needs. What is right now is not necessarily right for the future and while it would take some time for a position such as London's now to be eroded, it is possible in a world where the standard is growing connectivity.

5.3 Is the need for connectivity absolute or relative? Does 'the winner' take all?

Considerations around the competitive nature of connectivity are particularly important in the context of a constrained but significant airport system, such as that serving London.

As we have demonstrated above, and as the significant body of evidence described throughout the report suggests, there is strong evidence that increasing connectivity brings greater economic benefits. Hence, it is reasonable to suggest that therefore the absolute level of connectivity supports prosperity and economic growth. Increasing connectivity enables better functioning of markets, improves the ability of countries to exploit comparative advantage and ultimately increases long run productivity.

However, we have also described how air connectivity is an important factor in a city or region's ability to compete for globally mobile capital. By definition, the fact that there is a competitive market for, for instance, FDI, means that the factors on which competition is based must be important in relative terms to one another.

Again, this re-emphasises the highly complex relationship between connectivity and economic growth. Our analysis above suggests that to be an Alpha group world city, a city needs to have a significant absolute level of connectivity. However, one of the reasons that a high level of connectivity is important for these cities is that they are competing to secure globally mobile capital and trading relationships with other Alpha category cities that are also very well connected. Therefore it would seem logical to suggest that the need for connectivity is both absolute and relative.

In terms of the secondary question, does the 'winner take all', there is clear answer. Simply put the answer is no. This is a function of a number of things:

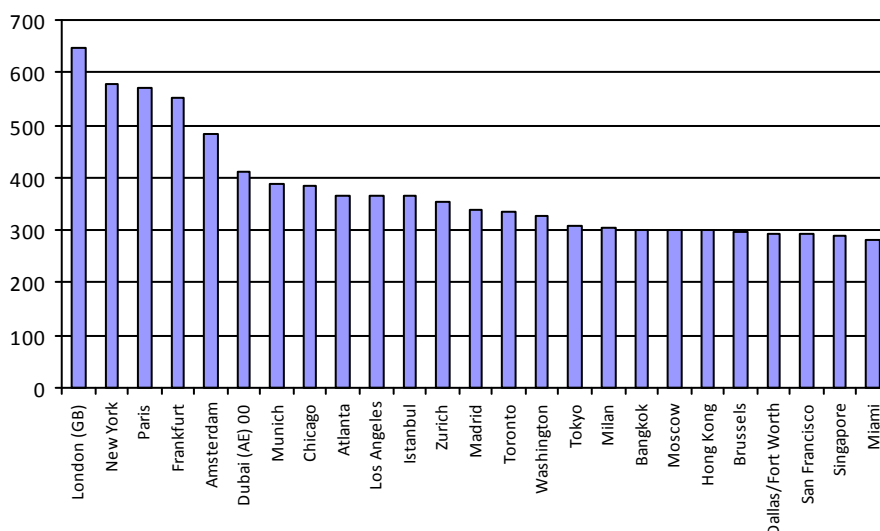
- connectivity is not homogenous. It means different things to different people in different circumstances. Therefore, it is not possible to define a winner in any meaningful sense;

- connectivity is a necessary but not sufficient factor in the relationship between economic growth and the factors we have discussed, such as trade, FDI, labour markets, tourism and agglomeration. Connectivity is not why people trade with a particular market or choose to locate in a particular place. Its existence simply makes it possible or easier. It is one of a number of factors that influence decisions in these areas. As a result, even if it were possible to define a winner in terms of air connectivity, that winner would still be reliant on their performance in relation to the other factors in the decision making process. The 'winner' would therefore not take all on the basis of connectivity performance alone.

Ultimately, the most that can probably be said is that improving connectivity and developing services that maintain a city's position as a leading connectivity node will improve its chances of being amongst the winners in terms of future economic growth.

In relation to London and South East, the message from this is again clear. London is already a well connected city. In fact, York Aviation's BCI would suggest it is the world's best connected city (see Figure 5.2). However, this does not mean that it 'wins' and 'takes all'. Its relative position compared to its key competitors is, however, one of the factors that makes it as successful as it is. If it cannot maintain that competitive edge, the chances of its position being eroded are increased and it will be able to 'take less'.

Figure 5.2: World's Best Connected Cities – the York Aviation Business Connectivity Index 2012



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