DEFINING ECONOMIC IMPACT AND BENEFIT METRICS FROM MULTIPLE PERSPECTIVES: LESSONS TO BE LEARNED FROM BOTH SIDES OF THE ATLANTIC

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Abstract

This paper compares UK and USA practices with regard to the frameworks and measures used in considering the wider economic impacts of transport investment (or other interventions), and considers what lessons each can draw from the other.

Regarding the frameworks for appraisal, there has been growing debate in the US about the need to better distinguish local, regional and national perspectives on the measures of benefits and wider economic impacts. Information at local and state levels is required to inform prioritisation of investments by state governments, for equity considerations ("environmental justice") in allocation of funds, and in negotiating agreements for the sharing of investment costs between different levels of government. Comparable issues arise in the UK (and to some extent in other European nations), but there is a need for more debate about the information needed to assist local decision-making as distinct from the information needed purely to comply with the WebTAG (or STAG) requirements for national decision-making. For instance, if we only calculate national measures of benefit we may be failing to make best use of the obtainable information, and may be misinforming local decision-makers about the consequences of their actions for their own constituents.

Regarding the specific measures used in appraisal, there may be need to recognise a broader set of perspectives or metrics to fully span the wider impacts of transport measures, while taking care to understand which ones represent additional benefits and which represent different manifestations of effects already counted in conventional Transport Economic Efficiency analysis. In this regard, there may be lessons to be learned from the efforts of US state and federal agencies to adopt an expanded range of metrics for assessing wider economic impacts, spanning local, intermediate and final outcome metrics. A range of intermediate measures (distinguishing economic impacts relating to freight flows, job access and product delivery market access) and of outcome economic measures (land values, incomes, value added) each get used in different ways in various forms of appraisal schemes.

Along with the concept of differential perspectives for viewing wider impacts, there are also corresponding differences in data and analysis methods required for their use, and issues concerning how they are interpreted.

1. Background: Distinguishing Economic Impact, Benefit and Productivity

Overview. In this paper, we examine the different ways that the economic impacts and benefits of transport projects are being measured and used for decision-making in the US and UK, and seek to identify ways that we can improve practice by learning from the different approaches taken. We chose the US and UK because the two authors come from these locations and are familiar with the economic tools and appraisal methods used in their respective countries. We presume that the general findings will similarly apply for other countries of Europe and elsewhere around the world, and hope that future researchers will be able to extend this type of discussion to other nations.

This paper is organized into five parts. First we identify the different measurement motivations and economic impact measures that commonly exist. Second, we discuss how productivity and wider economic benefits have been measured and modelled in different ways. Third, we examine the ways that economic impact factors are being incorporated into transport project appraisal and prioritisation.[1] Fourth, we discuss the implications of recognizing multiple spatial scales and access factors. Fifth, we discuss implications of alternative measurement definitions. The paper concludes with lessons learned and directions for further research.

Uses of Economic Impact Information. There are many different uses of information on the economic impacts of proposed transport investments, and it is these different uses that lead to confusion about how economic impacts or benefits are measured. They are:

1) to assess whether a proposed transport project can address an identified economic development need;
2) to evaluate the economic efficiency of going ahead with proposed solution to a particular need;
3) to provide information for the selection of alternative options or designs for a transport project;
4) to best allocate limited resources by prioritising transport investments that address different needs;
5) To support negotiating agreements for the sharing of investment costs between different levels of government, or among parties in a public private partnership;
6) to identify effects on particular areas, industries or population groups, as part of a broader environmental impact review or as information for future land use planning.

In each of these cases, economic impacts may be viewed differently by various stakeholders or decision-makers, as their perspectives may reflect different spatial scales and different aspects of the economy. These differing uses of economic impact information and their differing perspectives make it especially important that impact and benefit metrics be appropriately selected and applied to capture the effects relevant for desired decision-making.

[1] In the US, project “appraisal” is more commonly referred to as project “evaluation”

Metrics: Popular Confusion. To understand the above different perspectives, it is useful to distinguish three inter-related terms that are commonly confused by the general public: economic impact, economic benefit and productivity. Similarities and differences between these concepts are reviewed Weisbrod (2007). The most important finding is that each of them is useful for different aspects of the economic information uses discussed above.

- *Economic impact* can refer to essentially any change in the flow of money (income) in the economy of a region, whether that be a flow of money between industry sectors, population groups, or local areas. It is most commonly measured in terms of growth in income, jobs or output (GVA or GDP).[2] This concept is most useful to distinguish effects on growth of the economy of a specific area, industry or population group (corresponding to uses #1, 5, 6). Elements affecting local economic impact may also be included in project appraisal.
- *Economic benefit* (or economic value of benefit) is a broader concept of welfare gain than the preceding concept, in that it can include both money benefits and non-money benefits that have a "willingness to pay" value. (Hence time savings for which consumers or businesses are willing to pay are conventionally regarded as an economic benefit but not usually as an economic impact.) This concept is most useful for cost-benefit analysis (CBA) [3] calculations (corresponding to uses #2 ,3, 4).

  (An important point to note about the above two terms is that economic impacts are often considered in terms of the impact on a specific area of interest, whilst economic benefits are usually estimated for the whole of the economy within which the project is being considered. We return later to the question of the "region of reference".)
- *Productivity benefit* commonly refers to the incremental growth in value added per worker or per unit of investment, enabled because of the wider economic benefits of transport investment. It can generate real growth in income and jobs, and hence represent a source of social welfare gain. Productivity growth can also be viewed as the net portion of observed economic impact (growth) in any given region that is not due to a redistribution of money flows to/from other regions. Productivity is the primary measure of "wider economic benefits," which are distinguished because they may be included either as a factor in appraisal tables[4] or as an additional benefit in CBA accounting, though in the past they have often been missed by both.

This is where the first common problem comes in, as there are cost-benefit accounting tools as well as regional land use and economic impact models in existence in both the US and UK - though the two types of tools are typically used for independent purposes and are seldom reconciled. As a result, we cannot always be sure that our estimates of economic growth impact and productivity benefit are consistent and

[2] Gross value added (GVA) is commonly used in the UK and gross domestic product (GDP) is commonly used in the US, but they are essentially the same measure of the added value of economic activity in a region.

[3] In the US, CBA is more frequently referred to as Benefit-Cost Analysis (BCA). There is no difference in methods.

[4] In the US, an Appraisal Table is commonly referred to as Multi-Criteria Analysis (MCA) or rating scorecard.

mutually supportive. A recently developed analysis framework for the US and Canada, called TREDIS, bridges and reconciles the two forms of analysis. Nevertheless, most of its uses to date have been for either regional economic impact *or* CBA analysis, but not both. The primary exception in North America has been for multimodal passenger transport studies in Canada, where that same system was used for both regional economic impact and CBA (e.g., see HDR, 2010). In the UK, DfT guidance in 2005 assumed that land-use/transport modelling always worked with a fixed economic scenario for the modelled region, but that is no longer the case (see for example the SETLUM model described in Dobson et al, 2007, 2011).

Importance. Economic impact, benefit and productivity metrics are all important for a variety of reasons. First, many public leaders and some elements of the general public continually cite transport investment as a way of positively affecting the economic development of communities and regions, which means that they care about that form of benefit and expect it to be considered in transport appraisal and decision-making. Second, economic changes are shifting transport needs and benefits, through factors such as changing business requirements for freight distribution and access to customers, changing population patterns affecting job access needs, and changing technologies affecting business logistics processes and intermodal connectivity requirements. And third, with scarce public resources, it is particularly important that wider benefit and cost factors be taken into account to optimize the public welfare outcomes of public investments.

Addressing the changing business requirements noted above can thus potentially create economic growth and development in at least three ways: (1) by enabling new forms of trade among industries and locations, as a result of enhanced intermodal connectivity, (2) by expanding output as a result of enlarged customer markets that enable “economies of scale” in production and distribution, and (3) by increasing productivity through access to more diverse and specialized labour and supplier markets (facilitating agglomeration benefits). A variety of US and UK studies have focused on these same productivity factors. Those studies are discussed in the literature review which follows.

2. Past Research on Access, Connectivity and Productivity

Measures of Economic Impact. Economic impacts can be viewed in either gross or net terms, and that measurement can also depend on the spatial scale of analysis. For instance, consider a given region within a larger nation. From the viewpoint of regional economic impact analysis, a transport investment can lead to *economic growth* by enabling a region to be more competitive and hence attract more private investment to expand its level of economic activity (reflected by job, income or output metrics). The observed (gross) change in regional economic activity may occur via any combination of expanding current industries or attracting new industries. Either way, the reason for increased competitiveness and investment is usually enhanced *productivity* enabled by transport system improvements.

From the viewpoint of CBA, productivity is the net benefit remaining after adjusting for inter-regional transfers of activity. So while the rest of the gross change in regional economic activity may represent spatial transfers of activity that cancel out at a national level, the productivity benefit observed at a regional scale will remain when the project impact is viewed at a national level. It is for this reason that transport factors affecting net productivity benefits also affect gross economic growth impacts. These factors are discussed next.

Factors Affecting Economic Impact. A number of transport-related factors have been consistently identified in past research as affecting economic growth and productivity. They may be categorized into three groups: (1) travel cost and reliability, (2) market access, and (3) access or connectivity to intermodal terminals. The first group has traditionally been covered in CBA calculations for project appraisal, but the latter two have generally not been included, though they are very often important in the motivation for projects.

Research on Market Access and related variables. Much of the research distinguishing productivity effects from larger economic growth effects has followed from the work of Krugman (1995) which showed that, with imperfect competition, regions naturally develop differentiated industry mixes that reflect "agglomeration economies." The agglomeration is reflected in a disproportionately large concentration (or cluster) of specific industry activities, which is enabled by access to larger "markets" – which was defined to include specialized and differentiated markets for labour, material input suppliers and customers. That has led to further research on industry responses to changes in (a) labour markets, (b) business supply chains and (c) business delivery markets.

There has since been widespread acknowledgement of the multi-faceted nature of these market effects. The US DOT's Toolkit for Regional Policy Analysis (Cambridge Systematics, 2000) noted that "businesses benefit from easier access to suppliers, a larger labor pool, and expanded consumer markets…. Access to larger numbers of workers, consumers, and suppliers also provides greater choice and allows greater specialization, thus increasing business efficiencies." The Eddington Transport Study (DfT, 2006) noted that "the transport system links people to jobs; delivers products to markets; underpins supply chains and logistics networks; and is the lifeblood of domestic and international trade".

An approach for empirical measurement of industry response elasticities was laid out in the *Journal of Transportation Statistics* (Weisbrod and Treyz, 1998), which showed how local productivity for various industries varied by accessibility as measured by inter-regional trade flows. A study of the *National Cooperative Highway Research Program* measured productivity impacts of reducing urban traffic congestion, based on a statistical analysis of the relationship of productivity to market access for urban commuting trips and regional truck deliveries (Weisbrod, Vary and Treyz, 2001). The study concluded that labour markets and truck delivery markets had very different time/distance patterns that reflected differing needs for specialized worker/job skill matching and product/buyer feature matching among various industries. A series of further studies have documented how industry location patterns and clustering vary systematically by different types of access factors.

The most well known line of research has examined how the effective density and scale of urban labour markets affects productivity. Examples include research by Ciccone and Hall (1996), Weisbrod et al (2001), Prud'homme (2001), Graham (2006, 2007, 2009), Partridge et al (2009), Alstadt and Weisbrod (2011). Research in the UK has been reviewed by Laird and Mackie (2010), who also note the work on broader relationships between accessibility and productivity by KPMG (2009) and SERC (2009).

There have also been studies in the US regarding business concentration and productivity effects of improving connectivity within supply chains, or improving connectivity between markets via intermodal terminals and gateways. Examples

include research by Polenske (2003), Jack Faucett Associates (2004), Targa et al. (2005), Lynch et al. (2007), Manzaro et al (2011) and Alstadt and Weisbrod (2011). The issue of gateways is also recognized as important in UK work but has tended to focus in analysis and in applied modelling on property market effects rather than economic impacts in total.

Interestingly, there is little in the way of theoretical difference between the US and UK studies. However, the major difference has been one of perspective – many US studies have focused on "ground level" details regarding differences between forms of local and regional access and their differential effects on various industries, while many UK studies have mainly taken a broader view in order to derive general relationships which could be used to standardise across a wide range of projects. This largely reflects differences in project appraisal approaches, in which there are consistent national rules in the UK case and a wide range of different local approaches taken in the US case. These differences are discussed next.

3. Inclusion of Economic Impact Factors in Project Appraisal

UK Approach. In the UK, the Department for Transport (DfT) provides the New Approach to Appraisal (NATA), with a Transport Appraisal Guide (WebTAG) that is to be followed as a requirement for all transport projects and studies that require government approval. And for all other cases, it is highly recommended as a best practice guide. Scotland's Scot-TAG and Wales WelTAG are separate frameworks that draw heavily from the same basic principles.

The core of TAG is the Appraisal Summary Table, which from an American perspective may be described as a Multi-Criteria Analysis (MCA)[5] tool that incorporates Cost-Benefit Analysis (CBA) and Environmental Impact Assessment (EIA) techniques. It has included reliability, local economic regeneration effects and wider economic benefits as non-monetised rating factors, though newer guidelines are allowing for some wider economic benefits to be monetised in CBA calculations. This may occur in four main ways (see WebTAG Unit 3.5.14C):

- effects of increased competition, which are recommended to be estimated as an uprate factor applied to the calculated value of business cost savings;
- agglomeration economies, calculated on the basis of an elasticity of productivity with respect to change in effective labour market density;
- increases in production due to better transport drawing more people into work;
- increases in productivity due to jobs being relocated to more productive locations.

All of the above are inherently monetised. A separate category of wider effects which WebTAG allows is that of positive impacts on "economic regeneration areas". These are specifically local in nature, but based on the argument that it is of national benefit to reduce concentrations of unemployment and deprivation, *even if* this is done at the expense of jobs elsewhere.

A major study carried out for the Eddington Review (DfT, 2006 and Feldman et al, 2008) applied a land-use/transport interaction model and the then-new DfT "wider economic impacts" method to a sample region (South and West Yorkshire) and to a range of different interventions to assess these factors. It noted there is little evidence

[5] In Canada, this is sometimes referred to as Multiple Category Evaluation (MCE)

of type 2 benefits and difficulty addressing type 2 benefits due to uncertainties about labour force participation and movement of jobs. However, types 1 and 3 could be addressed, and the study concluded that the type 1 agglomeration benefits were most significant. The study focused on a single region, so inter-regional freight delivery and supply chain effects could not be fully tested.

US Federal Approach. In the US, a wide range of different approaches apply to the appraisal of proposed transport projects, depending on the mode and jurisdiction. There are two reasons for this. First, the US Dept. of Transportation is divided into modal agencies, and each makes its own rules regarding project appraisal and selection of projects to receive its "discretionary grant" funding. In addition, a large share of federal highway and transit funds are distributed by formula to state and metropolitan governments, each of which can have its own methods for appraising, prioritising and selecting projects.

Historically, federal discretionary grant programs have been divided into special purpose categories (such as safety, congestion reduction, air quality, scenic routes, etc.) and each has its own cost-effectiveness criteria for project ranking. In addition, a number of federal discretionary grant programs also have CBA requirements to ensure that only projects passing that efficiency test are funded. There are separate CBA guidelines for waterway, airport, rail, transit and highway investments. All recognize transportation benefits in terms of time and money cost savings to operators and travellers. In addition, the aviation, rail and highway guidance documents separately recognize wider benefits for freight shippers, who may incur additional costs (beyond the pass-through of operator costs) for reliability delays that affect inventory carrying costs and spoilage, as well as industry productivity changes associated with restructuring logistics processes (Landau, 2010) [6]

The US DOT has added multi-modal grants under the new TIGER (Transportation Investment Generating Economic Recovery) program. It requires a broader form of CBA with guidelines that explicitly monetise a wider range of non-user benefits. These include "economic competitiveness" (through measures of productivity associated with travel efficiency, reliability and access changes), "livability" (through measures of the availability of multi-modal options and health improvement), and "environmental sustainability" (through measures of the value of energy efficiency and reduction of air pollution and carbon emissions). The inclusion of productivity gains associated with reliability adds recognition to freight projects, while the inclusion of productivity associated with access changes allows potential recognition of agglomeration effects from urban passenger transport investments.

US State Approaches. While the US federal guidelines have focused on cost-effectiveness and CBA, many state transportation departments have adopted variants of MCA or related appraisal techniques that recognize qualitative factors. They tend to differ from the federal appraisal approach in that they explicitly recognize state-level economic development impacts as well as strategic state planning goals that have a spatial focus (such as connectivity and access enhancement). There are three primary methods used.

- A two step process of CBA and qualitative factor ratings: First, CBA assessment of user benefits and costs is conducted, following guidelines of the Association of State Highway and Transportation Organizations (AASHTO, 2003). Then qualitative factors are considered that reflect non-user benefit categories including

[6] Industry-level productivity impacts are also recognized in Canadian BCA guidance

regional and local economic development, environmental and social impacts. Minnesota and California use this method.

- Multi Criteria Analysis (MCA) is a method that allows for qualitative and quantitative factor ratings to be considered together in a summary table. In the US, each factor is assigned a weight so that an overall score can be computed for all every project. Ohio, Wisconsin, Missouri and Virginia use this method, as do various metropolitan planning organizations (e.g., Chicago and San Francisco). Most calculate GDP[7] or employment impacts from an economic impact model[8] that also addresses productivity and economic growth impacts, and then includes those impacts as an MCA element. However, they also add other more strategic local concerns, such as connectivity (to intermodal terminals, key state-wide corridors and export gateways) and spatial development (supporting regeneration, cluster and in-fill development).
- Composite Score - Kansas developed a variant method, which calculates a GDP impact rating using the TREDIS economic analysis framework to explicitly account for both labour market and freight market access impacts, as well intermodal connectivity impacts. The GDP impact rating is then combined with engineering rating and a "local consultation" rating (from community meetings) to provide a composite project score. North Carolina also takes this approach.

Table 1 shows elements that are explicitly named in appraisal tables and benefit calculations adopted by various government agencies in the US, UK and Scotland. While side-by-side comparison is difficult and sometimes subjective, it illustrates the main point that many of the same elements of wider economic benefits are broadly recognized and considered across both sides of the Atlantic.

[7] The "Gross Domestic Product" for a state or region is essentially the same as the "Gross Value Added"

[8] Usually either the REMI or TREDIS economic model is used to calculate statewide productivity and economic growth impacts. The latter model also accounts for fine-scale urban agglomeration and supply chain benefits.

Table 1. Economic Development Criteria Identified in Project Rating Systems
(from Weisbrod, 2011)

	CBA	MCA			Rating	Appraisal	
Rating Criteria	**USDOT**	**OH**	**WI**	**MO**	**KS**	**DfT**	**Scot**
Traveller Benefit and Environment							
Efficiency: Travel time, cost, level of service	X	X	X	X	X	X	X
Safety (accident rate)	X	X	X	-	X	X	X
Pollution emissions/air quality/greenhouse gas	X	X	X	X	-	X	X
Transportation Drivers of Business Productivity							
Intermodal facilities, access & interchange	*(x)*	X	*(a)*	X	*(a)*	X	X
Reduce localized congestion bottlenecks	*(x)*	X	X	X	X	*(b)*	*(b)*
Connectivity to key corridors or global gateways	*(x)*	-	X	X	*(a)*	-	-
Labour market access	*(x)*	-	*(a)*	-	*(a)*	*(a)*	*(a)*
Reliability of travel times	*(x)*	-	*(a)*	-	*(a)*	X	*(b)*
Truck freight route, supply chain impact	*(x)*	X	*(a)*	X	X	-	-
Transport Drivers of Localized Economic Growth							
Location: regeneration of distressed area	-	X	-	X	-	X	X
Land use: supports cluster or in-fill development	-	X	-	X	X	X	X
Econ Policy: support target industry growth	-	-	-	X	X	-	-
Local public support	-	-	X	-	X	-	-
Leveraging private investment	-	X	-	-	-	-	-
Macroeconomic Outcomes							
Jobs(support job growth/reduce unemployment)	-	X	X	-	-	-	-
Gross Regional Product or Value Added	-	-	-	-	X	-	-

X = factor explicitly included as an element of the rating system;
(x) = factor implicitly allowed via calculation of additional productivity benefit in CBA
(a) =factor implicitly included as a component of the macroeconomic productivity calculation (using TREDIS in US and agglomeration benefit guidance for DfT and Transport Scotland);
(b) = factor included in travel efficiency benefit shown above
" - " = factor not formally recognized as a separate element of the rating system, but may still be considered through other elements of the project appraisal and selection process
Abbreviations and Sources: CBA = Cost-Benefit Analysis; MCA =Multi-Criteria Analysis; USDOT =US Dept. of Transportation, OH =Ohio, WI = Wisconsin, MO = Missouri, KS = Kansas, DfT=Dept. for Transport, UK, Scot = Transport Scotland.

4. Distinguishing Different Spatial Scale and Access Factors

Levels of Government. The differences in transport prioritisation that take place at different levels of government in the US (previously discussed in section 3) can be interpreted as reflecting variation in the way that both access and economic impacts are viewed at different spatial scales. What are seen as general public welfare measures at the national scale devolve into more specific measures of access, connectivity, and industrial development as one moves to state and metropolitan agencies. That is neither surprising nor inappropriate, as there are often more specific strategies for corridor connectivity, export development, business market access and job creation as one focuses on smaller areas. There is a natural trade-off between maintaining consistency in appraisal methods at all levels of government (as in the UK) and allowing for differences in methodology to emerge at different levels (as in the US). One's preferences in that regard necessarily require personal value judgment.

Spatial Scale. There are also corresponding differences in how access and connectivity are viewed and measured in the research literature (identified in section 2). In the UK context, much of the research has focused on the ability of transport

investment to enhance the efficiency of urban labour markets. In the US context, where distances are larger, a major element of the research literature has given attention to factors such as same-day freight delivery markets, access to major airports and access to intermodal freight terminals – all of which may involve travel times of several hours and distances of 300 km or more. Even studies of labour market access often relate to the ability of rail or road infrastructure enhancements to connect relatively isolated and outlying rural areas to become economic satellites of major cities.

Dimensions of Measurement. In an effort to address the multiplicity of access metrics, Alstadt and Weisbrod (2011) measured seven different types of access and connectivity for 3,131 locations in the US, which corresponded to the employment centres in each county in the country. The metrics were:

- *Local Population Market.* This was measured as the population living within a 40 minute travel time of the business centre. It can be interpreted as an indicator of both the local labour market and the local commercial (retail/service) market. The 40 minute threshold represents the 80th percentile for commuting in the US, beyond which there is typically a dramatic drop-off of commuting trips..

- *Regional Freight Delivery Market.* This was measured as the employment working within a 3-hour truck travel time from the business centre. It can be interpreted as an indicator of the business opportunities for same-day freight deliveries of either input materials or products to customers. The 3-hour limit allows for same-day outbound and return inbound trips with loading and unloading time.

- *Intermodal Connectivity: Access to Terminal Locations (3 measures)* – These measures reflect average travel times to the nearest commercial public airport, marine port and freight rail intermodal terminal, multiplied by the magnitude of intermodal transfer activity occurring at that location.[9]

- *Access to Gateways (2 measures)* – These measures reflect average travel time to the nearest border crossing and to the nearest air/sea gateway for travel to overseas destinations.

Table 2 shows the correlation among these access and connectivity metrics. Not surprisingly, it shows that proximity to larger airports is correlated with larger urban markets, while intermodal road/rail container terminals tend to be located away from the most dense urban areas. However, even the highest correlations are on the order of 0.4 to 0.6, which are sufficiently low to not be problematic in multiple regressions. This allowed for simultaneous estimation of the economic impact of all seven dimensions of access and connectivity.

[9] Terminal activity is used as a proxy for expanded destination opportunities available at that location. It was available for airports in the original configuration reported here, though data for rail and marine transfers are also being added for future updates.

Table 2. Correlations between Access and Connectivity Metrics in the US

	Local Pop Market	Same-Day Delivery Market	Airport	Rail Terminal	Marine Port	Border	Intl. Gateway
Local Pop Market	1	0.635	0.617	-0.649	-0.570	-0.074	-0.51
Delivery Market	0.635	1	0.390	-0.505	-0.589	-0.021	-0.575
Airport	0.617	0.390	1	-0.533	-0.421	-0.105	-0.361
Rail Terminal	-0.648	-0.505	-0.533	1	0.496	0.080	0.407
Marine Port	-0.567	-0.589	-0.421	0.496	1	0.060	0.494
Border	-0.074	-0.021	-0.105	0.0798	0.060	1	0.095
Intl. Air Gateway	-0.505	-0.575	-0.361	0.407	0.494	0.095	1

Source: Alstadt and Weisbrod, 2011

A series of non-linear, simultaneous equation regressions were then estimated to identify the relationship of all seven access metrics to industry-specific measures of output, employment, exports and output/labour ratio (a measure of labour productivity). A key finding was that different forms of access affected the productivity of different industries in ways that are quite logical. For example:

- *The local population market scale* was a particularly strong productivity factor for wholesale and retail trade and service industries. However, it was generally less strong as a factor affecting manufacturing, construction and utilities industries.
- *The regional freight delivery market scale* was most important for manufacturing, and also important for food and agricultural industries.
- *Airport access time* was most important for professional, scientific and administrative industries (that require employee travel), as well as recreation industries (that depend on tourism) and manufacturers of specialized products (that rely on air cargo).
- *Intermodal freight terminal access time* was most important for industries that send or receive coal or other mining products, wood and paper products, or retail products.

These US regression coefficient values calculated by Alstadt and Weisbrod (2011) were transformed into elasticities that reflected output, employment and productivity effects, by industry. For instance, the elasticity of productivity with respect to changes in local population market scale were found to range from 0.01 to 0.04 for manufacturing industries, and 0.05 to 0.10 for business service industries. These results are generally in line with prior UK research (DfT, 2005; Graham, 2006).

5. Forms of Measurement and Overlapping Factors

Forms of Measurement. There is ongoing debate about the pros and cons of measuring market access via time, distance or generalized cost metrics. There is also ongoing discussion about whether effective market size should be measured in terms of thresholds, gravity decay functions or other functional forms. However, it is also clear that regional-scale access measures (at least in the US) are based on sparse networks, which makes time-based measures very different from distance-based measures. This is illustrated by the irregular shape of the regional freight delivery market shown in Figure 1.

Figure 1. Same Day Delivery Market: Portland , Oregon, US (3 hr. area)

While there is clearly need to refine market access measurement methods, the larger lesson now is that there are indeed many different dimensions of access that may be relevant for specific transport projects. Some are most relevant for urban transport enhancements, while others are most relevant for regional and inter-city corridor enhancements. Yet all have been found important in some prior research. For instance, of the seven types of access and connectivity that were examined in the preceding research, all have been cited as motivations or benefits for some projects, and are being used by some US state and metropolitan agencies as project appraisal factors (discussed in section 3). Not surprisingly given the importance of the state agencies, the use of methods that take explicit account of economic benefits arising within the agency's jurisdiction is better developed in the USA than in the English regions where the DfT's national analysis is dominant (a point also discussed by Laird and Mackie, 2010) - in Scotland the situation is of course different.

Overlapping Factors. A final concern is whether the use of multiple access measures, transport time and cost factors, and economic outcome measures represents a massive overlap or double count of benefits. It is clear that any time CBA and qualitative factors are combined, there is the likelihood that some impact factors are reflecting common drivers. It is also clear that many of the rating factors used by state or metropolitan organizations in the US explicitly incorporate both economic outcomes and intermediate factors that driving them.

The answer is that double counting is a potential source of error only if prioritisation relies solely on a CBA approach that monetises and adds every benefit element and then compares it to calculated cost. In that case, net benefits may be over-estimated. But if qualitative ratings are used (such as the UK appraisal table or the US state MCA methods), then overlapping factors may merely lead to greater weight for projects that have those features. That may be deemed appropriate as long as the desired set of impact factors is fully covered and the resulting set of factor weights and any overlaps are deemed acceptable. Where choices have to be made between impact factors that are different measures of the same effect, we would stress the need to focus on measure of "final" rather than "intermediate" outcome. There is an increasing problem in the public/political acceptance of conventional transport economic efficiency analysis based on time savings, in particular, and an increasing need to explain and show how time savings are "used" to create other kinds of benefits (such as increased economic activity. It has become generally accepted that providing additional road capacity does not relieve road congestion but "simply" leads to more traffic, and the same levels of congestion on the expanded network as before. In this, the fact that there are still benefits from the investment, but that they are being taken in other forms (eg additional leisure travel) rather than just in making the same trips more quickly, tends to be lost. The transport planning/economics profession needs to work on clarifying this.

6. Directions Forward

This paper has shown how transport access and impact characteristics can be defined and measured differently depending on the perspective and spatial scale being considered. It is also clear that any single project can lead to different economic changes depending on the industry sectors and spatial scales being observed. This suggests that there can be value in analysing wider economic impacts and the factors driving them from an urban or regional perspective as well as from a national perspective.

Measures of net economic benefit (in CBA), as well as qualitative appraisal methods, can be applied from the perspectives of different levels of government. This raises an issue that needs to be discussed on both sides of the Atlantic – which is how to make the best use of available information to assist local decision-making as well as meeting requirements to comply with guidelines for national decision-making.

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