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Project Appraisal Guidelines for National Roads Unit 6.9 - Wider Impacts

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1. Context

1.1 Background

Cost Benefit Analysis (CBA) forms one element of the appraisal process for road infrastructure projects. CBA serves a number of functions at both the individual scheme level and when comparing different projects. Traditional methods of CBA for road infrastructure projects focus on user and provider impacts.

“Wider Impacts’ is the term given to the welfare impacts of transport investments that are additional to transport user and provider impacts. These Wider Impacts include changes in productivity, output and employment as a result of an investment in transport infrastructure. These benefits occur because the transport investment addresses a market failure and allows the economy to function more effectively.

A number of market failures relevant to a transport appraisal can be identified. Transport investments can address these failures, and so give rise to Wider Impacts. These market failures are:

- **Agglomeration economies:** When firms are located close together their productivity increases. In economic terms this is an “externality”, that is, if a firm moves closer to other firms it will not capture all of the benefits of the resulting increase in productivity. An outside intervention such as an investment in transport infrastructure can, therefore, realise benefits by increasing agglomeration;
- **Imperfect competition:** Markets for goods and services are not perfectly competitive. Investments in transport can increase the intensity of competition on markets and so increase economic output and welfare;
- **Knowledge spillover effects:** These are another mechanism whereby firms clustering together will become more productive; and
- **Labour market imperfections:** Factors such as income tax, relatively immobile labour, sticky wages and labour market search costs mean that the labour market does not function like a theoretical competitive market. As a result any intervention that increases labour market participation can have net economic benefits.

These market failures mean that a transport investment has a number of potential Wider Impacts. This Unit describes these Wider Impacts and makes practical recommendation for the treatment of them in business cases. The benefits discussed are:

- Employment impacts during construction;;
- Agglomeration impacts;
- Increased competition in the economy;
- Increased labour supply;
- Tax benefits;
- Inward investment impacts;
- Re-organisation impacts; and
- Thin labour market impacts.

The assessment of wider impacts in transport appraisal is relatively novel compared to the inclusion of the components of transport sector user benefit (e.g. travel time savings). This means that the

data and methodologies for incorporating the wider impacts are in an early stage of development. Furthermore, for some of the impacts – particularly those that affect productivity, employment and earnings – a significant amount of data is required in a disaggregate form, and land use modelling may also eventually be required.

This guidance has therefore been written with this in mind. It blends the theoretically desirable with what is practically achievable and realistically relevant to an appraisal. It is expected that, typically, two types of wider impact would be estimated. These concern increased output of firms and employment during construction. For large schemes, expected to affect the largest agglomerations in Ireland, agglomeration impacts may also be calculated. It is however noted that this will require a significant amount of bespoke data analysis. More sophisticated approaches than are detailed here are possible to assess these impacts. Furthermore the inclusion of other impacts may be relevant for these large, strategic schemes acceptable (e.g. tax benefits from increased labour supply, inward investment impacts, and increased competition in the economy impacts). Project promoters should liaise with TII at an early stage in the appraisal of these schemes. TII will be able to give guidance on the appropriate treatment of Wider Impacts, and agree this treatment with DTTAS and DPER.

2. Employment Impacts During Construction

Labour market failures such as immobile labour and 'sticky' wages can prevent the labour market adjusting to ensure that all those who wish to work at the market wage can find employment. As a consequence of these market failures, structural unemployment can exist. In areas of structural unemployment, job creation through construction has a positive welfare impact. This welfare benefit is additional to transport user benefits - provided unemployed workers are taken out of unemployment.

Shadow Pricing is the commonly used tool for dictating the welfare benefit of generating employment through construction. For example, a Shadow Price Factor of 0.8 applied to labour costs of construction means that the wage that would clear the labour market is 80% of the observed market wage, and hence creating employment through construction would have a welfare benefit of 20% of the wage costs.

In times of low unemployment, individual construction projects do not necessarily lead to job creation, hence the assumption of a welfare benefit from construction projects would not be valid. In such circumstances, the adoption of a shadow price factor of 1.0 is reasonable.

Current guidance, as set out in the Department of Transport Tourism and Sport's Common Appraisal Framework (2016)¹, states that a shadow price factor for labour costs of 0.8 should be used in transport appraisals but that a sensitivity analysis must be conducted using a factor of 1.0.

3. Agglomeration impacts

Agglomeration effects arise because firms derive productivity benefits from being close to one another and from being located in large labour markets. If transport investment brings firms closer together and closer to their workforce this may give rise to an increase in labour productivity above and beyond that which would be expected from the transport efficiency saving alone. Greater productivity in agglomerations arises from the fact that firms have access to larger product, input and labour markets. Knowledge and technology spillovers are important aspects that make agglomerations make more productive.

This Section of PAG Unit 6.9 first sets out some background details on Agglomeration impacts and their measurement including references to their treatment in other jurisdictions. It goes on to recommend a practical and proportionate approach to their treatment in business cases prepared for TII.

3.1 Background

In an international context there is a large body of evidence on how productivity can vary with city size, though unfortunately no data specific to Ireland has been identified. From a transport appraisal perspective the evidence from the UK is probably of most relevance to the Ireland context. This is not only because the economies of the UK and Ireland are most similar (in an international context) but because the UK evidence has been developed very much with the transport appraisal context in mind.

In the UK the valuation of these agglomeration benefits is included in the official WebTAG appraisal process. This approach is based largely on the work of Dan Graham at Imperial College London. The main empirical points that can be drawn from this work are:

- An accessibility indicator based on employment in adjacent zones by industrial sector is a suitable measure of agglomeration. This measure is weighted such that employment in zones closest to the zone of interest have a stronger impact on the agglomeration indicator than employment levels in zones further away. In the UK guidance² this agglomeration indicator is referred to as 'effective density', though it is also referred to in other documents as economic density and economic mass.
- Productivity elasticities due to urbanisation are larger than those due to localisation economies⁸. Urbanisation relates proximity to economic mass/density in general, whilst localisation relate to proximity to the economic mass/density of a particular sector (e.g. textiles). The UK's current appraisal guidance is centred on urbanisation elasticities. From a policy perspective the fact that the urbanisation elasticities are larger than the localisation elasticities indicates that it is proximity to economic mass in general that is the key driver to labour productivity in an agglomeration context.
- Returns to agglomeration vary by industrial sector. Graham and colleagues estimate an overall agglomeration elasticity of 0.04 across all sectors of the economy, 0.02 for manufacturing and consumer services, 0.03 for construction, and 0.08 for business services⁸. This is relevant as it confirms that causality issues can upwardly bias productivity elasticities.
- Returns to agglomeration vary not only by sector but with the size of the city⁵. What this means is that the percentage uplift in productivity due to a percentage change in economic density varies with city size. For manufacturing, construction, distribution, hotels and catering and IT the percentage uplift for a percentage change in economic density increases as city size decreases. That is it is the smallest towns or cities experience the biggest uplifts for these sectors given for a given percentage

change in economic density. In contrast for banking, finance and insurance, business services and public services the percentage uplift increases with city size. That is it is the biggest agglomerations that experience the biggest uplifts in productivity in these sectors for a given percentage change in economic density.

- The estimation of how productivity varies with agglomeration (the productivity elasticity to economic mass/density) is very challenging econometrically. One of the principal difficulties is that of causality. The causality problem arises as a consequence that accessibility in large agglomerations and between large agglomerations may be high because that is where demand is the highest, rather than because the higher accessibility has created the agglomeration and its associated productivity. Another difficulty is that a substantial component of the observed spatial variation in productivity arises as the most productive workers tend to live in the largest agglomerations. It is very difficult to control for this self-selection process as controls for education and skill levels only go part the way to identifying the most productive workers.
- Empirically it is difficult to separate agglomeration effects on productivity and other impacts such as re-organisation effects and the effect of inward investment. This is because typically in large agglomerations firms have taken advantage of the ability to re-organise their structure to take advantage of economies of scale or density in production. Similarly inward investment is typically located in large labour markets. Thus empirically the effect of agglomeration on productivity is confounded with that of re-organisation and inward investment.
- There remain questions around the causal effect of transport infrastructure on productivity⁷. In his empirical work with van Dender, Graham found that variations in productivity between agglomerations may be entirely attributable to differing qualities of labour between locations. That is the effect on productivity due to variations in economic density was not statistically significant. Additionally, ex post work undertaken by the London School of Economics could find no evidence that firm level productivity had altered as a consequence of motorway investment⁴ – though this finding could result from a number of empirical issues in the analysis.

A recent literature survey¹⁴ for the UK Department for Transport provides a useful summary of research since Graham's work and shows the range of values for the key parameter of the productivity elasticity that are produced by research. The Table below is reproduced from this paper.

Table: Evidence on Accessibility and Productivity

Unit of observation: Places	Elasticity of productivity with respect to ATEM	Controls		Distance measure: Spatial decay
Rosenthal & Strange (2004)	0.05 - 0.11	--- Survey article ---		
Ciccone & Hall (1996)	0.03	Education level		Fixed
Rice, Venables & Pattachini (2006)	0.04	Occupation, skill		Travel time. Estimated.
Unit of observation: Firms				
Graham et al. (2009)	Econ average: 0.043 By sector: Manuf: 0.021 Construction: 0.034 Cons. servs: 0.024 Bus. servs: 0.083	Firm characteristics (e.g. firm age)		Geographical distance. Estimated.
Unit of observation: Workers		Observable (occupation, age, skill, experience) ²	Unobservable (individual fixed effects) ²	
Combes et al (2008)	0.035 0.024	√ X	X √	Fixed
Puga & Roca (2012)	0.046 0.023	√ √	X √	Fixed
SERC (2009) ¹ Car	0.08 (not signif) 0.05 (not signif) 0.07	X √ √	X X √	GTC car. Fixed, reciprocal
SERC (2009) ¹ Rail	0.258 0.17 0.05	X √ √	X X √	GTC rail Fixed, reciprocal

Source: Venables et al (2014)

3.2 Calculation of Agglomeration Benefits in England and Wales

As noted above the UK Department for Transport's "WebTAG" guidance on transport project appraisal in transport includes a detailed approach to calculating agglomeration benefits. The UK Department for Transport also publishes a software application, WITA, which implements this guidance.

The UK experience from the inclusion of agglomeration effects in an appraisal is that they only tend to be significant for transport schemes located within, or near, large and dense employment centres. The UK therefore identified areas, known as 'Functional Urban Regions (FURs)', where agglomeration benefits can be expected to be significant. The core FURs are defined as having a minimum working population of 60,000 and a minimum of 7 jobs per hectare. Areas surrounding the core FURs are assessed for inclusion in the 'commuting field' or hinterland FUR.

For the commuting field, the wards surrounding a core are examined. If more workers in the ward commute to that core than to any other core and a minimum 10% of the working population commutes to that core, then the ward is added to that core's commuting field.

For rural inter-urban road schemes agglomeration impacts are not therefore considered significant contributors to economic benefit.

The calculation of agglomeration impacts using the WebTAG approach is data intensive. It requires data at a very disaggregate geographic level on employment and earnings by broad industrial sector. At the minimum it is important to distinguish between employment and earnings in city centres and suburbs. Such data is not readily available in Ireland and bespoke analysis of the census and earnings related datasets would be necessary to implement such an approach.

Implementing such an approach in Ireland would also require either extensive primary research to identify a suitable value for the productivity elasticity or a decision at a high level to use the current UK value as an approximation.

3.3 Calculation of Agglomeration Benefits in Scotland

The Scottish government produces its own transport appraisal guidance, referred to as “STAG”¹¹. This guidance provides a simplified version of the approach set out in WebTAG for the calculation of agglomeration benefits and provides a spreadsheet based implementation of this approach for use in Scotland. This approach is significantly simpler than that set out in WebTAG, and could potentially be implemented using the output from a transport model in Ireland. In this approach the agglomeration benefits of a transport investment are estimated as:

$$\text{Agglomeration Benefit} = \left[\left(\frac{E^S g^B}{E^B g^S} \right)^e - \left(\frac{E^M g^B}{E^B g^M} \right)^e \right] \cdot h \cdot E^S$$

Where:

E^B , E^M and E^S = Employment in the base year, do-minimum and do something scenarios respectively, in the area affected by the investment.

g^B , g^M and g^S = total generalised travel cost in the base year, do-minimum and do-something scenarios respectively in the area affected by the investment.

e = the elasticity parameter, STAG uses a value of 0.041

h = GDP/employee in the area affected by the investment

This approach could be implemented in Ireland using outputs from the transport model used for a business case provided that a suitable elasticity value was available. Identifying such an elasticity value would require extensive primary research in Ireland or a high level decision to adopt one of the UK values.

3.4 Recommendations for agglomeration benefits in Ireland

Agglomeration impacts should only be assessed if the road scheme impacts on an urban area with, at its core, a working population of 60,000 and a minimum of 7 jobs per hectare. For rural inter-urban road schemes agglomeration impacts are not expected to be significant contributors to economic benefit.

The minimum primary data required for a quantitative assessment of agglomeration impacts are:

- Changes in the generalised cost of travel in the area affected by the investment;
- An agreed value for the economic density elasticity;
- Current and forecast Employment in the area affected by the investment; and
- Data on incomes and GDP per head in the area affected.

This minimum level of data allows for the calculation of an approximation of the value of agglomeration benefits, in line with the Scottish approach. The best estimates of these benefits require more detailed data where employment, travel data and elasticities are broken down by small area and industry, in line with the English approach.

The lack of nationally accepted values for the elasticity of output with respect to density and the complexity of these calculations means that only a qualitative assessment of agglomeration is recommended for the majority of schemes. Such an assessment should focus on the change in the size of the labour market that can access the densest employment areas – typically the city centre. Any quantitative assessment of agglomeration impacts should only be undertaken after consultation with TII.

4. Increased Output of Firms in Imperfectly Competitive Markets

The vast majority of markets for goods and services are not perfectly competitive. This means that output is lower and prices are higher than they would be if the market in question was perfectly competitive. In such a market a reduction in the costs faced by firms will lead to increased production, lower prices and an increase in economic welfare. Transport investment can provide such a reduction in costs as they reduce the transport costs faced by businesses. This is one of the Wider Impacts of a transport investment.

Markets will tend to be at least slightly imperfect even in developed economies due to product differentiation and transport costs. Through product differentiation a firm attempts to achieve the position of a monopolist so as to maximise its profits. High transport costs can also lead to areas becoming geographically isolated permitting businesses to increase prices above marginal cost.

The best available research on the likely size of this benefit remains a 1999¹³ study undertaken for the UK Standing Advisory Committee on Trunk Road Appraisal (SACTRA). This study demonstrated that the wider impact for increased outputs in imperfectly competitive markets could be calculated as a function of business and freight user benefits. These user benefits can be uplifted by a factor that is itself a product of the elasticity of demand and the ratio of the price-marginal cost margin to price. For the UK it is argued that the price – marginal cost margins are approximately 20% of ‘shop’ prices and the average elasticity of demand for goods and services is 0.5. An uplift factor of 10% to business and freight user benefits is therefore applied in the UK² to capture the wider impact of increased output of firms.

More recent research for the Scottish Government identified that price – cost margins in very remote areas may be much higher than elsewhere in the UK⁹. Very remote areas are defined as locations that are more than one hours travel from a settlement of 10,000 people or more. This conclusion was based on an analysis of the supply of petrol for which a government investigation had recently been completed. As a consequence the Scottish Government use an uplift on business and freight user benefits of 20% for trips with an origin or destination in a very remote area. The limited evidence for this uplift means that the additional wider impact due to remoteness is treated as a sensitivity to the core analysis¹¹.

4.1 Recommended Appraisal Method

In the absence of specific data for Ireland it is recommended that the UK data and method is utilised. That is:

$$\text{Wider impact of increased output by firms} = 0.1 \times \text{Business and freight user benefits}$$

Business and freight user benefits are defined as the change in consumer surplus for the business and freight modes over all types of use benefit (time savings, vehicle operating cost savings, toll/fare changes, reliability benefits, etc.) Further information on the calculation of Business and Freight User Benefits is provided in PAG Unit 6.1: Guidance on Conducting CBA. It should be noted that the 0.1 multiplier should be used for all areas of Ireland.

5. Other Impacts

Other market failures that can give rise to wider impacts are also theoretically possible. From a practical perspective it is however recommended that these impacts are excluded from an appraisal. This is due to either a lack of evidence or the large resource implications needed for their appraisal – or in some instances a mixture of both. The particularly circumstances for each impact are discussed in more detail below.

Employment benefits from increased labour supply. For the same reason that employment during construction will generate a wider impact, an increase in the supply of labour will also create a positive impact – providing that labour is supplied by taking workers out of unemployment rather than through increased immigration (or the return of expatriate workers). Given that the impacts of a transport improvement on employment is in the main re-distributional, the required analysis to estimate at the Ireland level the gain in employment and the proportion of that arising to workers previously unemployed is non-trivial, whilst the benefit anticipated is likely to be small (as transport schemes do not generally have a large impact on employment at the national level). The level of resources required to estimate employment benefits from increased labour supply is therefore not proportionate to the resulting improvement in the robustness of the appraisal.

Tax benefits. Income tax creates a market failure in the labour market. A transport improvement that affects either the number of people employed in the whole economy or average earnings therefore creates an additional welfare benefit. This is equivalent to the change in income tax revenues. Specifically tax benefits will arise from:

- Increased productivity of workers due to agglomeration impacts;
- Increased supply of labour at the national level; and
- Increased average productivity of workforce due to relocation of businesses/economic activity to more productive locations.

Each of these reasons is very resource intensive in terms of their estimation. Estimating both changes in productivity due to agglomeration and increases in the supply of labour have already been discussed. Predicting where economic activity will relocate to and whether it is relocating from a low productive area to a higher productive area would require at the minimum the some form of Land Use Transport Interaction (LUTI) model². It would also require earnings data by sector at a disaggregated geographic level.

Inward investment impacts. Foreign direct investment (FDI) can have a positive impact on an economy. If transport investment can facilitate inward investment then some of the spin off benefits from the FDI can be additional to transport user benefits. One of the principal spinoff benefits are productivity spillovers arising through knowledge transfer and enhanced competition in domestic markets. FDI can also have additional welfare benefits if employment is created in areas of structural unemployment. The difficulty in including inward investment impacts in a transport appraisal has two main themes. Firstly there is little to no reliable evidence on either how transport affects inward investment or how inward investment impacts on productivity¹⁰. The second theme is that the wider impact of inward investment may be double counted in other wider impacts – most notably agglomeration impacts as confounding means the agglomeration impact measures more than just agglomeration. The impact on employment would also be addressed in the wider impact of employment benefits from increased labour supply.

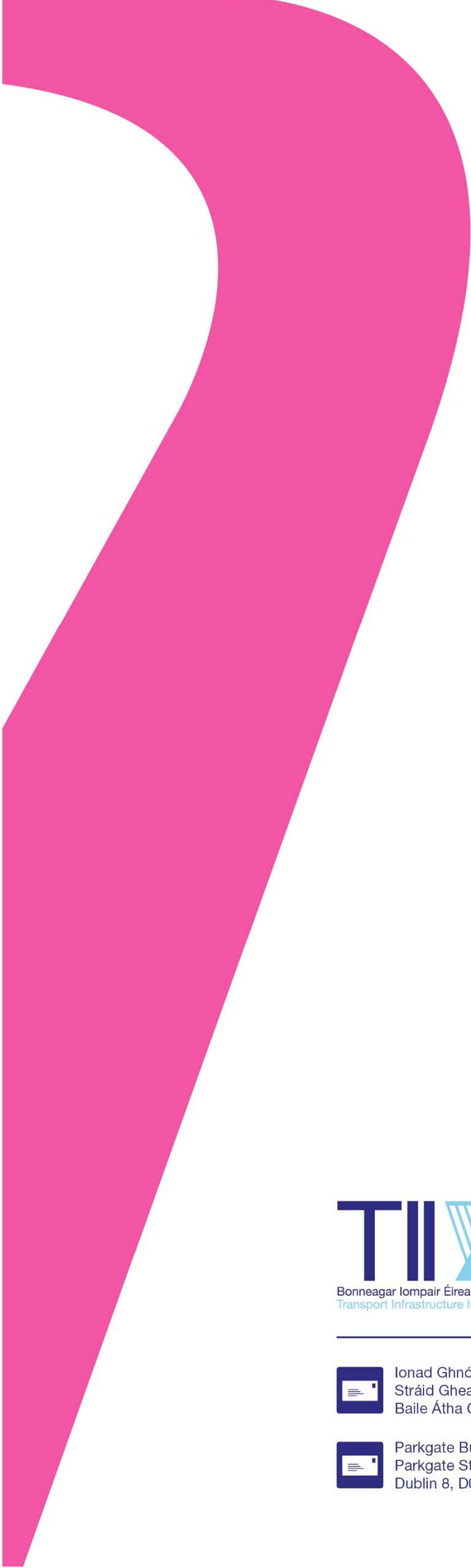
Re-organisation impacts. Reductions in transport costs can allow businesses to centralise activities at fewer sites. This is very noticeable in the freight sector, but is also evident in many other sectors. Re-organisation by businesses occurs as the transport improvement allows them to take advantage of economies of scale in production thereby increasing productivity. The presence of economies of scale is a market failure as prices will depart from marginal social cost. The most

effective way of capturing economies of scale in production in a cost benefit analysis is through the use of a spatial computable general equilibrium model. Such models however are beyond the scope of almost all transport appraisals. It is also noted that some confounding of economies of scale effects and agglomeration impacts will occur, if an attempt is made to estimate re-organisation impacts in isolation. Only the very largest projects in Ireland could possibly warrant such a research intensive approach.

Thin labour market impacts. The presence of search costs in remote and isolated labour markets leads to a market failure. Employment creation in such labour markets would therefore generate a welfare benefit additional to user benefits. To date however there is insufficient evidence on the functioning of remote labour markets in Ireland and the scale of the search costs relative to the wage. The latter is important as it determines the welfare benefit of increased employment.

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