

A5 Western Transport Corridor

Wider Economic Benefits

A technical note by Volterra Partners, October 2016

1 Introduction

- 1.1 Volterra has been commissioned by Mouchel to estimate the Wider Economic Benefits (WEBs) of the A5 Western Transport Corridor (A5WTC) scheme in Northern Ireland.
- 1.2 The A5WTC scheme will provide 85 kilometres of dual carriageway from south of Londonderry at New Buildings to the border at Aughnacloy, improving accessibility between urban centres in the west of the province and opening up regional gateways and cross border links.
- 1.3 Improvements to accessibility can increase productivity and this is measured by 'effective density', or Access to Economic Mass. The increase in output resulting from this effect is known as an agglomeration benefit. The Department for Transport's WebTAG guidance documents an approach to estimating agglomeration benefits.
- 1.4 This report summarises the approach used to estimate agglomeration benefits for the A5WTC, and the results of the analysis. It is intended to accompany Mouchel's report on the transport benefits of the scheme, which summarises the scheme and its objectives in greater detail. WEBs are entirely additional to the transport benefits of the scheme.
- 1.5 The rest of this report is structured as follows:
 - Chapter 2 provides some background on agglomeration benefits;
 - Chapter 3 summarises the approach that has been used for A5WTC;
 - Chapter 4 presents the results; and
 - Chapter 5 provides some conclusions.

2 Agglomeration benefits

- 2.1 Agglomeration benefits arise from the positive link between density and productivity. When employment clusters together, the jobs in the cluster are likely to be more productive than they otherwise would be, for a number of reasons:
- Better access to labour;
 - Increased competition between suppliers; and
 - Greater interaction between businesses spreading knowledge.
- 2.2 Transport schemes bring about increases in density by improving accessibility between areas of employment. Even if the level of employment in a particular area remains fixed, it can become effectively denser by being better connected to employment elsewhere.
- 2.3 So transport schemes bring about increases in ‘effective density’, which boosts productivity and hence leads to an increase in total output, which represents an economic benefit. This is the agglomeration benefit of the transport scheme.
- 2.4 Agglomeration is one of a set of WEBs that is acknowledged by the Department for Transport (DfT) in Unit A2.1 of its WebTAG guidance. This report focuses on the agglomeration benefit, other WEBs include:
- **Increase in output in markets with imperfect competition:** this benefit is calculated by adding a value worth 10% of the time savings to business users from the conventional transport appraisal, and has been estimated by Mouchel; and
 - **Move to More or Less Productive Jobs (M2MPJ):** whereas the agglomeration benefit is undertaken on the basis of a static appraisal, with fixed land use, the M2MPJ accounts for changes to the distribution of employment. However, the DfT says that this impact can only be valued if a Land Use-Transport Interaction model is used, and even then it can only be included as a sensitivity test.
- 2.5 An assessment of the agglomeration benefits for A5WTC was last made in 2009¹. This suggested that the value of the agglomeration benefit was £103.1m, as a Present Value in 2002 prices and values. The DfT guidance on wider economic impacts (WEIs) has changed since then, hence the requirement for this updated assessment.
- 2.6 The next chapter outlines the method that has been used to estimate the agglomeration benefits of the A5WTC scheme.

¹ ECOTEC (2009), *A5 Western Transport Corridor: Macro-Economic Study*, Report for Mouchel.

3 Method

Effective density

- 3.1 The first step to estimate agglomeration benefits is to estimate the change to effective density resulting from the scheme.
- 3.2 Effective density is determined by the level of accessibility and employment. For accessibility, matrices of generalised costs were provided by Mouchel between each of the 525 zones in the transport model used, for the Do Minimum and Do Something scenarios. The generalised cost (GC) matrices for the morning peak, inter peak and evening peak periods in 2028 (the first year in the appraisal period) and 2041 (model horizon year) were used in the analysis.
- 3.3 The generalised costs that were provided were weighted across business and commuter user classes. These were then weighted across the three time periods to obtain a single weighted GC matrix for each scenario and year.
- 3.4 Mouchel also provided employment by zone for the base year, 2011. In order to scale up employment to 2028 and 2041, the following was applied:
- For zones within Northern Ireland, Mouchel provided employment forecasts by district from Oxford Economics, and a correspondence file showing which zones are in which districts. Each zone then had an employment growth rate applied to it in line with the forecast for the district that it is located in; and
 - For zones within the Republic of Ireland, the annualised employment growth rate between 2011 and 2028 was calculated from labour force projections by the Central Statistics Office. This was then applied to all zones within the Republic of Ireland.²
- 3.5 Effective densities for 2028 and 2041 was then calculated using the standard formula from WebTAG, which is as follows (Paragraph 3.20 describes how effective densities for these two years were used to calculate the agglomeration benefit over the 60 year appraisal period):

$$ED_i = \sum_j \frac{E_j}{(g_{i,j})^\alpha}$$

- 3.6 Where:
- ED_i = effective density of zone i ;
 - E_j = Employment in area j ;
 - $(g_{i,j})$ = average generalised cost of travel between zones i and j ; and
 - α = a distance decay parameter, which reflects the fact that agglomeration benefits diminish with distance – so places that are close together influence each other's effective density more than places that are far away from each other.
- 3.7 The WebTAG guidance is that effective densities should be estimated by sector for four types of employment:

² Central Statistics Office (2016), *Population and Labour Force Projections*, CSO

- Construction;
- Manufacturing;
- Consumer services; and
- Producer services.

3.8 For schemes in England, the level of employment in each sector by district is provided in the WebTAG data book. However, Northern Ireland is not included in the data set. Instead, the split of employment was obtained from the Business Register and Employment Survey.³

3.9 WebTAG indicates that agglomeration benefits should only be calculated for the four sectors quoted. As shown by 'Other sectors' in Table 1, 40% of Northern Ireland's employment does not fall within the four broad industrial sectors defined by WebTAG hence this employment is excluded from the agglomeration calculations. This is similar to the figure for England which is 38%.⁴ Based on WebTAG's sectoral aggregation, 'Other sectors' captures the following sectors:

- Agriculture, forestry and fishing;
- Mining and quarrying;
- Public administration and defence; compulsory social security;
- Education;
- Human health and social work activities;
- Arts, entertainment and recreation; and
- Other service activities.

3.10 Nearly 90% of the employment captured within 'Other sectors' in Northern Ireland is within the following three sectors: public admin and defence; education; and human health and social work.

3.11 The WebTAG guidance provides a value of α , the distance decay parameter, for each sector. The employment split by sector for Northern Ireland was used to obtain a single weighted average decay parameter. To do this, the distance decay parameters in Table 1 were weighted by the employment split in Northern Ireland to get a weighted average distance decay parameter. 'Other sectors' were excluded from this calculation as this employment is not included within the effective density calculation.

Table 1: Distance decay parameters

Sector	Employment split in N Ireland	Distance decay parameter
Manufacturing	12%	1.097
Construction	4%	1.562
Consumer services	27%	1.818
Producer services	16%	1.746
Other sectors	40%	N/A
Weighted average	-	1.637

Source: WebTAG Unit A2.1, Volterra calculations (figures are rounded)

³ Department for the Economy (2016), *Business Register and Employment Survey*

⁴ Department for Transport (2013), *Wider Impacts Dataset*

- 3.12 Effective densities by model zone for the Do Minimum and Do Something scenarios in 2028 and 2041 were then calculated using the equation presented above. In other words, employment by destination zone (taking account of WebTAG’s four industrial sectors) was divided by the GC of travel between each origin and destination zone pairing to the power of the weighted distance decay parameter.

Productivity

- 3.13 The other key component of the agglomeration calculation is the base level of productivity. Changes in effective density translate into changes in productivity, so the base level of output per worker is required.
- 3.14 For schemes in England, WebTAG provides data on productivity by sector and district. However, this information is not provided for Northern Ireland.
- 3.15 Instead, data on Gross Value Added (GVA) per filled job at NUTS3 level was obtained for Northern Ireland, which was then disaggregated by sector using earnings differentials between the four broad sectors, as shown in Table 2. Each zone in Northern Ireland in the transport model was matched with its corresponding NUTS3 area using geographic information system analysis, and assigned a base level of productivity using the data for that NUTS3 area.

Table 2: NUTS3 GVA per filled job (£, 2014), Northern Ireland

NUTS3 region	Manufacturing	Construction	Consumer services	Producer services	Average
Belfast	52,400	49,900	32,800	47,700	45,600
Outer Belfast	50,500	48,100	31,600	45,900	43,900
East of Northern Ireland	52,200	49,700	32,700	47,500	45,400
North of Northern Ireland	45,200	43,000	28,300	41,100	39,300
West and South of Northern Ireland	45,600	43,400	28,500	41,500	39,600
Northern Ireland overall	49,600	47,300	31,000	45,100	43,100

Source: Office for National Statistics

- 3.16 For the Republic of Ireland, directly comparable data was not available. However, Eurostat publishes data on Gross Domestic Product (GDP) per inhabitant for NUTS3 regions across Europe. In order to obtain a value of GVA per filled job for NUTS3 regions in the Republic of Ireland, the following process was used:
- Calculate the ratio between GDP per inhabitant for Republic of Ireland and Northern Ireland, which is 1.69;
 - Estimate GVA per filled job for Republic of Ireland by applying that ratio to the GVA per filled job in Northern Ireland; and
 - Estimate GVA per filled job for each NUTS3 region in the Republic of Ireland by scaling the estimated Republic of Ireland GVA per filled job by the ratio between that NUTS3 region and the Republic of Ireland overall, from the Eurostat GDP per inhabitant data.

- 3.17 The resulting productivities for the Republic of Ireland are as shown in Table 3. Each zone in the Republic of Ireland in the model was then assigned a base productivity in the same way as the zones for Northern Ireland.

Table 3: NUTS3 GVA per filled job (£, 2014), Republic of Ireland

NUTS3 region	Average
Border	42,095
Midland	44,354
West	58,728
Dublin	110,475
Mid-East	49,488
Mid-West	62,219
South-East	48,872
South-West	89,735
Republic of Ireland overall	72,897

Source: Eurostat, Volterra calculations

Elasticity

- 3.18 In order to translate changes to effective density into changes to productivity, an agglomeration elasticity is required. This varies by sector; the values are provided in WebTAG.
- 3.19 As with the distance decay function, a weighted average elasticity was estimated. The elasticities by sector are shown in Table 4.

Table 4: Agglomeration elasticity

Sector	Agglomeration elasticity
Manufacturing	0.021
Construction	0.034
Consumer services	0.024
Producer services	0.083
Weighted average	0.040

Source: WebTAG, Volterra calculations

- 3.20 The agglomeration elasticity determines the extent to which productivity changes as a result of changes to effective density. So for instance, the agglomeration elasticity for construction is 0.034. This means that if the effective density of construction increases by 10%, then construction productivity will increase by $((1+10\%)^{0.034}) - 1 = 0.32\%$.

Agglomeration benefit

- 3.21 With all the parameters and data as described above in place, the total agglomeration benefit is then estimated as follows:
- Estimate the percentage change to generalised cost between the Do Minimum and Do Something scenarios, by zone;

- Use the agglomeration elasticity to convert the changes in effective density into a percentage change to average productivity;
- Uplift the 2014 GVA per filled job to 2028 and 2041 values using a real productivity growth rate⁵;
- Apply the productivity uplift to the base productivity to estimate the absolute uplift to productivity in each zone;
- Multiply the increase in productivity by the number of construction, manufacturing, consumer services and producer services workers in each zone, and thus estimate the total increase in output by zone; and
- Sum the results across all zones to obtain the agglomeration benefit for that year.

⁵ For Northern Ireland, real productivity is assumed to grow by 0.97% per year; for Republic of Ireland the assumed growth rate is 0.55%. These growth rates are derived by obtaining historic growth in GVA per person from the ONS / CSO respectively (from 1997 to 2014 for NI, and 2000-2013 for ROI), and adjusting for growth in consumer price inflation.

4 Results

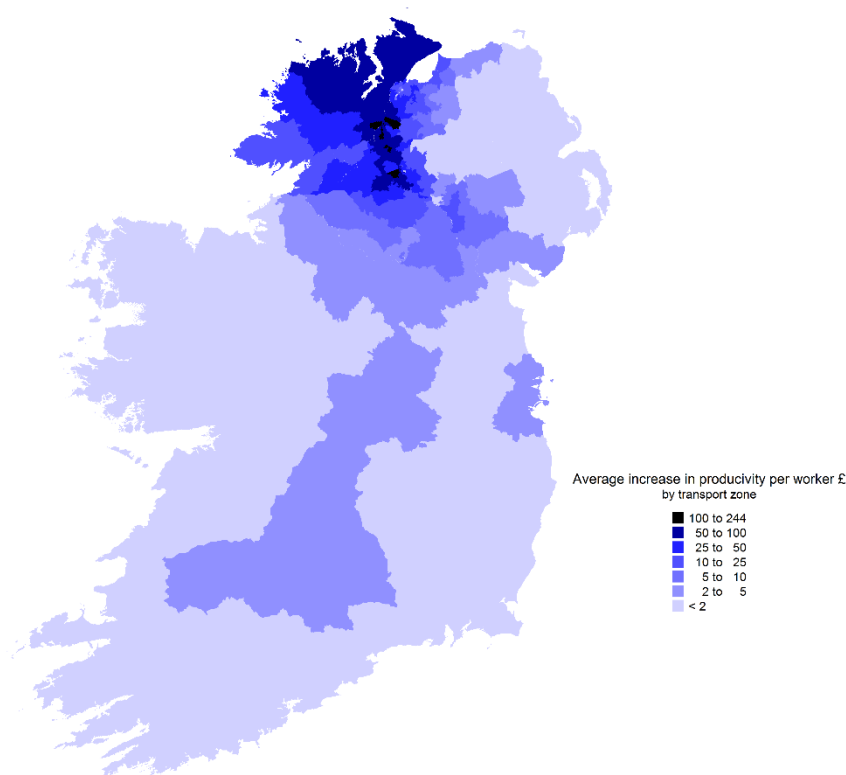
- 4.1 The process summarised in chapter 3 was applied for 2028 and 2041. The benefit for years in between 2028 and 2041 was obtained by interpolating the results for those two years. Beyond 2041, the only change to the annual benefit comes from the assumed real productivity growth rate.
- 4.2 A stream of benefits over 60 years (2028-2087) was estimated, and converted into a Present Value by using discount rates from WebTAG, discounting back to a base year of 2010.
- 4.3 Table 5 shows the results for the two modelled years and the overall benefit for the 60 year appraisal period.

Table 5: Agglomeration benefits of A5WTC scheme

	Benefit (£m)
Benefit in 2028, undiscounted	5.3
Benefit in 2041, undiscounted	7.7
Benefit over 60 year appraisal period, PV	112.2

- 4.4 The results suggest that the value of the agglomeration benefit of the scheme is just over £110m, which is similar to the result from the previous assessment.
- 4.5 Figure 1 maps the average agglomeration benefit per worker for each transport zone. This illustrates that the largest benefits accrue along the corridor that the route serves. This is because locations within closer proximity to the scheme benefit from larger increases in effective density.

Figure 1: Average agglomeration benefit per worker by transport zone, 2028



Sensitivity tests

4.6 The table below shows the results of a number of sensitivity tests. These are as follows:

- **30 year appraisal period:** this shows the impact of only including 30 years of benefits, as opposed to the 60 years that is assumed for the base case;
- **No productivity growth:** this shows the impact of assuming that there is no real productivity growth throughout the course of the appraisal;
- **Higher productivity growth:** this sensitivity test assumes that real productivity growth is 1.5% a year in Northern Ireland and the Republic of Ireland, higher than the base assumptions;
- **Functional Urban Regions (FURs):** In the UK guidance, agglomeration benefits are generally applied to areas that are defined by the DfT as being FURs, with a correspondence file showing which wards are part of a core FUR or hinterland to a FUR. However, this information on FURs is only available for England, not Northern Ireland. In addition, the WebTAG guidance says that:

“The map of FURs should be used only as a guide to where agglomeration impacts are likely to be significant. If an investment or scheme does not fall within a FUR, but it is believed that agglomeration impacts may still be significant, for example because it is expected to result in a significant change in average generalised costs, agglomeration impacts should be assessed”.

Agglomeration benefits for A5WTC have been estimated on that basis. However, this sensitivity test shows the value if only the benefit accruing to particular

areas is included. This has been selected on the basis of a zones employment density: all zones that have employment densities within the bottom 30% of all zones have been excluded from the analysis for the purposes of this sensitivity test.

Table 6: Results of sensitivity tests (£m)

	Base	30 year appraisal	Zero productivity growth	Higher productivity growth	FURs only
Northern Ireland	47.5	30.2	33.1	58.2	39.6
Republic of Ireland	64.7	42.9	52.9	92.9	46.6
Total	112.2	73.1	86.0	151.1	86.2

- 4.7 The sensitivity tests show that, even if it is conservatively assumed that there is no productivity growth at all throughout the appraisal period, the agglomeration benefit would still be over £85m.

Northern Ireland and Republic of Ireland

- 4.8 As shown in Table 6, the total agglomeration benefit that accrues to the Republic of Ireland is higher than that for Northern Ireland (42% to Northern Ireland compared with 58% to the Republic of Ireland). Given that the scheme is located in Northern Ireland and the majority of trips that benefit from the scheme are within Northern Ireland, this may seem counterintuitive.
- 4.9 However, the agglomeration benefit is not dependent on the number of trips – it is dependent on changes to accessibility and how that translates into changes to productivity via variations in effective density. Even though improvements to journey times as a result of the scheme are higher in Northern Ireland, there is still an impact, albeit a small one, for locations in the Republic of Ireland.
- 4.10 As shown in Figure 1, the total agglomeration benefit per worker is much higher in the north of Ireland (i.e. Northern Ireland and County Donegal in the Republic of Ireland) than elsewhere. This is summarised in Table 7.

Table 7: Summary of average agglomeration benefit per worker (£)

	2028	2041
Northern Ireland & Donegal	7.40	10.95
Rest of Republic of Ireland	1.60	1.95

- 4.11 By 2041, the benefit per worker in Northern Ireland and Donegal is over 5.5 times as high as the benefit per worker in the rest of the Republic of Ireland. Republic of Ireland takes such a high share of the total benefit because:
- Donegal has a large increase in output per worker, and is in the Republic of Ireland;

- The base level of productivity is higher in the Republic of Ireland, which means the same increase in effective density has a higher impact on the benefit per worker than in Northern Ireland, all else being equal; and
- The level of employment is higher in the Republic of Ireland (as of 2041, applying the assumed employment growth leads to employment of 470,000 in Northern Ireland and 1.1m in the Republic of Ireland) – so a smaller benefit per worker is nonetheless being applied to many more workers.

4.12 Over 50% of the total benefit to the Republic of Ireland accrues to Donegal – if the Donegal benefit is added to the Northern Ireland benefit, the split of total agglomeration benefit is 72% to Northern Ireland and 28% to the Republic of Ireland (minus Donegal).

5 Conclusions

- 5.1 This note summarises the agglomeration benefits of the A5 Western Transport Corridor (A5WTC) scheme in Northern Ireland. Agglomeration benefits are additional to the conventional transport benefits of a scheme and reflect the increase in productivity that is brought about by improvements to accessibility.
- 5.2 An approach consistent with the DfT's WebTAG guidance has been applied, supplemented by a set of assumptions in areas where WebTAG does not cover Ireland.
- 5.3 This suggests that the total agglomeration benefit of the scheme, as a Present Value over a 60 year appraisal period, is £112.2m. This is broadly consistent with a previous estimate of the agglomeration benefit that was made in 2009.
- 5.4 A map of the average benefit per worker shows that the highest increases are concentrated around the location of the scheme itself (Figure 1), although benefits do also accrue to other parts of Ireland. In the base case, a higher proportion of benefits accrue to the Republic of Ireland, although this is partly because County Donegal directly benefits from the scheme. If the benefit to County Donegal is added to the benefit to Northern Ireland, then 72% of the benefit accrues to this combined area.

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