Using the impacts of active traffic management rollout project to discuss wider economic benefits in transport appraisal

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1 INTRODUCTION

Traditionally, the benefits of transport schemes have been assessed on the basis of benefits from travel-time savings and fuel cost savings generated by the schemes. Dependent on the scheme itself, the majority of such benefits tend to relate to travel time changes accruing to users themselves or to others through decongestion elsewhere in the system (e.g. resulting from a modal shift from congested roads towards public transport). Increasingly, driven by the Department of Transport's New Approach to Transport Appraisal, other scheme impacts are incorporated in the appraisal framework, although most of these (such as Environment and Accessibility) can only be quantified, and not monetised.

However, it is argued (SACTRA, 1999) that transport schemes generate significant additional wider economic benefits, and are not accounted for in the current economic assessment methodology. Until recently these wider economic benefits have been unaccounted for in the analysis of schemes in the absence of available guidance and methodology.

In 2005, the Department of Transport (DfT, 2005) provided a methodology to include in the appraisal of transport schemes the wider economic benefits, including impacts on GDP. Some authors have claimed that these are additional benefits to traditional travel time benefits; in our view a more appropriate interpretation is that the methodology enables more impacts to be assessed (in other words, the boundaries of the system under analysis have been widened). It is possible for these additional impacts to be negative, i.e. to deliver disbenefits.

This paper uses the rollout of Active Traffic Management (ATM) across the West Midlands (U.K.) motorway box as a case study to compare conventional benefits and wider economic benefits in transport appraisal, and addresses the question whether or not these indirect impacts should be brought into transport scheme appraisals, and how this could be done.

1.1. Structure of this paper

In the next section of the paper we set out briefly the background of the Wider Economic Benefits (WEBs), and the concepts behind it. This section, and some of the discussion in the paper refers to the work presented at the Sixth Transport Practitioners Meeting (Kohli, S. et. al., 2008)

In secton 3, we give an overview of the transport model used for this study, as well as discuss the scheme being analysed as part of the study.

Section 4 discusses this further, focussing on the underlying calculation and assumptions.

In section 5 discusses the results from this study, along with key messages.

2 BACKGROUND TO WIDER ECONOMIC ANALYSIS

Essentially, the WEBs are benefits that are from accessibility improvements in the transport markets and accrue in form of productivity gains due to agglomeration effects, increased outputs in markets with imperfect competition and improvements in labour supply. Note all these benefits are assumed to accrue to *transport-using markets* and are additional to the benefits in the *transport markets* which are captured in conventional appraisals (DfT, 2005). Each of these benefits is explained in more detail below.

Agglomeration benefits: These benefits are an outcome of firms, workers and suppliers forming geographical clusters by being more closely located together. It has been observed that by being closely located many firms tend to be more productive (Graham, 2005, 2006). The reasons of co-location range from availability of workers and suppliers to knowledge and information sharing. This is the basis of the formation of cities and clusters of specific types of employment.

It is not so much the geographical location of the firms but their proximity to each other in transport terms that results in these benefits being realised. The term commonly used to define proximity of an area to other employment locations is *effective density* which is calculated as the weighted average of employments in surrounding areas with weights being the inverse[2] of travel costs. The theory is that the higher the effective density of an area gets the more productive the firms and workers in the area become. Hence any transport improvements that result in travel cost reductions will thereby increase accessibility and the effective density of the area they impact on. This would in turn result in productivity benefits to firms that are located in that area which can be calculated. These benefits are known as the agglomeration benefits. There could be second order impacts of firms relocating from other areas to this area with possible net positive or negative results.

Increased output from markets with imperfect competition: A reduction in transport costs as a result of improved transport links could generate *increased competition* in some sectors of the economy, especially in cases where transport costs are seen as a significant barrier for competition. However in developed

economies like the U.K., with fairly well connected infrastructure, this impact is considered to be negligible as a result of most transport schemes or policies aside from exceptional circumstances. However it is recognised that imperfect competition does exist in several transport using markets. The economic theory is that if imperfection in competition exists in a market then the value placed on additional production is higher than the cost of producing the good. This is known as the price-cost margin. Hence as a consequence of a transport scheme which causes a reduction of production costs through business and freight time savings, it is expected that there will be increased production. For example, a delivery company being able make more deliveries as a result of time savings made on each trip. The value of the additional goods produced over and above the cost of producing it would depend upon the price-cost margin of the good and are classified as the wider welfare benefits received as a result of increased outputs from a market with imperfect competition. This benefit can be calculated as the business time savings multiplied by an uprate factor (the price-cost margin) suggested by DfT as 0.1.

Labour supply impacts: Improvements in the transport network can have impacts on the labour markets through:

- More people joining the work force: In cases where commuting travel cost reductions result in more people deciding to work, there are productivity benefits that accrue to the country's GDP;
- People working longer: If the reduction in commuting time results in people deciding to work longer hours, this is also included as a productivity gain for a country's GDP. However in most cases this impact is considered to be negligible.
- People shifting to more productive jobs: This effect relates to a relocation of jobs into areas where people are more productive. This mainly implies an inward movement of jobs where transport accessibility is higher and therefore transport costs are lower.

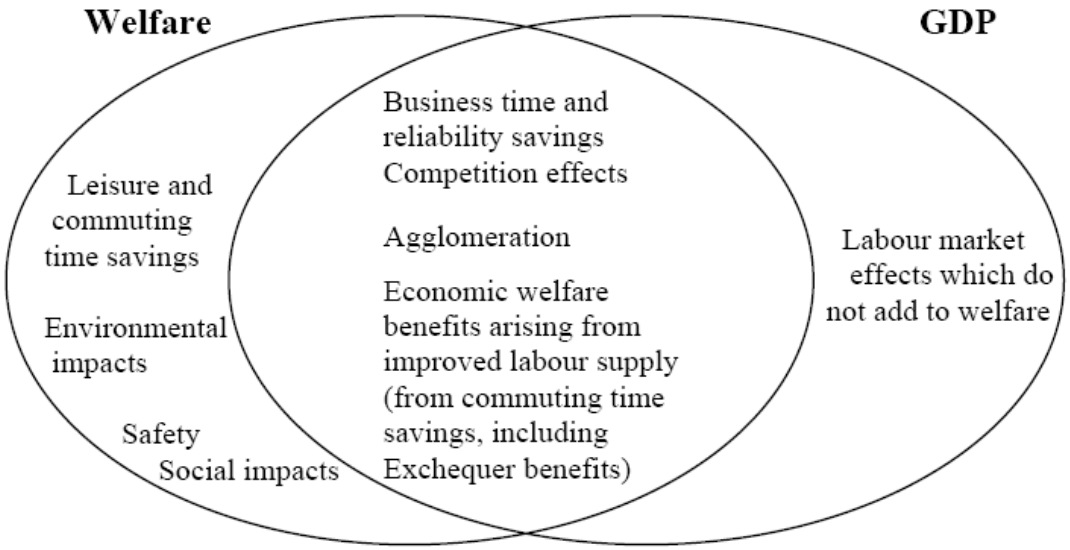
It is important to note that a proportion of these labour market effects, which accrue to the GDP, also benefit the exchequer through tax consequence. More simply, more people working, people working longer hours or people shifting to more productive jobs result in more tax paid to the exchequer which is considered as an additional welfare benefit.

2.1 Overlaps between welfare and GDP benefits and additionality to the conventional benefits

An important issue to consider in the presentation of wider economic benefits is to distinguish the benefits which are welfare benefits and those which are purely GDP (or productivity) benefits. Welfare benefits are classified as the overall gains to the society. GDP benefits are more focused on the direct benefits to a country's financial system. In some cases there are clear overlaps between some of the welfare benefits and GDP benefits and in other cases welfare benefits are distinct from GDP benefits. DfT's guidance (DfT, 2005) gives a clear indication on

what benefits can be classified as welfare and GDP benefits in a form of a Venn diagram shown below:

Figure 1: Overlaps between welfare and GDP benefits



Source: Dft, 2005

In conventional appraisal it is the welfare benefits (economy, safety, environmental etc.) that are evaluated. Hence it is important to only include the wider economic benefits that accrue to the welfare of society as additional to conventional appraisal. It is useful to quantify the GDP effects in any wider economic benefit appraisal; however, care must be taken not to consider them as additional over and above all the welfare benefits.

3 PRISM

For the purpose of this paper, the wider economic analysis is discussed using PRISM. Before proceeding further with the discussion on the implementation, it is necessary to describe what constitutes the model.

PRISM (Policy Responsive Integrated Strategy Model) for the West Midlands has been developed by Mott MacDonald and RAND Europe as a new strategic transport model, supported by the 7 district authorities, the Highways Agency and CENTRO. The model is a state of the art disaggregate demand model, with significant detail in zoning and networks.

It covers the West Midlands metropolitan area in about 600 zones, with a detailed network description of the highway and public transport networks. The model represents in a detailed manner the following travel responses to congestion, investment and policy:

- change in trip making;

- change of destination;
- change in mode;
- change in time of travel; and
- change in route.

It is important to note here that PRISM does not comprise of a land use response model that interacts with the transport model. Therefore PRISM cannot predict the changes in the land use patterns such as employment and household location due to the changes in the transport infrastructure. Land use inputs are fixed exogenous inputs in the model. This issue is significant from the point of view of the Wider Economic Benefit analysis, and is dealt with later on in the paper.

The model is a disaggregate travel demand model, based on principles applied previously in cities such as Paris, Copenhagen and Sydney. The key difference with traditional modelling techniques is that PRISM takes the individual traveller as the decision maker, rather than relying on zonal proxies. The main advantage of this approach is that the model is more reliable and robust.

Because of the detail in the representation of population, the model can forecast the impacts of socio-economic and demographic developments on travel patterns, and distinguish the impacts of policies on different social groups.

The model covers the whole West Midlands region in varying detail:

- The West Midland (WM) metropolitan area covering the 7 local authorities (Birmingham, Coventry, Dudley, Sandwell, Solihull, Walsall, Wolverhampton); on average 3 zones per ward (5 zones per ward in centres);
- A travel to work area of around 20 km around the metropolitan area, with around 1 zone per ward, called the intermediate area;
- The rest of the WM region and external (UK zones), with zoning roughly at District level and further away at wider area level;

The demand response model operates on households and workers residing in the core (WM metropolitan) and intermediate areas. The network model covers the core area in high-level detail including junction modelling and the intermediate area as a link-based network. The base year of the model is 2001 when all the surveys were carried out on which the model is based. Recently the model has been validated to 2006For further information please refer to model development, structure, calibration, validation etc. reports which are available on www.prism-wm.com.

3.1 ATM Scheme Tested

The following description of the M42 ATM scheme has been extracted from the Highway Agency's website.

(Source: http://www.highways.gov.uk/roads/projects/4698.aspx)

“The Active Traffic Management pilot brings together a number of motorway technologies to demonstrate how they can be used together to maximise their benefits.

Building on best practice and experience from the UK and around the world, Active Traffic Management combines existing, tried and tested technology, infrastructure and procedures with new and innovative ideas. Together, these make the best use of the existing road space, providing additional capacity for vehicles, with the aim of reducing congestion. This may reduce the need for motorway widening.

Active Traffic Management can be thought of as a 'tool-box' of technologies and procedures, which can be used on their own, or together, to provide solutions to specific problems.

Active Traffic Management is a pro-active approach to the management of traffic, and will allow us to better fulfil the Highways Agency's role as Network Operator by:

- Providing targeted solutions to specific problems
- Providing additional capacity for vehicles
- Piloting new and innovative concepts
- Helping to alleviate congestion
- Improving the detection of incidents
- Improving the response to incidents
- Reducing delays caused by incidents or congestion”

The scheme being tested as part of the Do Something scenario in this study is expected to have the above features, similar to the section J3a to J7 on the M42 which is assumed to be implemented in the Do Minimum case.”

In 2007, the Highways Agency (HA) commissioned Mott MacDonald to undertake an economic analysis of Phase 1 and 2 extension of ATM for the West Midlands motorway box to support the business case of the scheme. As part of this analysis, Do Minimum and Do Something schemes were assessed for 2011 and 2021. The Do Minimum network consisted of the committed or provisionally committed schemes for the region since 2001. The Do Something option included the Do Minimum network changes, along with ATM (increased capacity and lower speed limit) and controlled motorway (CM) (lower speed limit only) for sections in the West Midlands motorway box, up to M6 Junction 10a during the AM (0700-0930) and PM (1530-1900) periods. An assumption was made for the increased capacity, that hard shoulder running increases the capacity on the affected part of the network from 5700 vehicles/hour/direction to 7030 vehicles/hour/direction. The speed limit in both these cases is 60mph.

Note that the M42 ATM scheme, which was a pilot scheme, is implemented in the Do Minimum scenario itself; hence the scheme extends the ATM to the remainder of Motorway as illustrated below.

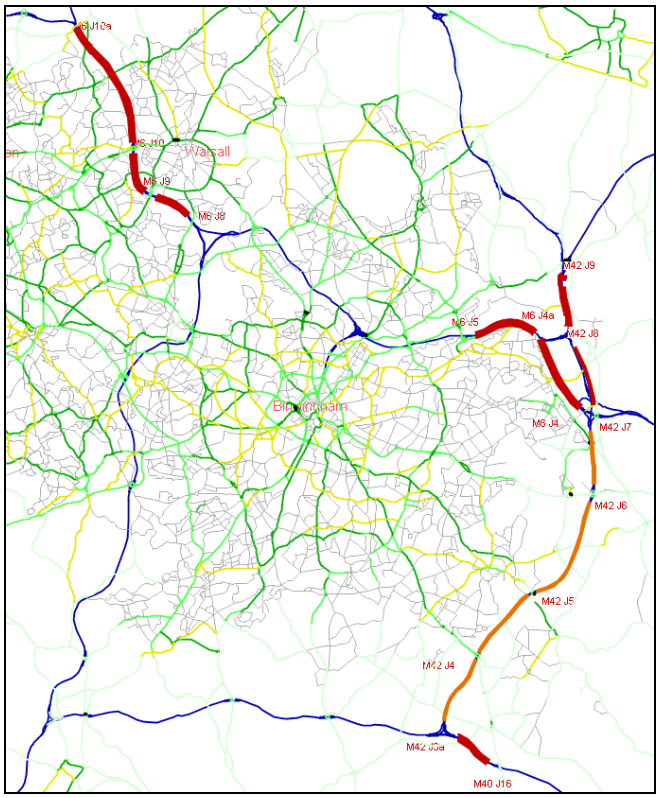
The following list (**Table 3.1**) shows the proposed schemes of operation between and at different junctions on the WM motorway box:

Table 3.1: Proposed ATM/CM schemes around the WM Motorway Box

Section	Proposed Scheme
M40 (J16 – M42)	CM
M40 (M42 – J16)	Do Nothing
M42 (J7-9)	CM
M42 (J9-7)	CM
M6 (J4a-5)	ATM
M6 (J5-4a)	ATM
M6 (J4-4a)	ATM
M6(J4a-4)	CM
M6 (J8W-10a)	ATM
M6(J10a-J8W)	ATM

Figure 3.1 shows the extent of the scheme that is to be tested. Note that M42 (J3a to J7) is assumed to have ATM in both the Do Minimum and Do Something scenarios. The speed limit for this part of ATM is however lower at 50mph.

Figure 3.1: WM Motorway Box ATM Rollout Test: Scheme Expanse



The forecast years modelled in the ATM study were 2011 and 2021, for Do Minimum and Do Something scenarios. 2011 was considered to be the opening year of the Phase I and II ATM rollout scheme with 2021 as the second forecast year. For modelling purposes, the ATM scheme is assumed to be operational in the AM and PM peak periods only.

4 CALCULATION OF WIDER ECONOMIC BENEFITS

This calculation methodology outlined here is based on the suggested methodology in the DfT publication (DfT, 2005). The following chapter derives heavily from this and is referred to as the DfT publication in the sections below. The key wider economic benefits that have been calculated are:

Impacts on welfare:

- **Agglomeration benefits (WB1)**: Includes productivity benefits that firms gain from being located in close proximity to each other. The calculation methodology is described in **Section 4.1**.
- **Increased output in imperfectly-competitive markets (WB3)**: The welfare gain due to transport impacts on output in imperfectly competitive markets is calculated by applying an "uprate factor" (0.1 as advised in the DfT publication) to the business time benefits and the reliability gains. The results are discussed in **Section 5**.
- **Improved labour supply (WB4):** Impacts of transport improvements on labour supply have been calculated to account for how much benefit the transport interventions facilitate by more people being employed (**GP1**), people working more hours (**GP2**) and people moving to more productive jobs (**GP3**). These GDP effects are described below. The DfT publication suggests the following equation for the calculation:

  $$WB4 = 0.4 \times GP1 + 0.3 \times (GP2 + GP3)$$

  The results are discussed in **Section 5**.

Impacts on GDP:

- **More people working (GP1)**: With improved transport connectivity the generalised cost of travel is reduced and this can be translated in a change in effective wages for workers. This calculation is based on the change in the travel costs and the number of people commuting from their home zone to work zone. This is described in **Section 4.2**.
- **People working longer hours in the same job (GP2):** As per the advice of the DfT publication this effect is considered to be zero.
- **People working in more productive jobs (GP3):** This effect relates to relocation of jobs into areas where people are more productive. This mainly implies inward movement of jobs where transport accessibility is higher and therefore transport costs are lower. The calculation methodology used is described in **Section 4.3**

PRISM models the entire West Midlands region with very high network and zoning detail. The key focus is on the West Midlands metropolitan area, covering Birmingham, Coventry, Dudley, Sandwell, Solihull, Walsall and Wolverhampton, which is modelled with 578 zones. There are 286 zones in the model that cover the shires of the West Midlands i.e. Shropshire, Staffordshire, Warwickshire, and Worcestershire. The rest of the country is represented by 34 external zones. All the calculations of the wider economic benefits have been restricted to the 864 zones (578 metropolitan + 286 shire zones) of the WM region only, as these forms the core study area of PRISM where demand responses are explicitly modelled. The travel cost and accessibility effects are precisely and robustly estimated for the WM region only.

4.1 Agglomeration benefits (WB1)

4.1.1 Employment Density

The agglomeration benefits have been calculated using the equation as suggested by the DfT publication. The process of calculation involves determining the employment density of zones in the study area using the following equation:

$$Ed_{j,t} = \sum_{k} E_{k,t} \times T_{jk,t}^{\alpha}$$

where: $Ed_{j,t}$:Employment density of in zone j in year t;

$E_{k,t}$:Work place based employment in zone k in year t;

$T_{jk,t}$: Generalised cost of travel between zone j and zone k in year t; and

α: Factor specified by DfT (assumed to be -1 for current study) [2]

The generalised cost (**GC**) of travel for each Origin-Destination (O-D) pair is calculated differently for highway and public transport trips using the following equations:

$$GC^{Highway}{}_{ij} = VOT \times (TravelTime_{ij}) + VOC \times (Dist_{ij})$$

$$GC^{PT}{}_{ij} = VOT \times (In-VehicleTme_{ij} + 2*(WalkTime_{ij} + WaitTime_{ij})) + Fare_{ij}$$

Where VOT and VOC are calculated using the same methodology as suggested in the conventional benefits calculation methodology guidance (WebTAG 3.5.6, 2004). As the VOT and VOC values differ for business and non-business (commuter and leisure) users, there are different generalised cost values calculated for each O-D pair for business and non-business users.

The highway and PT generalised cost of travel are then weighted by the trips made by each mode for commute and business purposes to give a single average weighted generalised cost of travel for each O-D pair. For business users, only car business user costs are included in the calculation of the generalised cost. Freight user costs are excluded in the current calculations as in the model, freight responses are limited to route choice changes only and they do not respond to any accessibility changes in different parts of the model area.

Assumption The model does not calculate any cost for intra-zonal trips. The intra-zonal travel cost is assumed to be half the minimum of the travel cost from a zone to any other zone.

The employment density for each zone is then calculated using the employment information available for the Do Minimum and Do Something scenarios. The methodology used to calculate the change in employment in the Do Something scenario from the Do Minimum scenario is described below in **Section 4.1.2**.

Assumption: The employment density calculation excludes any external zones in the model primarily due to the following two reasons:

- PRISM does not model the travel cost precisely for movements external to the WM region; and
- Employment forecasts for the modelled years for the external zones are not readily available.

This assumption does restrict the calculation of the agglomeration benefits to the West Midlands only but allows the impact of the scheme to be analysed more precisely without getting lost in the “noise” of the external zones. External zones are extremely large in their employment and therefore could have significant impacts on employment densities of the internal zones. With imprecise estimates of the travel costs to and from the external zones, the inclusion of the external zones in the agglomeration calculation could hide the benefits being generated within the West Midlands itself.

The calculation of employment density is carried out for each of the 4 modelled scenarios i.e.:

- 2011 Do Minimum;
- 2011 Do Something;
- 2021 Do Minimum; and
- 2021 Do Something.

For each of the intermediate years the employment density is profiled to vary linearly from 2011 to 2021 separately for the Do Minimum scenario and the Do Something scenario. The 2011 and 2021 estimates for each of the scenarios are used as the controls for this calculation.

4.1.2 Employment Change

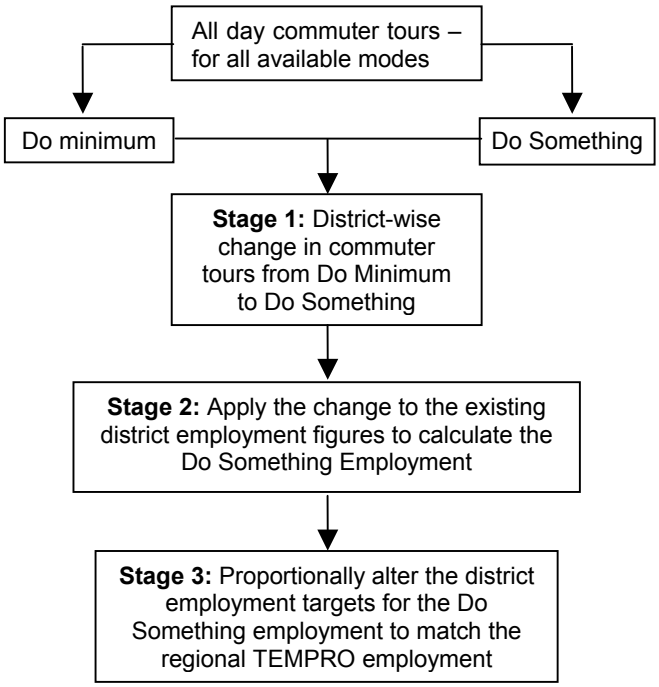
PRISM utilises employment information of each zone for its car-ownership and mode-destination choice models. The employment inputs that have been used in this study are based on the employment forecasts available for the 2011 and 2021 future years which themselves are based on DfT's TEMPRO forecasts of employment growth in the West Midlands.

An essential element in the calculation of wider economic benefits is the prediction of the change in employment in the study area due to the implementation of the proposed schemes and/or policies. Since PRISM does not have a land use-transport interaction capability these employment change impacts of schemes/policies must be determined externally and input into the Do Something scenario employment forecasts. These forecast employment changes are then used in the wider economic benefit calculations.

To calculate the employment changes due to the WM Motorway Box ATM scheme, the total *all day commuter tours* outputs by the model for the Do Minimum and the Do Something scenarios are compared. Commuter tours for each scenario are obtained from the outputs generated by the home-based work travel demand model component of PRISM. A change in commuter tours to an area occurs due to the change in accessibility of the area through the implementation of the ATM scheme. As the total households are assumed to be fixed in the planning data input used for Do Minimum and Do Something model runs, any change in commuter tours between the two scenarios is a result of change in accessibility to employment centres. These accessibility changes themselves are assumed to lead to more (or less) people being attracted to work in different parts of the study area. The assumption here is that the changes in commuter trip-ends, affected by destination changes in response to accessibility improvements, are a good proxy for changes in employment between the Do Minimum and Do Something scenario.

The methodology used to calculate the change in employment is as outlined in **Figure 4.1**. This methodology would be applicable in any transport model that lacks the land use interaction component but has a (singly constrained) trip distribution element in its structure.

Figure 4.1: Calculation steps for change in employment in the Do Something scenario



The above steps were applied to the employment data in the following steps.

Step 1:

Table 4.1: Commute Tours

		% Diff of Commute Tours	
		11DM to 11 DS	21 DM to 21 DS
West Midlands Metropolitan Area	Birmingham	-0.03693%	-0.17691%
	Coventry	0.19786%	0.07654%
	Dudley	-0.10274%	-0.04446%
	Sandwell	0.25679%	-0.08449%
	Solihull	0.09468%	0.33468%
	Walsall	1.06201%	0.49233%
	Wolverhampton	0.30737%	-0.05737%
West Midlands Shires	Shropshire	0.01408%	0.11421%
	Staffordshire	-0.49929%	-0.14082%
	Warwickshire	0.05421%	0.15585%
	Worcestershire	-0.08579%	0.01316%
Grand Total		0.06381%	-0.00115%

Step 2:

The above factors are applied to the DM employment.

Step 3:

Table 4.2: Do Something Employment Final Values: WM constraint

		2011 Employment ReDistributed (% Diff)	2021 Employment ReDistributed (% Diff)
West Midlands Metropolitan Area	Birmingham	0.99911	0.99819
	Coventry	1.00146	1.00073
	Dudley	0.99845	0.99952
	Sandwell	1.00205	0.99912
	Solihull	1.00043	1.00331
	Walsall	1.01009	1.00488
	Wolverhampton	1.00255	0.99939
West Midlands Shires	Shropshire	0.99962	1.00110
	Staffordshire	0.99449	0.99855
	Warwickshire	1.00002	1.00152
	Worcestershire	0.99862	1.00009

The assumption in step 3 is in line with the accessibility assumption that with the ATM rollout implemented, people would only choose to change their workplace between different parts of the West Midlands and therefore the total number of jobs in the region will remain the same as in the Do Minimum scenario but their location within the region would change. Under this assumption, the scheme only causes a redistribution of employment, and not generation due to accessibility changes. To represent the changes in employment as a net re-distribution of jobs, rather than a net increase or decrease, the Do Something employment totals are constrained back to the Do Minimum total for the WM region. The use of the WM region as an overall constraint reflects the assumption that the primary impact of the scheme would be on the WM regional economy. Also, as the external areas are not precisely modelled in PRISM, using U.K. wide constraints (with the trip end methodology outlined above) to predict the employment changes would lead to more inaccurate results. Some other related studies have calculated WEBs that rely heavily on contributions further away. These will inevitably be subjected to greater uncertainty.

All effects are relatively minor. Walsall centre, located right next to the M6, gains from the increase in accessibility showing the largest increase in employment. Centres such as Wolverhampton suffer from job shifting away as their centres are located further away from the motorway and the increased flow on motorway access roads results in a minor drop in their accessibility.

4.1.3 Agglomeration calculation

To calculate the agglomeration benefits, the GDP for each of the appraisal years is calculated. The average work place based GDP information is available at the local authority level. This GDP is then assigned to each of the zones in the local authority.

The 2010 GDP is calculated using a 2% growth in productivity per annum from the 2001 GDP as suggested by the HM Treasury Green Book. This 2010 GDP is assumed to be the same for both the Do Minimum and Do Something scenarios. The GDP for intermediate years between 2011 and 2021 is calculated separately for the Do Minimum and Do Something scenarios using the employment density profiles calculated earlier.

The equation used to calculate the GDP per worker for the intermediate years is:

$$GDP^{0}{}_{j,t} = GDP^{0}{}_{j,t-1} \times (1+g)\left(\frac{Ed^{0}{}_{j,t}}{Ed^{0}{}_{j,t-1}}\right)^{EIP_j}$$

(0 refers to the Do Minimum scenario)

where $GDP^{0}{}_{j,t}$: GDP per worker in zone j in year t;

$GDP^{0}{}_{j,t-1}$: GDP per worker in zone j in year t-1;

g: Annual GDP growth rate assumed to be 1.972% (Calculations explained below)

$Ed^{0}{}_{j,t}$: Employment density of zone j in year t;

$Ed^{0}{}_{j,t-1}$: Employment density of zone j in year t-1;

EIP_j: Elasticity of productivity of zone j (provided by the DfT).

Calculation of the underlying productivity growth factor g: To calculate the correct growth factor, a 2% net growth (HM Treasury Green Book Guidance) in GDP per worker in the WM region, including growth in GDP due to agglomeration, is assumed in the Do Minimum scenario. The value of g is the trend growth rate net of agglomeration effects, i.e. the underlying growth rate consistent with a 2% growth when changes in effective densities between years 2001 and 2010 are taken into account. This value is then utilised in the GDP per worker growth in the Do Something scenario as well. For the 2010 GDP per worker calculation the employment density per zone is extrapolated backward from 2011-2021 to obtain the 2010 employment density. This is input in the formula of calculation of 2011 GDP. The employment density calculation for 2010 is carried out using Do Minimum employment densities and, similar to the growth factor, is assumed to be the same for the Do Something scenario.

The GDPs are calculated for each zone in the Do Something scenario using the employment densities calculated earlier. This calculation is carried out for each zone in the model for each of the modelled years between 2011 and 2021 including the last modelled year 2021.

The net agglomeration benefit is then calculated for each zone for each year from 2011 to 2021 using the following equation:

$$\Delta GDP_{jt} = (GDP^{1}_{j,t} - GDP^{0}_{j,t}) \times E^{1}_{j,t}$$

where:$GDP^{0}_{j,t}$: GDP per worker of zone j in year t in the Do Minimum scenario;

$GDP^{1}_{j,t}$: GDP per worker of zone j in year t in the Do Something scenario;

$E^{1}_{j,t}$: Workplace base employment of zone j in year t in the Do Something scenario; and

$\Delta GDP_{j,t}$: Net agglomeration benefit for zone j in year t.

This calculation is carried out for the zones in the WM region only and the total benefits for a particular year are calculated. The agglomeration benefits are calculated for each year between the two modelled years i.e. 2011 and 2021, including the modelled years themselves. The 2021 benefits are assumed to be constant over the appraisal horizon period up to 2070, similar to the travel time benefit calculation methodology. These benefits are discounted back to the year 2002 to contribute to the net present value of the agglomeration benefits in 2002 prices.

WB1 benefits are calculated using the employment change assumptions as discussed earlier in **Section 4.1.2**.

4.1.4 Dependencies

The data required external to the model are:

1. Elasticity of productivity to agglomeration.

   The elasticities in the calculations are based on Dan Graham's 2005 paper (Graham, 2005).

2. GDP for West Midlands at a detailed level

4.2 More people working (GP1)

The equation suggested by the DfT publication for the calculation of benefits generated due to transport interventions enabling better labour market participation is:

$$GP1_{t} = -\sum_{i}\left[\frac{\sum_{j} dT_{ij,t} \times C_{ij,t}}{\sum_{j} W_{j,t} \times C_{ij,t}} \times \sum_{j} GDP_{j,t} \times C_{ij,t}\right] \times El$$

where: $GP1_{t}$: Wider economic benefit of labour supply changes in year t;

$dT_{ij,t}$: Change in travel cost for commuters between zone i and zone j in year t from the Do Minimum scenario to the Do Something scenario;

$C_{ij,t}$: Commuters living in zone i and commuting to zone j in year t;

$W_{j,t}$: Average wage of workers working in zone j in year t;

$GDP_{j,t}$: GDP per worker entering the labour market in zone j in year t;

El: Elasticity of labour supply, assumed to be 0.1 (as per DfT publication advice).

As a representation of the commuters between zones i and j in modelled years 2011 and 2021, the all day commute tours calculated by the travel demand model have been taken. It is assumed that all the commute trips originating from a zone are being made by the commuters living in that zone.

A similar assumption has been made for the Do Something scenario.

The average wages and GDP information is available for the base year at local authority combined level as mentioned earlier. This is allocated to each of the zones in the local authority to get zonal average wages and GDP. To obtain the **entry level GDP,** a **factor of 0.69**, i.e. the assumption is that a new worker will generate 69% of the average GDP per worker, is applied to calculate GDP (Greg et. al., 1999). Both the wages and GDP are grown to the modelled years using a 2% annual growth rate as used earlier.

Although it is feasible to profile the number of commuters between the two modelled years, a similar calculation is not appropriate for the travel cost (dT) profile. As outlined earlier in **Section 4.1.1,** the calculation methodology of travel cost (T) uses the mode share weighted average to evaluate the travel cost between each origin-destination (OD) pair. Therefore if no trips exist between an OD pair then the average travel cost is calculated as zero. If the transport scheme generates commuting trips between an OD pair where there were no trips in the Do Minimum situation, a linear profile of travel costs would have been drawn between £0 in 2011 to the actual cost in 2021. Clearly, the cost of a commuting journey for this OD pair would not be £0 in 2011 and to avoid this problem, the $\Sigma\, dT_{ij,t} \times C_{ij,t}$ is calculated for each zone for the two modelled years and *this* value is profiled linearly between 2011 and 2021.

Similar to the agglomeration benefit calculations, the GP1 benefits have been calculated for the WM region zones only as the travel cost estimates for external zones derived from PRISM are not precise enough.

The GP1 benefits are calculated for each of the modelled years and all the years between them using the profiles created for each of the other inputs. Similar to agglomeration benefits the 2021 GP1 benefits are kept constant over the appraisal horizon period up to 2070 and then discounted back to current year 2002 prices.

4.3 People moving to more productive jobs (GP3)

The formula suggested by the DfT publication for calculating the labour supply changes from transport intervention in a particular year is:

$$GP3_t = \sum_A \Delta E_{A,t} \times PI_{A,t} \times GDP_t$$

where: $\Delta E_{A,t}$: Change in employment in area A in year t;

$PI_{A,t}$: Index of productivity per worker in area A, where the base in the average national productivity per worker;

GDP: National average industry GDP per worker

The key driver of this result is the employment change assumption made in the model. The scale of the benefits also depends on the area from and to which the re-allocation or generation of jobs happens and to how the average productivity of the area compares to the national average productivity. The areas are classified as the local authority districts and the difference in Do Something and Do Minimum jobs is as shown in **Table 4.2**. The difference in employment is calculated for 2011 and 2021 and linearly profiled for the years between them. The difference in employment is assumed to be constant beyond the 2021 modelled year up to the appraisal horizon year.

To approximate the productivity differentials, the index of productivity has been derived from a relevant NERA report (NERA, 2002), which provides wage comparisons across the regions in England, correcting for industry, etc. The indices used for the WM metropolitan areas, and the rest of the WM shires have been adopted from the NERA report as +5% and -0.8% respectively. These indices are wage mark-ups for the rest of the country in relation to average wages in the Tyne and Wear area taken from the NERA report. In other words, the average earning, corrected for the above, are 0.8% less in the shires, and 5% more in the metropolitan area.

GP3 benefit calculations have been carried out using the employment change assumptions mentioned in **Section 4.1.2**.

4.3.1 Data Dependencies

The data required external to the model are:

1. Index of productivity
2. National Average Industry per worker

5 SUMMARY RESULTS

For the conventional economic analysis, 2002 was specified as the current year though the results reported at the end of the run were discounted to 2002 prices. The scheme opening year is taken as 2011 and the horizon year i.e. the end of the 60 year appraisal period is taken as 2070.

Table 5.1 below presents the presents a summary of the overall economic benefit results due to the ATM rollout Phase I and II scheme, including the results from the wider economic benefits. All values in the table have been reduced to percentages of the total economic benefits.

Table 5.1: Economic Benefits for the West Midlands of the ATM rollout Phase I and II

Benefits	Welfare (%)
Business time savings	46.3%
Commuting and Leisure time savings	39.3%
Total transport user benefits - conventional appraisal	**85.6%**
Increase in labour force participation **(GP1)**	GDP Effects
People working longer **(GP2)**	-
Move to more productive jobs **(GP3)**	GDP Effects
Agglomeration benefits **(WB1, GP4)**	9.4%
Increased competition **(WB2)**	-
Imperfect competition **(WB3, part of GP6)**	4.6%
Exchequer consequences of increased GDP **(WB4 which depends on GP1, GP2 and GP3)**	0.4%
Additional to conventional appraisal	**14.4%**
Total (excluding financing, social and environmental costs and benefits)	**100.0%**

The biggest component of the wider economic benefits generated as a result of implementation of ATM on the WM Motorway Box are the agglomeration benefits (WB1) (about 9%). The key driver of the agglomeration benefits (WB1) due to the ATM rollout scheme is the change in the employment density of the zones in the model area. The employment density in the Do Something scenario is primarily affected by the improved capacity on the M6 (especially between J8 and J10a). These sections of the M6 carry significant additional numbers of business and commuters users, when extra capacity is provided using the hard shoulder as a running lane as part of the ATM scheme.

Imperfect competition, which is 10% of the business time savings accounts for a further 4.6% welfare benefit.

6 CONCLUSIONS

While the current methodology for estimating the wider economic benefits is being refined, it can still be applied in its current form to the existing transport models, with certain assumptions in place.

Before proceeding with the analysis, a realistic assessment is required to be made of the extent of the analysis. Since the analysis is data intensive and very data sensitive, care should be taken to exclude those areas which are not represented in sufficient detail in the model.

It is possible to estimate the employment change by making certain assumptions for models without a land use interaction in the model. However, there is a requirement to do some sense checks of the outputs. For the model discussed in this paper, the proxy of commute tours shows small variations in the district employment targets. However, these have significant impacts on the benefits estimation.

Based on the above analysis we note that agglomeration benefits account for the largest share of the additional welfare benefits. For this scheme, the key driver of the agglomeration benefits (WB1) due to the ATM rollout scheme is the change in the employment density of the zones in the model area.

Based on the studies and the analysis emerging for the application of WEBs, it is evident that the additional benefits are quite significant. The impacts from continuing the application of this analysis could provide a more holistic view of the benefits (or disbenefits) of transport schemes, thereby improving the evidence base of the transport analysts and policy makers.

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Notes

[1] Serbjeet Kohli is now employed by Steer Davies Gleave

[2]The inverse relationship of effective density with travel costs can be weaker or stronger than -1 but will be negative.

[3] Productivity TIF (Transport Innovation Fund) is a funding stream established by DfT to support and deliver scheme that offer significant benefit to the nation's productivity.

- The work presented here is based on work carried out for the Highways agency.
- PRISM west Midlands is owned by the 7 metropolitan authorities, the HA and CENTRO.
- The opinion in this paper are those of the authors alone, and may not be attributed to the metropolitan authorities, the HA or CENTRO.