**Comparison of TPTS+ static agglomeration benefits for WITA and the economy model**

**Summary and recommendations**

WITA and the economy model have now been run for TPTS+, generating very different estimates for static agglomeration benefits. WITA estimates that static agglomeration benefits could be around £3.9bn[1] (before adjusting for missing modes) while the economy model estimates an equivalent figure of £0.8bn. It is important to be able to explain this difference and identify the core estimate for static agglomeration benefits to include in the adjusted BCR since this might have a material impact on the scheme's value for money rating. This note provides evidence explaining 60% of the difference between forecasts from WITA and the economy model.

It is recommended that the core estimate for static agglomeration benefits should be those from WITA but adjusted down by 20% to reflect for missing modes, implying a core estimate of £3.1bn. Previously an adjustment factor of 35% was used by WSP based on 2015 analysis for the M60. It is recommended that the 20% adjustment is more appropriate for this scheme as it has been estimated for TPTS+ using more up-to-date data and is auditable.

It is also recommended that results from the economy model are scaled up by 60% to reflect known biases in the results.

**Differences between WITA and the economy model**

This section summarises the key identified differences between analysis of static agglomeration benefits using the economy model and WITA. It also provides estimates for the potential scale of this bias where relevant.

1. **Masking**

When running the economy model, it has been assumed that the Trans-Pennine Tunnel will only improve travel times and costs for trips that both start and finish within the core area of the Trans-Pennine scheme model. All changes in travel times and costs for trips beginning and/or ending outside this area are assumed to be unaffected by the scheme. Hence the economy model may underestimate static agglomeration benefits by excluding benefits occurring outside the core modelled area.

The rationale for applying masking is that the scheme has only been modelled in the Trans-Pennine scheme traffic model and not the other regional traffic models. This has resulted in inconsistent forecasts and routing for traffic flows between the different traffic models. Hence combining data from the four regional traffic models and Trans-Pennine scheme traffic model has resulted in some implausibly large increases in forecasted distance travelled by region which might have biased the results. Furthermore it was not possible to use results from the Trans-Pennine scheme traffic model on its own to input into the economy model as forecasts are less robust outside of the core modelled area. Analysis of total travel time savings between different sector pairs as a result of the scheme suggest that there could be significant travel time savings for some areas partially outside the core modelled area including for Nottinghamshire, Lincolnshire and Derbyshire. By estimating

[1] Estimated based on employment and GVA forecasts from the current WebTAG data book

the proportion of forecasted time savings estimated to occur partially or wholly outside the core modelled area we estimate that model may underestimate the wider economic impacts of the scheme by around 30%. This has been confirmed by WSP who've tested the impact of applying masking to results from WITA.

By contrast no masking is applied in the WITA analysis - hence masking is not expected to bias these results.

**2. Modes included in model**

WebTAG recommends that agglomeration benefits should be estimated taking into account generalised cost for all relevant modes as this may affect the results. For example if a new road is built between two cities along an existing train line the benefits will be much less than if travelling by car is the only viable option.

Analysis from the economy model includes generalised costs for road, long-distance rail, air and bus and walking whereas analysis from WITA only includes road and long-distance rail generalised costs. Hence there's a risk that results from WITA may overestimate agglomeration benefits by excluding bus, walking and air generalised costs.

David Simmonds consultancy have undertaken some analysis to assess how removing non-car modes from the economy model affects static agglomeration benefits. They estimate that static agglomeration benefits for TPTS+ would increase by around 25% from removing generalised costs for bus, walking and air travel, suggesting that estimates from WITA should be reduced by around 20% (see explanation in annex A).

WSP have previously down-rated estimates from WITA by around 35% based on past estimates for the M60. It is recommended that a downrating of 20% is more appropriate as this has been estimated using data for the TPTS+ whereas the 35% estimate was estimated for improvements to the M60. Moreover the 35% was estimated over 4 years ago (so may use out-of-date assumptions) and it's unclear what assurance have been undertaken for this number as it's taken from an email.

It should be noted that neither the economy model nor WITA include generalised costs for short-distance rail e.g. metro and underground. As a consequence, both of these estimates may represent slight overestimates by excluding this mode; however, given these represent only 0.6% of trips in the north west and 0.3% of trips on Yorkshire and the Humber in 2017 they're not expected to significantly bias results[2].

**3. Method of estimating composite generalised cost**

WebTAG recommends that average generalised costs should be estimated across all journey purposes using the weighted average method. By contrast the economy model uses the logsum formula to estimate a composite measure of generalised costs across modes. The rationale for this is that the weighted average formula can result in implausible changes average generalised costs if there's a large modal shift as a result of the scheme.

[2] Table NTS9903 https://www.gov.uk/government/statistical-data-sets/nts03-modal-comparisons

While the logsum formula produces lower composite of generalised costs compared to the weighted average approach, these differences broadly net out when estimating the difference in agglomeration benefits between the do minimum and do something. Difference in static agglomeration benefits for the producer services sector in Manchester between the two methods have been estimated to be around 0.4%. While it's possible there may be larger differences for other districts and sectors, we don't expect this to be a significant factor explaining the difference in results.

Analysis using WITA has estimated the weighted average generalised cost across journey purpose as recommended in WebTAG.

4. **Intra-district costs**

WebTAG recommends that it's necessary to estimate intra-district generalised costs when estimating static agglomeration benefits, since agglomeration benefits are highly sensitive to change in generalised costs for short-distance trips. WITA allows intra-district generalised costs to vary between the do something and do minimum scenarios (as recommended in WebTAG) while the economy model holds intra-district generalised costs fixed at base year values. Hence results from the economy model may be biased either up or down.

Analysis using WITA suggests that holding generalised costs fixed at base year values reduces static agglomeration benefits by around 33%. This implies that results from the economy model may be underestimated by around 50%.

Work is currently in progress to recalibrate the model allowing for intra-district costs to vary.

5. **WebTAG data book**

WebTAG recommends that agglomeration benefits are estimated using forecasts for employment and GVA per worker from the WebTAG wider economic impacts data book. While this was used for the WITA analysis, static agglomeration benefits from the economy model have been estimated based on economy model forecasts for employment from the do something scenario (rather than from the WebTAG wider economic impacts data book). Analysis suggests that using equivalent numbers from WebTAG could have decreased forecasted benefits by around 25%.

**Adjusted results from WITA and the economy model**

This section applies adjustments to the forecasted static agglomeration benefits from WITA (£3.9bn) and the economy model (£0.8bn) to generate unbiased estimates.

The only identified factor which might bias results from WITA is missing modes, which is estimated to scale down WITA forecasts by around -20%. Hence the unbiased forecast for static agglomeration benefits from WITA is estimated to be **£3.1bn** (£3.9bn * 0.8).

The following factors have been identified which might bias results from the economy model:

- Masking – estimated to scale up benefits by +43%
- Intra-district costs – estimated to scale up benefits by around +50%
- WebTAG data book – estimated to scale down benefits by -25%

Hence the unbiased forecast for static agglomeration benefits from the economy model is estimated to be **£1.3bn** (£0.8bn*1.43*1.5*0.75).

Hence by adjusting results to reflect known biases we explain around 60% of the original difference between the static agglomeration benefit estimates from WITA and the economy model.

**Project: Highways England Economy Model**

# DSC PROJECT NOTE

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# Annex A - Switching value tests for assessing agglomeration impacts under different mode assumptions

## 1 INTRODUCTION

*1.01* This note summarises the method and results from Highways England's Economy Model for estimating the agglomeration impacts under different mode assumptions for the Trans-Pennine Tunnel scheme. It first explains the purpose of carrying out such tests followed by the test definitions. Secondly, it reports the method used in carrying out the tests. Finally, it summarises the results from the welfare calculations under these different mode assumptions.

## 2 PURPOSE OF THE TESTS AND TEST DEFINITIONS

*2.01* The purpose of undertaking these agglomeration impacts tests under different mode assumptions is to better understand the differences between the Economy Model results and WITA results, which only uses car and rail modes.

*2.02* Three switching-value tests have been undertaken using the Economy Model Wider Economic Benefits (WEBs) post-processing programmes to estimate the agglomeration impacts:

1. calculating agglomeration impacts under all modes set in the economy model (car, rail, bus, air, walking);
2. removing bus, air and walking modes, only considering car and rail modes;
3. only considering car mode.

*2.03* Comparisons between the three tests have been undertaken to understand the scale of differences.

# 3 TEST METHOD

*3.01* The unused modes must be removed from consideration in the log-sum averaging of generalised costs calculation. This is implemented through setting the costs for these modes to infinity, which makes them irrelevant in the calculation. This method is preferred in comparison to deleting the unused modes and recalculating log-sum average, because it keeps the dimensions of the economy model unchanged.

*3.02* Table 1 shows how the suppression of modes has been undertaken: Example (1) log-sum averages over 5 modes; example (2) log-sum averages over 2 modes (car and rail), example (3) log-sum averages over 5 modes while 3 of them were set to very large numbers, and example (4) log-sum averages for car mode only.

*3.03* Example (1) produces the smallest log-sum average result, which proves that providing additional modes results in better connectivity and lower average generalised costs. Note the average is the lowest of all the examples, and due to the mathematics of the log-sum average, the average is also lower than all the individual modes.

*3.04* Example (2) and (3) give the same averages. This is because in Example (3), providing very inefficient modes between the two cities will be regarded as little improvement to the connectivity. The log-sum calculation will have little change. Therefore, we use Example (3) to approximate removing air, bus and walking modes, which gives the same result [3] as Example (2) does, without having to change the dimension of the economy model.

*3.05* Example (4) further proves that adding inefficient modes will have little impact to the log-sum average.

**Table 1 log-sum averages under different mode assumptions**

| Examples | From | To | Generalised mins | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Car | Rail | Air | Bus | Walking | Log-sum average |
| 1 Averaging over 5 modes | Manchester | Aberdeen | 523 | 547 | 435 | 1034 | 5803 | 412 |
| 2 Averaging over 2 modes | Manchester | Aberdeen | 523 | 547 | / | / | / | 490 |
| 3 Averaging over 5 modes while 3 of them are set to be large numbers | Manchester | Aberdeen | 523 | 547 | 100000 | 100000 | 100000 | 490 |
| 4 considering car only | Manchester | Aberdeen | 523 | 100000 | 100000 | 100000 | 100000 | 523 |
| $g_{tij}^{po} = \frac{1}{-\lambda_T^{Mpo}} \ln \sum_m \exp\left(-\lambda_T^{Mpo} \cdot g_{tijm}^{po}\right)$. | | | Lambda= - 0.015757256 | | | | | |

*3.06* The process of supressing the non-car/rail modes was undertaken using the generalised cost matrices from both the Do-minimum (no Trans-Pennine Tunnel) and the Do-something (with Trans-Pennine Tunnel) tests.

*3.07* The average generalised costs under different mode assumptions were used respectively in the Do-minimum and the Do-something tests to calculate the effective

[3] The exact values are 490.1467590834580 in both examples, up to 13 digits as far as the calculation can show.

densities. In all examples, the same employment forecasts, from the do-minimum, were used for the effective density calculation.

*3.08* The agglomeration benefits (Do-something minus Do-minimum) were then calculated using explicitly the parameters and equations set out in WebTAG.

*3.09* Finally, the impacts of more people in work have also been updated using the log-sum averaged generalised costs under different mode assumptions described here.

# 4 RESULTS

*4.01* Table 2 summarises the welfare benefits with the breakdown of agglomeration and more people in work benefits. The numbers are discounted NPV from 2010 to 2091, with the assumption that the scheme opening year is 2031.

**Table 2 welfare benefits for the three switching value tests**

| | Test1 all mode | Test 2 car + rail | Test 3 car mode only |
|---|---|---|---|
| Total welfare benefits NPV (£billions) | 0.796 | 0.995 | 1.481 |
| Agglomeration impacts (£billions) | 0.790 | 0.988 | 1.470 |
| More people in work impacts (£billions) | 0.005 | 0.007 | 0.011 |

*4.02* The results show that the welfare benefits for car mode only test has the largest benefit (£1.497 billion in Test 3). In this test, the improvement from the Trans-Pennine Tunnel scheme for car trips was not averaged by other unchanged modes, so the benefit is the largest. After averaging by rail, the benefit decreased by 33% to 0.995 billion, and after averaging by all other modes, it decreased by 46% to 0.796 billion.

*4.03* The results of welfare benefits shown in the switching value tests provide an estimate of the scale of impacts under different mode assumptions. Hopefully this note provides further understanding on why the different methodological assumptions in the Economy Model and WITA produce difference wider economic impacts.

[end]