UNIVERSITY OF LEEDS

Buses and the Economy II

Task 2 Report: First Order Effects and Wider Impacts Case Study

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June 2014

1. Introduction

The objective of Task 2 is to carry out some appraisals to identify the relativities between the primary, first order effects, ie the typical user benefits and operator revenues, and the wider impacts.

The relationship between funding and fares/service levels has been considered in many previous studies and simulation models have been used. To model first order effects of cost/service level changes we require a model for carrying out indicative appraisals to identify relativities between first order effects and wider impacts. For this purpose we have decided to use the National Bus Model as a way of generating first order effects.

As described in WebTAG Unit A2.1 (DfT, 2014a) first order effects change transport costs which alters the incentives of individuals to enter the labour market and thus the level of employment. The wider economic impact is captured by the change in tax revenue from this employment level change.

The next section of this report describes in brief the National Bus Model. Section 3 describes the scenarios that were modelled. Section 4 describes the methodology used to link the first order effects from a CBA to the wider economic impacts as estimated in the Task 3 report. Section 5 shows the results.

2. National Bus Model

The National Bus Model (NBM) has been built to allow users to understand the effects of different policies on the bus market. The user applies policy and exogenous demand changes to the model for individual bus markets within each of England's Government Office regions. These markets are:

- Metropolitan PTEs
- Urban Conurbation
- Small Towns
- Rural.
- London (defined as a single market)

Outputs can be at a national level or broken down by area type (mets, large urban, other urban, rural) but are less robust when disaggregated at a more region level

The model is elasticity-driven and allows modelling of scenarios involving different exogenous demand impacts, and then to test strategies changing the following attributes:

- fares
- ticket types,
- concessions,
- bus service provision,
- quality of service,
- road speeds.

The user can also define parameters affecting bus costs; these include such elements as the fuel efficiency of buses and the number of staff members.

3. Scenarios

We have undertaken to investigate 2 policy scenarios involving changes to Bus Service Operators: Grant (BSOG). This is a grant paid to local bus operators to recover some of their fuel costs and companies are remunerated on the basis of their annual fuel consumption. The aim is to help keep fares low and enable operators to run services which might not otherwise be profitable. We look at a cut of 50% and a total removal of BSOG.

This policy is modelled as impacting purely on waiting times through improvements in frequency. This assumption is more appropriate in urban areas where buses are more frequent, rather than in rural areas where people will follow a timetable. In reality we would also expect such a change in BSOG to also impact on journey times and walk times as some more vulnerable routes would be cut completely.
Such changes need to be converted into changes in the travel time[2] measures[i] as used in our Fixed effects model reported in Task 3. The parameter estimates from the econometric modelling allows us to estimate the impact of these changes in accessibility on employment, ie the link to wider economic effects.

We apply these across England excluding London and show how the impacts differ across the different area types used in the Task 3 analysis.

4. Methodology

4.1 Estimation of Journey Time component elasticities

The reported employment elasticities in Task 3 are based on changes in travel time as measured in door to door minutes. Our NBM model results are based on changes in waiting time. We can derive an elasticity of employment with respect to changes in waiting time if we know the share of waiting time in overall journey time. However, in line with the NBM and standard appraisal (Department for Transport, 2014b), wait time (and walk time) should have a weighting of 2 relative to in vehicle time in the calculation of Generalised Journey Time (GJT). If we assume this weighting reflects the behavioural response of people to changes in these components of journey time then the overall employment elasticities estimated in Task 3 in terms of changes in absolute journey time are rather difficult to interpret, conflating as they do different components of GJT with the incorrect (ie, same) weighting.

We propose to adjust the journey time components within the elasticity estimates to reflect the higher weighting for wait (and walk) time. To do this we need to know the share of these components in overall journey time. We impute this by looking at the typical share of waiting

[2] With use of the appropriate value of time, fares impacts could also potentially be converted into equivalent minutes

and walking time in overall journey time for journeys representative of the average travel times in the different area types taken from the National Travel Survey (NTS) diary data.

Although not designed for this purpose, the NTS diary data allows us to look at the stages of individual commuter journeys undertaken by respondents[3]. We use these data to estimate the average wait, walk and in vehicle time for bus journeys in 10 minute time bands.

Average travel times derived from our accessibility data for each area type are reported below.

Table 4-1: Average Travel Times (mins) to Employment Areas by Urban Type

Urban_Rural	Minimum	Maximum	Mean	Std. Deviation
Other Urban	5.32	120.0	33.3	24.8
Mets/Major Urban	6.01	78.2	23.1	11.9
Rural	9.76	120.0	58.7	27.8

We allocated the average journey times from Table 4-1 into the different NTS time bands corresponding to urban type -Other Urban journeys, with an average journey time of 33 minutes taken from Table 4-1 are allocated to the 30-39 minute category, Mets/Major Urban to the 20-29 minute category and Rural to the 50-59 category. These bandings are shown in the first column of Table 4-2. For each of these time bands, we report the average amount of walk, in vehicle time, wait time and total journey time we derived from the NTS data in column 3 and the % of these times within total unweighted journey time in column 4.

We apply double weightings for walk and wait time in column 5 to derive the generalised time values for each journey component in column 6. Column 7 reports the % of these times within total weighted journey time.

The elasticity of employment with respect to travel times are shown in column 8. The overall employment elasticities with respect to total journey time are taken from the recommended values in Task 3. We derive elasticities for employment with respect to walk, wait and in vehicle time based on the share of these components in total journey time. These component elasticities sum to match the total journey time elasticity. The derived elasticities for walk and wait time are then doubled in line with the GJT weightings[4]. This gives us a new overall GJT elasticity and a new walk and wait time elasticity, shown in column 9. These GJT based elasticities are re-scaled to the estimated travel time (TT) based elasticities, maintaining the double relative weighting of wait and walk time within these values and shown in column 10.

[3] Specifically, the diary data only records short walks for 1 of the 7 recorded days. Additionally, short walks of less than 50 yards are not recorded at all. However, any walking element of access journeys in the accessibility data assumes a minimum of 5 minutes, so where there was any observed bus journey in the NTS data which did not have a supporting access walk journey of 5 minutes or more, we added one in.

[4]In the context of GJT, an extra minute of wait (or walk) will have double the impact of a minute of extra in-vehicle time time hence a doubling of the wait time elasticity to more accurately reflect the employment response from the change in GJT.

Simply put, we are doubling the weighting and thus the elasticity on walk and wait time components because the WebTAG advice (Department for Transport, 2014b) supports a double weight on walk and wait time relative to in-vehicle time.

Table 4-2: Representative GJT components and Elasticities

1) Area/Band	2) Time element	3) Average NTS Time	4) %Unweighted JT	5) Weighting	6) Generalised Value	7) %GJT	8) Employment Elasticity wrt TT	9) Employment Elasticity wrt GJT	10) Adjusted Elasticity
Mets/Major Urban:	Walk	6.7	28.9	2.0	13.5	42.0	-0.0071	-0.0143	-0.0104
	In Vehicle	14.5	62.2	1.0	14.5	45.2	-0.0154	-0.0154	-0.0112
20-29 mins	Wait	2.1	8.8	2.0	4.1	12.8	-0.0022	-0.0044	-0.0032
	Total	23.3			32.1		-0.0247	-0.0340	**-0.0247**
Other Urban:	Walk	7.6	23.2	2.0	15.3	34.8	-0.0044	-0.0087	-0.0066
	In Vehicle	22.0	66.7	1.0	22.0	50.1	-0.0125	-0.0125	-0.0094
30-39 mins	Wait	3.3	10.1	2.0	6.6	15.1	-0.0019	-0.0038	-0.0028
	Total	32.9			43.9		-0.0188	-0.0251	**-0.0188**
Rural:	Walk	8.7	16.7	2.0	17.4	26.3	-0.0007	-0.0014	-0.0011
	In Vehicle	37.9	72.9	1.0	37.9	57.3	-0.0030	-0.0030	-0.0024
50-59mins	Wait	5.4	10.4	2.0	10.8	16.3	-0.0004	-0.0009	-0.0007
	Total	52.0			66.1		-0.0041	-0.0052	**-0.0041**

4.2 Applying NBM Results

The NBM does not report waiting time changes as an output, just changes in bus kilometres. In order to derive the changes in employment stemming from a service level change we have to work through the following steps.

1. Convert any changes in bus kilometres from the NBM model outputs to changes in wait times
2. Apply the appropriate waiting time elasticity from Table 4-2 to the change in wait times.

We calculate the associated changes in waiting times in the following way:

Waiting time change %=(100-Service level change%)/100[5]

4.3 Change in employment

We apply the waiting time elasticity of employment from column 10 of Table 4-2 to the changes in waiting times and then to the employment levels (taken from the 2011 Census) for each area to derive the changes in employment.

[5] This formulation assumes that people will turn up at random, so the average wait time is half the headway stemming from the service level. Whilst this is a simplification for less frequent services, there is still an element of schedule adjustment that people will have to undertake, which has an associated cost.

4.4 Change in output

To convert these employment figures into output changes we took the minimum wage per hour from the ONS (http://www.ons.gov.uk/ons/dcp171778_256900.pdf), and multiplied by average hours per week and by 52 weeks per year, to give an average annual earnings figure of around £11,000.

4.5 Additional value of national Output

The labour market effects are valued not by the gross value added of the additional output but by the additional tax revenues generated by the change in labour supply. This is the so-called tax wedge which reflects the difference between the *net* wage on which the individual balances their choice to enter the labour market or not, and the *gross* wage which represents the added value of output to the economy. We apply the recommended value of the tax wedge which is 40% so that £1k of additional output would be associated with an additional net social benefit of £400.

5. Results

5.1 Scenario 1: Reduction in BSOG of 50%

As previously stated, we used the NBM to model various scenarios to derive the first order effects of policy changes. This section applies the methodology discussed in section 4 to these results to derive the wider economic effects. Outputs from the NBM following this scenario are shown in Table 5-1. The impact of the policy is a net negative present value (just for 2014) of over £91 million, with a BCR of 1.8.

Table 5-1: ***NBM Outputs from 50% BSOG Cut (2014)***

Analysis of Monetised Costs and Benefits	Total
Economic Efficiency: Consumer Users (Commuting)	-27,260,249
Economic Efficiency: Consumer Users (Other)	-140,661,447
Economic Efficiency: Business Users and Providers	-33,390,628
Wider Public Finances (Indirect Taxation Revenues)	-4,425,572
External Impacts	**3,275,252**
Present Value of Benefits (PVB)	**-202,462,645**
Present Value of Costs (PVC)	**-111,151,854**
Overall Impacts	
Net Present Value (NPV)	**-91,310,791**
Benefit to Cost Ratio (BCR)	**1.8**

The NBM gives the changes in bus km reported by urban area and by scenario in rows A of Table 5-2. This is converted into a change in waiting time reported in row B. We then apply the employment elasticity with respect to changes in waiting times from Table 4-2 shown in row C to this change in waiting times and the level of employment in each area type (row D, taken from 2011 Census data) to derive the loss of jobs reported in row E. This is converted to the loss of output reported in row F. Row G calculates the Tax Wedge from this loss in output – this is set (in WebTAG guidance, Department for Transport, 2014a) at the rate of 40% of the loss in GVA (approximated by Row F). It is this final amount which is additional to the first order impacts. This amount represents an additional 10% reduction in welfare on top of the first order effects and would increase the BCR figure to 1.9.

Table 5-2: Impact of 50% BSOG reduction on Waiting times, Journey Time, Employment and Output (2014)

	Mets	Major Urban	Other Urban	Rural	
A1 Bus km fall (from NBM) for 50% BSOG cut	-4.8%	-2.9%	-3.2%	-7.5%	
B1 Waiting time increase following 50% BSOG cut	5.0%	3.0%	3.3%	8.1%	
C. Employment Elasticity wrt. Wait time (Table 4-2**)**	-0.0032	-0.0032	-0.0028	-0.0007	**TOTAL**
D Employment level (Mill)	4.8	3.6	4.2	9.1	**21.6**
E. Change in jobs (B*C*D)	-752	-341	-390	-491	**-1,974**
F. Loss of output (E*£11K) (M)	-8.3	-3.8	-4.3	-5.4	**-21.7**
G. Additional CBA impact from Tax Wedge	-3.3	-1.5	-1.7	-2.2	**-8.7**

5.2 Scenario 2: Reduction in BSOG of 100%

Outputs from the NBM following this scenario are shown in Table 5-3. The impact of the policy is a net negative present value (just for 2014) of over £192 million, with a BCR of 1.9.

Table 5-3: Impact of 100% BSOG reduction on Waiting times, Journey Time , Employment and Output (2014)

<u>**Analysis of Monetised Costs and Benefits**</u>	
	Total
Economic Efficiency: Consumer Users (Commuting)	-53,762,017
Economic Efficiency: Consumer Users (Other)	-276,841,949
Economic Efficiency: Business Users and Providers	-69,141,366
Wider Public Finances (Indirect Taxation Revenues)	-8,699,257
External Impacts	**4,629,453**
Present Value of Benefits (PVB)	**-403,815,136**
Present Value of Costs (PVC)	**-211,686,710**
<u>**Overall Impacts**</u>	
Net Present Value (NPV)	**-192,128,425**
Benefit to Cost Ratio (BCR)	**1.9**

Table 5-4: Impact of 100% BSOG reduction on Waiting times, Journey Time , Employment and Output (2014)

	Mets	Major Urban	Other Urban	Rural	
A1 Bus km fall (from NBM) for 100% BSOG cut	-9.1%	-5.5%	-6.0%	-13.5%	
B1 Waiting time increase following 100% BSOG cut	10.0%	5.8%	6.4%	15.6%	
C. Employment Elasticity wrt. Wait time (Table 4-2)	-0.0032	-0.0032	-0.0028	-0.0007	**TOTAL**
D Employment level (Mill)	4.8	3.6	4.2	9.1	**4.8**
E. Change in jobs (B*C*D)	-1,505	-659	-756	-945	**-3,865**
F. Loss of output (E*£11K) (M)	-16.6	-7.3	-8.3	-10.4	**-42.5**
G. Additional CBA impact from Tax Wedge	-6.6	-2.9	-3.3	-4.2	**-17.0**

Results of the wider economic calculations from Scenario 2 are reported in Table 5-4.

The NBM reports an NPV of £192.1 Million following the first year of the BSOG cut. Table Table 5-4 shows our wider economic impacts represent an additional £17 million which represents a 9% reduction in welfare and an increase in the BCR to 2.

6. References

Department for Transport (2014a), Transport Analysis Guidance Unit A2.1, https://www.gov.uk/government/publications/webtag-tag-unit-a2-1-wider-impacts

Department for Transport (2014b), Transport Analysis Guidance, www.gov.uk/transport-analysis-guidance-webtag

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Mackie, P., Laird, J. and Johnson D., (2012), *Buses and Economic Growth Final Report*, Greener Journeys, www.greenerjourneys.com/wp-content/uploads/2012/06/BusesEconomicGrowth_final-report.pdf

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[i] With use of the appropriate value of time, fares impacts could also potentially be converted into equivalent minutes