Recent Evidence on Bus Fare Elasticities for Older and Disabled Concessionary Passengers

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Summary

In April 2006, free off peak bus travel was made available for older and disabled people in England. It was expected that this would lead to a significant increase in the number of concessionary trips made, but it was unclear by how much.

Travel Concession Authorities such as the Passenger Transport Executives (PTEs) are required by law to reimburse bus operators so that they are "no better off and no worse off" as a result of providing a concessionary fare. In order to calculate a correct level of reimbursement, it is necessary for authorities to estimate how much of the observed concessionary travel has been "generated" by the concession. The impact of the introduction of free travel provides welcome new evidence on the sensitivity of concessionary travel to changes in the fare.

The fare elasticity is used as a measure of the sensitivity of passenger demand to changes in fare, and is central to the estimate of generation. Appropriate elasticity values to use for concessionary travel have been much debated during the many appeals against reimbursement arrangements made by operators since free travel was introduced. Robust, recent and relevant evidence on concessionary travel elasticities has now emerged from the growth in travel that has taken place since bus travel became free.

This Report discusses evidence from the four PTE areas, in Greater Manchester, Tyne and Wear, South Yorkshire and West Yorkshire, where previously a non-zero concessionary fare was charged[1]. In these four PTE areas, concessionary travel by older and disabled people[2] increased by between 23% and 27% between 2005-6 and 2006-7, with an average level of growth of 25%. The extent of change (but in the opposite direction) is very similar to that observed in PTE areas in the past when free fares were replaced by non-zero concessions.

After allowing for various non-fare influences on travel demand, and also adjusting for the effect of new passholders, point elasticity values have been calculated that vary from -0.49 to -0.57 at a nominal full fare of £1.00. These are somewhat higher (in absolute terms) than the bus fare elasticity values often quoted in the past. For example, in the last few years the guidance issued by the Department for Transport (DfT) to travel concession authorities has recommended a value of -0.4 as a central estimate for use in Metropolitan area such as the PTEs. However, much of the research on which this guidance was based is quite old, and has been focussed on bus users in general and not concessionary passengers.

There are a number of technical issues which can confuse discussion about elasticity values. For the avoidance of doubt, the values found for the PTE areas which are reported here are based on:

- use of a Proportional Elasticity model to represent assumptions about the shape of the demand curve, as incorporated into the DfT "Toolkit";

[1] In the other two PTE areas, in the West Midlands and Merseyside, free travel was already largely provided prior to April 2006.

[2] Some classes of concession were not affected by the change to free travel in some areas, and these are excluded from these figures.

- a comparison of the concessionary trips made in 2006-7 with those made in 2005-6, after allowing for external factors and new passholders. It is likely that comparisons with data covering a longer time period would show larger increases and higher elasticity values.
- The point elasticity values quoted above are calculated at a fare of £1.00; at the average commercial fares charged by operators in these PTE areas, the point elasticities would be larger.

These elasticity values imply significantly lower levels of reimbursement payments to operators than would have arisen from application of the original DfT central guidance. This is illustrated in the Table below, which shows the level of reimbursement that would be paid to an operator charging an average commercial fare in PTE areas of £1.199. The Reimbursement Factor shown is the ratio of hypothesised commercial trips to observed concessionary trips. In many determinations a specific value of between 60% and 62.5% was imposed. This Factor allows the number of trips that would have been made in the absence of the Scheme to be estimated, and thus is central to the calculation of the reimbursement that will leave operators "no better off and no worse off".

	Elasticity based on			Typical factor imposed by determinations	*Difference in payment levels*
	2006-7 evidence, average from 4 PTEs	Original DfT Central Estimate for Met. areas	Difference in payment levels		
Fare elasticity at £1.00	-0.523	-0.400			
Trip Reimbursement Factor	53.4%	61.9%		62.50%	
Reimbursement payments per 10 million concessionary trips *(assumes a commercial fare of £1.199)*					
for revenue forgone	£6.41m	£7.42m	*15.9%*	£7.50m	*17.0%*
for additional cost[3]	£0.42m	£0.34m	*-18.2%*	£0.34m	*-19.5%*
Total reimbursement	£6.83m	£7.77m	*13.8%*	£7.83m	*14.8%*

It is acknowledged that in arriving at these estimates of elasticities, a number of technical judgements are required which create scope for uncertainty and debate. In general, the assumptions that have had to be made are regarded as more likely to underestimate these elasticity values rather than overestimate them. Consequently, it is concluded that the evidence presented within this report suggests that elasticities are higher (in absolute terms) than those set out in the original DfT guidance which will have helped inform schemes and appeal determinations.

[3] Assuming a payment of 9 pence per generated passenger

1 Introduction and Background

1.1 On 1st April 2006, older and disabled people in England became eligible for free use of off-peak local buses within their local Travel Concession Authority areas. Of the six English Passenger Transport Executives (PTEs), those in the West Midlands[4] (Centro) and Merseyside (Merseytravel) already provided free concessionary travel. For the remaining four, in Greater Manchester (GMPTE), South Yorkshire (SYPTE), West Yorkshire (Metro) and Tyne & Wear (Nexus), mandatory free travel replaced the previous concession that typically took the form of a flat fare, generally significantly lower than the previous mandatory half fare.

1.2 Travel Concession Authorities (TCAs) are obliged to compensate bus operators for providing concessionary fares under Regulations made by Government. These state[5] that it should be the objective of the TCA that operators are left no better off and no worse off as a result of participating in a concessionary fare scheme. The Regulations go on to identify the need for reimbursement to compensate operators for revenue forgone (that is, fares revenue that the operator would otherwise have earned in the absence of the scheme), and for additional costs necessarily incurred through participation in the scheme.

1.3 Implicit in both of these types of reimbursement is the assumption that as a result of having a lower than commercial fare, or no fare at all, concessionary passengers will make more journeys than if they had to pay the full commercial fare. In other words, it is assumed that the concessionary fare generates some proportion of the concessionary travel actually made. The concept of generation is therefore central to the calculation of operator reimbursement, both for revenue forgone and for additional costs.

1.4 Unfortunately, some degree of speculation is an unavoidable part of the process of calculating levels of generation. Many concessionary schemes have been in existence for a long time, and there is no hard evidence of what happened before concessions were introduced. The practical calculation of reimbursement therefore relies upon the application of two economic concepts, of demand curves and elasticities, to help establish the level of generation.

1.5 Demand curves are assumptions about how the demand for travel varies with fare. Elasticities are a measure of the sensitivity of demand to changes in fares. The two are inextricably linked: different forms of demand curve (i.e. with different mathematical formulations) show different relationships between fare, demand, and elasticity. There is not much evidence to demonstrate that one form of demand curve is more realistic than another, although most transport economists would probably agree that it is likely that the elasticity (in absolute terms) will rise with fare.

[4] In the West Midlands, from 2003 free travel was not available for those turning 60 but aged less than 65.

[5] The Travel Concession Schemes Regulations 1986, Regulation 4.

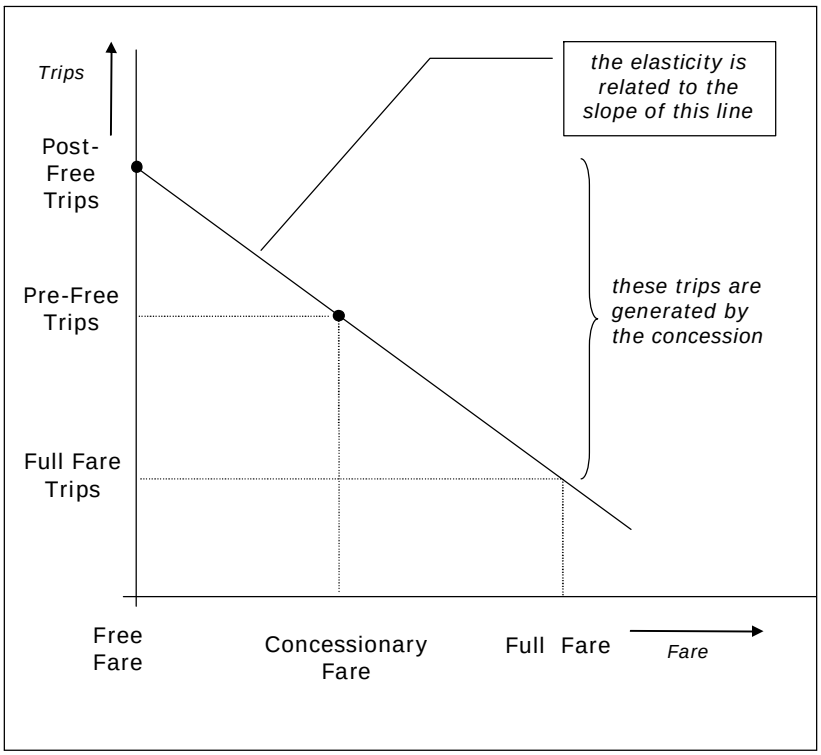
1.6 There is a substantial body of evidence available about fares elasticities, although prior to April 2006, much of the reported research was relatively old, and little of it was specific to concessionary passengers. The introduction of free travel has thus provided a unique opportunity to observe the effect of a significant change in the concessionary fare on concessionary travel demand, throughout England, except where free travel was already provided.

1.7 This note reports on the elasticities implied by the observed changes in travel volumes in the four English PTES in which flat fare concessions were replaced with free concessions in April 2006. The results are of particular significance, because the reimbursement arrangements for three of these PTEs, (and for two that were already providing free fares) were the subject of appeals by operators against PTE reimbursement arrangements, as were many of the schemes operated by other TCAs. An apparent key factor in the determinations of appeals was the issue of appropriate elasticity values, but because of the timing, it was not possible for evidence available from the introduction of free travel to be considered. That evidence is now available.

2 Methodology

2.1 A number of technical issues need to be addressed when inferring elasticities from the observed change in concessionary travel volumes, and in subsequently applying the elasticities to calculate reimbursement. Some of the principles are illustrated in Figure 2.1.

Figure 2.1 Role of demand curve in estimating reimbursement



2.2 The sloping line shown in the diagram represents the "demand curve". It illustrates a simplified example of a demand model – a mathematical expression defining the relationship between demand (i.e. the number of bus trips) and price (i.e. the bus fare).

2.3 The elasticity can be thought of as being associated with the slope of the line. A shallow slope implies that trip making is not very sensitive to price, and hence has a low elasticity (in absolute terms), whereas a steep slope implies greater sensitivity and a higher elasticity. In practice, demand models tend to define a shallow concave curve, but for simplicity these are often portrayed as a straight line.

2.4 The number of concessionary trips that are made can in principle be directly observed. But in order for operators to be left "no better off and no worse off", it is necessary to infer from the observed number of concessionary trips how many would be made if commercial fares were charged – the difference between the two being the number of trips assumed to be "generated" by the concession. The ratio of the trips made with the concession, and the number that would be made if

commercial fares were charged can be calculated, provided the slope of the line is known.

2.5 The introduction of free travel has provided the opportunity to observe the change in trips when the concessionary fare changes to zero from its previous value, which was half the commercial fare or less. Consequently, by fixing the slope of the demand curve from the observed change in moving from the pre-free concession to zero, it is possible to infer how many trips would be made if the fare was increased to the full fare. Finding an elasticity value that reproduces an observed change of trips in this way is known as “before and after” analysis.

2.6 The straight line shown in the diagram is a simplification; most practical demand models are curved, with the shape of the curve dictated by the mathematical formulation. In the past, PTEs have used a variety of assumptions about demand models. The Department for Transport issued guidance on concessionary travel reimbursement in 2005 and 2006, recommending one particular form of demand model known as the Proportional Elasticity Model. This model was used to test reimbursement levels during the 2006 appeals. Although other models may have equal validity, the Proportional Elasticity model has been used to calculate the elasticities reported here.

2.7 Apart from the issue of choice of demand curve, the other complicating factor in identifying an appropriate elasticity value is the potential increase in the number of passholders when free travel was introduced. Not all of those people who are eligible for a pass apply for one, for a variety of reasons, including perceived difficulty in obtaining the pass or low actual or potential levels of bus use. Take up rates are likely to be higher in large urban areas (such as those served by the PTEs) than elsewhere, and hence the scope for further passholding to be stimulated by the introduction of free travel will be relatively modest. Nevertheless, the inclusion of trips that are apparently generated by the free concession but which are associated with “new” passholders creates a need to ensure that elasticity estimates are based on a true like-for-like comparison.

2.8 It could be argued that the issue of new passholders is irrelevant to the issue of measuring elasticities. The way in which they have been taken into account here could therefore be regarded as leading to understatement of the estimates of sensitivity to fares. This issue is discussed in detail in the Appendix. In practical terms, the effect is that for each PTE, a proportion of the apparent growth in trips with the introduction of free travel has been assumed to arise from new passholders, and is taken out of the elasticity estimates.

2.9 It is also necessary to make some allowance for underlying trends, so that the comparison is between the number of trips that would have been observed in 2006-7 if free travel had not been introduced, and those actually observed. Thus the estimated increase in trip making has been calculated taking into account trend effects, and considering only trips by those passengers who would have held a pass even if free travel had not been introduced.

3 Headline Changes in Concessionary Travel Volumes

3.1 The underlying sources of data on concessionary travel volumes in PTE areas are the continuous on-bus monitoring surveys that each PTE carries out. These survey systems are used to calculate operator reimbursement, and are designed to satisfy well-defined precision criteria. In general, the accuracy of PTE surveys was not a subject of dispute in operator appeals during 2006-7. The great advantage of the PTE surveys, as a source of data for the purpose of calculating elasticities, is that the introduction of free travel did not change the process through which data is collected, helping ensure that estimates of concessionary travel before and after the introduction of free travel are comparable.

3.2 The total number of trips by older and disabled concessionaires reported by the four PTEs in 2005-6 and 2006-7 is summarised in Table 3.1 below.

Table 3.1 Gross change in older & disabled concessionary trips

Concessionary passenger trips (m)	GMPTE[6]	Nexus	SYPTE	Metro	Sum of all four PTEs
2005-6	33.258	30.212	27.067	36.779	127.316
2006-7	42.764	37.337	33.814	45.428	159.343
Percentage change	28.6%	23.6%	24.9%	23.5%	25.2%

3.3 Overall, the introduction of free fares increased concessionary travel volumes in 2006-7 by about 25% in the PTE areas. Growth in individual PTEs range from 23.5% to 28.6%. These increases are very much in line with those forecast by MVA in previous work for pteg, and also with experience from the late 1980s and early 1990s when some PTEs introduced a charge for concessionary travel having previously provided free fares. For example, there was about a 20% reduction in trips when free travel in Tyne and Wear was replaced with a non-zero flat fare in 1992, which if reversed would be identical to a 25% increase in trips.

3.4 It should be noted that in all the PTEs, it has taken some time for the full impact of the introduction of free travel to be apparent. Although the figures shown in Table 3.1 represent the actual 2006-7 figures, these do not necessarily reflect the full-year trip volumes associated with a stable post-free fare situation. Current indications are that substantial growth in trips is continuing to occur in some areas. At least 18 months of data is probably required to assess the full impact of free fares on concessionary travel volumes, and hence establish a sound long-term view of elasticities[7]. Including data for a longer period would almost certainly lead to an increase in the elasticity values found.

[6] GMPTE figures for both years exclude trips made in the morning peak, for which a concessionary fare of 50 pence was available and continues to be charged, and trips by the disabled which were already free.

[7] Note that even though established over one to two years, this should still be regarded as a short-run elasticity. Long-run elasticities, reflecting changes in travel patterns stretching over five years or more, would take much longer to identify, and would require a more sophisticated treatment of other factors than is attempted here.

4 Adjustments for External Factors and New Passholders

4.1 Meaningful estimates of elasticities from before-and-after analysis require the two sets of data to provide like-with-like comparisons. There are a number of factors that could influence changes in concessionary trips between 2005-6 and 2006-7 that are not related to the introduction of free travel. These include:

- changes in the eligible population;
- changes in the supply of bus services;
- allowances for secular trends additional to influences otherwise included.

4.2 With regard to the eligible population, the Office of National Statistics forecasts a gradual increase in the size of the elderly population (i.e. those aged 60 or more) in the PTE areas; its forecasts of the mid-year population in 2006 and 2007 were used to derive a straight proportional adjustment for this effect. Very little information is available on the size of the disabled population, nor on trends. Where separately identified, the disabled typically represent about 15% of elderly and disabled concessionary passholders. For simplicity, it has been assumed that the same growth trends apply to the disabled as to the elderly, even though there is no strong reason to suppose that there is a trend in the number of disabled in either direction.

4.3 With regard to the quality and quantity of bus services, it has been assumed in this analysis that there were no significant changes between the two years. This is a simplification, since in all four PTE areas, the two years of relevance have seen some significant changes in service patterns by different operators, more often than not leading to a reduction in headline indicators of bus supply such as bus miles. On the other hand, aspects of service quality may have improved through investment in buses and facilities. However, the judgement of PTE colleagues is that there is not a sufficiently strong body of evidence on the overall effects of these changes in isolation to justify an adjustment to "do-nothing" concessionary trip numbers, one way or another. Consequently, a neutral; "no change" assumption has been adopted here.

4.4 It should also be noted that the analysis has been carried out on aggregate data for all significant operators within each Metropolitan area (i.e. "County-wide"). Relative changes of market share between operators should not therefore influence comparisons of data between the two years to any significant degree. This is potentially a major problem with before-and-after data from individual operators, which is why in general elasticity analysis at a multi-operator level is the more robust approach.

4.5 With regard to the secular trend, there is consistent evidence[8] that concessionary travel in PTE areas has been in decline for the last five years and more, for reasons

[8] See "Concessionary Travel Trends", report prepared by MVA for *pteg*, April 2005.

that are not explained by demographic change, changes in bus service levels and changes in the concessionary fare. There appears to be a steady "unexplained" decline in concessionary travel which varies between PTEs from 1% per year to 2.5%. There is no reason to suppose that the underlying factors contributing to this decline would not continue to operate when free travel was introduced, and therefore it is assumed that this would have continued into 2006-7 had free travel not been introduced.

4.6 The analysis method applied these three factors to obtain an estimate of "Do nothing" concessionary trips in 2006-7, in other words, an estimate of the number of trips that would have been made if free travel had not been introduced and there had been no change in the concessionary fare charged in 2005-6, as summarised in Table 4.1.

Table 4.1 Adjustments to obtain estimate of "Do Nothing" 2006-7 concessionary trips (without free travel)

	GMPTE	Nexus	SYPTE	Metro	All 4 PTEs
2005-6 annual total trips (m)	33.258	30.212	27.067	36.779	127.316
Changes in: eligible population	0.7%	0.6%	1.1%	1.0%	
Bus service supply	0.0%	0.0%	0.0%	0.0%	
Secular trend	-1.0%	-1.0%	-2.5%	-2.3%	
"Do nothing" 2006-7 Old passholder concessionary trips (m)	33.149	30.086	26.676	36.294	126.205

4.7 Overall, these external factors have a relatively modest impact, reducing the number of trips by less than 1%, with some increase in trip making associated with population growth offset by the underlying trend of decline in concessionary passenger numbers.

4.8 The identification of the trips associated with new passholders is complicated, and is discussed in more detail in the Appendix. The approach adopted here is to estimate the proportion of passholders in 2006-7 who can be regarded as "new", in other words, were eligible for a pass but would not have applied for one if free travel had not been introduced. The proportion of 2006-7 free trips associated with these new passholders is then calculated by reference to the relative trip rates of "old" and "new" passholders. But there are uncertainties created by both the nature of the available data on passholder numbers, and also about the relative trip making characteristics of "new" and "old" passholders.

4.9 With passholder numbers, it is difficult to accurately monitor passholders who move away, give up their pass because of infirmity, or who have died. Although PTEs maintain databases of passholders, to varying degrees the aggregate statistics on the number of passholders tend to be in error because of the unknown number of passes no longer in use. However, with all the PTEs, there is a clear increase in the rate of new pass issues in 2006-7 compared with previous years, associated with the introduction of free travel. The increase in rate of issue is therefore used to measure the number of new passholders who have been stimulated to apply for a pass because of the introduction of free travel.

4.10 With regard to relative trip rates of old and new passholders, the main evidence that is available is from surveys carried out by MVA to monitor the impact of free travel in Wales in 2002 and 2003. This concluded that with free fares, new passholders typically made between 43% and 50% of the trips per week of old passholders. The free travel concession in Wales is significantly more generous than that in England, providing free travel at any time of day, anywhere within Wales. In addition, pre-existing pass take up in the PTE areas is much greater than was the case in Wales. It could be expected that higher take up rates would be associated with greater differentials between the trip making of passholders and non-passholders. Consequently, it is probable that use of the Welsh data overstates the extent of trip-making by new passholders relative to old passholders, and would imply that the resulting elasticities may be under-estimated in absolute terms.

4.11 This is supported by National Travel Survey data, which demonstrates that non-passholders are likely to make far fewer bus trips than passholders. Table 5.8b of the Transport Statistics Bulletin reporting on the National Travel Survey 2005 tabulates the trips per year of respondents aged 60 or over, by mode, by concessionary pass ownership. For Metropolitan areas, such as West Yorkshire, non-passholders make about 20% of the bus and rail journeys of passholders. This data predates the introduction of the national free concession. With the order of fare elasticity found here, of about -0.5, free travel might be expected to increase this ratio to about 30%, which is still significantly less than the 42.8% (from the Welsh survey) used in our calculations.

4.12 These assumptions lead to the following estimates of free trip making by new passholders, and hence identification of the number of 2006-7 trips made by old passholders.

Table 4.2 Calculation of free trips by "Old" passholders

	GMPTE	Nexus	SYPTE	Metro	Sum of all four PTEs
All free fare trips in 2006-7 (m)	42.764	37.337	33.814	45.428	159.343
Average number of passes on issue '06-7	326,000	203,600	217,700	374,700	1,122,000
of which new passholders	22,000	5,400	15,000	24,300	66,700
Percentage of new passholder trips in 2006-7	2.7%	1.2%	3.1%	2.9%	2.5%
Old passholder free fare trips (m)	41.624	36.086	32.771	44.112	154.593
Change in trips by old passholders in 2006-7 compared to 2006-7 "Do nothing" trips	25.6%	22.7%	22.8%	21.5%	22.5%

4.13 For all four PTEs, "new" passholders account for about 6% of the average number of passholders in 2006-7, although this varies between PTEs, with least growth in passholders occurring in Tyne and Wear. The proportion of free trips made by new passholders ranges from 1% to 3%. Consequently, when concessionary trips by new passholders are taken out of the calculations, the overall impact of free travel appears to have been to increase the concessionary trips made by old passholders in the four PTE areas in 2006-7 by 22.5% overall.

4.14 It is worth noting that the indications are that substantial growth in concessionary trips appears to be continuing into 2007-8. This is in line with research that suggests that the first year effect of a major fares change may be only 70% of the full effect that may become apparent over a two or three year time scale. Even on a conservative basis this would imply that if 23% growth has been observed in 2006-7 relative to 2005-6, growth in 2007-8 relative to 2005-6 could easily exceed 32%. This would lead to substantially larger elasticity values than those reported here.

5 Calculation of Elasticity Values

5.1 In order to calculate an elasticity, it is necessary to know the average level of fare actually paid in 2005-6, before free travel. Although most PTEs provided a nominally flat fare concession, the average concession paid will typically have varied because of:

- availability of a number of ticket types, some of which give a larger concessionary discount than others;
- short journey fares in which the nominal flat fare was greater than the mandatory half commercial fare;
- in some instances, operators provided a discount on the nominal concessionary fare, for commercial reasons (e.g. to attract a larger market share); and
- cash actually taken is sometimes less than that which would be calculated from the nominal fare because of an element of passenger fraud.

5.2 The estimates that have been used are largely based on PTE continuous surveys, but supplemented by operator returns, and range from £0.343 per trip in West Yorkshire to £0.460 in Greater Manchester.

5.3 Elasticity estimates have been calculated on the basis of the Proportional Elasticity model incorporated into the DfT's Toolkit. The form of this model is as follows:

$$T_F = k * Exp^{bF}$$

where T_F is the number of trips made at fare F. b is the proportional elasticity constant: it is the value of the fare elasticity at a given (fixed) fare level. With this model, the elasticity varies in proportion to the fare, so the convention used here is to define b relative to a nominal fare of £1.00. If it is known that trips increased from T_1 to T_2 when a non-zero fare F was replaced by a zero fare, then b can be calculated from the formula $b = Ln(T_2/T_1)/F$. $Ln(T_2/T_1)$ is the natural logarithm of the ratio of trips after and before the change, and F is the average concessionary fare before free travel was introduced.

5.4 The elasticities calculated for each of the four PTEs from this formula, together with the key items of data on which these calculations are based, are summarised in Table 5.1 below.

Table 5.1 Proportional Elasticity Constants and fares elasticities

	GMPTE	Nexus	SYPTE	WYPTE	All 4 PTE
"Do nothing" 2006-7 Old passholder trips (m)	33.149	30.086	26.676	36.294	126.205
Old passholder free fare trips (m)	41.624	36.904	32.771	44.112	155.411
Average concessionary fare paid in 2005-6	£0.460	£0.412	£0.381	£0.343	£0.398
Proportional Elasticity Constant	-0.495	-0.496	-0.540	-0.569	-0.523
Fare elasticity implications:					
at £0.50	-0.248	-0.248	-0.270	-0.285	-0.261
at £1.00	-0.495	-0.496	-0.540	-0.569	-0.523
at £1.50	-0.742	-0.744	-0.810	-0.853	-0.784

5.5 The conclusion is that evidence from the first year of the introduction of free concessionary travel points towards an average fare elasticity of about -0.52 at a fare of £1.00. This varies from between -0.495 and -0.569.

5.6 These values can be contrasted with the guidance on fare elasticities published by DfT in November 2005. The values suggested by DfT as "defaults" are summarised in Table 5.2; broadly these correspond with the average elasticity values reported in the most comprehensive recent review of public transport elasticities published in 2004[9] (DFPT).

[9] "The demand for public transport – a practical guide", R. Balcombe (editor), TRL 2004

Table 5.2 DfT default fare elasticity values (2005)

	Point elasticity at full fare	
	Central estimate	Reasonable range
Metropolitan areas (outside London)	-0.40	-0.25 to -0.55
Other Urban	-0.45	-0.30 to -0.60
Rural	-0.60	-0.45 to -0.75

5.7 Neither DfT, nor the DFPT report, provide indications as to the average fare values at which these elasticities were measured, typically only stating that they are at "full fare", although in its example Toolkit application DfT used a commercial fare of £1.00. It has therefore been assumed that they can be regarded as point elasticities at a nominal fare of £1.00, in which case they can be compared directly with fare elasticities at £1 shown in Table 5.1.

5.8 The principal conclusion is that the evidence from 2006-7 suggests that concessionary passengers in PTE areas exhibit significantly higher elasticities (in absolute terms) than the averages reported in DFPT. However, DFPT reports on a number of individual studies that have come up with equivalent elasticity values or higher, and this is reflected in the fact that when measured at £1 the values found here are largely within (but at the upper end) of what DfT suggested was a reasonable range.

5.9 It is not surprising that there is a gap between the emerging evidence from the introduction of free concessionary fares and established research results. Although pre-existing research on elasticities is extensive, it is largely for non-concessionary passengers, and was mostly carried out many years ago. Moreover, bus fares have increased significantly in real terms and if the underlying assumption of most demand models that fares elasticities increase with real fare level is correct, this alone would suggest that values obtained ten or more years ago would now be significantly higher than they were.

5.10 In addition the elasticities found here at concessionary fare levels are broadly consistent with historic research on elasticities obtained from changes in the concessionary fare. The introduction of successively higher flat fares in some PTE areas has typically led to the identification of fares elasticities at the "concessionary fare" part of the demand curve of the order of -0.25 (in Tyne and Wear, the West Midlands) and -0.3 (in West Yorkshire). These are close to the elasticities of about -0.26 at a fare of £0.50 which are shown in Table 5.1.

6 Implications of Elasticities for Reimbursement Levels

6.1 The reimbursement paid to operators is directly influenced by the elasticity used. Higher elasticity values imply that the difference between observed volumes of concessionary trip making and the volume of trips that would be carried if commercial fares had to be paid will be greater (in other words, more trips will have been generated by the concession). All other things being equal, higher elasticity values mean that reimbursement for revenue forgone should be less. On the other hand, if reimbursement is paid for additional costs, then a higher level of generated trips may increase these payments, but almost certainly less so than reductions in payments for revenue forgone.

6.2 The best indicator of the level of reimbursement for revenue foregone is the Reimbursement Factor, defined here as the ratio of commercial trips (that is, the trips that would be made in the absence of the scheme) to the number of concessionary trips actually made.

6.3 Table 6.1 sets out the Reimbursement Factors that would be calculated from the application of the average PTE elasticity, based on the evidence from 2006-7, and the DfT's default elasticity value of -0.40. In both cases, the level of commercial fare that is assumed is the average across all PTEs of the actual commercial fares charged in 2006-7, which was £1.199. Also shown is the typical value of Reimbursement Factor imposed on PTEs by Appeal determinations. The actual values imposed (where provided explicitly) varied somewhat between determinations, although it was stated by the adjudicator that he believed that a fair reimbursement rate probably lay in the range 60% to 65%.

6.4 For completeness, the calculation also illustrates the implications of additional cost payments, assumed to be made on the basis of 9 pence per generated passenger.

Table 6.1 Reimbursement implications of 2006-7 evidence

	Elasticity based on		*Difference in payment levels relative to that based on 2006-7 evidence*	Typical factor imposed by deter-minations	*Difference in payment levels relative to that based on 2006-7 evidence*
	2006-7 evidence	DfT central estimate for Met. areas			
2006-7 average fare	£1.199	£1.199			
Fare elasticity at £1.00	-0.523	-0.400			
Trip Reimbursement Factor	53.42%	61.90%		62.50%	
Reimbursement payments per 10 million concessionary trips at the 2006-7 average commercial fare (£m):					
for revenue forgone	£6.41	£7.42	*15.9%*	£7.50	*17.0%*
for additional cost	£0.42	£0.34	*-18.2%*	£0.34	*-19.5%*
Total reimbursement	£6.83	£7.77	*13.8%*	£7.83	*14.8%*

6.5 On the basis of the evidence of the actual increase in trip making observed in 2006-7 when free travel was introduced, and the actual average commercial fare, the average PTE Reimbursement Factor would be 53.4%, rather than the typical value of 62.5% imposed by the Determinations. So if 10 million concessionary passengers are carried, the Reimbursement Factor of 53.4% implies that 5.34 million bus trips would continue to be made by passholders even if they had to pay the full commercial fare, so that the operator would receive revenue of £6.41 million. If additional costs were paid, at a typical rate of £0.09 per generated passenger, then the operator would receive additional reimbursement of £0.42 million. Total reimbursement to leave the operator no better off and no worse off would then be £6.83 million.

6.6 If the DfT's original central elasticity estimate for Met areas is used, the Reimbursement Factor would be 61.9%. Reimbursement for revenue forgone would be 15.9% more than the value based on 2006-7 evidence. Although additional costs would be 18% less, the total reimbursement calculated under DfT "default" assumptions would be nearly 14% more than if reimbursement is based on the actual 2006-7 elasticity value.

6.7 If the Reimbursement Factor typically imposed on PTEs by Appeal determinations is used to calculate reimbursement, then even greater levels of overpayment are implied. Revenue forgone would be 17% higher than if the elasticity based on 2006-7 evidence is used; and although additional cost would be 20% less, overall, the determinations would overpay operators by nearly 15%.

7 Sensitivity of Results to Input Assumptions

7.1 The estimates of elasticities described in this report are largely driven by the increases in concessionary trips reported by individual PTEs from their survey systems. As with all surveys, these are potentially subject to sampling and other forms of error, but there can be good confidence that the reported increases in trip making represents an accurate like-for-like comparison between 2005-6 and 2006-7.

7.2 However, other potential sources of uncertainty include:

- the adjustments made for population growth – these generally lead to a decrease in the estimate of trip growth associated with free fares, and hence reduce elasticity values. By applying growth in the 60+ population to all trips, including those by disabled people, this affect is probably overstated. More fundamentally, it could be argued that growth in the 60+ population will be fully accounted for by the underlying assumptions about growth in passholder numbers, and the additional adjustment for population is double counting. This would lead to underestimates of the size of the elasticity.

- allowance for changes in bus service supply – these are generally assumed to be neutral, even when it is known that bus operations have reduced bus service miles overall; and

- allowance for the secular trend – for all four PTE's, there is clear evidence that for the five years prior to the introduction of free travel there was a consistent downward trend in concessionary trip making, when changes in population, service levels and the concessionary fare have been taken into account. However, quantification of long term trends requires various assumptions which are potentially subject to debate.

7.3 These assumptions are therefore generally regarded as robust, and tending to err on the side of understating the extent of passenger growth associated with free travel rather than over-stating it. However, to illustrate the impact of alternative assumptions, Table 7.1 shows the elasticity and reimbursement consequences if the net effect was to increase or decrease the gross increase in trips by 2%, in other words if a 25% overall increase in trips was actually 27% or 23%.

Table 7.1 Sensitivity to overall level of growth in trips

	GMPTE	Nexus	SYPTE	WYPTE	4 PTE Average
Best estimate of Elasticity	-0.495	-0.496	-0.540	-0.569	-0.523
Implied Reimbursement Factor for £1.00 commercial fare	61.0%	60.9%	58.3%	56.6%	59.3%
Elasticity with +2% more free fares growth	-0.529	-0.536	-0.582	-0.617	-0.564
Trip Reimbursement Factor for £1.00 commercial fare	58.9%	58.5%	55.9%	54.0%	56.9%
Elasticity with 2% less growth	-0.460	-0.456	-0.497	-0.521	-0.482
Trip Reimbursement Factor for £1.00 commercial fare	63.1%	63.4%	60.9%	59.4%	61.8%

7.4 The typical impact of a 2% increase in the volume of growth attributed to free travel is to reduce reimbursement factors by about 2.5%, while reductions in growth have a similar but reverse effect.

7.5 The area of greatest uncertainty is probably the impact of new passholders. There are two issues here: the extent to which new passholders have been encouraged to apply for a pass by the availability of free travel, and the relative trip making of new passholders compared with “old” passholders. However, in PTE areas there is a reasonable degree of confidence that pre-existing levels of pass take up were already quite high, and correspondingly it might be expected that the use of bus trips by those not already holding a pass would be small.

7.6 Table 7.2 shows the effects on reimbursement factors of varying the assumed impact of new passholders, first by doubling the percentage growth in concessionary trips attributed to them (equivalent to assuming that new passholders make 86% of the trips per week of old passholders), and then by halving this percentage.

Table 7.2 Sensitivity to alternative assumptions about new passholders

	GMPTE	Nexus	SYPTE	WYPTE	Four PTE Average
Best estimate of elasticity	-0.495	-0.496	-0.540	-0.569	-0.523
Implied Reimbursement Factor for £1.00 commercial fare	61.0%	60.9%	58.3%	56.6%	59.3%
Elasticity with double new passholder trips	-0.448	-0.474	-0.473	-0.499	-0.471
Reimbursement Factor for £1.00 commercial fare	63.9%	62.3%	62.3%	60.7%	62.4%
Elasticity with half new passholder trips	-0.518	-0.507	-0.572	-0.604	-0.549
Reimbursement Factor for £1.00 commercial fare	59.6%	60.2%	56.4%	54.7%	57.8%

7.7 Overall, doubling the assumed percentage of new passholder trips adds 3% to the average reimbursement factor, although this varies between PTEs depending upon the central estimate of the scale of new passholding. The biggest effect is in West Yorkshire, while the smallest is in Nexus. Reducing the percentage of new trips to a half of the central estimate results in a fall in the reimbursement factor of about 1.5%, again varying by PTE.

7.8 These sensitivity tests demonstrate that the elasticities, and consequently reimbursement factors and reimbursement payments, are highly sensitive to these assumptions. In many application areas, the differences in elasticity values shown would not be regarded as of great significance; indeed, it would be regarded as unjustified to quote elasticity values to three decimal places, as we have here. Unfortunately, with concessionary travel reimbursement there is an inescapable need for precision because of the financial implications of the arithmetic, even though on an objective basis the apparent precision is arbitrary.

8 Conclusions

8.1 The evidence from the introduction of free travel in the four PTE areas that did not previously have a free concession is that fare elasticities are higher in absolute terms than previously accepted average values, although largely within the range suggested by the DfT to be reasonable. There are areas of uncertainty in the estimates, but sensitivity tests do not suggest that alternative assumptions would lead to elasticity estimates close to the central estimate originally recommended as a default value by DfT. Overall, the assumptions that have been made are regarded as more likely to lead to underestimates (in absolute terms) of elasticity values rather than overestimates.

8.2 The reimbursement paid to bus operators for their participation in concessionary travel schemes is extremely sensitive to the elasticity value adopted. If the elasticity values that have now been identified had been used as the basis for determining reimbursement in 2006-7, they would have led to significantly lower levels of reimbursement being paid to operators. The precise levels depend upon local average commercial fares and other local factors, but at the typical average fare value, the level of overpayment is likely to be about 15% more than the value that would leave operators “no better of and no worse off”. If the assumptions that we have made err on the side of lower elasticity values, as we believe is probably the case, the implied level of overpayment is even greater.

8.3 It was not possible to include in this research analysis of data from Merseytravel and Centro, the two PTEs in which there was no change in fares in April 2006. Whilst there is no recent evidence on which to base an estimate of local fares elasticity for older and disabled people in these two areas, it would be reasonable for these PTEs to base local values on the research reported here, which covers very similar areas in terms of demographic and bus service characteristics.

8.4 These calculations use the observed increase in trips in the 2006-7 financial year relative to 2005-6 to infer an elasticity for calculating reimbursement in 2006-7. It will take some time for the full impact of free travel on concessionary passengers to become evident. With continued growth in trips, it is likely that similar calculations made on the basis of the observed increase in 2007-8 relative to 2005-6 would imply even higher elasticities, and even lower levels of reimbursement than those suggested here. It is important that PTEs continue to monitor levels of concessionary patronage, and it is likely that in due course further elasticity estimates will be produced building on this additional data.

Appendix A – Treatment of New Passholders

The Issues

One of the complicating factors when identifying an elasticity for concessionary travellers is that the change to free travel is likely to have stimulated TCA residents who were previously eligible for a concessionary pass, but who had opted not to apply for one, to now obtain a pass. Their reaction to the change to free travel is more complex than that of "old" passholders (who are simply faced with a change in fare, since they previously had a pass), and it is simplest to seek to identify the elasticity from the change in trip making by "old" passholders.

The extent of passholding varies considerably between authorities; in denser urban areas where bus services are relatively good and the pass brings most benefit, take-up rates amongst older people may be of the order of 80 to 90%. However, in rural areas where bus services are sparse, significantly lower rates may apply, potentially as low as 20% to 30%. Clearly, the scope for increases in passholding will be much greater in those areas where take up is historically low compared with those where take up rates are already high. Take-up rates amongst disabled people are poorly understood, since data on the number of eligible individuals relative to the eligibility criteria adopted by individual authorities is not readily available.

The passholder statistics produced by authorities are extremely variable in quality, partly because the characteristics of passholders are likely to vary enormously. Many passholders use their passes very little, if at all. However, even where passholders are frequent bus users initially, it is inevitable that they will become less active as they become older and more infirm, and authorities will usually not be notified or passes returned when the named passholder gives up bus use, moves home or dies. Although some authorities require passes to be renewed on a regular basis (typically, between one to five years), some authorities issue passes "for life". Consequently, the number of passes issued at one point in time is inevitably greater than the number of "active passholders", or passholders who might potentially use them.

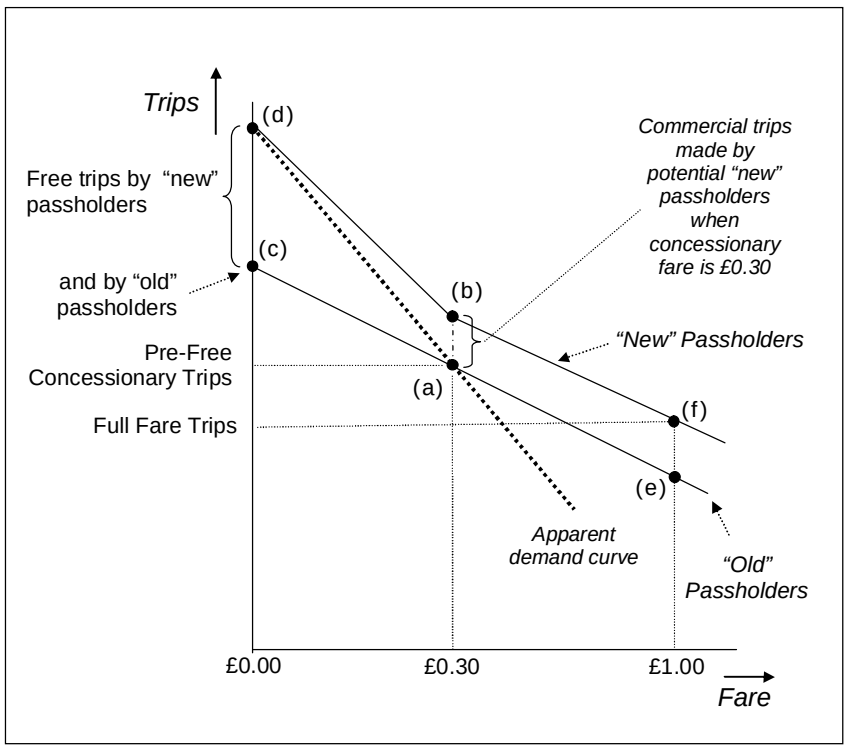
The change to a zero concessionary fare will have different impacts on existing passholders, and non-passholders. Existing passholders previously paying a flat or half fare can be expected to increase their trip making, to reflect the reduction in fare to zero. However, some potential passholders who at the previous non-zero fare had not applied for a pass can be expected to do so, and will then make some concessionary trips that will contribute to the apparent increase in concessionary trips arising from free fares. For simplicity, passholders who have been stimulated to apply for a pass because of the introduction of free travel are referred to here as "new" passholders, in contrast to "old" passholders.

It is not obvious to what extent new passholders will have been making bus journeys, by paying commercial fares, prior to obtaining their bus pass. It can be presumed that these individuals will be relatively infrequent bus users, otherwise the benefits from the pre-free scheme concession would have prompted the acquisition of a pass. There are a number of potential reasons why eligible persons might not obtain a pass, including personal circumstances, low levels of local bus service and perceived obstacles to obtaining a pass. The latter two are likely to be particularly prevalent in rural areas. It is understood that in many

areas operators claim to have detected a significant reduction in commercial trips at the time that free travel was introduced which is attributed to passengers switching to concessionary fares, but we are not aware of any evidence of this effect in PTE areas.

Implications for Elasticity Estimation

The difficulty that new passholders creates for elasticity estimation is that the apparent increase in concessionary trips associated with the introduction of free travel consists of two distinct components: the increase in concessionary trips made by "old" passholders, arising from the change from a non-zero concessionary fare to a zero fare; and the entirely new concessionary trips associated with "new" passholders. The latter will itself consist of two elements: trips previously made as commercial passengers, paying the commercial fare, that are now made as free concessionary trips; and newly generated concessionary trips, stimulated by the change in fare from the commercial fare level to free. This situation is illustrated in the diagram below.



The vertical axis represents the number of trips, while the horizontal axis represents the fare paid – note that the slopes of the lines shown have been exaggerated to illustrate the concepts. The lower of the two demand curves (labelled "Old" Passholders) is equivalent to that shown in Figure 2.1 in the main text, which would remain valid if new passholders could be ignored. Point (a) represents the demand at the pre-free concessionary fare, and point (c) is the demand with free travel associated with old passholders, whereas point (d) represents the observed concessionary demand with free travel, including trips made by new passholders.

It could be argued that the whole of the observed increase in concessionary trips is generated, (i.e. from (a) to (d)), and therefore should be included in the elasticity calculation. However, at least some of the free-fare concessionary trips associated with "new" passholders were being made as commercial trips when the pre-free concession was in operation. It is difficult to then

argue that they would not have been made as commercial trips if there was no concession at all. They are therefore not genuinely "generated", and in principle the operator should be compensated for these trips at the commercial fare, along with other non-generated trips. On the other hand, estimates of elasticities do not generally (e.g. in a conventional consumer goods situation) seek to exclude demand from new customers in their calculation. The approach adopted here will lead to the estimation of lower elasticity values (in absolute terms) than if the difference between new and old passholders was ignored.

In attempting to quantify these different components, the problem is that the commercial trips made by "new" passholders before they obtained a pass cannot be easily identified, nor can we directly identify the concessionary trips made by new passholders after free travel was introduced (the trips from (c) to (d)).

For the purposes of "no better off, no worse off" operator reimbursement, the quantity of interest is the volume of trips at full fares, for example at an average value of £1.00. With free travel, it is necessary to estimate the quantity (f), including those trips previously made at commercial fares by those who become new passholders.

In theory it is likely that differences in the characteristics of old and new passholders would be associated with differences in elasticities. However, given the challenge of estimating a single elasticity from the available data, it is proposed to adopt the working assumption that the fare elasticities of both sets of passholders are identical. In practice, what is required is an estimate of an elasticity applied to a demand curve leading from point (d) to point (f), with an elasticity derived from the change in trips by old passholders from (c) to (a).

The methodology adopted here relies upon estimates of the number of new passholders, and of the relative trip rate of new and old passholders, to estimate the number of trips represented by (c) to (d). This can then be subtracted from the total quantity of trips (d), which can be directly observed, to give the quantity (c). The increase in trips in going from (a) to (c), which is associated purely with the change in the concessionary fare, then allows the slope of the demand curve to be estimated by reference to the size of the pre-free concessionary fare.

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