Department for Transport

Concessionary travel for older and disabled people: guidance on reimbursing bus operators (England)

The Department for Transport has actively considered the needs of blind and partially sighted people in accessing this document. The text will be made available in full on the Department's website in accordance with the W3C's Web Content Accessibility Guidelines. The text may be freely downloaded and translated by individuals or organisations for conversion into other accessible formats. If you have other needs in this regard please contact the Department.

Department for Transport
Great Minster House
33 Horseferry Road
London SW1P 4DR
Telephone 0300 330 3000
Website www.dft.gov.uk

To order further copies contact:
DfT Publications
Tel: 0300 123 1102
www.dft.gov.uk/orderingpublications

Contents

1. Introduction

A mandatory national free bus concession for older and disabled people has been in place since April 2008, providing free off-peak local bus travel to eligible older and disabled people anywhere in England. Eligible older people are those currently over state pension age. Guidance on assessing the eligibility of disabled people can be found on GOV.uk.

The mandatory bus concession is administered locally by Travel Concession Authorities (TCAs). The following authorities are TCAs: County Councils, Unitary Authorities, former Passenger Transport Executives (now within Combined Authorities), and London Boroughs.

In addition to the mandatory bus concession TCAs are also able to offer discretionary concessionary travel schemes.

Provision for travel concessions in England is at present contained in five separate pieces of primary legislation: the Transport Act 1985, the Greater London Authority Act 1999, the Transport Act 2000, the Travel Concession (Eligibility) Act 2002 and the Concessionary Bus Travel Act 2007. The reimbursement of bus operators by TCAs for carrying concessionary passengers will also be governed by the Public Service Obligations in Transport Regulations 2023[1].

This guidance is solely concerned with how TCAs in England reimburse bus operators for concessionary travel in accordance with the legal requirements. The Department intends that this guidance will assist TCAs in their compliance with legal requirements. This guidance supersedes previous guidance published on reimbursement.

This guidance applies to schemes commencing on or after 1 April 2024.

This guidance has been informed by an extensive programme of research by the Institute of Transport Studies (ITS) in 2009, followed by a refresh and update carried out by SYSTRA and Frontier Economics Ltd in 2023. Representatives of local government and bus operators have been consulted and their views have been taken into account by the Department during the development of this guidance. The contents of the guidance, however, represent the considered views of the Department alone. Guidance on reimbursement will continue to be improved in the future as new evidence becomes available.

We would particularly draw the attention of practitioners to Annex D: Research and Summary of Evidence, which discusses a number of the updates which have been made to the calculator and to the guidance following the most recent research. Not all parameters in the guidance and calculator have been reviewed in the same level of detail – the focus has been on parameters which are

---

[1] Available at https://assets.publishing.service.gov.uk/media/652d4e5c6972600014ccf8fd/retained-eu-law-statutory-instrument-the-public-service-obligations-in-transport-regulation-2023.pdf

expected to drive material changes to the level of operator reimbursement and/or were identified by stakeholders as being desirable of review.

TCAs and Bus Operators should also note the provisions of the Travel Concession Schemes Regulations 1986 (under the Transport Act 1985) and the Mandatory Travel Concession (England) Regulations 2011 (under the Transport Act 2000). Both sets of regulations set out the framework for reimbursement arrangements and the appeal process.

This guidance is designed to provide pragmatic advice on calculating appropriate reimbursement for bus operators. It does not seek to be a definitive interpretation of the law, which is ultimately a matter for the Courts. It applies only to England (including London for the purposes of reimbursement of non-London Bus Network Services).[2]

The methodology set out in this guidance represents the Department for Transport's preferred approach for calculating reimbursement. TCAs are free to use the methodology of their choice in estimating reimbursement subject to ensuring compliance with relevant legislation that governs concessionary travel reimbursement. While the Department for Transport has drafted this guidance to be wholly consistent with legal requirements pertaining to the compensation payable to bus operators, in specific certain circumstances it may be appropriate to deviate from it in order to give effect to the 'no better, no worse off' principle. We strongly encourage TCAs to discuss reimbursement arrangements with their local bus operators at the earliest opportunity.

In determining appeals by bus operators, the Secretary of State (or decision makers appointed on his behalf) will apply the law relating to the compensation of operators. The Secretary of State will be guided by the Department for Transport (DfT) reimbursement guidance but will also consider any additional evidence brought forward by parties when determining appeals.

The guidance sets out:

- The legislative background;
- The appeal process;
- Background to reimbursement principles;
- Advice on how to estimate the revenue forgone and additional costs;
- Background to the theoretical framework for reimbursement, including a summary of the available research evidence;
- Information on the calculations in the Department for Transport's Reimbursement Calculator through worked examples.

The Department has also prepared a User Guide and updated Calculator to assist authorities and operators with calculating their reimbursement, which is available on GOV.uk alongside this guidance.

[2] Arrangements for compensating Transport for London (TfL) for the cost of the statutory concession on the London Bus Network are negotiated between London Councils and TfL.

Guidance on the £2 capped fare scheme is provided in Annex J.

If you want to discuss reimbursement guidance with other local authorities please register with the Knowledge Hub and then join the concessionary travel group.

Alternatively, if you have any comments, suggestions or questions about reimbursement you can contact the Department by email directly.

2. Legislative background

The legislative framework

Travel Concession Authorities (TCAs) are required to implement the mandatory travel concession as set out in the Transport Act 2000 and the Greater London Authority Act 1999, both of which were amended by the Concessionary Bus Travel Act 2007. The mandatory travel concession guarantees free off-peak local bus travel to eligible older and disabled people anywhere in England.[3]

In addition to the mandatory bus concession, TCAs are also able to offer discretionary concessionary travel schemes, using the powers provided in the Transport Act 1985.

TCAs are required by law to reimburse bus operators for carrying concessionary passengers. In respect of the mandatory concession, TCAs must reimburse bus operators for all concessionary journeys starting within their boundaries, regardless of whether the concessionary passholder making the journey is resident in the TCA area.

In both the Transport Act 1985 and the Transport Act 2000 there is provision for bus operators to apply to the Secretary of State for modification and in the case of schemes established under the Transport Act 1985, cancellation of the arrangements of the TCA, if they consider that there are special reasons why the arrangements would be inappropriate.

The mandatory concession

The provisions of sections 149 and 150 of the Transport Act 2000 apply in determining how operators are to be reimbursed in respect of the mandatory concession. The Mandatory Travel Concession (England) Regulations 2011 make provision for the reimbursement arrangements between Travel Concession Authorities and bus operators. A summary of the timetable for agreeing reimbursement arrangements as set out in the Transport Act 2000 is provided in Table 1.

With a mandatory draft publication date of 4 months before the scheme commencement or variation and a final publication date of 28 days before the scheme commencement or variation, this period of approximately 3 months is an opportune time for TCAs to share data and define reimbursement arrangements. It is recommended that this period is used as a discussion or negotiation period so that TCAs and operators can finalise reimbursement arrangements within the statutory timescales. In the interests of transparency, schemes could be published online on the TCAs website as well as an electronic copy of the agreement issued to operators within the statutory timescales. Should there be any commercially sensitive information contained

[3] Free local bus travel anywhere in England between 9.30am and 11pm on weekdays and at anytime at weekends and bank holidays.

within published arrangements, this should be removed before publication on the TCAs website.

Where TCAs publish a scheme for multiple years, it is expected that the scheme is published as above with details of how reimbursement will be calculated in future years.

Table 1 Mandatory concession timetable

Final dates for action (where X = date of scheme commencement/ variation)	**X minus 4 months**	**X minus 28 days**	**X plus 56 days**
Required process for the mandatory concession	TCA to publish reimbursement proposals in as much detail as possible to allow for meaningful negotiation. (Transport Act 2000, section 150(1))	TCA to determine final reimbursement arrangements (Transport Act 2000, section 149(2))	Last date for bus operators to appeal to the Secretary of State. Prior notice must be given to the TCA. (Transport Act 2000, section 150(4) and 150(5)

Discretionary enhancements

In addition to the mandatory bus concession, TCAs are also able to offer discretionary concessionary travel schemes. For example, schemes which go beyond the statutory minimum in one or more respects under the provisions of the Transport Act 1985. This does not necessarily require a separate scheme to be created; a scheme that offers benefits which include, but are more generous than, the statutory minimum will at the same time fulfil any obligation to ensure that the statutory minimum is provided.

The proposed arrangements for discretionary concessionary travel schemes should be published by the TCA at least 28 days before the scheme commences. It should be clear to operators from the published details what concessions they will be required to offer and the timing and amount of reimbursement that they can expect to receive to cover their revenue forgone and any additional costs incurred.

The Transport Act 1985 permits the service of a Participation Notice upon an operator who does not wish to participate voluntarily in a travel concession scheme made under that Act (a "section 93 scheme").

The operator may lodge an application to the Secretary of State regarding the Participation Notice if they feel that there are special reasons why their participation would be inappropriate, or if they consider that any details of the scheme or the reimbursement arrangements are inappropriate. Any such applications must be made no later than 56 days from the date the obligation to participate commences (or in the case of a new service from the date that the service is due to begin). TCAs can request a specific period of notice (of at least seven days) if an operator intends to appeal.

If, under section 97(2) of the Transport Act 1985, a TCA wishes to be in a position to serve a Participation Notice in the event of the operator indicating that he was not prepared to accept a Variation to the Scheme, then the Authority should allow a period of at least 56 days plus any time required for the delivery of notices between the issue of a Variation Notice and the date on which the Variation is due to take effect. This would allow 28 days for operators to respond to the Variation notice, and a further 28 days for the TCA to serve a Participation Notice.

When establishing what, if any, local enhancements to offer, TCAs need to consider how the reimbursement arrangements will work in practice and the potential impact on additional cost claims by operators. This is particularly important when the add-on involves a right to travel free, or at a concessionary rate, outside of the TCA's boundary (for example, cross-boundary travel before 9.30am on weekdays). It is important that in such situations there are clear and transparent arrangements in place with the neighbouring TCAs for reimbursing the local bus operators.

Ideally, bus operators should be able to claim reimbursement from the same TCA for all journeys starting in a particular area, with inter-authority arrangements to cover out-of-area take-up of enhanced concession. Unclear and confusing arrangements are likely to result in the bus operator applying to the Secretary of State for a modification of those arrangements.

The appeal process

The right of an operator to make an application to the Secretary of State for Transport for cancellation or variation of a Participation Notice under section 97(2) of the Transport Act 1985 and for modification of reimbursement arrangements under section 150(1) of the Transport Act 2000 is an important safeguard. This application process is often referred to as the 'appeal process'. The procedure is set out by Regulations made under the relevant Act, for example, The Travel Concession Schemes Regulations 1986 regarding the 1985 Act, and The Mandatory Travel Concession (England) Regulations 2011 regarding the 2000 Act.

Applications by operators should only be submitted after proper consideration and after attempts to reach a resolution at the local level have been exhausted. The time limit for making an appeal is 56 days from the commencement or variation of a scheme.

Any application submitted by an operator should be properly evidenced. Evidence is requested through the provision of a data proforma issued to the applicant operator and TCA by the Department. It should be made clear in the application and proforma exactly which elements of the reimbursement arrangements are being disputed. In its proforma, the TCA should set out the elements of reimbursement which it considers are in dispute. Operators and TCAs have the opportunity and are encouraged to comment on the other party's proforma.

It is expected that any evidence provided within an appeal should have already been shared between the TCA and operator (and vice versa). If new data or evidence becomes available outside of the formal negotiating period between the draft scheme publication and final publication dates, or during the notice period for a variation notice, TCAs and operators are strongly encouraged to share this evidence with each other, and before the submission of an appeal.

Even after the submission of an application, TCAs and bus operators are encouraged to continue local negotiation with the aim of reaching a settlement. An operator may withdraw their application at any time before the Secretary of State has reached a determination.

When a bus operator appeals a scheme but requests the appeal is postponed, this shall only be agreed if all parties agree to the pause (also known as a stay). The three parties involved in an appeal are the operator, the TCA and the Secretary of State for Transport, or their agent. The Department for Transport currently procures an Independent Decision Maker to review appeals.

The Department for Transport has published further guidance for TCAs and bus operators with regards to the appeal process which can be found on the Department's website and which will continue to be updated as part of the wider review into Concessionary Travel announced in the 2021 National Bus Strategy.

In determining appeals by bus operators, the Secretary of State (or decision makers appointed on his behalf) will apply the law relating to the compensation of operators. The Secretary of State will be guided by the DfT reimbursement guidance but will also consider any additional evidence brought forward by parties when determining appeals.

3. Principles of reimbursement

The objective –"no better, no worse off"

Providing free bus travel for eligible concessionary passholders is a major market intervention, and the requirements to provide adequate reimbursement to bus operators is fundamental. Equally, however, regulations prevent concessionary travel schemes being used to provide hidden subsidy (or state aid) to operators. The underlying principle which underpins reimbursement is set out in Regulations which state that operators should be left 'no better and no worse off'[4] as a result of the existence of concessionary travel schemes. The exception for this was during the COVID-19 Pandemic, when a number of temporary Statutory Instruments were introduced to remove the 'no better' clause. The last of these Statutory Instruments expires in April 2024.

This means that Travel Concession Authorities should:

- compensate operators for the ***revenue forgone.*** This is revenue that an operator would have received from those concessionary passengers who would otherwise have travelled and paid for a (full fare or discounted) journey in the absence of a scheme; and
- compensate operators for any ***net additional costs*** they have incurred as a result of the scheme. This includes the marginal costs of concessionary journeys which would not have been made in the absence of the scheme, or 'generated journeys'. It also includes scheme administration costs. These costs are net of additional revenue.

TOTAL REIMBURSEMENT DUE = Revenue Forgone [R] + Net Additional costs [A]

The elements of reimbursement

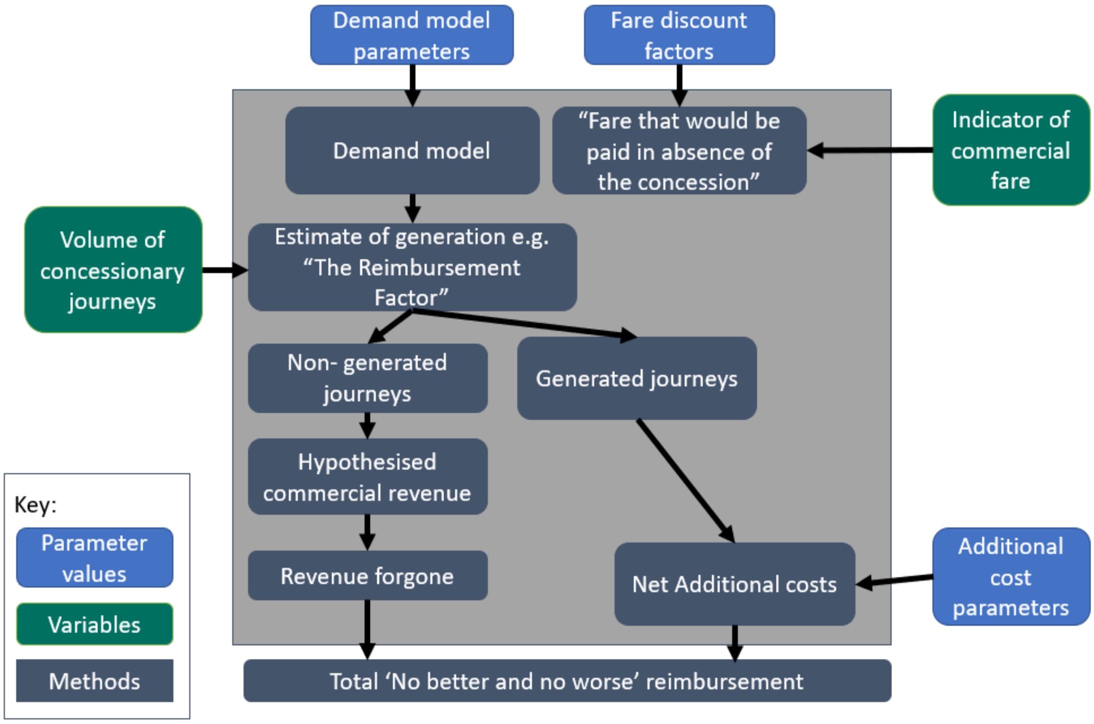
Calculating concessionary travel reimbursement is predicated on determining what would have happened in the absence of the scheme, otherwise known as the **counterfactual**. The counterfactual refers to a hypothetical situation (the absence of a scheme), it does not describe a particular point in the past. For example, it does not refer to the situation as it was in 2005/06 before the introduction of the national free-fare scheme.

The flowchart below illustrates how the various components of reimbursement, which are briefly described in this section, fit together. The rest of the guidance provides more detailed explanations as to what data inputs are required and how the different elements are calculated and combined. In addition, Annex A contains a Glossary of Terms, Annex C provides a simple illustration of how the

[4] 'No Better and no worse off' is in relation to what the situation would have been in the absence of the scheme, not in relation to last year or to the year prior to the introduction of the scheme.

different components of reimbursement are calculated and Annex G provides details of how the Calculator works, together with further worked examples.

Figure 1: Components of reimbursement



TCAs need to estimate the various components of reimbursement as outlined below.

The revenue forgone is an estimate of the revenue that would have been received in the absence of a scheme – it is therefore dependent on:

- The number of <u>journeys</u> that would have been made by concessionary passholders in the absence of a scheme if they had to pay a fare. These journeys are also known as non-generated journeys. This is covered in Section 6.
- The <u>fares</u> that would have been paid for non-generated journeys in the absence of a scheme. This is covered in Section 5.

Revenue forgone **[R] =** Non-generated journeys [N]
X
Average fares that would have been paid [F]

The approach to estimate the number of journeys that would have taken place in the absence of the concession is to apply an adjustment factor – the ***reimbursement factor*** – to the number of observed concessionary journeys made using the free fare concession. The reimbursement factor depends on the sensitivity to fare changes of passengers' desire to travel by bus. Annex B provides some theoretical background on the relationship between fares and the demand for travel.

Non-generated journeys **[N]** = Total concessionary journeys at free fare [J]

X

Reimbursement factor [RF]

The additional costs are made of up to four components (see Section 7):

- ***Scheme administration costs*** – these are administration costs associated with running the scheme.
- ***Marginal operating costs*** – the marginal costs of carrying passengers for generated journeys which include additional fuel, tyres and oil, maintenance and cleaning, insurance, information and additional time costs.
- ***Marginal capacity costs*** – the net costs incurred from additional capacity on a route to accommodate generated journeys.
- ***Peak Vehicle Requirement (PVR) costs*** – the costs associated with increasing the number of buses within the fleet to meet demand from generated concessionary travel.

Net Additional costs [A] = Generated journeys [G]

X

Net Additional costs per generated journey [C]

+

PVR costs [P]

+

Scheme administration costs (S)

Net Additional costs per generated journey **[C]** = Marginal operating costs [MOC] + Net marginal capacity costs [MCC] per generated journey

Generated journeys [G] = Total concessionary journeys at free fare [J]

X

(1 - Reimbursement factor [RF])

The Public Service Obligations in Transport Regulations 2023 state that an allowance for 'reasonable profit' must be made in public service contracts. There is an implicit allowance for operator **profit** within the revenue forgone element of reimbursement through the average fare forgone. In addition, it is recommended that a profit allowance be made, in the form of rate on return on capital employed for additional peak vehicle requirements. It is recommended that a profit margin of 10% is reasonable.

Approach of the guidance and tools

This guidance sets out DfT's preferred approach for calculating reimbursement based on the latest research and evidence available. TCAs are free to use the methodology of their choice in estimating reimbursement subject to ensuring compliance with the law. We strongly encourage TCAs to engage with their local bus operators as early as possible to help define the key variables in their schemes.

This guidance is concerned with providing practical advice on how to calculate reimbursement. [A Reimbursement Calculator based on the recommended methods is available on the DfT website.] The Calculator is provided to aid TCAs in their estimation of the total reimbursement required by operators and can be used to assist discussions and negotiations with bus operators. The Calculator is accompanied by instructions on how to perform the calculations and Annex C provides worked examples of some of the detailed calculations in the tool.

The methodology outlined in this guidance requires high quality data throughout in order to achieve an accurate estimate of reimbursement and TCAs and operators are encouraged to check and validate the data that feed into the calculations.

Research evidence

The advice provided in the guidance draws from extensive research commissioned by DfT from the Institute for Transport Studies (ITS) at Leeds University and more recently reviewed and updated by SYSTRA and Frontier Economics Ltd. The purpose of the research was to develop a robust, evidence-based framework for estimating concessionary travel reimbursement.

Annex D provides a summary of the main research findings and other relevant evidence which underpin the reimbursement calculation methods described in the guidance.

Level of calculation

Spatial aggregation

The principles set out in this guidance can be used at different levels of spatial aggregation (such as area, operator, route, service type) and ultimately TCAs need to consider what level of calculation is most appropriate in the view of local circumstances. It is suggested that generally, it would be sensible to undertake revenue reimbursement, marginal operating costs and marginal capacity costs calculations at operator level but this is subject to local circumstances.

Whatever the level of aggregation at which the calculations are made, the same type and coverage of average fare should be used to estimate the revenue forgone, as to determine the reimbursement factor. In both cases they should ideally be the level of average fare (or the change in average fare) that concessionary passengers would have paid in the absence of the scheme for a specific operator. A disconnect between the average fare forgone and the reimbursement factor (for instance by applying a TCA-wide reimbursement factor to an individual operator's average fare) may create an incentive for fares to be set with reimbursement in mind. Consistency in type and coverage of average fares particularly applies to estimating average fares and the change in average fares in future years.

Treatment of infrequent services, community bus services, small operators and small route legs

TCAs may wish to consider making special arrangements for the reimbursement of **infrequent bus services**. The reason for making this provision is that concessionary passengers using infrequent bus services may not have the same incentive or opportunity to increase the number of journeys as a result of the free scheme compared to more frequent bus services. The users of infrequent bus services are relatively small in number so do not show up in national surveys or datasets. However, such services are an important link for rural communities and can be an important part of the business of small bus operators.

This guidance recommends that the definition of infrequent services is a service of once a day or less.

The same principle applies to **community bus services** which are eligible for the national travel concession.

This guidance does not recommend a particular elasticity or reimbursement rate for either of these types of services. It is recommended that operators and TCAs should consider appropriate local data or results of surveys to determine appropriate reimbursement.

TCAs may also wish to have regard to the regulations governing concessionary travel reimbursement. These recognise that the application of a standard method may prove unduly onerous to both the authority and the operator in the case of **small operators**. In such cases the operator and the authority may reach an ad hoc agreement as to the reimbursement to be paid through negotiation.

Similarly, calculating reimbursement using a standard method such as provided in this guidance may be burdensome in the case of a small number of services going through a local authority for just a **few stops**, irrespective of the size of the operator operating these routes. In this case the TCA and operator may agree to calculate reimbursement off-model.

Timing of calculations

Data used in reimbursement calculations may change over the course of the year. For example, up-to-date outturn data on journeys or fares may become available, or forecasts of inflation may be revised. TCAs should consider whether they will want to reconcile calculations when more up-to-date data becomes available. Where TCAs take the view that their calculations will need to be reconciled and / or reviewed, it is advised that published schemes should set out clearly under what circumstances, at what frequency and how such reconciliation exercises are to take place. This is important to provide clarity from the outset to both TCAs and operators.

Failure to set out clearly the circumstances and method for reconciling/revising reimbursement calculations in published arrangements means that any significant changes to the level of reimbursement may constitute a variation to reimbursement arrangements under the Transport Act 1985 or the Transport Act 2000.

In terms of best practice, it would seem unreasonable to set scheme terms that:

- Limit the number of fare changes that an operator can apply in a year.
- Include clauses reserving the right for unilateral changes to terms at any time without consultation.

Where revisions/reconciliations take place, it is important to use the same type and coverage of average fare in estimating the revenue forgone and average fare used to determine the reimbursement factor.

Comparisons over time

When combining data across a number of years (for example in deriving the proportional change in fares between 2019/20 and the year for which the calculation is taking place), it is important that the figures used are on a like-with-like basis.

For instance, the data should cover the same range of services. Data based on a sample of months should cover similar periods and the periods should be chosen to be representative of concessionary travel. In comparing financial years, consideration should be given to normalising the data to take account of the fact that the timing of the Easter holiday period relative to the end of the financial year varies from year to year (a financial year may include one or two Easter holiday periods).

Data provision

Regulation 8 of the Mandatory Travel Concession Regulations 2011 stipulates that:

When formulating reimbursement arrangements, a travel concession authority may request information from operators which it reasonably considers relevant to assisting it in the formulation and operation of those arrangements.

Bus operators are therefore legally obliged to provide data (as long as it is available) relevant to the calculation of reimbursement except for the data items specified in Regulation 13. However, TCAs may only use the data in connection to reimbursement calculations and may not disclose the information without the prior written consent of the operator (Regulation 12).

We strongly encourage TCAs and bus operators to discuss data requirements at the earliest opportunity. For ease of reference, Annex E includes a list of the data items likely to be required if the DfT guidance and Calculator are being used to estimate reimbursement. Other data may be required if the TCA uses a different method for calculating reimbursement.

4. Measuring concessionary journeys

Of all the data items required to provide a sound estimate of reimbursement, the total number of concessionary journeys (boardings) undertaken by older and disabled people in the reimbursement period is most easily observed and should be the easiest to obtain.

According to DfT statistics, in 2022/23 94% of buses in England outside London accepted ITSO smart-cards,[5] while all TCAs should have their own HOPS[6] to record ENCTS journeys made in their own areas. Occasionally HOPS data does not contain all journeys made by passholders as cards, electronic ticket machines and HOPS data transfers could occasionally fail. TCAs may therefore wish to consider using HOPS data, whilst recognising that there could be a small adjustment required to accurately record all ENCTS journeys made.

[5] DfT BUS06d Percentage of buses used as public service vehicles with accessibility/technology features by metropolitan area status and country https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/114144%209/bus06.ods

[6] Host Operator or Processing System (HOPS) – a central back office which securely processes all smart transactions

5. Estimating the average fare

Introduction

Operators should be reimbursed for the average fare forgone, the fare that concessionary travellers would have paid for journeys made in the absence of a scheme. The average fare forgone features in reimbursement calculations in two ways:

- as a determinant of generation and the reimbursement factor (larger increases in fares imply higher levels of generation and a lower reimbursement factor) – see Section 6.
- as a direct input in the calculation of revenue forgone (revenue forgone = average fare forgone x observed concessionary journeys x reimbursement factor).

The calculation of the average fare forgone is not as straightforward as looking at the average equivalent single fare or the average commercial adult 'cash fare'.[7] In the absence of the concession, it is likely that some of those passengers who now use buses for free would have bought various discounted products such as travel cards, day tickets (or day caps) and weekly tickets which allow an unlimited number of journeys to be made in a given period. These products offer a lower average fare per journey and take-up of those types of tickets would therefore have had the effect of reducing the average yield per journey earned by operators. There is evidence from smartcard journey frequency data that some concessionary passholders use buses sufficiently often to make ticket type choice a real question in the absence of a scheme.

It is also plausible to suggest that in the absence of a scheme operators would want to consider their marketing strategies to older people very carefully and either introduce discounted products for some of those now benefiting from the concession or rebalance the tariff structure (such as lower off-peak fare, higher peak fare) or combinations of both. However, there is not sufficient evidence to be able to quantify this potential effect.

In general, we would therefore expect the average commercial adult cash fare to be higher than the average fare forgone that concessionary travellers would have paid in the absence of a scheme. It is therefore not appropriate to use the average commercial adult cash fare in reimbursement calculations. However, there may be some circumstances where an operator does not offer discounted tickets or where tickets are priced such that they attract only a very small minority of passengers. In those cases it may be appropriate to use the average commercial adult cash fare as a proxy for the fare that would have been paid in the absence of a scheme.

---

[7] The average equivalent single fare is the fare that would have been paid by the passenger if a cash single ticket had been purchased. A cash fare is a type of ticket that allows the purchaser to make a finite number of journeys such as singles, returns or fixed trip carnets.

Recommended approach

The recommended approach to estimate the average fare forgone is to use the **Discounted Fare method**. This method is the preferred default approach for all operators because fewer data inputs are required, they are easily auditable and it is not necessary to make assumptions about the journey rates associated with discounted tickets.

This method consists of applying a discount factor based on the prevailing ticket price structure for a TCA/operator to the average commercial adult cash fare. This is similar to the Basket of Fares method except that the underlying journey frequencies used to derive the discount factor are based on observed data for the concessionary market and therefore reflect the actual travel behaviour of concessionary passholders.

The Discounted Fare method uses a lookup table developed using concessionary journey data from HOPS – more detail is provided from paragraph 5.15 onwards. TCAs can choose the most appropriate lookup table to reflect travel in their local area, or develop their own lookup table should they wish using HOPS or ETM data.

However, this approach may not be appropriate in certain circumstances as outlined below.

The Discounted Fare method is not appropriate for operators with predominantly **low frequency services**. These are defined as operators who have 60 per cent or more of concessionary passenger boardings (on services serving a TCA's area) carried on buses where the average weekday daytime frequency (09.30 to 18.00) is one bus per hour or less.

In these cases, TCAs can use the **Basket of Fares method** as a fall-back approach. This consists of estimating the average fare based on the average fare per journey of a range of commercial cash and non-cash fares weighted by the journeys that would have been made by concessionary passengers in the absence of the scheme using each ticket type. To guard against unintended consequences such as routes being split or reorganised to artificially meet the criteria, TCAs may wish to consider the combined frequency along a corridor as well as for individual registered services.

There are also some cases which cannot currently be catered for by the Discount Fare method (such as particular ticket combinations or price ratios) and where the Basket of Fare method should therefore be used:

- In the case of operators who a) only have **cash fares and weekly tickets (or caps[8])** but no daily tickets (or caps) *or* b) only **daily and weekly tickets** (or caps) but no cash fares.
- In the case of certain ticket price combinations which result in the **daily ticket to average cash fare price ratio to be greater than 5** (before or

[8] Caps relate to contactless EMV or ITSO Pay As You Go caps applied when bus users are offered a maximum price for travel during a given day, week or other period of time.

after degeneration). Users will be alerted to this problem when using the Calculator. This is not expected to be a common occurrence.

- There may also be some rare cases where the Discount Fare method may yield **implausible** results. For example, if using this method it is found that after degeneration the proportion of daily or period ticket to cash fare ticket sales is higher for concessionary passengers than for current fare paying passengers. In this instance the alternative Basket of Fares method of estimating the average fare would likely be a more appropriate method to use.

Finally, TCAs in large urban areas may have access to comprehensive journey data (such as from continuous sample surveys) and are able to develop average fare calculation methods in line with the principles of the DfT Discounted Fare methodology. TCAs in large urban areas may also have their own average fare lookup tables. In those cases it would be justified for those TCAs, in consultation with operators, to use their own data and methods to estimate the average fare forgone, or develop their own updated lookup table.

The table below summarises when the different methods should be applied:

Table 2: Recommended method to calculate the average fare forgone

Circumstances	**Method**
All cases except those below	Discounted Fare method
Operators with cash fares only	Average cash fare
Operators with no cash fares	Basket of Fare method
Operators with atypical ticket price combinations The daily ticket to average cash fare price ratio to be greater than 5 (before or after degeneration)	Basket of Fare method
Operators with ticket price ratios that lead to implausible results in the Discount Fare method The proportion of daily or period ticket to cash fare ticket sales is higher for concessionary passengers than current fare paying passengers	Basket of Fare method
Operators with predominantly low frequency services 60 per cent or more of concessionary passenger boardings (on services serving a TCA's area) are carried on buses where the average weekday daytime frequency (09.30 to 18.00) is one bus per hour or less	Basket of Fare method
Former Passenger Transport Executive areas	Local method
TCAs with appropriate smartcard data	Discounted Fare Method with locally derived smartcard lookup table

Discounted fare method

Introduction

This is the recommended approach for estimating the average fare for predominantly urban operators. The basic principle of this method is to calculate a discount factor to adjust the full commercial adult cash fare downward so as to reflect the fact that in the absence of free-fare schemes, individuals would take up discounted tickets.

The discount factor is derived from a sample of smartcard data on observed concessionary passholders journey frequencies at free fares from four different areas. These four areas have been selected to reflect: Large Urban, Medium Urban, Rural Areas and Mixed Urban/Rural areas. The journey data has been used to model how eligible people would allocate themselves to different ticket types (cash, daily and weekly tickets) depending on the relative price structure.

Ideally, we would want to base the discount factor on the journey distribution which would occur in the absence of the scheme but this is not observable so this has to be inferred from the distribution in the presence of the scheme (at free fares). However, in the absence of a scheme and faced with having to pay full fares, it is expected that individuals would make fewer journeys and would buy a different mix of ticket types. The journeys used to derive the four lookup tables are therefore adjusted to account for this (journeys are reassigned from discounted products to single tickets and the total number of journeys is reduced).

Smartcard data based on zero-fare concessionary journeys has the advantage that it records actual travel behaviour by concessionary passengers and will not be coloured by the prevailing commercial strategies of bus operators.

Lookup table selection

In previous guidance, one default lookup table was provided to enable TCAs and operators to derive an average fare using the discounted fare method. In this version of guidance, four lookup tables are provided for four different area types. These lookup tables reflect the travel making behaviours of passholders in those areas and provide TCAs and operators with greater choice. The four area types are:

- Large Urban area
- Medium Urban area
- Mixed Urban/Rural
- Rural

The benefit of having four lookup tables to choose is that it allows TCAs to choose the area most like their own, and that best reflects the journey making behaviour of passholders. There is no relationship between the choice of the demand curve (discussed later) and the selection of the lookup table.

Lookup tables have been provided to reflect the journey making characteristics of passholders within an entire TCA area. They are intended for use by a TCA for all journeys made within it and for all operators. However, there may be circumstances where an operator has a particularly unique set of circumstances that suggests that an alternative lookup table could be used to more accurately estimate the average fare forgone. An example of this could be an operator of a predominantly rural bus service, but which serves only a small part of an urban TCA. In such circumstances, the TCA and operator should consider what approach most accurately reflects the calculation of the average fare forgone.

All four lookup tables have been produced using data for between 45 and 49 weeks. Further detail around the derivation of the lookup tables can be found in Annex D.

TCAs and operators should select the lookup table that best reflects their local area. Table 3 below presents the characteristics of the four areas from which the lookup tables were derived to support this choice. It is very important that TCAs and operators do not select the table that provides the most favourable outcome, but the one which is most closely aligned with their local area and reflective of ENCTS passholder journey making behaviours. An analysis of local smartcard data contained within a TCAs HOPS can provide indicators that, when compared to the values in Table 3, help to make an informed decision. The average number of journeys per day when a card is used is a particularly helpful metric that illustrates the level of ENCTS journey making in an area.

Table 3 Properties of lookup table areas

Lookup Table	Description	Population	Density (population /sq. km)	Population (Over 65s)	Lookup Table Characteristics
Large Urban Area	Combined authority area	1.15m	2,100	0.20m	Journeys = 19,449,708 Unique Passes Used = 193,271 Number of days a pass is used (pass days) = 8,794,372 Average journeys made each day a pass is seen = 2.21
Medium Urban Area	Medium sized city	0.35m	5,000	0.05m	Journeys = 4,453,481 Unique Passes Used = 38,758 Number of days a pass is used (pass days) = 1,837,200 Average journeys made each day a pass is seen = 2.42
Mixed Urban /Rural	Large county area of mixed urban and rural settlements	1.25m	400	0.25m	Journeys = 6,661,511 Unique Passes Used = 127,485 Number of days a pass is used (pass days) = 3,505,073 Average journeys made each day a pass is seen = 1.90
Rural	County area of mostly rural settlements	0.90m	200	0.20m	Journeys = 4,390,618 Unique Passes Used = 92,390 Number of days a pass is used (pass days) = 2,194,713 Average journeys made each day a pass is seen = 2.00

There are differences in the outputs between the four lookup tables and these are worthy of some discussion. In all four lookup tables, 12 months of data was obtained initially, with some data removed from the analysis due to incomplete or erroneous data.

The average number of journeys made per day per card provides a comparable metric with which to compare the four datasets used to derive the lookup tables.

The medium-sized urban area saw 2.42 journeys per pass per day which is greater than the large urban area (2.21) and significantly greater than the mixed urban/rural (1.90) and rural areas (2.00). Typically, the higher the number of journeys made per pass day, the more likely that, in absence of a scheme, a greater proportion of passholders would have purchased day and week tickets compared to cash tickets. This would likely result in a higher discount factor and lower average fare, all things remaining equal.

The medium-sized urban area is reflective of cities that have dense urban populations – as reflected by the population densities in Table 5.2 - and frequent bus services serving urban and suburban areas.

The large urban area lookup table is more representative of Mayoral Combined Authorities, whereas the rural lookup table is representative of a large, predominantly rural shire authority area with a small city and a small number of small urban settlements. The mixed urban/rural lookup table is broadly comparable to the NoWcard lookup table from previously published guidance and calculators given the mix of urban settlements and rural areas in the area on which it was developed.

For those TCAs that have robust smartcard data and who wish to develop their own average fare lookup tables, this is encouraged as using local data is always more likely to better meet the ‘no better, no worse’ position. Annex F presents the methodology for how to develop a local lookup table.

The Smartcard data should be drawn from a sufficiently large sample (for example, cover enough representative weeks) and be appropriately cleaned for missing data before it can be used in the Discounted Fare Method. Annex F provides further information on how to clean and process smartcard data to derive a lookup table for use in the Discount Fare Method.

Generic ticket types

The only information required as an input for calculating the average fare is data on the prevailing ticket price structure expressed as the price ratio of three generic ticket types.

In practice, fare structures can be extremely complex with a wide variety of ticket types being available across different operators (singles, returns, carnets, five-day tickets, weekly tickets, monthly tickets, etc) and with various geographical (Zone, A, Zone B, Zone A+B) and temporal (peak/off-peak, weekends) combinations. Ticket products which are directly comparable are also likely to be branded with different names. It would be therefore difficult for TCAs to assemble a framework dealing with each distinct ticket product and monitor their prices.

The proposed method assumes that ticket products and their geographical and temporal dimensions can be summarised into three generic ticket types:

- ‘cash’ fares which entitle the purchaser to make a finite number of journeys which include cash singles, cash returns and carnets (for example ten journey tickets);
- daily tickets; and
- weekly tickets.

Although concessionary travellers would have made use of all sorts of ticket types, including monthly tickets, the three generic products outlined above are deemed to be a sufficiently representative way of summarising the range of non-cash fares relevant to concessionary travel reimbursement without creating too complicated an overall structure.

In practical terms TCAs will need to discuss with each operator how to map individual ticket products onto the generic ticket types. Decisions will need to be made as to which tickets are in scope and which are deemed to be not relevant to the concessionary market (such as annual season tickets, peak period tickets). Some pragmatic judgements may also need to be made about atypical products and how they fit into the three generic ticket types. Atypical products may include day carnet products in different pre-purchase denominations, multi-operator products, day or week caps amongst others. Each of these should be discussed and agreement reached over which product sales/prices to include within the cash, day and week ticket prices.

The types of products selected should as far as possible correspond to the period of the concession, include those tickets which apply within the TCA area and should **exclude child, student or other discounted ticket types**. In making choices about what tickets are in scope, TCAs and operators should attempt to come to a shared understanding of the likely ticket mix that concessionary passengers would purchase in the absence of the scheme. Note that weekly tickets are assumed to be in scope. A table in the Calculator next to the final calculated fare shows the final ticket allocation and journey distribution.

Preferably the mapping should be defined in terms of the internal ticket product codes that operators use in their ETM[9] systems, thus ensuring precision and auditability, and also facilitating production of data by the operator. A complete mapping exercise should only be needed when systems are initially set up, but should then be kept under review as operators change the product mix (but not as they change prices as this will be captured in the sales revenue data).

In some areas, multi-operator tickets may be widely available and may constitute a significant proportion of ticket sales. In those cases, TCAs should look to include these types of tickets in the calculations.

Price ratios

Once the various products have been mapped onto the generic ticket types, data on **total ticket sales** and **ticket revenue** for each of the three ticket types can be obtained from operators so as to derive the average price per journey. These data should be easily available and auditable and do not require operators to make assumptions about the number of journeys made with each ticket type.

[9] ETM or Electronic Ticket Machine

The average price of each generic ticket type can be derived as follows:

Average ticket price = Total revenue / Total number of tickets sold

Care will need to be taken in the cash fare category as this may comprise tickets with a different number of journeys per ticket. For instance, the total revenue for return tickets will need to be divided by two and the total revenue for carnets of ten journeys will need to be divided by ten before the average revenue per journey for cash fares tickets is calculated.

The example in the tables below illustrates how ticket revenue and sales data on the products which have been assigned to generic ticket types can be used to derive the average price of each ticket type. The examples are purely illustrative using made-up data. The Calculator includes a facility to calculate price ratios in this way. Only ticket sales and revenue data are required.

Cash fares

Table 4 Derivation of average cash fare (Illustrative example)

Product	Ticket price (£) [A]	Single journey multiplier [B]	Number of tickets sold [C]	Total revenue (£) [D]	Equivalent number of journeys [E=BxC]
Single Zone 1	£2.50	1	50,000	125,000	50,000
Single Zone 1+2	£3.00	1	180,000	540,000	180,000
Return Zone 1	£4.80	2	15,000	72,000	30,000
Return Zone 1+2	£5.60	2	90,000	504,000	180,000
Carnet (10) Zone 1+2	£22.00	10	5,000	110,000	50,000
All cash fares				1,351,000	490,000
Average cash fare (per journey) = £1,351,000 / 490,000 = £2.76					

Day tickets

Table 5 Derivation of average day ticket price (Illustrative example)

Product	Ticket price (£) [A]	Number of tickets sold [B]	Total revenue (£) [C=AxB]
Day saver (Advance)	£4.80	3,000	14,400
Day saver (Standard)	£5.00	20,000	100,000
All day tickets		23,000	114,400
Average day ticket price = £85,600 / 23,000 = £4.97			

Weekly tickets

Table 6 Derivation of average weekly ticket price (Illustrative example)

Product	Ticket price (£) [A]	Number of tickets sold [B]	Total revenue (£) [C=AxB]
5 Day saver	£18.00	3,000	54,000
7 Day saver	£20.00	1,000	20,000
All weekly tickets		4,000	74,000
Average weekly ticket price = £74,000 / 4,000 = £18.50			

Deriving the discount factor using the calculator

The three average ticket prices can be input in the Average Fare Calculator and the discount factor associated to that price structure is then easily derived. It can then be applied to the average cash fare reported for the period to derive the fare that would have been paid in the absence of a scheme:

Average fare forgone = Average cash fare x (1 – Discount Factor%)

Annex G explains in detail how the discount factor in the Reimbursement Calculator is derived by way of a worked example.

Different combination of ticket types

As discussed above, the Discount Fare method does not work if the only ticket types available are daily tickets and weekly tickets - in those cases the recommended approach is to use the Basket of Fare method. Other ticket combinations, cash fares / daily / weekly tickets or cash fares / daily tickets or cash fares / weekly tickets work with the Discount Fare method and the Calculator has a facility to enter the appropriate ticket combination.

Operators who only offer cash fares can calculate the average cash fare according to Table 2 (a template is included in the Calculator).

Basket of Fares Method

Introduction

This method is appropriate for TCAs to use where the discount fare method is not suitable, for example, for operators with a high proportion of passengers carried on infrequent buses.

It allows TCAs to estimate an effective discount rate by calculating a weighted average fare per journey from assumed usage of different commercial ticket types. It is not dissimilar to the first method but requires more data inputs and requires TCAs to make assumptions about the number of journeys that would have been taken with each ticket purchased in the absence of the scheme and the proportion of total journeys that would have been taken by concessionaires holding each type of ticket in the absence of the scheme.

Data requirements and method

Table 7 below illustrates how the average fare should be calculated using a basket of fares. It should be noted that this is an example with illustrative ticket types and illustrative assumptions about journeys per ticket. In particular, the suggestion of applying the method at a very disaggregated level or for different lengths of journey is entirely optional and depends on the types of products available.

Table 7 Basket of fares (Illustrative example)

Type of ticket [A]	Price £ [B]	Assumed journeys per ticket purchased [C]	Implied revenue per journey £ [D=B/C]	% of total journeys with this ticket type [E]	Weighted revenue per ticket [F=DxE]
Single (<1 mile)	1.50	1	1.50	3%	0.05
Return (<1 mile)	2.8	2	1.40	5%	0.07
Single (>1 mile)	2.50	1	2.5	22%	0.55
Return (>1 mile)	4.80	2	2.4	24%	0.58
Daily pass	5	3	1.67	33%	0.55
Weekly pass	18	16	1.13	13%	0.15
Totals				100%	
Weighted average fare					£1.94

The first step is to consider all the ticket types [Col. A] that would have been purchased by concessionary passholders in the absence of the scheme and the associated commercial price [B]. Operator or survey evidence will be helpful in identifying the most relevant basket of tickets. In deciding what tickets are in scope, TCAs and operators should attempt to come to a shared understanding of the likely ticket mix that concessionary passengers would purchase in the absence of the scheme. As a general principle, weekly tickets should be presumed to be in scope unless there is evidence to indicate that concessionary passengers would not purchase them in the absence of the scheme.

TCAs will have to make explicit assumptions about how many journeys [C] would have typically been made by holders of each ticket type. Although it is reasonably obvious for single and return tickets, it requires some judgements to be made on the use of multi-journey tickets. Again, good evidence from operators or surveys will be helpful in deciding what assumptions to make. Those operators who electronically record sales and uses of tickets using QR codes or smart cards should have good quality data upon which to determine the number of journeys made for each product type, and TCAs and operators are encouraged to share this evidence where it is available to aid discussions.

Another assumption needs to be made about the proportion of total journeys [E] that would have been made by eligible concessionary passholders in the absence of a scheme using each type of ticket. The percentage split does not correspond to the commercial share of journeys but need to be weighted in line with the likely purchase of such tickets by concessionary passholders.

From the data inputs above the following information can be derived:

- The implied revenue generated by each journey using a particular ticket type [D] – this is the price per ticket divided by the assumed number of journeys per ticket;
- The weighted revenue per ticket [F] – this is the implied revenue per journey multiplied by the percentage share of journeys made with this ticket type.

The average weighted fare per journey is the sum of the weighted revenues per ticket. In this example it is around £1.94. Clearly it is lower than the weighted average price of a single ticket.

In practice the best estimate of average fare in the basket of fares may be based on a combination of: (i) historical data (where available) about the types of ticket that those eligible for concessions previously bought; (ii) surveys of current concessionary travellers; and (iii) operator ETM data about the type of tickets being purchased now by non-concessionary travellers. Some quality assurance of these last two data sources would significantly enhance the robustness of this calculation. Asking concessionaires what ticket they would have bought in the absence of the scheme may not always give accurate data, and the travel patterns of non-concessionaires as indicated by ETM data may not reflect the likely patterns of concessionaires in the absence of the scheme. However, such data may help inform judgements made in applying this methodology.

6. Estimating demand

Introduction

The amount of revenue forgone that needs to be paid to operators is dependent on non-generated travel or the number of journeys that would have been made by current concessionary passengers in the absence of the concessionary travel scheme – it is not possible to observe this directly it and needs to be estimated.

As a reminder, the number of non-generated journeys can then be multiplied by the average fare forgone to calculate the level of revenue forgone by the operator.

Throughout this section, and for the sake of simplicity, reference to 'free fares' or 'free scheme' should be taken as meaning free or concessionary fares, as the same principles apply. This is only relevant where the TCA chooses to use its powers under the 1985 Act to enhance the local scheme by adding travel at reduced (rather than free) fares at times, on services, or for groups outside the national concession.

The demand for bus travel

The reimbursement factor

The level of non-generated journeys is best expressed by the ***Reimbursement Factor (RF),*** the percentage of journeys that would have been made in the absence of a scheme.

$$\text{Reimbursement Factor} = \frac{\textbf{Estimated}\text{ journeys made in the absence of the free scheme}}{\textbf{Observed}\text{ journeys made at free fare}}$$

The concept of a demand curve

To estimate the number of journeys made in the absence of the ENCTS, it is necessary to link the number of journeys made at free fare with the change in price arising because of the difference between the free fare under the ENCTS and what would have been charged in the absence of the scheme.

To estimate the number of the journeys that would have been made in the absence of the scheme, we need to understand how concessionary passholders' bus usage would have varied if they had to pay the prevailing commercial fares. An increase in bus fares is expected to lower the demand for bus journeys, meaning that fewer journeys would be made. In contrast a reduction in fares (all else equal) would be expected to increase the number of bus journeys made. An assumption is made that bus users respond to the real change in fares[10] (as opposed to the nominal change in fares). The change in the level of demand or journeys, compared to the change in fares depends on the responsiveness of users to changes in price. The ENCTS reduces the price of off-peak travel to £0, therefore driving an increase in the demand for bus journeys. This increase in demand is the source of the 'generated journeys' resulting from ENCTS.

As a first step to calculating the reimbursement factor for a given financial year, an estimate is needed for the factor in the baseline fares year (2019/20). This is provided by the outputs from the demand curves incorporated within the calculator. This factor will change between financial years depending on what the change to real fares would have been in the absence of the scheme. An increase in real fares between financial years would have reduced the number of bus journeys taken, therefore decreasing the reimbursement factor. Alternatively, a decrease in the real fare would increase the reimbursement factor. The scale of change to the reimbursement factor is driven by how responsive passholders are to changes in fares, in effect for an x% change in fares, what would be the resulting y% change in journeys. It is understood that the level of responsiveness varies by area type, therefore there are separate demand curves for 'Urban' and 'Non-urban' areas. Annex D provides detailed explanations of this conceptual framework and the research evidence which underpins it.

This relationship between fares and the number of journeys made is described by a demand curve. Annex B provides further background on these concepts and the impact of fares on the demand for concessionary travel.

Choice of urban/non-urban demand curve

As a general principle, it is recommended that TCAs which were formerly PTEs should use the urban demand curve. In addition to those former PTE areas, it is recognised that the responsiveness of passholders in some former non-PTE areas is more similar to the responsiveness of people in former PTE areas.

An important determinant of bus use is the level of car availability, which also has some influence on responsiveness to changes in bus fares. As with previous iterations of guidance, household car availability has been used to determine areas recommended to use the urban demand curve which are identified in Table 8. The method adopted to define which demand curve should be adopted for which areas is consistent with the previous methodology, but updated to reflect the most up to date evidence currently available from the 2021 census (noting car availability is not currently available by age in census 2021).

Car availability, when weighted by population density in individual local authorities within former PTE areas, showed that car availability ranged from 68% in Tyne and Wear to 74% in South Yorkshire (excluding London at 58%). Taking the top end of the range, which is considered to be indicative of similarity with former PTE areas, there were 24 local authority areas in England outside

---

[10] The change in real fares are those that have been adjusted for inflation by subtracting inflation from the nominal (cash) change i.e. change in real fares = change in nominal fares - inflation

former PTEs and London that had car availability lower than 74% (this excludes the Isles of Scilly).

Some of the areas identified in Table 8 are not TCAs themselves, but one lower tier Local Authority which is part of a larger TCA. In these circumstances, it is necessary for TCAs and operators to work together to identify the most appropriate method of reimbursement for journeys made by passholders from these areas. One option to consider is that journeys made by passholders from these specific areas are treated differently to those made by passholders from areas not in the list in Table 8. There are examples from other TCAs where reimbursement calculations are carried out using both the urban and non-urban demand curves for when journeys are made by passholders from urban and non-urban areas but boarding within the same TCA. In these circumstances, we would expect TCAs and operators to consider such an approach to reimbursement.

For the avoidance of doubt, the two demand curves relate to the inherent characteristics of residents from an area (for example, they reflect the car ownership characteristics of the population).

Table 8 Areas recommended to use urban demand curve

Former Passenger Transport Executive areas:	
South Yorkshire CA	Eastbourne
Tyne and Wear ITA	Hastings
West Midlands CA	Kingston upon Hull, City of
West Yorkshire CA	Leicester
Liverpool City Region CA	Lincoln
Greater Manchester CA	North East Lincolnshire
Other areas:	Norwich
Tees Valley CA	Nottingham
Barrow-in-Furness	Oxford
Blackburn with Darwen	Portsmouth
Blackpool	Preston
Brighton and Hove	Reading
Bristol, City of	Scarborough
Burnley	Southampton
Cambridge	Stoke-on-Trent
Derby	Thanet

A particular demand curve relates to the inherent characteristics of residents within an area. Therefore, it is the passholders from a particular area that impact on which demand curve to adopt. For example, if a passholder from a large urban area is making journeys in their own TCA, these journeys are most likely to be reimbursed using the urban demand curve. When they make journeys in other areas, these journeys should also be reimbursed using the urban demand curve – assuming this evidence exists within HOPS data or can be easily defined through surveys or operator ETM data. The converse is true of a passholder from a rural area making journeys, with all journeys they make being reimbursed using the non-urban demand curve regardless of location.

There is no automatic relationship between the choice of one of the two demand curves and selection of one of the four average fare lookup tables. TCAs and operators should choose the demand curve that reflects the journeys made by passholders in their areas, while selecting an average fare lookup table that best reflects journey making in their local areas, using the information provided in Table 2.

Application of the fare in the demand curve

This section of the guidance describes how the average fare that concessionary passengers would have paid in the absence of the concessionary fare scheme should be calculated for the reimbursement period. This section deals with how the average fare is applied to the demand curve in order to calculate reimbursement.

Principle

The demand curve measures the effect of changes in fare on the demand for journeys by concessionary passengers. The appropriate reimbursement factor must be calculated based on the change in local fares between 2019 and the current reimbursement period. This approach recognises that bus services are not now, and were not in 2019, homogenous in journey length or quality.

To calculate the reimbursement factor, it is therefore necessary to estimate the growth in real fares (nominal fares adjusted for changes in the Consumer Prices Index) between 2019 and the current reimbursement period. The higher the growth in real fares between 2019 and the current reimbursement period, the lower the rate of reimbursement will be and vice versa.

Growth in fares since 2019 and impact on reimbursement

The percentage change in real fares is as follows:

Percentage growth in real fares =

$$[(\text{Nominal fare}_{\text{current}} / \text{CPI}_{\text{current}}) / (\text{Nominal fare}_{2019}\ \text{CPI}_{2019})]$$

Estimating the growth in nominal fares between 2019 and the year of calculation

The best way to estimate a reimbursement factor for an individual operator is to use an estimate of the change in fares across the whole period which is specific to that operator. It is desirable for the calculation to be based on as large a sample of routes as possible and for these routes to be based on a representative sample period.[11] It is recognised that comparable fare data going

[11] It is preferable for the sample period to be one full (financial) year, making appropriate adjustments for seasonal oddities such as the Easter period falling twice in one (financial) year. Where it is not feasible, or disproportionately costly to use a sample period of one full year, it is important that the sample period chosen is demonstrated to be sufficiently reliable to have confidence that the sample period being used is representative of the full year. The first few months of the (financial) year are unlikely to be sufficient.

back to 2019 may not be readily available, for instance because there may have been significant changes to the operator's network or more simply because an operator is new to the market.

The suggested options to calculate the growth in fares required are as follows (in order of preference):

Option 1 – Comparing operator-specific fares between 2019 and the year of calculation

If the appropriate data are available, TCAs can produce a best estimate of the fare that concessionary passengers would have paid in the absence of a concessionary fare scheme in 2019 for a specific operator.

TCAs and operators may have a record of the fare calculation inputs used in previous reimbursement calculations from 2019. In these circumstances, it is necessary to derive an average fare for 2019 and the year of calculation using the same method with the same lookup table – assuming the discounted fare method is used.

It is important that deriving the proportional change in fare between 2019 and the year of the calculation is done using two comparable datasets, and that the comparison of fares is 'like with like'. The comparison of the 2019 fare and the year of calculation should, cover the same range of services. If operators have either taken over other operators or run new routes, or have closed routes, then these changes should be factored out as far as possible so that the comparison of fares is on a like-for-like basis.

Where a 2019 fare comparable with a fare in the year of calculation is not available, local authorities can consider the following next best options outlined below.

Option 2 – Using TCA-wide average fares from 2019

There may be instances when like-for-like comparisons of fares cannot be made at the operator level. For example if the operator did not run services in 2019, or there has been a radical change in the services run by the operator or records of fares do not exist in 2019. In this case the next best approach is to estimate the fare change for those operators within a TCA where data is available and calculate a TCA-wide average change in fare, potentially weighted by concessionary passengers carried on each operator's services. A weighted proportional change in fare since 2019 would enable TCAs to derive a reimbursement factor for those operators for which data is not available.

Non-zero fare concessionary schemes

TCAs can offer enhancements to the national statutory scheme and some of these provide non-zero fare enhancements, for example before 09.30.

The reimbursement factors produced by the demand curve can be used for a non-zero fare concessionary scheme by running two versions of the calculator and comparing the difference between the two:

- a "normal" version of the calculator comparing the situation with the zero-fare scheme and without, and capturing the number of non-generated journeys at the full average fare; and
- a "non-zero fare concessionary scheme" version of the calculator, where the average fare in the calculator is replaced by appropriate percentage reduction to the average fare, and difference in the number of non-generated journeys.

By comparing the results of these calculators, the number of non-generated journeys affected by the non-zero fare scheme can be calculated.

7. Estimating additional costs

Introduction

In order to meet the principle of “no better, no worse off” bus operators should be reimbursed for the additional costs incurred as a result of the concessionary travel scheme. This section provides guidance on the procedure for calculating the amount of additional costs. It outlines a recommended approach, describes the unit values to be applied and when and where to apply those values. Annex D goes into more detail about the research and thinking behind the recommended approach.

This guidance does not rule out the use of alternative approaches such as detailed network modelling or data analysis to estimate the effect on costs of passenger demand with and without journeys generated by the concessionary travel scheme. The application of an alternative approach depends on circumstances and in particular the availability of robust and verifiable data to populate models. It is desirable that such models should have a mechanism that includes the implications for the operator’s net revenues of changes in demand and frequency. If it is the opinion of the TCA or the operator that more reliable results could be obtained from an alternative approach, then they may use that approach. Operators may also wish to suggest alternative approaches that the TCA could adopt, though the final choice of a locally appropriate methodology rests with the TCA.

The research has investigated differences in cost relationships between areas. The differences tend to be relatively small overall though non metropolitan areas appear to have slightly higher costs than metropolitan areas. However, we recognise that such small differences will not always be the case so local data and local relationships can be used where these are demonstrably more appropriate. We also recognise that a different approach may be needed in a small number of places where the frequency of services and route density is significantly untypical, or the size of operators is small. Particular criteria are described below.

Types of additional costs

For the purpose of this guidance additional costs fall into four categories plus a set of other generic issues:

- Scheme administration costs;
- Marginal operating costs;
- Marginal capacity costs;
- Peak vehicle requirements;
- Other issues.

Scheme administration costs

Costs associated with the production of concessionary passes will be borne by the TCA. There are, however, other administrative costs borne by operators that should be reimbursed for. ‘Everyday’ operational costs such as publicity, ticketing and software changes are included within marginal operating costs and not reimbursed through administration costs. However, the collation of data and submission of monthly or periodic claims is considered to be within the scope of administration costs, while management time and costs incurred from requests for information are also within the scope of administration costs.

Administration costs are not intended to be claimed for covering the costs of an operator appeal or challenge.

The relevant amounts are a matter for negotiation between the TCA and the operator as administration costs should be based on the costs incurred and the evidence that sits behind those costs.

Marginal operating costs

Definition

Marginal operating costs are the costs to a bus operator of carrying an additional passenger assuming a fixed level of service. The components of these costs comprise fuel, tyres and oil, maintenance and cleaning, insurance, information and additional time costs. These costs exclude operators’ administration/management time but include costs such as publicity, ticketing and software changes.

Marginal operating costs are applicable to all eligible services and all eligible operators without the need for further information.

The calculation of marginal operating costs is split in two parts: a fixed element and a variable element, as discussed below.

Recommended value

The recommended value is **6.1p per generated journey** (at 2009/10 prices). Annex D provides further information on how this value was derived.

Variation by journey length

The marginal operating cost per additional concessionary passenger of 6.1p is based on an average journey length of 3.9 miles. If TCAs and operators have good evidence that the average concessionary journey length in their area is different from the default value, then they may use a local average concessionary journey length value instead and apply the following formula to calculate a marginal operating cost:

Marginal operating cost = 5.5 + 0.6 x [AverageConcessionaryJourneyLength (in miles) / 3.9]

All in pence 2009/10 prices

Evidence may come from surveys of passengers, observation of boardings and alightings or interpretation of ticket sales data. For the purposes of this guidance, evidence on the length of all concessionary journeys is sufficient (the distinction between the average length of generated and non-generated concessionary journeys is not essential).

Elements of marginal operating costs

If there are local circumstances where one or more elements of the marginal operating costs is significantly higher or lower than the standard approach then the TCA and the operator may negotiate a different rate. The research findings on the bottom up approach to estimating marginal operating costs have the following components:

Table 9 Elements of marginal operating costs

Item	Marginal cost per generated concessionary passenger (pence, 2009/10 prices)	Percentage of total
Fuel, tyres & oil Of which fuel	0.4 0.3	8% 6%
Maintenance & cleaning	0.1	2%
Insurance	2.7	54%
Information	0.5	10%
Additional time costs	1.3	26%
Total	5.0*	100

* Note: ITS previously identified a bottom up component approach to marginal costs, which has been retained. The total of these identified components comes to 5.0 pence. This is different from the recommended composite marginal operating costs of 6.1 pence. However, in making any adjustment for local variations to marginal operating costs they should be justified by reference to the components. If a change to any of the components is agreed then this change is scaled by the difference between 6.1 and 5.0. Thus if the agreed change is an increase of 0.5p in one of the components the recommended value is increased by 6.1*0.5/5.0 = 0.61 or to 6.71 pence (in 2009/10 prices).

The component values cited in the above table are deemed to be robust and should be applicable in most cases. However, if TCAs or operators have good evidence that the level of one or more of these components is significantly different in their area from that described above, then a revised level of marginal operating cost can be applied. However, components values should not be considered independently so as to avoid either party being selective with particular elements to the detriment of others. The guidance therefore suggests that a change should only be agreed when **all** components have been reviewed and evidenced.

The evidence to support a change should as far as possible be auditable and verifiable and clarify the way in which the calculation is different from the default value. For example, in the case of fuel costs a variation on the default values should state assumptions about passengers per tonne of additional weight, fuel economy and effect of additional weight on fuel economy. The insurance cost rate quoted above includes an allowance for the higher level of claims by concessionary passengers. Auditable evidence on claims paid or insurance costs per concessionary passenger might support a different value, and operators may be required to provide appropriate information to inform the TCA's judgement as to the appropriate rate to apply.

In cases where a different value is agreed by the TCA and operator then the overall marginal operating unit cost (6.1p) should be adjusted by a proportion using the relationship below:

Adjustment to Marginal Operating Cost = 6.1 x [**Agreed** item unit cost minus **Default** item unit cost] / 5.0

Marginal capacity costs

Definition

These are the costs to a bus operator of carrying additional passengers and allowing the capacity of bus services to increase, by using the existing bus fleet more intensively to provide that additional capacity through increased frequency.

Marginal capacity costs should be net of the additional revenue generated from commercial journeys that arise from increased frequency. These costs are additional to the marginal operating costs.

Additional marginal capacity costs arise from increased frequency. Issues relating to increased seating capacity (larger buses) are covered later on in the guidance in the 'Other issues' section.

When to apply marginal capacity costs

There is a presumption that marginal capacity costs could potentially apply to all routes within a network during scheme operating hours.

Method to calculate marginal capacity costs

Marginal capacity costs can be calculated using the DfT MCC Calculator (which gives an estimate in pence per generated journey) or other methods such as counterfactual or hypothetical network models where available.

When using counterfactual or hypothetical network models, it is important that the counterfactual represents the service that would be provided by the operator in the absence of the concessionary scheme. The operator will need to be able to demonstrate that the capacity being provided is additional capacity compared to what would have been provided in the absence of the scheme, and that this additional capacity is a result of an increase in passenger numbers because of the concessionary scheme. This could for example include the need to evidence different timetables to carry the extra concessionary passengers, analysis of the pattern of commercial patronage to show that it has fallen and that the current pattern of services is maintained because of concessionary services. It should also take into account the limits to the level of service reduction which the operator could make if he were to ensure an attractive level of service to the commercial market.

DfT MCC model[12]

Network approach to the calculations

The DfT MCC Calculator is a network model and as such **the preferred approach is to calculate marginal capacity costs at network level rather than route by route**, even though the data inputs to the model may only be available at route level. Annex I provides further detail on the marginal capacity costs.

However, TCAs and operators may wish to consider grouping routes/services with similar characteristics into subsets of networks rather than calculating an MCC for one single network.

The route data will need to be aggregated into network averages during scheme operating hours for use in the Calculator. Route data should be weighted using the number of journeys on each route. Annex I provides further advice on calculating network averages from route-level data.

Data inputs into the Calculator

It is recommended that local values should be used in the MCC Calculator wherever possible. However, default values have been provided should no local data be available. **It is advised that the Calculator is to be used with either all default values or all local values.** This is because mixing local and default values may distort the relationships between variables and lead to spurious results. This advice has been retained with the update in the guidance.

Some elements of the Calculator are fixed, such as the relationship between the change in demand and change in costs (Mohring factor), and the relationship between the change in service frequency and demand (frequency elasticity). These are fixed because they represent network averages.

Variables that can be varied locally include average bus occupancy, average speed, average one way bus route length (miles), average journey length, the proportion of journeys that are commercial fare paying in the period that the concession is valid and the average commercial fares. Where local data on these factors is not available, then default values are suggested in the Calculator (with the exception of the average commercial fare).

---

[12] Annex G includes a worked example and Annex H includes a more detailed explanation of how the Marginal Capacity Cost Calculator works

It is recommended that the default values for vehicle hour costs and vehicle mile costs (these are the cost elements which vary with time and with mileage) are used because of the difficulty in determining accurate local estimates. However, local values may be used where TCAs are confident that these estimates constitute an accurate, verifiable and auditable representation of marginal vehicle hour and vehicle mile costs (see further explanation below).

Table 10 summarises the various inputs to the model and which variables can be varied locally. When local values are used, it is preferable where possible, to base these values on one full (financial) year of data making appropriate adjustments for seasonal oddities such as the Easter period falling twice in one (financial) year, to avoid the perception of favourable selection of data. Where it is not feasible, or disproportionately costly to provide one full year of data, it is important the sample of data chosen is demonstrated to be sufficiently reliable for users of the data to have confidence that the data being used is representative of the actual operator specific value.

Table 10 Summary of inputs to the cost model

Variable	Use default values	Use local values
Mohring factor	0.6	0.6
Speed	Urban areas – 8.8 mph Non-urban areas – 10 mph	Local evidence
Average route length	Urban areas – 6.2 miles Non-urban areas – 7.1 miles	Local evidence
Average journey length	Urban areas – 3.1 miles Non-urban areas – 3.6 miles	Local evidence (or 50 per cent of route length)
Average occupancy	10 (passengers per bus mile)	Local evidence
Unit Costs (2009/10 prices) Vehicle hours Vehicle miles	 £13.30 £0.70	 £13.30* £0.70*
Demand response to service change	0.71	0.71
Commercial journeys as % of total in statutory concession period	65 per cent	Local evidence
Average commercial fare	Local evidence	Local evidence

* These may be varied locally subject to the caveats outlined below (Paragraph 7.43).

Vehicle miles & demand (Mohring factor)

This relationship is required to estimate the extent to which operators will change the frequency or network density of their services in response to changes in demand. It is a standard assumption that vehicle miles increase less than proportionately to demand.

For the purposes of this guidance we suggest using a **Mohring factor** of **0.6** (vehicle miles change by 0.6 per cent for every 1 per cent change in total demand). This is a network average and is therefore fixed whichever the approach chosen (default or local values).

Speed

The model provides a default **average speed** estimate of **8.8** mph and **10** mph for urban areas and non-urban areas respectively. The speed estimates should include turn times and recovery time but exclude scheduled breaks.

This variable can be varied locally.

Occupancy, journey length and route length

The default **average bus route length** is **6.2** miles in large urban areas and **7.1** miles in non-large urban areas. If operators or TCAs have good evidence that these averages in their local area are different then local averages may be used.

The default **average bus journey (boarding) length** is **3.1** miles in Metropolitan areas and **3.6** miles in non-Metropolitan areas. If operators or TCAs have good evidence that these averages in their local area are different then local averages may be used.

In many areas, average journey length data may not be readily available. It may be possible to derive an estimate using fare stage data. Alternatively, an estimate could be derived by making assumptions about the relationship between average journey length and route length. TCAs and operators could use a rule of thumb that the average journey length is about half the average route length. However, the 50 per cent rule of thumb may not apply for some types of services such as inter-urban services. TCAs and operators may wish to take into account how this relationship could vary depending on the nature of the routes under consideration.

The default value for **mean occupancy** is **10** passengers per bus mile. An estimate of average occupancy can be calculated from local data on total passenger journeys multiplied by the appropriate journey length and divided by local data on bus vehicle miles.

Where mean vehicle occupancies are lower than 4, this would calculate abnormal marginal capacity costs. Where mean vehicle occupancies are 4 or below, it is recommended that the marginal capacity cost model is not used, instead, TCAs and operators seek an alternative approach to estimating marginal capacity costs.

Unit costs

Marginal capacity costs are the costs of increasing the supply of bus services using resources from within the existing bus fleet. The costs include elements that vary with mileage and those that vary with time on the road.

The recommended cost rates are **£0.70 per vehicle mile** and **£13.30 per vehicle hour (in 2009/10 prices)**. These rates are applied to the calculated increase in vehicle miles and vehicle hours required to carry one additional passenger.

The derivation of these default values is explained in Annex D. It is recommended that the default values are used in the Calculator. Although data on vehicle costs may be readily available from operators' accounts, it is not straightforward to estimate a true marginal cost. As explained in Annex D, accounting models typically attribute elements of costs that may not necessarily be 'marginal' such as staff overheads and materials, vehicle maintenance and administrative staff. These costs are unlikely to vary with increases in the number of vehicle hours operated. For instance, for the purposes of calculating additional vehicle hour costs from an additional generated passenger, it is the costs that increase with additional vehicle hours that are relevant. However, if TCAs can satisfy themselves that locally derived values are an accurate measure of the true marginal unit costs and can be audited, then a local value could be used.

It should be noted that DfT default value for vehicle hour costs includes London (see Annex D for further details).

Commercial journeys as percentage of total journeys

The percentage of commercial journeys is used to derive average one way commercial boardings (by reference to the relevant average occupancy, average route length, and frequency). The number of commercial boardings is required to estimate the additional commercial revenue generated from the increased frequency (see MCC worked example in Annex H).

The figure should relate to the period during which the frequency effects take place. This is the same period over which the marginal capacity costs apply. Commercial journeys undertaken by children paying the full commercial child fare[13] should be included in the number of commercial journeys and in the number of total journeys, as these passengers occupy seats and generate a commercial revenue. It is most important that the definition of commercial journeys in this input is consistent with the definition used for the commercial fare (see below). The percentage of commercial journeys should be calculated as follows:

Commercial journeys as a percentage of total journeys = \

[commercial adult journeys + commercial child journeys]

/
[[commercial adult journeys + commercial child journeys + concessionary older/disabled journeys]

Where 'child' journeys refer to children paying the full commercial child fares

[13] Children paying the full commercial child fare excludes children paying a fare that is part of an arrangement with the local authority, such as a child concession

In England outside London, total commercial bus journeys as a proportion of total journeys is around 70 per cent, although there is some variation by broad area type (Source: 2021/22 DfT Bus Statistics, Table BUS01d).

A plausible estimate after 9.30 am is around **65 per cent**. If operators and TCAs have good evidence that commercial journeys as a percentage of total journeys in the period when the concession is available is significantly different in their local area then that data can be used.

Average commercial fare

The average fare to be used in the calculation of the offsetting revenue gain due to increased frequency of services should be the local average commercial fare per journey (including commercial adults and full-fare paying children). The different ticket types available to commercial passengers (such as cash fares, daily, weekly, monthly tickets and other season tickets such as three-monthly and annual tickets) their prices and the number of journeys made using the ticket should be taken into account. The fare data should be relevant to the operator or area to which the costs are being applied and should be consistent with the journey data used to estimate the percentage of commercial journeys. This fare is not the same as the average fare forgone (the fare that would have been paid by concessionary passengers in the absence of the scheme).

An example is shown below with illustrative figures:

Table 11 Calculation of the average commercial fare - Illustrative example

Type of ticket	Price (£)	Average Journeys per sale	Sales	Total Journeys (Sales journeys per sale)	Revenue (Sales price)
Single	2.5	1	500	500	1250
Return	4.8	2	100	200	480
Daily	5.2	3	50	150	260
Weekly	22	18	30	540	660
Monthly	70	80	10	800	700
Totals				2,190	3,350
Average commercial revenue per journey = Total revenue / total journeys = £1.53					

The first three columns are local data inputs (where available). The last two columns are calculated. The average weighted fare is total revenue divided by total journeys.

Demand response to service change

Evidence suggests that demand responds to increased frequency of bus services. For the purposes of this guidance we recommend that a long run service elasticity of **0.71** should be used in all cases (for a 1 per cent increase in frequency a 0.71 per cent increase in demand will occur in the long term). Annex D discusses this in more detail.

Net revenue effect

The net additional revenue per journey should be deducted from the gross marginal capacity costs to give net marginal capacity costs. In some cases, the net additional revenue per journey from commercial passengers may outweigh the gross marginal capacity cost from the generated concessionary passengers. In such cases the net costs are set to zero.

The calculation of the net revenue effect with the interaction of the demand response to service change, average fare and other factors is illustrated at Annex G.

The net marginal capacity costs are additional to the marginal operating costs.

Generated journeys

Marginal capacity costs are calculated per additional generated concessionary journey. This rate per journey is applied in the Calculator to the generated journeys. The generation factor used to estimate generated journeys should be derived from the reimbursement factor used in the calculation of revenue forgone (generation factor = 1- reimbursement factor).

Costs on subsidised journeys

Where the service is secured through Minimum Gross Cost tender, the level of service is specified in the contract. Given that the TCA takes on all revenue risk, the need for separate reimbursement for additional costs (additional capacity and marginal operating costs) does not arise.

Where the service is secured through Minimum Subsidy or Net Cost tender, the authority is determining the capacity it wishes to see provided so that additional capacity costs are covered through the tender process. However, in this case the operator should be reimbursed for the marginal operating cost of carrying additional passengers on that secured capacity.

Peak Vehicle Requirements (PVR)

Definition

These are the costs associated with the requirement to run additional vehicles in the peak period due to generated concessionary travel. Generated concessionary travel may add demand in the peak period of travel, change the peak period or not affect the peak period of travel. The latter is likely to apply in the majority of cases and in such circumstances no additional peak vehicle is required, and no peak vehicle costs are calculated.

When PVR costs apply

PVR costs apply where an operator can provide evidence that they have increased the number of and/or capacity of vehicles in order to accommodate generated concessionary passengers. If the operator wishes to claim additional peak vehicle requirements then the operator must supply data and analysis to support such a claim. The expectation is that additional peak vehicle requirements will be exceptional so that operators will have to demonstrate that exceptional or unusual circumstances are relevant.

Evidence to be provided

Operators wishing to make a claim for additional peak vehicle costs will have to supply detailed data on passenger loadings by route by annual (or neutral period) average weekday half hour (or if not possible hourly) intervals for all services (individually) covered by the claim. As a minimum the time periods covered should be 0700 to1900 weekdays. If the existing peak of boardings (including concessionary travel) per hour or half hour, or the peak hour or half hour without generated concessionary travel is at the weekend, data should be supplied for the weekend hours as well.

Data on passenger loadings should be broken down into concessionary journeys under the statutory concession, other concessionary journeys and other journeys. In addition, the concessionary journeys under the statutory concession should be split between journeys made because of the statutory concessionary travel scheme and those that would have been made at the relevant average adult fare in the absence of the concession. This split should use the generation factor derived in the revenue reimbursement part of the calculation and assume that the rate of generation is the same in all time periods.

This methodology does not imply that every peak demand is met in full by putting on extra buses. Operators should demonstrate the criteria they use to decide whether to put on extra services to meet peaks in commercial journeys or allow load factors to be above 100 per cent for short periods.

Calculation

The formula to use for working out the peak vehicle requirement (PVR) is derived from the peak vehicle requirement parameter of **£23,908** (2022/23 prices) – this is the cost per vehicle per annum that has to be added to the fleet to cater for additional concessionary journeys (Annex D provides further information on how this value was derived). Operators and TCAs can use an alternative value if it can be demonstrated that these are the PVR costs incurred.

For future years, the PVR parameter of £23,908 should be adjusted based on CPI inflation or using more accurate local data if available to produce an accurate PVR cost per vehicle per annum.

This is a per year figure so equates to £91.95 per PVR per weekday or £2.30 per PVR seat per weekday assuming 260 weekdays per year and a mean of 40 seats per vehicle.

If the new peak lasts one hour and that each additional peak passenger blocks one seat for one route length, the PVR cost per **additional peak period passenger** can be estimated using the overall route time and speed. The calculation would be £2.30 multiplied by one way route time (expressed in hours, and based on local circumstances or defaults) = £[…] per additional journey in the peak hour (or period).

In cases where the peak period with and without additional concessionary journeys is the same time period, then the calculated unit cost per additional journey can be applied directly to the additional concessionary journeys in that peak period only to calculate a total peak vehicle requirement cost.

In cases where the peak period with generated concessionary journeys is different from the peak period without generated concessionary journeys, for example, where the pm peak is higher than the am peak, the calculation is slightly different. The unit cost may be different between the two periods if the one way route times are different, but otherwise would be the same. The additional concessionary journeys over which the unit cost is applied are the difference between journeys in the “with generated journeys” peak period minus journeys in the “without generated journeys” peak period.

In these calculations the period referred to may be an hour or half hour, but should be the same length of time, i.e. hour or half hour when comparing journeys in the peak period.

The following illustrative example demonstrates how the PVR calculations should be done using the 2022-23 PVR cost per vehicle:

PVR cost per additional peak period passenger (including profit allowance) = £2.30

Number of generated journeys on the service that has the additional PVR, and in the time period over which the PVR has been justified:

100 concessionary journeys * (1-reimbursement factor 0.5) = 50

Grossing up from weekday to annual = 260

Annual PVR cost for that service (in 2022/23 prices) = 260 x £2.30 x 50 = £29,900.

The peak vehicle requirement costs should be added to other elements of the additional cost calculation.

Profit

This guidance is informed by the relevant regulations and case law. The Public Service Obligations in Transport Regulations 2023 defines ‘reasonable profit’ as ‘taking account of the amount of any capital or other resources (or both) invested by the public service operator and the risk, or absence of risk incurred by the public service operator by virtue of public authority intervention, having regard to the size and nature of the services, including by transfer of financial risk around any capital investment, revenue or operating expenditure.

Reasonable profit is defined therefore as **expected rate of return on capital invested** and not a constant profit margin on all costs. In cases where an increase in the peak vehicle requirement is identified this guidance recommends that the reimbursement should include an allowance for profit.

In the light of evidence from a previous research report (Review of Bus Profitability, DfT – see Annex D) this guidance continues to recommend that where peak vehicle requirement is increased as a result of the additional concessionary journeys then a return on capital of 10 per cent is used and added to the PVR costs. This is done by obtaining the value of a vehicle and multiplying by **10 per cent**. This cost is then to be added to the £23,908 (See 7.16) above to calculate the total peak vehicle cost per additional passenger. Operators should derive the average value of a vehicle from their accounts (to reflect the present value of a bus), and this should be the average written down value and not the new value. Therefore the total peak vehicle requirement parameter cost should be

Total PVR cost = £23,908 + [Average written down value x 10%]

Other issues

Seating capacity

The unit costs and inputs in this guidance refer to an average seating capacity. It is recognised that a possible response to the increase in demand from generated concessionary travel would be to increase seating capacity rather than increase frequency of service. Where this is likely to be the case operators can submit, or may be required to provide, information on the extra costs arising from the use of larger buses, but these costs should not exceed the net costs of increasing frequency (including revenue effects) of using existing buses.

Different types of areas and operators

The ITS research produced indicative cost rates for services in Metropolitan and urban non-Metropolitan areas (the cost rates from this research have been retained in the SYSTRA/Frontier update but updated for inflation, under 'urban' and 'non-urban'). ITS also considered services in rural areas, and the relevant inputs that could be used. ITS noted that the calculations were problematic because they were based on frequency and route density effects normally found in urban areas. Also load factors on some services in rural areas may not warrant the application of marginal capacity costs. On the other hand, some services in rural areas serve urban areas and to some extent may have the same characteristics as services in urban non-Metropolitan areas. There is no hard and fast rule as to what constitutes a rural service, but we continue to suggest that where more than half of boardings are in rural areas then that service might come within the definition of rural. In the case of rural services so defined, this guidance suggests that the additional costs should be calculated as set out above, but that TCAs and operators should bear in mind that in order to meet the no better no worse off principle in Regulations there is scope for variation in approach according to local circumstances, such as frequency of existing service and load factors.

The approach adopted in this guidance is appropriate for larger operators. In some cases smaller operators may find that the approach does not match their circumstances, for example the ability to manage frequency changes within existing bus fleets. Operators with large fleets may find this easier as the variation in daily and hourly demand profiles for different services can be supplied from a common vehicle pool. Operators with small fleets (20 or less) may be less able to match supply with variations in demand from a common vehicle pool. In these cases this guidance suggests that small operators, in conjunction with the relevant TCA, should agree which aspects of the approach described in this guidance can be used and where different approaches are required. Different approaches should be evidence based and demonstrate that they are consistent with the 'no better, no worse off' principle. The evidence required to support a claim for a peak vehicle requirement would remain the same as described above.

Uprating figures

The marginal operating, marginal capacity and peak vehicle requirement unit cost figures quoted in the guidance are in 2009/10 prices. These are uplifted to 2023/24 prices using factors derived from an analysis of bus industry operating cost data provided by the CPT. These costs will serve as a base for all calculations in future years.

To uprate the costs to date, this guidance recommends that a bespoke composite cost index consisting of weighted driver and other staff costs, fuel costs and CPI is used; these are weighted 60%, 15% and 25%, respectively. This is done automatically in the Calculator. The Office for National Statistics (ONS) provide independent datasets on Average Weekly Earnings for the Transport and Storage sector, diesel costs and CPI.[14]

The guidance also suggests using the composite index for uprating of costs forecasts for future years using the same weights. The same composite index would be based on forecasts for Average Earnings and CPI which are available from the Office for Budget Responsibility (OBR); fuel costs are available from the TAG Databook, produced by the DfT. The relevant calculations to update costs are also done automatically in the Calculator.[15]

Other inputs to the calculation such as journey lengths should be left unchanged unless there is good evidence to change them.

---

[14] AWE: Transport & Storage Index: Non Seasonally Adjusted Total Pay Including Arrears - Office for National Statistics

A time series of the average petrol and diesel prices used in compiling the Consumer Prices Index. - Office for National Statistics

CPI INDEX 00: ALL ITEMS 2015=100 - Office for National Statistics (ons.gov.uk)

[15] Home - Office for Budget Responsibility (obr.uk)

TAG data book - GOV.UK (www.gov.uk)

ANNEX A: Glossary of terms

Additional costs

The costs imposed on an operator by the existence of the concession that would not otherwise have been incurred. Additional costs can take the form of scheme administration costs, marginal operating costs, marginal capacity costs and peak vehicle requirement costs.

Average fare forgone

This is the average fare that bus operators would have received from concessionary passengers in the absence of the free fare concession.

Bus journey

A bus journey is defined as a single bus boarding. The journey starts when the concessionary passenger boards the bus at a bus stop and ends when the passenger alights the bus. A journey is different from a trip in that a trip can include several separate bus boardings/journeys. However, the word 'trip' can sometimes be used to mean ‘journey’ in such expressions as 'trip frequency', 'trip rate', 'trip making'.

Damping factor

For the concessionary market, it is expected that the fare elasticity will increase less than proportionally with higher fares. The damping factor λ can be between 0 and 1. As λ approaches zero (the higher the damping), the point elasticity is both closer to zero and is less sensitive to the fare.

Degeneration

Degeneration is the process of reducing the number of journeys made by concessionary passholders within the discounted fare method of the average fare model to remove concessionary journeys generated by the free travel scheme.

Demand curve

The demand curve is the relationship between the price of a particular good and the quantity that is demanded by consumers at that price. As a general rule, the demand curve slopes downward from left to right. So the higher the price, the lower will be the quantity demanded, holding all other factors constant. This general rule is expected to hold for the concessionary market where the higher the fare, the lower will be the number of journeys made, holding all other factors constant.

Discount factor

The average fare forgone will be a weighted average of the single, daily, weekly and other period tickets that concessionary passengers would have bought in the absence of the scheme. This is generally expected to be lower than a single cash fare. So a discount factor is applied to the cash fare to obtain an estimate of the average fare forgone.

Fare elasticity

The fare elasticity in economics refers to the slope of the demand curve or alternatively the proportionate change in quantity demanded of a particular good with a proportionate change in its price. In the context of the demand curve for the concessionary market, an increase in fares is expected to produce a less than proportionate reduction in demand. Depending on the functional form of the demand curve, the elasticity at different points on the demand curve can vary proportionately with fares, or less than proportionately with fares.

Generation factor

The generation factor (GF) is a measure of the increase in journeys, relative to the previous level of journeys, as a result of a reduction in fares. For example, a generation factor of 50 per cent at half fare means that journeys have increased by 50 per cent (as a proportion of the original number of journeys) as a result of moving from full fare to half fare. Thus the definition of generation depends on the starting point. In this guidance, other than where stated, generation is based on patronage that would have occurred with 'average fare forgone' being charged.

Generated journeys

Generated journeys are those journeys that are made by concessionary bus passholders as a result of a reduction in fares – these are in addition to the non-generated journeys that would have happened anyway.

Marginal cost

In economics, the marginal cost is the change in total cost when the quantity produced changes by one incremental unit. In the context of reimbursement, the marginal cost is the increment in total cost that arises from one extra generated concessionary passenger journey.

Marginal capacity cost

If journey generation from concessionary passengers at free fare results in operators having to increase their service frequencies by using their existing fleet of vehicles, they will incur some additional costs beyond the marginal operating costs. These costs will include the additional fuel costs, bus driver costs etc of running the extra services.

Marginal operating cost

The marginal operating costs associated with an incremental passenger are the costs to an operator of additional (generated) concessionary journeys without any change in service capacity. These costs include wear and tear, insurance and fuel costs associated with the extra journeys.

Mohring factor

The Mohring factor is an estimate of the responsiveness of service frequency or network density of their services in response to changes in demand. It is expected that vehicle miles change in less than proportion to demand.

Non-generated journeys

Non-generated journeys are those journeys that are estimated to be made by concessionary bus passholders in the absence of the free fare scheme, if they had to pay 'the average fare forgone'.

Peak Vehicle Requirement costs (PVR)

If journey generation from concessionary passengers at free fare during peak hours results in operators having to extend their bus fleet, the additional costs that are incurred, for example the costs of purchasing the new vehicle, additional bus driver costs etc, are referred to as the PVR costs.

PTE area

An authority which was formerly within the Metropolitan Counties of the West Midlands, Greater Manchester, Merseyside, South Yorkshire, West Yorkshire and Tyne and Wear. These are now typically termed 'Metropolitan areas'.

Reimbursement factor

The number of journeys estimated to be made at 'average fare forgone' as a proportion of total journeys that are observed to be made at zero fare. The reimbursement factor is applied to the number of observed concessionary journeys at zero fare to estimate the number of journeys that would have been made in the absence of the scheme (non-generated journeys) and to determine the amount of revenue forgone. The reimbursement factor is closely related to the generation factor (mathematically RF = 1 / (1+GF)) and hence the fare elasticity. The higher the fare, the lower the reimbursement factor. The larger the increase in fare, the lower the reimbursement factor.

Revenue forgone

The revenue operators would have received from those concessionary passengers who would otherwise have travelled and paid for a (full fare or discounted) ticket in the absence of a concession. It is the product of the number of journeys made in the absence of a concession and the average fare forgone.

Urban and non-urban areas

In relation to the demand curves, urban areas are defined as former Passenger Transport Executive (PTE) areas, and areas that are not former PTE areas but have comparable levels of car ownership. Former PTE areas are typically extensively built up, with typically higher levels of public transport provision and lower levels of car ownership than other parts of the country. Please see table 8 for the full list of areas.

Non-urban areas cover all those areas that are not included under urban areas. It is noted that TCAs cover quite broad areas, and that TCAs classed as 'non-urban' may include within them some smaller areas typically defined as 'urban', such as cities. The definitions applied are based on the characteristics of TCAs as a whole. As detailed in section 6 for some TCAs defined as 'non-urban' it is appropriate to use the urban demand curve for specific lower tier authorities, while retaining the 'non-urban' definition and demand curve for the rest of the TCA. This is based on these lower tier authorities having characteristics that are distinctly different from the rest of the TCA.

ANNEX B: Economic principles

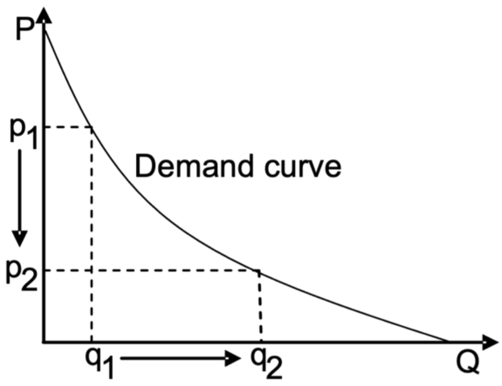
Introduction

This Annex provides some theoretical background on some of the economic principles which underpin concessionary travel reimbursement. Further information can be found in ITS Research Paper Economic Principles Underlying Reimbursement.[16]

The relationship between price and demand

The amount of any good or service that people buy depends, among other things, on its price. The relationship between the price of a particular good and the quantity that is demanded at any such price level is described by the demand curve. An illustrative example is shown below:

Figure 2 Demand curve



In the figure above, the x-axis is the quantity of the particular good demanded and the y-axis is the price of that particular good. Generally, the demand curve is expected to slope downwards from left to right indicating that the higher the price the lower the quantity demanded will be. As illustrated, a reduction in price from p1 to p2 leads to an increase in the quantity demanded from q1 to q2.

Another important aspect of the demand curve is its slope. The steeper the demand curve, the less responsive people's demand will be to a change in price. The slope of the demand curve at any particular point is referred to as the point elasticity of demand. This elasticity is usually negative as the demand curve slopes downward from left to right – people buy more as the price falls. However, for convenience, in discussions of the price elasticity the sign is often

[16] Available at https://webarchive.nationalarchives.gov.uk/ukgwa/20111005175844/http://www.dft.gov.uk/publications/research-into-the-reimbursement-of-concessionary-fares

omitted, and ‘higher’ elasticity values are generally meant to refer to larger elasticity values in absolute terms (so an elasticity of 0.5 might be referred to as being larger than an elasticity of -0.4).

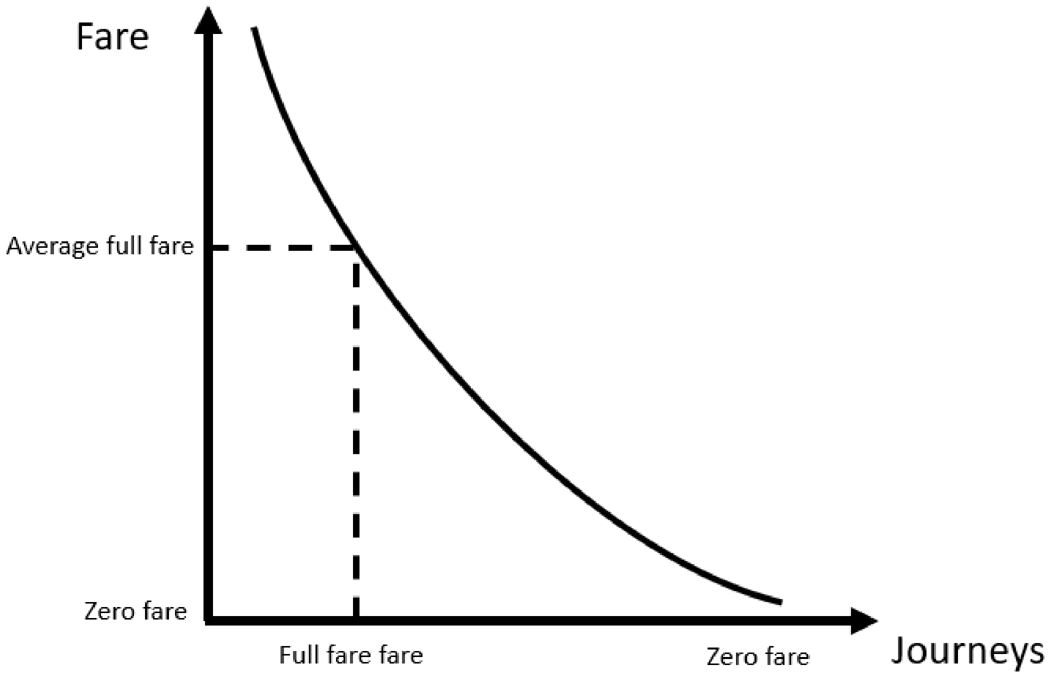
Demand for bus travel

The demand for bus travel is no different from that for other goods and services. As ticket prices change so do the number of journeys made by bus. The existence of concessionary fares schemes means that eligible travellers face much lower prices (in fact, zero outside the am-peak in most areas) and thus we would expect there to be more journeys made by these people than in the absence of a scheme. Indeed there is very strong evidence to support a relationship between falling fares and more journeys made by bus passengers.

The demand for essential goods and services tends to be more inelastic than demand for “luxuries” meaning the quantity demanded is less responsive to changes in price. In the context of bus users, demand for journeys to the nearest place where they can buy reasonably-priced food is likely to be less elastic than demand for journeys to distant places. People who are in employment (and many older and disabled people work) will have relatively inelastic demand for their journey to work. If they have no alternative means of travel (car, train, bicycle) their demand will be still more inelastic.

The impact of free fares on concessionary travel

Figure 3 Impact of free fares on demand for concessionary travel



The figure above illustrates the impact of the move from full fare to free local and national travel. The y-axis gives the average fare and the x-axis the number of journeys made purchased (in a year) for local bus travel. If the fare falls to zero then $\mathbf{t}_{\text{zero fare}}$ will be demanded. This represents the amount of concessionary travel.

In the absence of any concession the operator earns an amount equal to the number of journeys multiplied by the (average) full fare, here represented by the areas **a** and **b** (setting aside additional costs at this stage). Under a free fare scheme the operator earns no revenue from concessionary passengers. The operator needs to be reimbursed for the lost revenue from those who would have travelled at full price (the areas **a** and **b)**.

The difference between $\mathbf{t}_{\text{full fare}}$ and $\mathbf{t}_{\text{zero fare}}$ represents the number of additional journeys that are made by concessionary travel passholders because of the introduction of the free fare. To estimate the revenue forgone by the operator, the recommended approach is to apply an adjustment factor to $\mathbf{t}_{\text{zero fare}}$ to give revenue of **a + b**. This is obtained by applying a factor called the **Reimbursement Factor (RF)** to the average full fare. It is the reimbursement factor that determines the number of generated journeys and it is estimated to ensure that the operator receives the revenue it would have received in the absence of a scheme.

The reimbursement factor

The reimbursement factor is the proportion of journeys that are made at zero fare that would have been made in the absence of the concession.

Reimbursement Factor =

Estimated journeys made in the absence of the free scheme

Observed journeys made at free fare

The generation factor

The generation factor is the proportion of journeys that are made at zero fare in addition to those to those that would have been made in the absence of the concession.

Generation Factor =

Observed journeys made at zero fare minus

Estimated journeys made at full fare

Observed journeys made at free fare

Therefore, the higher the reimbursement factor, the lower the generation factor and vice versa.

Fare elasticity of demand and the reimbursement factor

There is a direct relationship between the fare elasticity of demand and the reimbursement factor. At higher fare elasticities, people are more sensitive to changes in fare, and the reduction in journeys in moving from free fares to the full fare will thus be greater than if lower elasticities apply. Therefore, holding all other factors constant, the higher the elasticity, the lower the reimbursement factor will be and vice versa.

Demand and the reimbursement factor

The calculation of the reimbursement factor requires the estimation of a demand curve for the whole concessionary travel market and thereby an estimate of the number of journeys made at full fare.

The shape of the demand curve

The demand curve can take one of several shapes depending on the specific characteristics of the market. Empirical evidence on the shape of the demand curve for the concessionary travel market is not clear-cut and a number of different sources of data, logical argument and assumptions are needed for its estimation. There is evidence on the behaviour of the adult commercial market in the region of adult full fares and the evidence about the concessionary market at zero fare. However, there is no recent information on the actual behaviour of eligible concessionary passholders at commercial fares so some extrapolation is required.

Based on the recommendations of the ITS and SYSTRA/Frontier research, the preferred demand function is a damped negative exponential curve taking the following form:

$$T = ke^{\beta F^{\lambda}}$$

where:

e = Mathematical constant (2.7183 to four decimal places)

T = Number of bus journeys at fare F

k = Constant

β = Elasticity Constant

λ = Damping factor (0> λ >1)

This functional form is referred to as the ***damped negative exponential curve***. It has the following desirable properties:

- It crosses the x-axis implying a finite number of concessionary journeys at zero fare.
- The elasticity is damped by λ so that a proportionate change in fares will result in a less than proportionate change in demand elasticity.

The damping factor

The formula for a fare elasticity based on the negative exponential demand curve is:

Fare Elasticity = $\lambda\beta F^{\lambda}$

The exact relationship between fares and fare elasticity depends on the exact magnitude of λ:

- A λ= 1 implies that the fare elasticity varies in exact proportion to fares, i.e. the fare elasticity is equal to βF. So a 5 per cent increase in fares will lead to a 5 per cent increase in the fare elasticity.
- With $0<\lambda<1$, the fare elasticity varies less than proportionately with fares.

For instance with λ = 0.9 (low damping), the fare elasticity is 0.9β and a with λ = 0.3 (high damping), the fare elasticity is 0.3β. It follows from this simplified example that with low damping (0.9), the fare elasticity will be more sensitive to fare changes than with high damping (0.3).

The formula for a Reimbursement Factor based on the negative exponential demand curve is:

Reimbursement Factor = $e^{\beta F^{\lambda}}$

With low values of λ (implying high damping), the reimbursement factor will be much higher in comparison to fare elasticity with λ=1. On the other hand, at high values of λ (implying lower damping), the reimbursement factor will only be slightly lower than the fare elasticity at λ=1.

ANNEX C: Reimbursement worked example

200 **concessionary journeys** are observed to be made by concessionary passholders today.

Of those, 90 journeys would have been made even if passengers had to pay a full fare in the absence of the scheme. There are therefore 90 **non-generated journeys** for which the operator needs to be reimbursed fully (at full fare)

The **reimbursement factor (RF)** is 90/200 = 45%.

These 90 journeys would have been made at an average fare of £1.50 (the **average fare forgone**).

The **revenue forgone** by the operator (that she/he would have received in the absence of the scheme) is thus 45%*200*£1.50 = £135.

The remainder (110) of the observed journeys are **generated journeys**, journeys being made because travel is free.

The **generation factor** is 110/200 = 55% (100%-RF).

For these journeys, operators are reimbursed the additional costs they have incurred as a result of passengers travelling because it is free. There are two main components to these additional costs (in addition to scheme administration costs and potential PVR costs): marginal operating costs and marginal capacity costs.

In this case, marginal operating costs are paid at 6.1p per generated journey. These are the additional costs from having to carry additional passengers with the same level of service.

Total marginal operating costs due to operators are 200*55%*£0.061 = £6.71.

In this case, marginal capacity costs apply and are reimbursed at 10p per generated journey. These are the costs incurred from having to increase the frequency of the service to cater for the increased demand.

Total marginal capacity costs due to operators are 200*55%*£0.10 = £11.

PVR costs do not apply in this case.

Total reimbursement due is the sum of the revenue forgone and additional costs: £135+£6.71+£11 = £152.71.

This represents an **average reimbursement** of £152.71/200 = £0.76 per observed concessionary journey.

ANNEX D: Research and summary of evidence

Introduction

The advice provided in the guidance draws from extensive research commissioned by DfT from a research consortium led by the Institute for Transport Studies (ITS) at Leeds University, and updated in 2023 by research from SYSTRA/Frontier Economics.

The purpose of the research was to investigate the factors influencing the reimbursement of bus operators for concessionary travel with a view to develop a robust, evidence-based framework for estimating concessionary travel reimbursement.

This Annex provides a summary of the research findings and other relevant evidence which underpins the reimbursement calculation methods described in the guidance.

Average fare

Updates from the previous calculator

In the previous version of the reimbursement calculator, there was a table which reflected the distribution of concessionary journeys by ticket type (Cash, Daily, Weekly) and ratio of relative prices of each of these ticket types. This table was known as a fares lookup table and was based on NoWcard data from 2009. It enabled the average fare forgone to be calculated using the discounted fare method.

The updated reimbursement calculator now contains four such lookup tables, which have been developed based on HOPS data. The data was extracted for the period from the 1st April 2022 until the 31st March 2023 (reflecting a full financial year and chosen to try to exclude the effects of COVID-19 legal restrictions which ended in February 2022).

Characteristics of the revised lookup tables

In the updated calculator, four lookup tables are included and available to use. These are based on the following range of geographies across TCAs: Large Urban Area, Medium Urban Area, Mixed Urban/Rural, Rural. Lookup tables are reflective of TCA-wide areas and should be applied in that context.

The number of annual journeys and passholders analysed from the HOPS data for each area type is shown in the table which follows. HOPS data stores information on concessionary boarding numbers (data includes journeys by date, operator and pass type).

Table 12 Impact of free fares on demand for concessionary travel

Area Type	Passholders	Journeys	Average Journeys per Passholder
Large Urban Area	274,645	20,057,311	73
Medium Urban Area	38,676	4,331,494	112
Mixed Urban/Rural	160,543	6,472,044	40
Rural Area	92,099	4,270,697	46

The above table demonstrates that for each lookup table produced, a large sample size has been reflected and obtained from HOPS. This should provide the user with confidence that the sample is robust and reliable.

It is also important to note that the process used to clean the HOPS data and develop each lookup table has followed the steps outlined in Annex F of this guidance. It is expected that any bespoke lookup table produced in place of the four default tables would follow the same process using local data from a source such as HOPS.

Demand

Modelling what the behaviour of ENCTS passengers would have been in the absence of the ENCTS is a challenging exercise as it cannot be directly observed. At the centre of the challenge is to link the change in journeys from those observed at zero fare to what the number of journeys would be at the average commercial fare: this is achieved through a demand curve which models the number of journeys made by ENCTS passengers at any given level of fare.

This demand curve cannot be observed directly (because ENCTS passengers have travelled at zero fare since the introduction of the national free fare scheme in 2005/06; and the behaviour of passengers before then (on the half-fare concession) is now dated and unlikely to represent the behaviour of concessionary passengers.

Therefore both the ITS and SYSTRA/Frontier Economics research have analysed a number of sources of evidence to draw inferences about the likely behaviour of ENCTS passengers in the absence of the scheme. This research is summarised below.

Evidence on elasticities

A price elasticity is defined as the percentage change in passenger demand in response to a percentage change in price (the fare), all other things being equal: it is a measure of how responsive passengers are to changes in fares. Price elasticities are typically negative meaning a higher price results in a fall in demand. So a price elasticity of -0.6 can be interpreted as meaning that a 1% increase in price would result in a fall in passenger demand of 0.6%.

A price elasticity is a central part of assessing the reasonableness of the demand curve by examining whether the price responsiveness implied by the chosen demand curve is consistent with the observed passenger behaviour in the market.

The demand curve used in the old calculator implies a particular relationship between the level of fares and the price elasticity: specifically, that the price elasticity increases with the level of fares, but at a rate which is less than proportional (this formulation is retained in the new calculator). Therefore, before assessing the new evidence on price elasticities available from academic and industry literature, it was helpful to begin by assessing what the 2022/23 version of the calculator implied about price elasticities.

While there has been considerable academic interest in the magnitude of fare elasticities in existing research, not much of past research has been focused specifically on the concessionary travel market. Therefore, only some basic inferences could be made by SYSTRA/Frontier Economics into the nature of the market from such past studies.

Based on the inferences from the various data sources and academic judgement, the ITS research gives the following as their estimates of long run elasticities at “average full fare” as follows:

Table 13 Long-run elasticities at average full fare

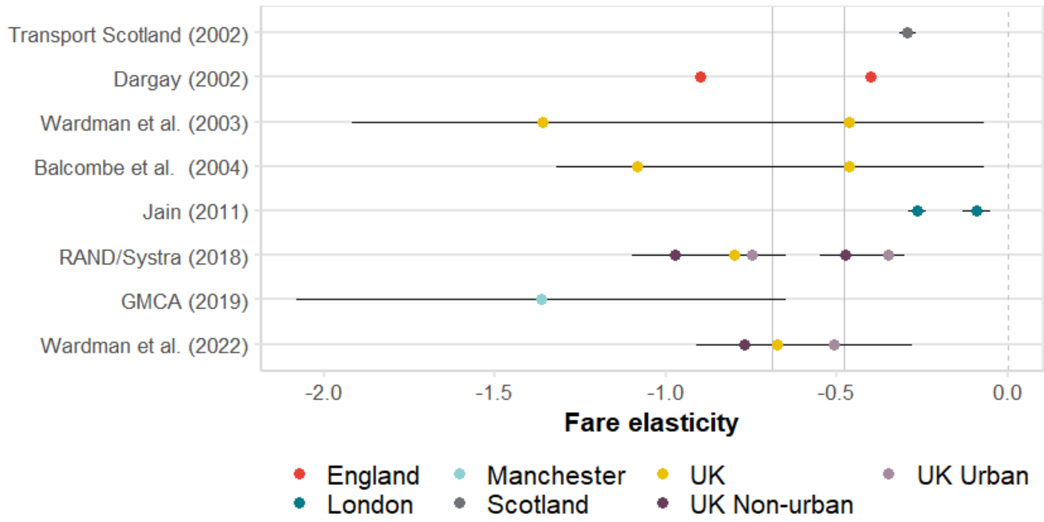
	Central Estimate	**Reasonable Range**
PTE	-0.5	-0.45 to -0.55
Non-PTE	-0.65	-0.60 to -0.70

Beyond this disaggregation in elasticities by PTE and Non-PTE areas, the ITS research did not find any other significant variation in elasticities by any other detailed disaggregation by area type, income or age.

The SYSTRA/Frontier Economics analysis reviewed the industry and academic literature on price elasticities of bus travel to seek to identify how the evidence had developed since the ITS research.

There are a number of studies by industry practitioners (particularly by RAND/SYSTRA and for Greater Manchester Combined Authority (GMCA)) and by academics (the most notable of which is a meta-analysis of price elasticities by Wardman et al).

Figure 4 Range of elasticities in literature



As can be seen from the figure above, there are a wide range of elasticities contained within the literature. What can be seen is that urban areas are typically less responsive to changes in price (have a lower - in absolute terms - price elasticity) than non-urban areas.

One aspect that SYSTRA/Frontier Economics looked at, in particular, is whether there is evidence on the price elasticity for passengers in rural areas: we find that there is very limited evidence on the demand response for rural areas and therefore we suggest to not incorporate different demand curves for these areas.[17]

Their literature review has not identified price elasticities that are specific to disabled passengers. Therefore, while there is a conceptual case for differentiating demand curves for disabled passengers, there is no empirical evidence that they identified on how the price responsiveness of disabled people differs from the market as a whole. Even if there are some studies that they were not able to identify, they therefore conclude that there is insufficient empirical evidence to support a separate demand curve for disabled people. Therefore, a demand curve which combines older and disabled people is retained.

This evidence of price elasticities from the academic and industry literature also does not reflect changes in passenger behaviour from post-COVID-19. This is not surprising given the typical lead times needed to gather data, conduct analysis and publish findings of this type of research.

In summary, this review of the existing literature has identified that there are a wide range of price elasticities estimated but it is difficult to put a great weight on the findings in developing precise recommendations on the form of demand

[17] TCAs responsible for reimbursement in rural areas will need to use the “non-urban” demand curve outlined in section 6

curves to be used in calculating reimbursement for operators carrying passengers under the ENCTS.

Econometric analysis of NTS data

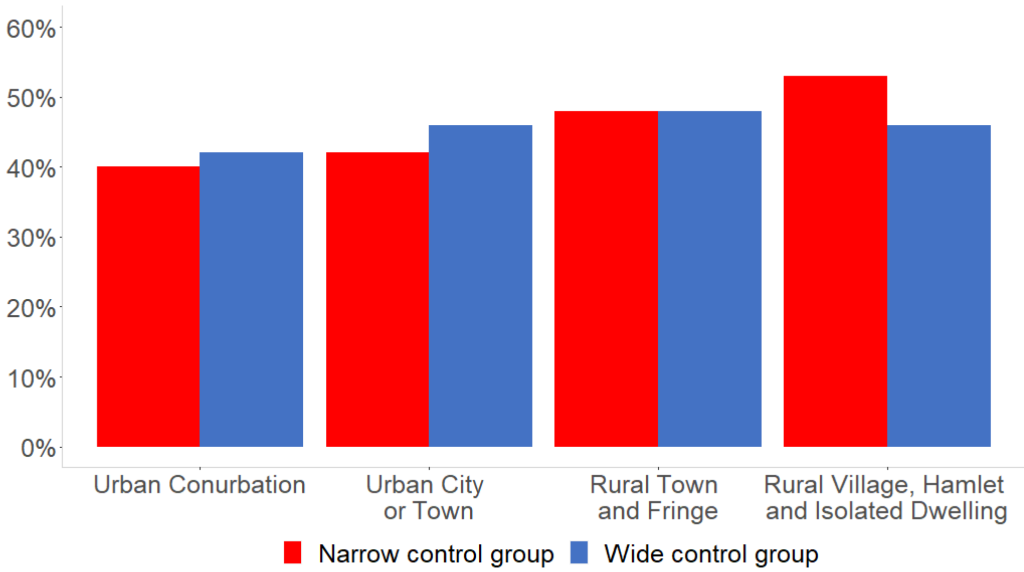
SYSTRA/Frontier Economics have conducted an econometric analysis of the NTS which seeks to directly estimate the generation factor by assessing the difference in the number of bus journeys between people eligible for an ENCTS pass, and not eligible, after controlling for other personal characteristics known to affect journey making such as age, income and employment. This analysis is used as the foundation of the demand curves outlined in section 6.

They used data from 2010-2021 (data for 2022 was not available at the time of the analysis being conducted), for NTS respondents over the age of 50. This data was supplied to SYSTRA/Frontier Economics by the UK Data Service and consists of an average survey of 33,300 individuals (although the 2020 and 2021 surveys were substantially smaller at 13,800 and 21,600 responses respectively).

The overarching objective of the analysis was to use the NTS responses to predict the number of bus journeys that would be made by ENCTS passholders if they did not travel for free, using data on the travel patterns by survey respondents.

Figure 5 provides the estimated generation factor for different types of geographic area. The geographic area is based on the location of the respondent and from the ONS.[18]

Figure 5 Estimated generation factor for different types of geographic area



The urban demand curve (recommended for use by TCAs which are former PTE areas, or have PTE-like characteristics as explained in section 6) outlined

[18] https://www.gov.uk/government/statistics/2011-rural-urban-classification-lookup-tables-for-all-geographies

in section 6 is based on the results for the "urban conurbation"; the non-urban demand curve is based on the average of the other area-types. The parameters of the demand curves are derived by analysing combinations of parameters which deliver generation factors which are consistent with the results of this econometric analysis and are consistent with the evidence on price elasticities.

It is important to note that this analysis does not capture changes in passenger behaviour arising from the COVID-19 pandemic (as the data series ends in 2021) and it does not control for fares in different areas.

As this analysis did not assess for differences in passenger behaviour before and after the COVID-19 pandemic, SYSTRA/Frontier Economics considered evidence from ENCTS smartcard data (HOPS) to assess whether there is evidence of a change in the generation factor arising from the COVID-19 pandemic as set out below.

HOPS data analysis

Data from six TCAs (Nexus (Tyne & Wear only), South Yorkshire Mayoral Combined Authority, Leicester City Council, Lancashire County Council, Wiltshire Council and Norfolk County Council) on ENCTS pass usage in 2019-20 and 2022/23. These TCAs provide a wide range of geographic coverage and types of area.

This data contains information on concessionary boarding numbers (data included journeys by date, operator and pass type). This data was requested for both 2019/20 and 2022/23 in order to understand how journey frequencies have changed pre- and post-pandemic.

This analysis involved assessing over 130 million transaction records as individual transaction records were aggregated to calculate average journey by passholder by week, and then averaged for each week over a year. This provided an average number of pass uses, by passholder, by week.

There are three types of passes:

- Passes for individuals in both years of data (2019/20 and 2022/23);
- Passes which are in the 2019/20 data but not in the 2022/23 data;
- Passes which are in the 2022/23 data but not in the 2019/20 data.

All passes for individuals which appeared in both 2019/20 and 2022/23 were grouped as existing passes for the purposes of analysing and summarising trends in HOPS data. Any passes which only appeared in 2022/23 were grouped and defined as new passes. Any passes which appeared only in 2019/20 were grouped and defined as legacy passes.

Inferring changes in the generation factor from journey numbers is challenging and so it is important to start from the perspective of setting out what would be expected to be in the data if the generation factor had materially reduced – which is a substantial number of passholders who made small numbers of journeys before the pandemic leaving the market, leaving behind a smaller number of passholders who use the bus more frequently. The rationale for this is that infrequent pass usage may be more likely to indicate that those journeys are generated than journeys made by passholders who make frequent journeys:

the logic of this (which is heard within the industry, but is not – so far as we know – supported by empirical evidence) is that passengers making relatively few bus journeys with the ENCTS are more likely to be car users and therefore more price sensitive than passengers who make lots of journeys.

There appears to be a broad move to passengers making, on average, fewer journeys with movements from 4-6 journeys per week in 2019/20 to 2-4 journeys per week in 2022/23; and from 2-4 journeys in 2019/20 to 1-2 journeys per week in 2022/23.

The evidence has been reviewed for all six TCAs that data is available for. There are differences across the TCAs, but overall, SYSTRA/Frontier Economics observe:

- a reduction in active passholders between pre- and post-pandemic;
- that the passholders who have "left the market" appear to be drawn from all parts of the journey distribution;
- that the level of journey making appears to have reduced at all levels of the journey distribution.

This evidence is not consistent with what would be expected if the generation factor had reduced materially following the Covid-19 pandemic and therefore no further change to the generation factor supported by the NTS econometrics is undertaken. However, drawing firm conclusions from this evidence is challenging and any conclusions are necessarily tentative at this stage.

Additional costs

Many of the parameters related to additional costs have been kept broadly the same as those in the previous guidance and calculator (with the exception of unit costs which have been reviewed in more detail) – as outlined in the introduction, the focus of the study has been on parameters which are expected to drive material changes to the level of operator reimbursement and/or were identified by stakeholders as being desirable of review.

Marginal operating costs

The paragraphs below outline the original ITS findings and recommendations on marginal operating costs. A few arithmetic miscalculations and inconsistencies in the original input values used in calculating the operator capacity cost were subsequently uncovered. This led to a revision of the initial MOC estimate from ITS prior to this update of the calculator. A one-off adjustment was also made to the figure to take account of the 20 per cent reduction in the Bus Subsidy Operator Grant (BSOG) on 1 April 2012. The original calculations and subsequent changes are explained below.

ITS research report results

The research considered evidence from three different types of sources: (i) an econometric model of bus operator costs, based on data for the period 1999–2007; (ii) past claims and settlements; and (iii) evidence from official statistics, the industry and academic research on the individual sub-components of marginal cost such as fuel and insurance.

The econometric model combined data from STATS 100 and TAS using operator level data. Total cost is the dependent variable and explanatory variables comprise final outputs (journeys), and intermediate outputs (vehicle miles, peak vehicle requirement). The preferred model is a translog function. The marginal cost per additional journey is calculated as the derivative of dTC/dQ where TC is total costs and Q is the number of journeys holding vehicle miles and vehicle fleet constant. The model has a good fit to the data. The coefficient on the journey variable is not quite significant at the 95 per cent confidence interval. The estimated marginal cost per journey from this model is estimated to be 8p.

The sub-components approach presented in the ITS research report estimated that operating costs add up to 6.7p per generated concessionary journey. The estimates of the different sub-components were derived from a variety of sources including official publications, industry data and academic research.

Recent claims and settlements were considered. There were problems with interpreting this data due to concern about whether quoted costs were average rather than marginal and whether costs included an element of additional capacity costs. A wide range of 1p to 15.3p per additional journey was found in this data.

The research gives most weight to the econometric and bottom-up estimates, with most weight given to the latter given the wide confidence interval on the econometric results. The research report recommended a mean value per generated passenger journey outside London of 7.2 pence (at 2009/10 prices).

The research also considered varying the marginal cost estimate for journey length. This variation is justified given the variation in fuel, tyres and oil, and maintenance and cleaning costs with distance. The recommended approach is composed of a fixed element, 4.2 pence, and an element that is variable with distance.[19] The average bus stage length of concessionary passengers is 4.1 miles from the National Travel Survey 2008.

Revisions to the recommended MOC estimate

Arithmetic miscalculations were found to affect some of the components of the bottom-up estimate of marginal operating costs. The estimates of these components were revised as a result. Some of the revisions were made to ensure consistency of approach with other elements of the guidance. The changes are outlined below.

[19] The formula to adjust marginal operating costs per generated concessionary passenger by journey length is 5.5+0.6*(average journey length, (miles)/3.9) (all in pence 2009/10 prices).

Fuel cost

The fuel cost component was originally estimated at 1.5p per generated passenger (2009/10 prices). The following issues were identified:

a. The fuel price used in the original calculation excluded all tax and duty. However, the BSOG rate only partly compensates bus operators for fuel duty and therefore the fuel price should include the non-recoverable duty. Diesel duty in 2009/10 was estimated to be on average 56.19p and the BSOG rate was 43.21p.
b. An average journey length per concessionary passenger of 4.8 miles was used. However, this figure is based on NTS trips - these include all stages of a journey from the point of origin to destination (and thus are likely to include other modes of transport and not just individual bus boardings). Therefore the appropriate figure to use from the NTS is the average bus boarding length by concessionary bus passholders aged over 60 in England (excluding London), which for 2009/10 was estimated at 3.9 miles.

As a result of these revisions, the estimate for the fuel cost component of the marginal operating cost per passenger was 0.24p and the revised bottom-up estimate for fuel, tyres and oil is 0.3p (2009/10 prices).

Additional time cost

The costs due to additional vehicle time were estimated at 0.7p per generated concessionary passenger (2009/10 prices) in the research. However, this was based on an estimate of vehicle hour costs of £14.90. This figure was subsequently changed in the guidance to £13.30 (see section on Marginal Capacity Costs below). The more up-to-date value of £13.30 was therefore applied to the revised calculation of additional time costs to ensure consistency with marginal capacity costs.

In the original research paper, a reimbursement factor of 60 per cent was also assumed to estimate the net boarding and alighting time effect per generated passenger. However, in their final research report, ITS subsequently revised the parameters of the Single Demand Curve which resulted in a lower reimbursement rate. In order to ensure consistency with the current demand curve used in the guidance, the reimbursement factor used in the calculation of additional time costs was revised to 45 per cent (based on a weighted average of the reimbursement factors in PTEs and NPTEs derived from the Single Demand Curve assuming a nominal fare increase between 2005/06 and 2009/10 in line with the National Bus Index).

These methodological revisions resulted in an increase in additional time costs from the original 0.7p to 1.3p.

Maintenance and cleaning cost

The maintenance and cleaning cost of 1.2p reported in ITS research was estimated using an average journey length of 4.8 miles - this should be 3.9 miles for the reason explained above.

The calculation of the estimated figure also implies that this figure represents an average cost and not a marginal cost. The ITS research report suggests that there are likely to be strong economies of scale in repairing and cleaning the bus and therefore the cost elasticity with respect to passengers is likely to be greater than zero, but not much greater. They present a cost elasticity with respect to passengers of 0.0635 which needs to be applied to the average cost estimate to calculate a marginal cost estimate.

These corrections resulted in a revised maintenance and cleaning cost estimate of 0.1p in 2009/10 prices.

BSOG adjustment

In addition, an upward adjustment was made to the fuel component of the marginal operating cost to account for the 20 per cent reduction in BSOG from 1 April 2012. The fuel component was adjusted by the percentage change in fuel cost resulting from the reduction in BSOG. As a result the marginal fuel cost (in 2009/10 prices) is 0.3p and the overall marginal cost for fuel, tyres and oil is 0.4p.

Revised MOC estimate

D.1 The table below summarises the revisions to the components of the bottom-up estimate (including adjusting for BSOG):

Table 14 Revisions to components of MOC bottom-up estimate, pence (2009/10 prices)

Component	Original value	Revised value
Fuel, tyres and oil Of which fuel	1.6 1.5	0.4 0.3
Maintenance and cleaning	1.2	0.1
Insurance	2.7	2.7
Information	0.5	0.5
Additional time costs	0.7	1.3
Bottom-up estimate of MOC	6.7	5.0

The resulting total bottom-up estimate is therefore 5.0p (revised down from 6.7p). The implied weights used by ITS in their published study in combining the bottom-up estimate and the estimate from the econometric model (8.0p) yields an overall MOC estimate of **6.1p**.

Marginal capacity costs

The research estimated marginal capacity cost using evidence from: (i) the econometric model of bus costs; (ii) accounting cost models of the CIPFA type; (iii) and a range of other evidence required to complete the analysis. Unit costs were updated to 2009/10 prices.

The econometric evidence is based on evidence about vehicle miles and peak vehicle numbers. Vehicle hours were not included due to lack of data. The estimates derived from the econometric model are marginal capacity costs in the economic sense because the calculation is concerned with the way in which costs vary with vehicle mile and vehicle numbers. The econometric results provide an estimate of the additional capacity costs per vehicle mile of £0.853 (£0.530 per vehicle km) with a 95 per cent statistical confidence interval of £0.507 to £1.201 (£0.315 to £0.746 per vehicle km). This implies a cost elasticity, or marginal capacity costs as percentage of average capacity cost, at 46 per cent. Peak vehicle costs are £17,941 per vehicle with a 95 per cent statistical confidence interval of £12,335 to £23,547.

Accounting cost models provide estimates of the cost of vehicle hours, vehicle miles and peak vehicle requirements – see the table below:

Table 15 Additional capacity costs from accounting models, 2009/10 prices

Accounting models	Per vehicle hr	Per vehicle mile	Per peak vehicle
NERA (2006) – PTE	£29.86	£0.811	£27,515
NERA (2006) - non-PTE	£22.34	£0.607	£20,203
Whelan, Toner, Mackie and Preston (2001)	£26.01	£0.232	£24,030

The econometric and accounting evidence cannot be directly compared because accounting models typically attribute elements of costs that may not necessarily be 'marginal' such as staff overheads and materials, vehicle maintenance and administrative staff. These costs are unlikely to vary with increases in the number of vehicle hours operated. For the purposes of calculating additional vehicle hour costs from an additional generated passenger, it is the costs that increase with additional vehicle hours that are relevant. The econometrics model attempts to estimate this true 'marginal' cost. However, the econometric model excludes vehicle hours and that exclusion would tend to increase the estimates of the parameter value on vehicle miles in the econometric equation.

An independent review of the evidence carried out by Professor Ian Preston concluded that there was a risk of double counting by adding in a separate estimate of the vehicle hours costs to the econometric results. The research and review noted that in theory an adjustment to the parameter on vehicle miles could be made to strip out the vehicle hours effect. But the size of that adjustment is unclear.

In order to make an informed judgement about the appropriate level of unit costs, and bearing in mind the comments about double counting, DfT also considered confidential evidence from operators and the timing and size of the change in demand likely to take place in the absence of a concessionary travel scheme. The unit costs proposed are well below average accounting costs. The largest component of the vehicle hours unit cost is likely to be drivers' hours. ITS also noted that drivers wages were paid on average as £10.20 per hour plus on-costs. Evidence of tenders suggests that marginal costs per hour can be lower than driver wages if drivers are being paid for hours that they do not drive. On the other hand, operators suggest that there is little slack in driver schedules so that a requirement to drive extra hours in the middle of the day requires additional remuneration for the additional hours employed.

Given the uncertainties about the use of the econometrics, the use of the accounting data, the use of the cost elasticities and other evidence, a pragmatic view that the appropriate hourly costs are around the hourly costs of drivers including an allowance for on-costs, i.e. a vehicle hours unit cost of **£13.30** is recommended.

This unit cost estimate was primarily based on 2009/10 ASHE (Annual Survey of Hours and Earnings) data on the gross hourly pay for bus and coach drivers. It is the mean hourly wage for bus and coach drivers in England, including London, plus an additional allowance of 30 per cent to include non-wage costs (such as National Insurance contributions and pensions).

The SYSTRA/Frontier Economics analysis assessed the increase in the gross hourly pay for bus and coach drivers since 2009/10 and recommended an inflationary adjustment of 49.0% to convert to 2023/24.

While wage rates in the East and South East tend to be higher than in other regions, the wage rate in London is significantly higher than anywhere else. Exclusion of the London hourly wage from the calculation would result in a sharp downward impact on the estimated wage cost. This is illustrated in the table below.

Table 16 ASHE results on hourly earnings of bus and coach drivers in 2009

Region	**Number of jobs**	**Hourly pay**
North East	6,000	£8.73
North West	12,000	£8.88
Yorkshire and the Humber	9,000	£8.74
East Midlands	7,000	£8.52
West Midlands	9,000	£9.04
East	10,000	£9.59
South East	12,000	£9.42
South West	10,000	£8.69
London	34,000	£12.99
England excl. London w/o overheads		**£9.00**
England excl. London with 30 per cent overheads		**£11.69**
England incl. London w/o overheads		**£10.24**
England incl. London with 30 per cent overheads		**£13.31**

It is also worth noting that the addition of the 30 per cent overheads is likely to be overestimating the true marginal vehicle hour cost. While there will be certain costs that vary with vehicle hours other than drivers' wages, the addition of 30 per cent is likely to be an overestimate.

The recommended value for the rate per mile is based on a consideration of a range of evidence and in particular costs that are likely to vary directly with bus mileage, such as fuel, and excluding fixed costs. This suggests a figure of £0.61 per vehicle mile.

In addition an adjustment has been made to the vehicle mile unit cost to account for the 20 per cent reduction in BSOG from 1 April 2012. The fuel component was isolated using assumptions in the ITS research about the fuel component (92 per cent) and adjusted by the percentage change in fuel cost resulting from the reduction in BSOG. As a result the recommended value for the vehicle mile unit cost is **£0.70** per vehicle mile.

The SYSTRA/Frontier Economics analysis has considered the increase in fuel costs since 2009/10 and recommends an increase of 23.3% to this figure, to £0.86 per vehicle mile (2023/24 prices).

The 23.3% increase in fuel costs is based on analysis of CPT bus operating cost data from 2010 to 2022. The growth over this period has been extrapolated from 12 to 14 years to adjust from 2009/10 prices to 2023/24. The cyclical variations in fuel prices between 2010 and 2022 mean that these costs grew by just 1.5% per annum on average, with peaks in prices reached in 2014 and 2022.

Mohring factor

Evidence on the Mohring factor is limited. The value of 0.6 suggested in this guidance is within the range of values found in mainly theoretical studies that consider the response of operators to changes in demand that maximises the overall net benefit of passengers and bus operators. The theoretical relationship also depends on an element of spare capacity. In a practical situation where the criteria for changing vehicle miles is the effect on operator profit and load factors are also driven by commercial considerations it is possible that the Mohring factor would be different, but we do not know by how much. For the purpose of this guidance we recommend using a value of **0.6**.

The SYSTRA/Frontier Economics analysis did not review this aspect of the guidance.

Demand response to frequency change

The extent to which the demand for bus service responds to increased levels of service has been covered in the literature and examined in bespoke econometric analysis. The basic premise is that increases in the frequency of bus services reduces waiting time. Waiting time has a higher value (higher disbenefit) than in-vehicle time so that passengers respond to changes in frequency. The degree of response is thought to be significant but less than proportionate meaning demand increases but by less than the proportionate increase in bus vehicle miles.

Evidence developed in bespoke econometric analysis conducted by Frontier/SYSTRA suggests that a 1 per cent change in vehicle miles leads, in the long term, to a 0.71 per cent change in passenger journeys. This guidance recommends that an elasticity of **0.71** is used as a default unless there is very good evidence to the contrary.

Profit

A report for the Department for Transport by LEK, Review of Bus Profitability in England, considered the appropriate weighted cost of capital for bus operators. This proposed a range of the nominal weighted cost of capital of 8.2 per cent to 10.9 per cent in 2009. The report noted that feedback from major operators suggested that they believe that their respective weighted average cost of capital to be at the top end of this range. In the light of this evidence this guidance recommends that where peak vehicle requirement is increased as a result of the additional concessionary journeys then a return on capital of 10% is used and added to the PVR costs.

The SYSTRA/Frontier Economics analysis did not review this aspect of the guidance.

ANNEX E: Data provision

The Mandatory Travel Concession Regulations 2011 provide that a TCA may request information from operators which it reasonably considers relevant to assisting it in the formulation of reimbursement arrangements. The following lists the data items that may be required in using the DfT guidance and Calculator.

All data items relate to the year of reimbursement calculation unless specified otherwise.

Table 17 Data items required to use DfT reimbursement guidance

Component of reimbursement	Data items
Journeys	Total concessionary journeys (older/disabled people)
Average fare – Discount Fare Method	For each product within the cash fare, daily ticket and weekly ticket categories: - Total revenue - Total number of tickets sold The data should cover the period of the concession and exclude child tickets
Average fare – Basket of Fare Method	For each product in the basket: - Price of ticket - Assumed number of journeys per ticket - Percentage of journeys made with ticket type
Reimbursement Factor	Percentage increase in nominal fares between 2019/20 and the year of calculation
Marginal Operating costs	Average concessionary journey length [optional]
Marginal Operating costs	All components of marginal operating costs (per concessionary passenger) [optional]: - Fuel, tyres and oil - Maintenance and cleaning - Insurance - Information - Additional time costs
Marginal Capacity Costs	- Average commercial fare - Average speed [optional] - Average route length [optional] - Average journey length [optional] - Average occupancy [optional] - Commercial journeys as a % of total [optional]

ANNEX F: Processing of smartcard data

Raw data

The subset of data to be extracted should be selected such that the geographical coverage is deemed comprehensive (to maximise the capture of data by smartcard-enabled operators) and representative of the local area.

The data should include all concessionary journeys starting in the local area on smartcard-enabled buses for the period of the concession. Data from non-residents could be included but consideration should be given to whether the coverage of their journeys is not complete and could therefore undermine the main strength of the data source.

The data should include a record for each journey made by concessionary passholders within the time period. Data on the passholder (unique ID, postcode, gender, date of birth, older/disabled concession and disability type, TCA of issue and date card issue) is useful for analytical and data validation purposes.

Data cleaning and processing

The data should be analysed and cleaned to exclude outliers, extreme values and records of suspicious quality. For instance the data should be sense-checked to identify the following potential issues:

- Records with missing passholder ID information;
- Passholders who are too old or too young (e.g. under 5s);
- Passholders who were issued a pass after the data extraction start date (the week of issue should be excluded to provide a clean period for analysis);
- Duplicate card holders;
- Possible outliers (implausible number of journeys) based on the distribution of the data.

It is likely that a number of journeys will have been excluded from the dataset due to transaction failures. It should be possible to derive operator and service-specific expansion factors to correct for this based on information from the operator on failure rates and on other data sources such as continuous surveys. It is advisable to use the weighted journey data to derive the lookup table.

Derivation of lookup table for use in the discount fare method

The individual bus transaction records should be summarised into the total number of concessionary journeys made by each passholder on each day of the sample period (passholder days) as follows:

Table 18 Aggregation of raw data into passholder days

PassholderID	Day 1	Day 2	…
ID1	Number of journeys made	Number of journeys made	Number of journeys made
ID2	Number of journeys made	Number of journeys made	Number of journeys made
ID3	Number of journeys made	Number of journeys made	Number of journeys made

The number of journeys made on each day by individual passholders can be summarised further into the total number of journeys made in each week of the sample period (passholder weeks).

The data can then be allocated into the lookup table which can be seen in the Lookup *Table* sheet in the Calculator. The lookup table is dimensioned as follows (a subset is shown):

Table 19 Smartcard lookup table (Mixed Urban Rural example)

Selected Area

Selected Area	Mixed Urban Rural

Lookup Table

Weekly Ticket Price as Multiple of Cash Fare per Journey	Weekly Tickets		No Day Ticket		
	Weekly Tickets	Weekly Journeys	Daily Tickets	Daily Journeys	Cash Fare Journeys
0	0	0	0	0	6,661,511
1	1,635,114	6,661,511	0	0	0
2	1,279,428	6,305,825	0	0	355,686
3	818,755	5,384,479	0	0	1,277,032
4	653,281	4,888,057	0	0	1,773,454
5	473,009	4,166,969	0	0	2,494,542
6	381,291	3,708,379	0	0	2,953,132
7	290,371	3,162,859	0	0	3,498,652
8	234,817	2,773,981	0	0	3,887,530
9	182,264	2,353,557	0	0	4,307,954
10	147,156	2,037,585	0	0	4,623,926

The smartcard data is to be aggregated for each combination of weekly to cash fares and daily to cash fares price ratios to derive a lookup table (see also worked example in Annex G):

- For each value of the weekly ticket price to cash fare ratio (1:1, 2:1, 3:1, …, 40:1) the total number of passholders who had weekly journey totals at or above that value are counted and the number of journeys made are summed. For instance, for a weekly ticket priced at three times the cash fare, it is assumed that all passholders who make three or more journeys a week would purchase a weekly ticket. Summing across all such passholders would then yield the number of weekly tickets, and summing their journeys would yield the total number of weekly journeys at that price ratio.

- The process is repeated for the remaining journeys (the journeys not assigned to weekly tickets) for each value of the daily ticket price ratio (1:1, 2:1, …, 10:1).
- The journeys not categorised as weekly or daily tickets are assigned to the cash fare category.

The final lookup table can be pasted directly in the Lookup Tables Options sheet of the Calculator. No further changes to the spreadsheet are required. However, TCAs using local smartcard data should assure themselves that using the Discount Fare Method using a locally derived lookup table yields plausible results.

ANNEX G: Reimbursement calculator

Introduction

A Reimbursement Calculator in Excel format based on the recommended approach set out in this guidance is available on the DfT website to aid TCAs in their reimbursement calculations and assist in discussions with bus operators.

This Annex briefly describes the Reimbursement Calculator and goes into the detail of some of the underlying calculations by way of worked examples.

Reimbursement calculator

The Reimbursement Calculator is subdivided into eighteen sheets, nine of which take users through the various steps required to calculate reimbursement:

Table 20 Reimbursement calculator sheets

Contents	**This sheet provides guidance on the formatting, contents and structure of the Calculator.**
Instructions	This sheet provides instructions on the calculator methodology, inputs, and outputs.
Lists	This sheet records the lists used in the dropdown inputs.
General Inputs	This sheet records the user's selected methodologies and mandatory inputs.
Average Fare - Basket of Fares Inputs	This sheet records the user's inputs to calculate the Average Fare using the Basket of Fares method.
Average Fare – Discount Factor Inputs	This sheet records the user's inputs to calculate the Discount Factor using the Basket of Fares method.
Marginal Capacity Costs Inputs	This sheet records the user's inputs to calculate Marginal Capacity Costs.
Inflation Inputs	This sheet records the user's inputs to update inflation.
Outputs	This sheet gathers all of the Calculator outputs.
Marginal Capacity Costs Outputs	This sheet gathers the detailed Marginal Capacity Costs outputs at network level

There are nine further sheets containing the calculations completed by the calculator, as well as parameters for some of the calculations that are not intended to be changed by users. They are as follows:

Table 21 Reimbursement calculator working sheets

Average Fare Calculations - Discount Factor Method	**This sheet contains the calculations to derive the Average Fare via the Discount Fare method**
Average Fare Calculations - Basket of Fares Method	This sheet contains the calculations to derive the Average Fare via the Basket of Fares method
Reimbursement Factor Calculations	This sheet contains the calculations to derive the Reimbursement Factor
Marginal Operating Costs Calculations	This sheet contains the calculations to derive the Marginal Operating Costs
Marginal Capacity Costs Calculations	This sheet contains the calculations to derive the Marginal Capacity Costs
Inflation Calculations	This sheet contains the calculations to derive Inflation
Lookup Table Selection	This sheet references the lookup table selected by the user to calculate the Average Fare using the Discount Fare method
Lookup Tables Options	This sheet gives the four lookup tables options used to calculate the Average Fare using the Discount Fare method, and an additional slot to include a custom lookup table
Calculation Parameters	This sheet lists all the model parameters used to derive the Calculator outputs

General inputs (Step 1)

On this page users enter

- The appropriate area type (Urban and Non-Urban) - this will dictate which Single Demand Curve parameters are used in the degeneration process in the estimation of the average fare forgone, which Single Demand Curve is used in the estimation of the Reimbursement Factor and which default values are used in the Marginal Capacity Cost Model – ['General Inputs' Cell F6];
- The year for which reimbursement needs to be calculated – [Cell F8];
- The total number of concessionary journeys observed in reimbursement period (See Section 4 of the guidance) – [Cell F10].

Average fare (Step 2)

Average fare calculator

Users can choose which method to apply to calculate the average fare forgone using the dropdown options in ['General Inputs' Cell F14] The options are as follows:

Table 22 Average Fare Calculation - Options

Method	Criteria	Action
Discount Fare method	Most circumstances (see § 6.5 – 6.13 for exceptions)	Follow hyperlink in ['General Inputs' Cell H14] to sheet ['AF – Discount Factor']. Enter the average ticket prices of cash fares, day and weekly tickets either directly in [Cells E19-E21] or using the templates (see § 6.14-6.23 for how these should be calculated). The lookup table can be selected in the dropdown list in [Cells E17 and E28]. The average fare is displayed in ['Outputs' Cell F24] and calculated in ['Discount Factor – Calculations' Cell E6].
Basket of Fares method	For operators with a high proportion of total boardings on low frequency services or with particular ticket combinations (see § 6.5-6.13)	Follow hyperlink in ['General Inputs' Cell H14] to sheet ['AF – Basket of Fares']. Enter data in [CellsD18:G28] and the average fare is displayed in ['Outputs' Cell F24] and calculated ['Basket of Fares – Calculations' Cell E6].
Local method	For operators in large urban areas such as the former PTEs where journey patterns are significantly different (see § 6.5-6.13)	Enter locally derived fare in [Cell F16]

The final Average Fare Forgone will be fed through the Reimbursement Factor calculations in Step 3. Once the user has input their data for the average fare forgone, if they have followed a hyperlink to one of the separate input sheets, they should follow the hyperlink in Cell D7 of that sheet to return to the 'General Inputs' sheet.

Calculation of the discount factor (AF workings)

The section below explains how the discount factor (in the Discount Fare method) is calculated in the sheet *Discount Factor - Calculations*.

HOPS data

Smartcard Data Ticket Choice Assignment

Smartcard data on journey frequencies from HOPS have been used to model how concessionary passholders would allocate themselves to different ticket types (Cash, Daily and Weekly tickets) at free fares. The data provides information on the concessionary journeys of about 566,000 passholders across four different TCAs over the financial year 2022/23.

Four TCAs have been used to provide Lookup Tables to reflect different geographies. These are stored in the following areas of *Lookup Tables Options:*

- Mixed Urban Rural [Cells D6:AM50]
- Medium-Sized Urban [Cells D54:AM98]
- Large Urban [Cells D102:AM146]
- Rural [Cells D150:AM194]
- A custom lookup table can be entered [Cells D198:AM242]

The appropriate Lookup Table for the TCA in which the operator is making the reimbursement is selected in [Cell E17] or [Cell E28] of *AF – Discount Factor*.

The HOPS data feeding into each Lookup Table have been summarised to give the number of concessionary journeys made in each day and each week of the year. The summarised data have then been used to simulate how the observed travel patterns would map onto different ticket types, assuming different combinations of price ratios.

For instance, in a fare structure where weekly tickets are priced at ten times the average cash fare and daily tickets are twice as expensive as the average cash fare, one would expect weekly tickets to become financially attractive to those making 10 or more journeys per week and we would expect those making two or more journeys in a day to buy a one-day ticket (the below is an example for a Mixed Urban Rural TCA):

Table 23 Example of smartcard data ticket choice assignment based on a specific price structure (Mixed Urban Rural example)

Ticket type	Price ratio	Tickets	Journeys	Journeys per ticket
Cash fare	1 (e.g. £1.60)	1,172,821	1,172,821	1.0
Daily	2 (e.g. £3.20)	1,546,598	3,541,105	2.2
Weekly	10 (e.g. £16.00)	147,156	2,037,585	13.8
Total		2,866,575	6,661,511*	
Discount factor	13.9%			

* Components may not add up to total due to rounding.

- There were 6,661,511 zero-fare concessionary journeys observed in the Mixed Urban Rural dataset over the time period.
- Some 2,037,585 journeys would have been made using Weekly tickets across 147,156 tickets if concessionary travel was unavailable, leading to an average of 13.8 journeys per ticket.
- Some 4,623,926 journeys would not be allocated to Weekly tickets on this basis. Of these, 3,451,105 journeys would have been made using Daily tickets from sales of 1,546,598 tickets – this corresponds to an average journey rate per ticket of 2.2.
- About 1,172,821 journeys would not have been made using either Daily or Weekly tickets. It is assumed that these journeys would be allocated to Cash fares.

The analysis is repeated for a range of ticket price ratios across each of the four geographical Lookup Table types previously listed. Each Lookup Table was constructed as a matrix of journeys by different price ratio combinations of Weekly to Daily to Cash tickets. The analysis was limited to Weekly tickets priced at 41 times the Cash Fare or less and Daily tickets at 10 times the Cash Fare or less. Beyond these ratios the proportion of journeys on Daily and Weekly tickets becomes a very small percentage of overall journeys.

Discount Factor

For each price ratio and the associated journey frequencies by ticket type, a discount factor can be derived. Under the 10:2:1 ratio, if a passenger makes two or more journeys using a Daily ticket, the average cost per journey will be less than the average Cash Fare per journey. Therefore, on a per journey basis, the passenger buys their ticket at a discount relative to the Cash Fare.

The implied discount factor on the Cash Fare based on the price ratio of 10:2:1 is derived from the total revenue denominated in terms of the Cash Fare:

Discount factor = 1 – [10 x 147,156 + 2 x 1,546,598 + 1,172,821] / 6,661,511 = 15.4%

However, this is the discount factor at free fares, before de-generation (see below).

Interpolation

In practice TCAs will need to input price ratios in the Calculator derived from real data and those are likely to be decimal numbers rather than integers (e.g. 9.9:1.8:1 based on a pricing structure of weekly tickets at an average of £15.84, daily tickets priced at £2.88 and an average cash fare of £1.60). This is a purely illustrative example. In these cases it is necessary to make an estimate of the number of journeys by interpolating between the lower and upper band of the price ratio. This is done in [Cells D55:I67] of *Discount Factor - Calculations*.

Table 24 Discount factor calculations – interpolation (mixed urban rural example)

	User Input Derived Values	Lower Band	Upper Band	Factor	Interpolated Value
Daily Ticket Price / Cash Fare	1.80	1.00	2.00	0.80	
Weekly Ticket Price / Cash Fare	9.90	9.00	10.00	0.90	
Cash Fare Journeys		0	1,168,836	0.80	935,069
Daily Tickets		2,704,246	1,535,409	0.80	1,769,176
Daily Journeys		4,592,329	3,423,492	0.80	3,657,260
Weekly Tickets		182,264	147,156	0.90	150,667
Weekly Journeys		2,353,557	2,037,585	0.90	2,069,182
Check Journey Total		6,945,886	6,629,914		6,661,511
Discount Factor		37.5%	13.9%		15.8%
Average Discount Factor	25.7%				

In this example the Weekly ticket price ratio lies between 9 and 10 and the Daily ticket price ratio lies between 1 and 2 (the lower band price ratio is 9:1:1 and the upper band is 10:2:1) of the Cash Fare. The number of journeys and tickets sold corresponding to each price ratio are referenced from the smartcard data table [Cols E and F] in the case of Weekly tickets and Weekly journeys. Or, they are derived in the case of Daily tickets, Daily journeys and Cash Fare journeys.

To illustrate how values are derived from the smartcard data table, take the example of Daily tickets. Given the Weekly ticket price ratio of 9.9, for a daily ticket price ratio of 1, we must be 90% of the way between 2,353,557 and 2,037,585, i.e. the number of Weekly journeys will be 2,353,557 + 0.9 * (2,037,585 – 2,353,557) = 2,069,182. Similarly, for a Daily ticket price ratio of 2, the number of Daily journeys will be 4,592,329 + 0.9 * (4,592,329 – 3,423,492) = 3,657,260.

A weighted average of the journeys made and tickets sold in the upper band and lower band price structure is taken [Col. I] with the weights based on the difference between the input values and lower band values [Col. H]. The associated discount factor is in ([Cell I66]).

Degeneration

The discount factor estimated above is based on concessionary passholders' journey frequencies at free fare. However, in the absence of a free concession, the number of journeys that would be made would be significantly smaller if fares were paid than if travel was free. It is therefore necessary to 'de-generate' journeys to allow for the move from free to full fare. The amount of generation that was created depends on the assumed price per journey of the discounted tickets, which in turn depends on the assumed use. Hence, the degeneration factor is estimated using the parameters of Single Demand Curve parameters (lambda and beta) and the fares of the individual ticket types.

For instance in our example the price or fare per journey is the average price per ticket divided by the number of journeys per ticket – this is calculated in [Cells D72:G77].

Table 25 Discount factor calculations - average price per journey (mixed urban rural example)

	Cash Fare	Daily	Weekly
Price ratio	1	1.80	9.90
Price per ticket	£1.60	£2.88	£15.84
Tickets sold (from Look Up Table)	935,069	1,769,176	150,667
journeys made (from Look Up Table)	935,069	3,657,260	2,069,182
journeys per ticket	1.00	2.07	13.73
Price per journey	£1.60	£1.39	£1.15

The resulting fares are used to estimate the associated reimbursement factor from the Single Demand Curve using the following formula

$$RF = e^{\beta \times FarePerTrip^{\lambda}}$$

where the Single Demand Curve parameters are

β (Urban) = -0.5963

λ (Urban) = 0.700

β (Non-urban) = -0.7226

λ (Non-urban) = 0.900

The resulting Reimbursement Factors are then used to adjust the Weekly and Daily price ratios upwards in [Cells D81:G83] (this example relates to an Urban demand curve in 2023/24).

Table 26 Discount factor calculations - degeneration of price ratio (mixed urban rural TCA with urban demand curve example)

	Cash Fare	Daily	Weekly
Reimbursement Factor	51.47%	54.72%	58.97%
Price Ratio	1.00	2.79	15.74

This effectively amounts to reassigning the number of journeys allocated to the Weekly, Daily and Cash tickets as shown in [Cells D87:I96].

Table 27 Discount factor calculations - journey reassignment (mixed urban rural example)

	User Input Derived Values	Lower Band	Upper Band	Factor	Interpolated Value
Daily Ticket Price / Cash Fare	2.79	2.00	3.00	0.79	
Weekly Ticket Price / Cash Fare	15.74	15.00	16.00	0.74	
Cash Fare Journeys		1,262,378	4,446,912	0.79	3,762,271
Daily Tickets		2,010,585	418,318	0.79	760,639
Daily Journeys		4,644,690	1,460,157	0.79	2,144,798
Weekly Tickets		44,482	35,551	0.74	37,895
Weekly Journeys		853,252	719,287	0.74	754,443
Check Journey Total		6,760,320	6,626,355		6,661,511
Discount Factor		12.0%	5.4%		2.8%
Average Discount Factor	8.7%				

However, this leads to too many single journeys in the basket and these are also abated using the reimbursement factor at Cash fare in [Cells D103:G106]. However, the abatement is only applied to the initial number of journeys in the basket (935,069) as the rest of the single journeys have been reassigned from Weekly and Daily tickets from the first de-generation step.

Table 28 Discount factor calculations - degeneration of single journeys (mixed urban rural example)

	Cash Fare	Daily	Weekly
Price Ratio	1.00	2.79	15.74
Tickets Sold	3,281,018	760,639	37,895
Journeys Made	3,281,018	2,144,798	754,443

Average Fare Forgone

The resulting discount factor is 3.0% in [Cell E108]. This is fed back to [Cell E6]. The discount factor is applied to the Average Cash Fare to derive the average fare forgone. In this example:

Average fare = Cash fare x (1 – Discount Factor)

£1.55 = £1.60 x (1 – 0.030)

Reimbursement factor (Step 3)

Reimbursement factor calculator

There are two options available to the user to estimate the reimbursement factor. These are selectable in the dropdown menu in [‘General Inputs’ Cell F20].

a. To estimate the reimbursement factor based on the change in operator-specific nominal fares between 2019/20 and the current reimbursement period:

   - In [‘General Inputs’ Cell F20], select this option and enter the percentage value of operator specific change in nominated fares in Cell F22. This will feed through into the reimbursement calculations in the sheet [‘RF – Calculations’].

b. To estimate the reimbursement factor for a new operator who did not exist before the current reimbursement period.

   - Select ‘New Operator’ in the dropdown menu in [‘General Inputs’ Cell F20] and enter the change in TCA wide average fares from 20019/20 and current reimbursement period in Cell F22. This percentage change is fed into the [‘RF – Calculations’] sheet which calculates the reimbursement factor.

Estimation of the Reimbursement Factor (RF workings)

The underlying calculations are performed in the *RF - Calculations* worksheet.

Calculating the reimbursement factor based on the change in operator specific fares between 2019/20 and the current year:

- The current average nominal fare forgone is retrieved from the RF - Calculations worksheet [Cell E16]
- The current nominal fare is deflated to 2019 prices [Cell E24] by referring to the CPI deflator value in ['Inflation – Calculations' Cell E9]
- The percentage change in nominal operator specific fares entered by the user is retrieved from the *General Inputs* worksheet [Cell E25]
- This percentage change is applied to the nominal operator specific fare in the current period [Cell E24] to give the nominal operator specific fare in 2019 in [Cell E26]
- This 2019 fare in nominal terms is the base fare to which the real fare in the current year [E24] is benchmarked against. The real fare in the current year [E24] divided by the operator fare in 2019 [Cell E26] gives the index value [Cell E27] appropriate to be used in the Single Demand Curve.
- The appropriate Single Demand Curve parameters are referred to [Cells E19:E20], with area type as selected in the General Inputs sheet. These are then applied to the index value [Cell E28] to calculate the appropriate reimbursement factor.

Calculating the reimbursement factor for a new operator

- The current average nominal fare forgone is retrieved from the *RF - Calculations* worksheet [Cell E16]
- The current nominal fare is deflated to 2019 prices [Cell F24] by referring to the CPI deflator value in ['Inflation – Calculations' E9]
- The change in TCA wide average fares between 2019/20 and the current year entered in *General Inputs* is retrieved in [Cell F25]
- This change is applied to the current nominal fare to obtain an estimate of the fare in 2019 (in 2019 prices)[F26]. This is the benchmark against which the current real fare [F24] is compared against.
- Dividing the real average fare in the current year [Cell F24] by the fare in 2019/20 gives you the appropriate index to be applied to the Single Demand Curve [F27]
- The appropriate Single Demand Curve parameters are referred to [Cells E19:E20], with area type as selected in the *General Inputs* sheet. These are then applied to the index value [Cell F28] to calculate the appropriate reimbursement factor [Cell F28].

Additional costs (Step 4)

There are a series of additional cost options on the 'General Inputs' sheet which users can use to estimate additional costs.

Marginal operating costs (MOC)

In the 'General Inputs' sheet, users are offered the option of using the default value for journey length or inputting a local journey length, in the case where there is good evidence that the journey length in the user's area differs from the average value of 3.9 miles. If the user wishes to enter a local value, they should select 'Local' in the dropdown menu in ['General Inputs' Cell F26].

The marginal operating cost is calculated in the 'MOC – Calculations' sheet, using the formula in § 8.11.

Marginal capacity costs (MCC)

If the user wishes to provide for MCC, they should select yes in the dropdown option in ['General Inputs' Cell F32] and follow the hyperlink in Cell H32 to the separate inputs sheet for MCC. The MCC calculator is in a separate spreadsheet to the inputs, *MCC – Calculations,* and, given the aggregate nature of the model, should be used at network level to estimate additional marginal capacity costs (see § 8.24). Some of the parameter values in the model are average network values and are therefore fixed (Mohring power, service elasticity) while for other parameters, users can either enter local values or use the default values provided (it is recommended not to mix local and default values). The guidance recommends that the default values for unit costs (vehicle hour costs and vehicle mile costs) should be used unless TCAs are confident that accurate locally-derived values can be derived.

The sheet *Marginal Capacity Costs Inputs* contains the options for using default or local values, starting in Row 17. A network must be turned on by selecting 'Yes' in the dropdown menu in Column E of its row before MCC can be estimated for it. Network subsets can be named in Column F although this does not affect calculations if not completed. Values must be input in Column G for the number of journeys on the network and Column T for commercial average fare. For all other input options, users can leave values as default or select 'Local' in the dropdown menu of blue-shaded cells and a green-shaded cell will appear below where the default value was displayed, where a local value can then be input.

All the underlying calculations are performed in the *MCC* – Calculations sheet, which pulls through all values from the input sheet. Annex H includes a more detailed explanation of the methodology behind the Calculator.

Data inputs

The Table below shows some illustrative data inputs that enter the MCC calculations for this worked example for a rural area in 2009/10 prices:

Table 29 Illustrative data inputs for the MCC Calculator

Variable	Status [Cell reference where option is chosen as applicable]	Value	Cell reference of value
Mohring power	Given	0.6	['MCC- Calculations' Cell E14]
Vehicle/mile cost	Given	£0.70	['Marginal Capacity Costs Inputs' Cell I17]
Vehicle/hr cost	Given	£13.30	['Marginal Capacity Costs Inputs' Cell K17]
Speed (mph)	Local	10.9	['Marginal Capacity Costs Inputs' Cell M17]
Mean vehicle occupancy	Local	17.8	['Marginal Capacity Costs Inputs' Cell O17]
Mean route length (miles)	Local	10	['Marginal Capacity Costs Inputs' Cell Q17]
Mean journey length (miles)	Local	4.9	['Marginal Capacity Costs Inputs' Cell S17]
Service elasticity	Given	0.71	['MCC- Calculations' Cell N14]
Average commercial fare	Local	£1.50	['Marginal Capacity Costs Inputs' Cell T17]
Commercial journeys as a % of total	Local	45%	['Marginal Capacity Costs Inputs' Cell V17]

Step 1: The link between patronage and frequency supplied (the supply response to demand changes)

This step predicts the increase in service frequency as a result of increased bus demand from generated concessionary patronage. It is not expected that commercial bus operators will increase bus frequencies in direct proportion to demand.

The aggregate relationship between demand and frequency supplied is estimated as follows:

The Mohring rule

$$\left(\frac{\chi_1}{\chi_0}\right) = \left(\frac{B_1}{B_0}\right)^{0.6}$$

Where:

χ is frequency supplied (0 without an additional passenger, 1 with an additional passenger)

B is patronage (0 without an additional passenger, 1 with an additional passenger)

Therefore, the proportionate change in frequency supplied is modelled to be the proportionate change in patronage to the power of two-thirds.

This formula implies that operators' response to an increase in demand will be a combination of a less than proportional increase in frequency and load factor.

The Mohring relationship is based on proportionate changes in patronage and proportionate changes in frequency supplied so it is necessary to make assumptions about a base case scenario.

Base case assumptions

10 minute service frequency = χ_0 = 6 buses/hour

Mean journey length = M = 4.9 miles

Mean vehicle occupancy = MVO = 17.8

Mean route length = 10 miles

With mean occupancy = $\dfrac{MB}{\chi}$

Where

M = mean passenger journey length

B = passenger boardings per mile of route per hour

Applying assumptions on journey length, mean vehicle occupancy and service frequency to this relationship gives:

$$B_0 = \frac{MVO \times \chi}{M} = \frac{17.8 \times 6}{4.9} = 21.7959 \; passenger\,boardings / mile\,of\;route / hour$$

One additional generated passenger on a route translates into 1/10 (additional passenger/route length) passengers per mile of route/hour.

Applying this to the Mohring rule, the frequency supplied with one additional passenger is calculated as follows:

$$\chi_1 = \chi_0 \times \left(\frac{q_1}{q_0}\right)^{0.6} = 6 \times \left(\frac{21.8959}{21.7959}\right)^{0.6} = 6.0165$$

Step 2: Additional vehicle hour costs from one additional generated passenger

Where:

Vhr is the rate at which vehicle hours are supplied to a route

s is speed

L is route length

Without the marginal passenger,

$$Vhr_0 = \frac{\chi_0}{s/L} = \frac{6}{10.9/10} = 5.5046$$

With one additional marginal passenger,

$$Vhr_1 = \frac{\chi_1}{s/L} = \frac{6.0165}{10.9/10} = 5.5197$$

Change in vehicle hours supplied = 5.5197-5.5046 = 0.0151

Vehicle hour cost = £13.30

Additional vehicle hour cost per additional passenger = £13.30x0.0151 = **£0.20**

Step 3: Additional Vehicle mile costs from one generated passenger

$$Vm = Vhr \times s$$

Where

Vm = Vehicle miles

Vhr = Vehicle hours

s = speed

Vehicle miles without the additional passenger

$$Vm_0 = Vhr_0 \times s = 5.5046x10.9 = 60$$

Vehicle miles with additional passenger

$$Vm_1 = Vhr_1 \times s = 5.5191 \times 10.9 = 60.165$$

Change in vehicle miles = 60.1647 - 60 = 0.165

Additional Vehicle mile cost per additional passenger = 0.16473 x £0.70 = **£0.12**

Step 4: Commercial revenue generated from increased frequency

Evidence on the demand response to service frequency changes is used to estimate demand increase and increase in revenue gain brought about my commercial passengers.

Fare paying passengers have a long run service elasticity = 0.71

$$Service\,Elasticity = \frac{\%\ change\ in\ patronage}{\%\,change\ in\ service\ frequency}$$

% change in frequency = ((6.0165 /6) -1)x100 = 0.275%

% change in demand = 0.275% x 0.71 = 0.20%

Total number of boardings per hour = B x L = 21.7959 x 10 = 217.959

Assuming that 45% of total patronage on the bus is commercial

Total number of commercial boardings per hour = 217.959 x 45% = 98.08

The increase in commercial patronage with increased frequency = 98.08 x 0.20% = 0.1962

If average commercial fare = £1.50

This implies a revenue gain = 0.1962 x £1.50 = £0.29

There will however be marginal operating costs from the additional commercial patronage generated

Applying the default marginal operating cost to the increase in commercial patronage:

0.1962 x 0.061 = £0.01

Summary: Net additional capacity cost

Table 30 Net additional capacity cost: worked example

Cost component/generated passenger	**£**
Time related additional capacity costs from generated concessionary journeys	0.20
Distance related additional capacity costs from generated concessionary journeys	0.12
Revenue gain from additional commercial journeys	0.27
Additional cost from generated commercial journeys	0.01
Net additional capacity cost per generated concessionary journey	0.06

Additional Costs

The General Inputs Sheet also provides for the input of administration costs of the scheme and for Peak Vehicle Requirement costs. These costs should be calculated separately and entered into Cells F36 and F38 respectively.

Net additional capacity cost per generated passenger journey = Time related capacity cost + distance related capacity cost - additional revenue from generated commercial journeys + additional operating cost from generated commercial journeys.

Impact of Changes to Inflation Index on Reimbursement Calculator

The reimbursement calculator uses a data series of past and forecast inflation, to work out the reimbursement factor, as well as other elements of reimbursement. The inflation data series used for cost inflation in the calculator is based on the Consumer Price Index (CPI), Average Worker Earnings (AWE) and diesel costs. CPI is also used to create a CPI deflator which is used to deflate fares in the reimbursement factor calculations.

The composite inflation index created using the inputs above is designed to more accurately reflect the increases to costs for bus operators than in previous iterations of the DfT calculator. Data for these calculations is sourced from the Office of National Statistics (ONS), with forecast data from the government's TAG Databook and the Office or Budget Responsibility used to extend indices to the forecast year.

This index is rebased for 2023/24 to start at 1.475. This represents the inflation in bus operator costs between 2009/10 and 2023/24, as informed by analysis of bus operator costs since 2009/10. The composite inflation index is then applied to all subsequent years.

ANNEX H: Marginal Capacity Cost Model

This Annex describes the methodology behind the Marginal Capacity Cost Calculator and the way it works. The variables that go into the Calculator are highlighted below together with a description of how they fit in the Calculator.

The Marginal Capacity Cost Calculator can be used to estimate the additional capacity costs that would be incurred if there was an increase in demand of one journey given the existing demand and supply of bus services. In other words it can be used to calculate the marginal capacity cost of one additional (generated) journey, a journey that would not have been made in the absence of a concessionary scheme.

It is recommended that the Calculator is used to calculate marginal capacity costs at the network level. The model is aggregate in nature and its parameters are most suitable for a network-based approach.

It is important to bear in mind that the Calculator estimates the cost of the marginal boarding per mile and assumes that changes in capacity can be continuous (or very small). In reality capacity changes tend to be discrete or large. For example, it would not make sense to change frequency by a fraction of a minute; similarly it would not make sense to change capacity in response to an increase in demand of one passenger. In order to identify the marginal capacity cost per generated journey it is necessary to estimate the impact of a small change in demand on capacity provision which, when grossed up, presents a more realistic picture.

Accommodating extra demand

Theoretically, there is an expectation that marginal capacity costs will be zero when generated passengers join the bus with free seats. However, if potential passengers are being systematically left behind at bus stops then service capacity will be increased to accommodate them. This is because bus operators are assumed to care about demand and associated revenue.

Extra demand can be catered for in two ways; either by increasing load factors or by increasing capacity. The Calculator estimates additional capacity cost where the increased capacity is provided through an increase in frequency.

Clearly there is a trade-off between these. Allowing load factors to rise will lead to an increase in boarding and alighting times, an increase in the number of stops made and impact on the ability of a bus operator to maintain timetables or expected journey times. Increases in journey times and unreliability would reduce demand. Apart from the potential loss of revenue this would not involve any additional costs. On the other hand, increases in frequency would increase demand as waiting time is reduced (generally valued as twice as much as in-vehicle time). This, however, would involve additional costs.

Economic theory and some empirical research have shown that if the network is fixed, for example if there is no change in access times (walking to the bus stop), then the mix would be 50:50[20]. This means that 50 per cent of an increase in demand would be accommodated by an increase in load factors and 50 per cent of demand would be accommodated by an increase in frequency. If the network is not fixed and access times can be reduced then this mix would change to 66:33 in favour of a change in frequency.

A central position recommended by ITS in its Research Report 9 (Costs) was that 60 per cent of a change in demand would be accommodated by a change in frequency. This is referred to as the **Mohring Factor** in the Calculator – the response in service frequency to a change in demand.

Based on this relationship between an increase in demand and the increase in frequency needed to accommodate this demand, the additional capacity costs that would be incurred with an increase in demand of one additional passenger can be calculated using the vehicle costs per mile and hour.

The methodology from this point is fairly straightforward. Given a level of service and a level of demand the Calculator simply converts the "required" increase in frequency into costs.

The level of demand is given by the **average load** or the average utilisation of seats. To be used in the Calculator it needs to be converted into the number of passenger boardings per route kilometre per hour. This is done to ensure that the marginal increase is not distorted by journey length.

Passenger boardings per route mile per hour =

[1]

The marginal increase would be the marginal boarding per route mile:

Marginal boarding per route mile =

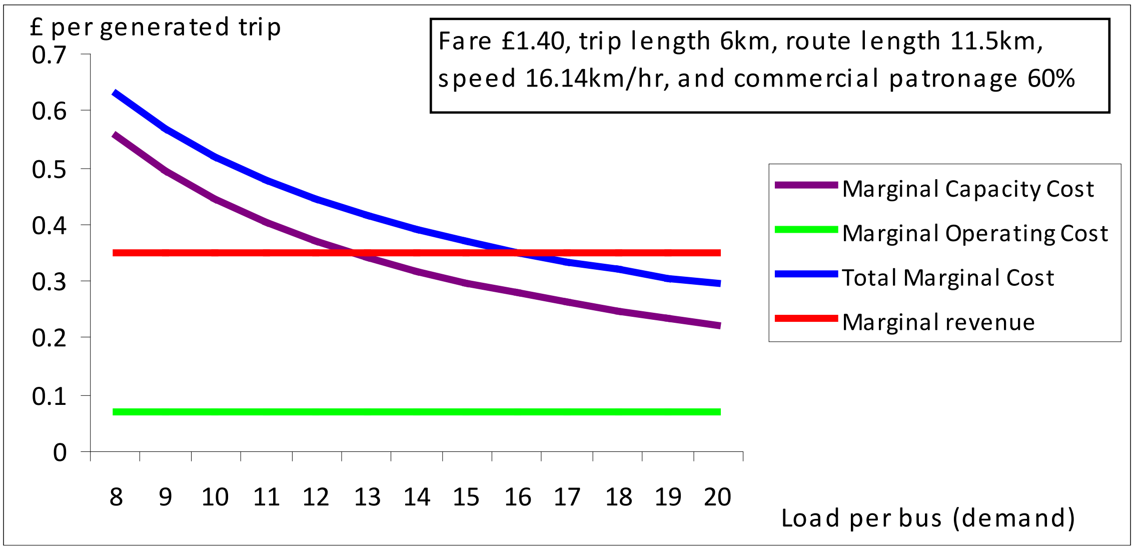
[2]

The change in demand at the margin is [2] ÷ [1].

Given this marginal increase is fixed, the higher the existing demand is, and the higher the existing supply is, the smaller this increment will be in percentage terms. As a result, the frequency response (60 per cent of the change in demand) reduces as demand rises and the percentage increase in vehicle hours and vehicle kilometres falls. In other words a smaller increase of a larger base is needed to accommodate one additional passenger mile. The marginal capacity cost is then seen to fall as demand increases as shown in Figure 6 below:

[20] This is the "square-root rule" which was a theory put forward by Vickrey (1955) and developed by Herbert Mohring (1972). It has been developed further by Jannson, Jara-Diaz and Small with similar conclusions. A useful summary is given in Jara-Diaz and Gschweinder, Transport Reviews, 2003, Vol 23 No.4, "Towards a general micro-economic model for the operation of public transport".

Figure6 Marginal capacity costs, revenues and loadings



The resulting increase in frequency will result in an increase in vehicle miles and vehicle hours which can be monetised using the additional cost data.

The cost per vehicle hour is a large component of costs so it is necessary to account for **average bus speeds** to estimate the impact on vehicle hours of an increase in frequency.

Frequency generated revenue effect

As noted above, an increase in frequency will affect demand because waiting times will be reduced. Therefore, there will be an effect on commercial revenue that will need to be taken into account when looking at the overall impact of an increase in frequency.

The revenue effect of a marginal change in frequency will depend on the **average commercial fare**, the **percentage of commercial passengers** and their response to changes in service, i.e. **their service elasticity**.

The overall effect is that marginal capacity costs will tend to vary inversely with demand and, at some point, be less than the revenue effect of changes in frequency. This is shown in Figure 6.

Some of the variables in the MCC Calculator can be input to reflect local conditions. The averages used for purpose of illustration are national averages, or reasonable assumptions based on available evidence.

ANNEX I: Aggregation of MCC Model Data Inputs

The MCC Calculator is a network model and as such it is recommended that variables at route level are aggregated into a network average for use in the Calculator.

Estimating a network average is not as straightforward as calculating an arithmetic average of the route values – these need to be weighted to reflect the fact that some routes are more heavily used and therefore should contribute more to the total estimate of marginal capacity costs.

The example below illustrates how a weighted average should be calculated:

Let's assume a network consists of two routes.

Route 1 carries 200 concessionary journeys which are on average 4-miles long.

Route 2 carries 100 concessionary journeys which are on average 10-miles long.

The simple arithmetic average journey length across the network is (4+10)/2 = 7 miles. However, this does not recognise the fact that the route with longer average boardings carries fewer passengers (the formula overstates the weight of the Route 2).

The network average journey length should be the weighted average of the journey length on each route which is the sum of the total journey length on each route divided by the total number of journeys made on each route:

Network average journey length = (200x4 + 100x10)/(200+100) = 6 miles.

The table below provides guidance on how each route variable used as an input to the MCC Calculator should be aggregated into a network average:

Table 31 Aggregation of route variables into a network average

Route variable	Aggregation into a network estimate
Mohring power	0.6 (fixed network value)
Average journey length	Weighted average by concessionary journeys
Average route length	Weighted average by concessionary journeys
Speed	Aggregate underlying components first - average route length as below - convert each route speed into a journey time in minutes (journey time = 60 x route length / speed) - calculate a weighted average of the journey times by concessionary journeys Average network speed = 60 x average network length / average network journey time
Average occupancy	Aggregate underlying components first - sum vehicle miles - sum passenger miles (passenger miles on a routes = journeys x journey length) Average occupancy = total passenger miles / total vehicle miles
Unit costs – vehicle hours	It is highly unlikely that this should vary by route (see also caveats about using local value). If this is the case use weighted average by concessionary journeys.
Unit costs – Vehicle miles	It is highly unlikely that this should vary by route (see also caveats about using local value). If this is the case use weighted average by concessionary journeys.
Demand response to service change (service elasticity)	0.71 (fixed network value)
Passenger journeys (concessionary, commercial, all)	Sum across routes
Commercial journeys as percentage of total	Total commercial journeys (summed across routes) / total 'all' journeys (summed across routes)
Average commercial fare	Weighted average by commercial journeys

ANNEX J: Guidance on £2 capped fare scheme

The £2 capped fare scheme was launched in January 2023 and is due to remain in place until 31st December 2024.

Operator reimbursement for concessionary travel schemes must adhere to the 'no better, no worse' principle. While commercial fare payers at the current time will be purchasing £2 tickets/products, the operator reimbursement mechanism for the £2 capped fare scheme does not take into account the impact on concessionary reimbursement. Therefore, concessionary reimbursement must remove the effects of the £2 capped fare scheme when estimating operator reimbursement in order to meet the 'no better, no worse' position.

There are five ways in which the £2 capped fare scheme impacts upon ENCTS reimbursement estimates:

1. It artificially reduces the cash fare paid by commercial fare payers within the Discounted Fare method. This results in the 'live' data provided by operators no longer being able to be used to derive the average fare forgone using the Discounted Fare method;
2. It impacts the proportional change in fare to derive the reimbursement factor, artificially reducing the change and increasing the reimbursement factor;
3. It artificially impacts on the ticket types and products that commercial fare payers purchase and would influence the weightings when calculating an average fare using the basket of fares method;
4. It artificially reduces the commercial average fare for use within the marginal capacity cost (MCC) model which results in incorrect MCCs being derived;
5. It potentially increases the proportion of commercial journeys as a percentage of total journeys due to journeys being generated by the £2 capped fare scheme.

In all five circumstances, TCAs and operators will need to identify an alternative approach to removing the influences of the £2 capped fare scheme on concessionary reimbursement.

Calculating the average fare forgone using the Discounted Fare method

Within the Discounted Fare method, there are three main inputs: cash fare, day ticket price and week ticket price. The latter two inputs should not be affected by the £2 capped fare cap, but it is necessary to confirm this with local operators. The cash fare, however, is likely to be lower than it would otherwise be without the £2 capped fare scheme. It is therefore necessary for TCAs and operators to derive an alternative cash fare that more accurately reflects the cash fare that fare payers would pay in absence of a £2 capped fare scheme.

Guidance previously provided by the DfT related to deriving a shadow fare; '*calculate a set of 'shadow' fares for the various ticket types operating during the period of the promotion and use these to* calculate *the Average Fare Forgone for concessionary travel over this period. Shadow fares would represent the 'actual' ticket prices in the first three months of 2023, were a national fare cap not in place'.*

Shadow fares are potentially useful if the quality of the data is robust. Concerns have been raised in the past of drivers potentially mis-recording journeys which may impact on the robustness and reliability of shadow fare data for this purpose. Instead, a proxy fare should be derived for the cash fare using what data an operator or TCA may have available.

If an operator has not changed cash (single, return and carnet fixed number of journeys products) fares since December 2022, the cash fare from the three-month period from October to December 2022 could be used as a reasonable proxy within the Discounted Fare model. If the October-December period is not a representative period from which to derive an average cash fare within a local area and seasonality impacts on the average fare, a longer period may be used instead. Consideration must be given, however, to when operators may have changed their fares during 2022-23 to ensure that the most recent cash fare is robust.

If an operator has increased fares since December 2022, then it will be necessary to adjust the pre-£2 scheme cash fare to reflect this. This adjustment can come in one of several ways:

The default position is that the pre-£2 scheme cash fare could be adjusted by CPI. In these circumstances the change in CPI since November 2022 (i.e. the midpoint of the three month pre-scheme fare) until the period for which the calculation is carried out.

Illustrative example to determine reimbursement in September 2023

Average cash fare October-December 2022 = £2.50

CPI index in November 2022 = 126.7

CPI Index in September 2023= 132

Proportional change in inflation = ((132/126.7)-1) = 4.183%

September 2023 cash fare = (£2.50 * 1.04183) = £2.605

Using CPI to estimate changes in fares is the recommended default position. However alternative options exist that may be worthy of consideration where there is strong evidence to suggest that CPI is not appropriate. If an operator (or a TCA) can robustly demonstrate what their cash fares would have been in absence of the £2 capped fare scheme, then this could be considered by TCAs. Some bus operators have maintained a set of proxy fares that they would charge should the scheme cease, and these proxy fares could provide an alternative method to estimate the cash fare.

Some caution should be given to using changes to day and week product prices as a proxy to what would happen to cash fares. Operators may choose not to change day and week product prices as a result of the £2 capped fare scheme, or may even change these fares in a different way due to the nature of the £2 scheme. However, in all cases, TCAs and operators should share information and evidence to justify the values it uses to derive the average fare forgone.

Where there are new bus services without any evidence of what the fare would have been before the £2 capped fare was introduced, TCAs and local bus operators will need to work together to determine an appropriate proxy fare for the October - December 2022 period. This could consider fares on comparable services provided by the affected operator, or comparable services in that area provided by other operators. Where there is no alternative evidence in the immediate area, a best estimate should be agreed by all parties using TCA-wide averages for services of a similar route length and similar geography operating within the TCA. In all cases, TCAs and operators should seek to estimate the average cash fare for the period immediately preceding the £2 capped fare scheme as accurately and as reasonably as they can given the information available.

Where bus services have fundamentally changed compared to the period immediately preceding the introduction of the £2 capped fare scheme, then this should be taken into account in the estimation of the average cash fare. A fundamental change is where there have been changes to a bus service that will likely have materially changed the average cash fare, all other things remaining equal. TCAs and operators should consider what the impact of the fundamental changes to the service are likely to have had on fares paid by adult bus users and incorporate these changes within the average fare calculation. However, if the changes to a service are so substantial, it may be prudent to consider treating the service as a new service and applying the process in the paragraph above.

Calculating the proportional change in fare to derive the reimbursement factor

Many TCAs and operators use the outputs from the Discounted Fare model to derive the proportional change in fare in order to update the reimbursement factor. Therefore, adopting the approach detailed for estimating cash fares is important to ensure that the change in fare compares like with like and derives an appropriate reimbursement factor.

To summarise:

- Unless there is compelling evidence to suggest otherwise, use CPI to forecast the change in the cash fare for the calculation period;
- If there is evidence to suggest an alternative change in cash fare, use this if it is reliable and can be agreed by both parties.

If day and week ticket prices have not been affected by the £2 capped fare scheme, then these should be used to support the calculation of the proportional change in fare.

For all calculations to derive the change in fare, it is essential that TCAs and operators are comparing like with like to determine an accurate change in fare since 2019-20. This will likely become increasingly challenging the longer the £2 fare cap is in place given changes to networks, pricing policies and competition effects. In such circumstances TCAs and operators should work together, share evidence and make best efforts to carry out like for like comparisons to derive a robust change in fare that both parties can evidence.

Using the Basket of Fares method

For those TCAs and operators who use the basket of fares method, the £2 capped fare scheme is likely to have had a significant impact on the weightings of products sold. Evidence provided from the scheme has shown that there has been a shift away from day, week and other period products towards £2 single fares. It is therefore essential that TCAs and operators use weighting from before the scheme was introduced in January 2023 when using this method.

Using sales and revenue data from the 3-month period before the £2 capped fare scheme was introduced is a reasonable period, although local circumstances may suggest using data from a longer periods where there are seasonal services that impact on journeys being made. It is important to ensure that whatever weightings are used, that they are representative of the period of time for which the reimbursement calculation is being carried out.

In addition to the weightings, the single, return and carnet tickets will need to be estimated within the basket of fares calculation. Using the same approach as with cash fares within the Discounted Fares model discussed above is recommended. For example, for single fares, adopt the pre-£2 capped fare scheme single price and adjust by CPI or operator own data to reflect likely price changes. Apply the weightings from pre-£2 capped fare scheme for single products. TCAs and operators should adopt the same approach for returns and carnet tickets. Average day and week ticket prices shouldn't be affected by the £2 capped fare scheme, so use these where all parties are confident that prices are reliable, but with pre-£2 scheme weightings. If day and week product prices have been affected by the £2 capped fare scheme, TCAs and operators will need to define what would have happened in absence of the capped fare scheme and use those prices alongside pre-scheme weightings.

Commercial average fare within the marginal capacity cost model

The fourth way in which the £2 capped fare scheme impacts on ENCTS reimbursement is in relation to the calculation of the commercial average fare.

The commercial average fare should take into account all farebox revenue to reflect the increased revenue an operator may receive if bus services were run at a higher frequency to accommodate generated concessionary passenger journeys. The £2 capped fare cap therefore has the potential to constrain the commercial average fare and therefore underestimate the amount of additional revenue an operator may receive.

There are many variables to consider here. The £2 capped fare scheme is not just for adults, but young people and students too where their fares are higher than £2. In addition, as discussed above, the shift in products purchased by fare payers has been impacted by the scheme, which makes calculating the commercial average fare accurately fraught with challenges.

In such circumstances, a pragmatic approach would be to derive the commercial average fare from the October – December 2022 period, and adjust by inflation or an alternative metric (as discussed above) where operators can supply robust evidence of an alternative approach. Consistency in approaches across the different average fare values being derived by TCAs and operators is strongly encouraged, for example, if CPI is used to adjust the cash fare for use within the Discounted Fare model, then it would be expected that CPI would be used to adjust fares to determine the proportional change in fare as well as the calculation of the commercial average fare.

Commercial journeys as a proportion of total journeys

In some circumstances the £2 fare may have influenced the proportion of commercial journeys as compared to all journeys – a separate input variable within the marginal capacity cost model. These circumstances may be reasonably isolated and it is not expected to have a significant impact on the MCC model outputs. However, operators should provide evidence from their back office systems where it holds it for the TCA to consider i.e. increased commercial patronage over and above other routes due to the scheme.

Other considerations

One aspect that TCAs should consider carefully is that operators should have control over their fares given that they take the commercial revenue risk for operating bus services. The existence of the £2 capped fare scheme prevents participating operators from increasing their single fares (albeit operators are compensated for being part of the scheme by the DfT), and the scheme has impacted on the other products that operators sell – due to the shift in user behaviour that the scheme has brought about.

TCAs and concessionary travel schemes should not prevent or constrain an operator from changing their fares. If an operator wishes to increase fares, this should be considered sensitively and pragmatically within ENCTS reimbursement calculations. However, it would be expected that operators would follow similar fare changing practices that have been adopted in previous years. For example, if an operator changes fares on an annual basis at a specific time, this would be considered typical behaviour. If an operator changes fares on a service-by-service basis throughout the year, again, this would be considered typical and TCAs should reflect this in how it treats the calculation of ENCTS reimbursement.

Summary

This guidance provides a practical approach to deriving operator reimbursement for ENCTS where operators are part of the £2 capped fare scheme. The £2 capped fare scheme impacts upon several areas within operator reimbursement calculations, and it is essential that wherever possible, these effects are accounted for and removed to ensure that ENCTS reimbursement best reflects the ‘no better no worse’ position.

In all circumstances, TCAs and bus operators should engage at the earliest opportunity, share knowledge and evidence and attempt to find pragmatic solutions to the issues encountered.