IPART
New South Wales

Independent Pricing and Regulatory Tribunal

Estimating the external benefits of public transport

Used in setting maximum fares for rail, bus and ferry services

Transport — Issues Paper
August 2014

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Invitation for submissions

IPART invites written comment on this document and encourages all interested parties to provide submissions addressing the matters discussed.

Submissions are due by 30 September 2014.

We would prefer to receive them electronically via our online submission form <www.ipart.nsw.gov.au/Home/Consumer_Information/Lodge_a_submission>.

You can also send comments by fax to (02) 9290 2061, or by mail to:

Review of external benefits of public transport
Independent Pricing and Regulatory Tribunal
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We may choose not to publish a submission—for example, if it contains confidential or commercially sensitive information. If your submission contains information that you do not wish to be publicly disclosed, please indicate this clearly at the time of making the submission. IPART will then make every effort to protect that information, but it could be disclosed under the *Government Information (Public Access) Act 2009* (NSW) or the *Independent Pricing and Regulatory Tribunal Act 1992* (NSW), or where otherwise required by law.

If you would like further information on making a submission, IPART's submission policy is available on our website.

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1 Introduction

The Independent Pricing and Regulatory Tribunal of NSW (IPART) is responsible for determining maximum fares for public train, bus and ferry services in Sydney and surrounding areas each year. Historically, fares recover only a small proportion of the total cost of providing these services. The NSW Government pays the bulk of the cost. Given this, our key decision in determining fares is how much of the total cost should be paid by the people who use public transport (through fares) and how much by the NSW community as a whole (through the Government subsidy).

Over the past five years, we have made this decision by estimating the value of the 'external benefits'[1] associated with each mode of public transport as well as the efficient costs of providing it.[2] We then set the Government subsidy broadly in line with the estimated value of the external benefits, and set fares to generate the difference between the Government subsidy and the estimated efficient costs. We used this approach because one of the main reasons governments subsidise public transport services is that having these services benefits the whole community, not only the people who use them. For example, using public transport leads to lower road congestion, and lower air pollution and greenhouse gas emissions than if these journeys had been taken by private vehicle. Therefore, we considered that it was appropriate to set the Government subsidy broadly in line with the estimated value of these community-wide or external benefits.

While we still consider this broad approach is appropriate, we are reviewing the detail of the approach – including, for example, which external benefits we include in estimating the value, and the methodology we use to estimate the value of each benefit. This issues paper is the first step in our consultation process for the review. It explains the purpose and context of the review in more detail, and discusses the key issues we will consider. We invite all interested parties to participate in this review (see Box 1.1).

1 Also called 'positive externalities'.

2 We use the efficient costs of providing public transport rather than the total costs because we do not consider it appropriate to ask passengers to pay for inefficient Government expenditure.

1.1 Why are we conducting this review?

We are responsible for determining maximum fares for trains, buses and ferries. We began using the estimated value of external benefits as a key input to our public transport fare determinations in 2008. We are reviewing our approach for estimating this value because it is good regulatory practice to review significant inputs periodically.

We recognise that, unlike estimating the efficient costs of public transport, estimating the external benefits of those services is not straightforward. These benefits are difficult to quantify and it is unlikely their value can be precisely measured. Nevertheless, we consider a 'best estimate' of their value represents the best guide available to us for setting public transport fares.

The value of the external benefits is also affected by decisions that are made about transport planning, investment and service levels, as well as land use and urban development. These are decisions of Government and are not within the scope of our review. We propose to assess the external benefits associated with changing fares and implications this may have for patronage.

Given these issues, it is important to review our approach periodically to ensure it continues to provide a 'best estimate'.

Our main goals for this review are to ensure the approach we use for estimating the external benefits of public transport services:

- incorporates all relevant external benefits
- uses robust methodologies and correct, up-to-date underlying data to value each benefit, and
- uses inputs and produces outputs that are consistent across all three modes of public transport (trains, buses and ferries).

1.2 What will be the outcome of the review?

The review will result in a revised approach, as well as a new 'best estimate' of the external benefits of public transport for input to our fare determinations from 2016. This best estimate will be:

- relevant to fare setting
- able to be applied over the next three to five years.

To date we have estimated the external benefits of each mode of transport during our fare review for that mode. We are conducting this review of external benefits outside those fare reviews so that we can consider the external benefits of train, bus and ferry services at the same time. The outcome of this review will feed into our next round of fare reviews, which begins next year with a new determination

of maximum fares for trains in Sydney and surrounding areas due to commence in January 2016.

At this stage, we expect that the new best estimate will be in the form of a reasonable range for the value of the external benefits, most likely on a dollar per passenger journey basis and/or a dollar per passenger kilometre basis.

Box 1.1 How and when can you participate in this review?

Like our other reviews, this review of our approach to estimating the external benefits will involve public consultation as well as research and analysis, including by IPART and possibly external consultants.

This issues paper is the first step in our consultation process. All interested parties are invited to make submissions in response to the paper by Tuesday 30 September 2014. We also propose to release a draft report and invite further submissions before making our final decisions.

An indicative timetable for the review is set out below.

Table 1.1 Indicative timetable

Event	Indicative date
Submissions on issues paper due	30 September 2014
Draft report released	November 2014
Public hearing	November 2014
Submissions on draft report due	December 2014
Final report released	March 2015

Note: For the most up to date timetable information please see www.ipart.nsw.gov.au

1.3 The key issues we will consider and our preliminary views

During this review we will consider the current set of benefits we include and how we go about putting a value on them. We also intend to consider whether there is a wider set of benefits that should be included in our analysis and if so, how we would go about measuring the value of these benefits. We have proposed criteria that we intend to use to determine whether additional benefits are relevant for our purposes. We are also seeking feedback on those criteria.

Our preliminary view is that our fundamental approach to estimating external benefits remains appropriate but that some modifications should be made to it, including:

- Changing how we use the Sydney Strategic Travel Model (SSTM) to model benefits associated with avoided car use. In particular, focusing on modelling changes that are incremental to the status quo rather than those that involve

major changes. We also intend to work with the Bureau of Transport Statistics (which owns and runs the SSTM) to consider whether it is necessary to make adjustments to address certain simplifications included in the model.

- Considering further whether we can estimate external benefits for the network as a whole and/or consider differences in external benefits at different times of day.
- Updating the input data that we use to form estimates of the cost of pollution and greenhouse gas emissions avoided by public transport.

Many of these modifications would address concerns that have been raised with us by stakeholders in previous reviews.

Our preliminary view is also that there are some additional external benefits and external costs that may warrant inclusion in our analysis, they are:

- **Accident externalities**. We previously considered the external benefits of avoided accidents to be too small to warrant inclusion. However, more recent analysis suggests that there are additional external accident costs that are avoided by public transport and as such, there are some additional external benefits that should be included.
- **Scale benefits**. These are benefits of reduced travel time for existing users of public transport when patronage increases, if this increase in patronage results in an increase in service frequency. There is significant complexity around measuring and including these externalities as their existence (and value) depends on decisions regarding transport planning, investment and service levels. If service frequency does not increase in response to higher patronage, the additional crowding on public transport may actually impose an external cost.
- **The excess burden of taxation**. This refers to the cost of raising funds to pay for public transport subsidies. We intend to reconsider whether to make an adjustment to account for this and if so, how such an adjustment should be calculated. This would constitute an external cost of public transport rather than an external benefit.

1.4 List of questions on which we seek comment

Following is a list of questions that we have posed as a starting point for stakeholders to respond to. However, we are happy to receive input on any aspect of our approach.

1 Do you agree with our proposed criteria for deciding whether a benefit should be included in estimating the external benefits of public transport for fare setting purposes? 13

1.5 How this paper is structured

This paper is structured as follows:

- Chapter 2 sets out what the external benefits of public transport are and how they affect fares
- Chapter 3 discusses the external benefits that we currently include in our public transport fare determinations, their values and how we have estimated them
- Chapter 4 raises other external benefits, sets out some of the issues involved with them and our preliminary views on which should be included
- Appendix 1 provides more detailed information on how we currently estimate external benefits.

2 What are the external benefits of public transport and how do they affect fares?

Public transport imposes direct costs (fares) and provides direct benefits (getting from A to B) for the individuals who decide to use these services. However, public transport also imposes costs (Government subsidies) and provides benefits (eg, lower road congestion) to the community as a whole. These community-wide costs and benefits are known as external costs and benefits because they are external to the people making the decision to use public transport.

As Chapter 1 noted, in recent years IPART has used the estimated value of the external benefits of train, bus and ferry services in the greater Sydney area as a key input to our fare determinations for these services.[3] In particular, we have used this estimated value to decide how much of the total efficient cost of providing the services should be:

- funded through Government subsidies (to reflect the external benefits), and
- recovered through fares (to pay for the remaining costs).

While it is likely that many governments consider the existence of external benefits implicitly when setting public transport fares, it is not typically done explicitly. NSW is one of the few places with an independent public transport fare regulator and as a result, ours is one of the few estimates of the external benefits of public transport services that are publicly available. The absence of alternative estimates, as well as the inherent challenges involved in quantifying and valuing external benefits, make cross-checking our estimates difficult.

To help stakeholders participate meaningfully in the review, the sections below provide a high-level overview of:

- why we consider the value of external benefits of public transport in setting fares
- whether these external benefits justify subsidisation of public transport
- what we have included in estimating the value of the external benefits to date, and what we may include in the new 'best estimate' of this value

[3] Specifically, these include train services provided by Sydney Trains and NSW TrainLink (formerly CityRail), metropolitan and outer metropolitan bus services, and Sydney Ferries services.

- how we have used the estimated value of the external benefits in setting fares to date and how this may change in the future
- how the new best estimate resulting from this review may affect the level of fares.

The next chapters provide more detailed (and technical) discussion of these issues.

2.1 Why does IPART consider the value of external benefits in setting fares?

As Chapter 1 noted, one of the main reasons governments subsidise public transport is because it provides external benefits to the community as a whole. In line with the 'beneficiary pays' principle, this means it is reasonable for the community to contribute to the efficient costs of public transport.

In general, the existence of external benefits justifies government subsidy of an activity considered to be beneficial to the community if the following criteria are met:

- the subsidy would make people undertake more of the beneficial activity than they otherwise would, and
- the external benefits society receives as a result of people undertaking more of the beneficial activity exceeds the net cost of providing the subsidy (including the administration costs of verifying that the external benefit has been produced and distributing the subsidy).

For the public transport services where we set maximum fares, we consider that some government subsidy is justified. In our most recent reviews of rail, bus and ferry services, we have calculated the appropriate Government subsidy (including subsidies for concession, pensioner and student travel as well as the subsidy for external benefits) as being 72% of efficient costs for rail,[4] around 60% of efficient costs for Sydney metro and outer metro buses,[5] and 35% of efficient costs for Sydney Ferries.[6]

Ideally, the subsidy for external benefits should be provided up to the level where it no longer meets the above criteria – that is, up until the point where additional subsidy either does not make any difference to the amount of the beneficial activity being undertaken or up until the point that the benefits received by society are equal to the net cost. There is no sound justification for

4 IPART, *Review of maximum fares for CityRail services from January 2013 – Final Report*, November 2012, p 3.

5 IPART, *Review of maximum fares for metropolitan and outer metropolitan buses from January 2014 – Final Report*, November 2013, p 1.

6 IPART, *Review of maximum fares for Sydney Ferries services from January 2013 – Final Report*, November 2012, p 5.

continuing to subsidise fares for public transport above this point because the net benefits of public transport use (external benefits plus revenue minus costs) would no longer be positive.

2.2 Do the external benefits justify full subsidisation of public transport?

In the past, some stakeholders have argued that the external benefits of public transport mean that it should be fully subsidised by government – as is the case for other public goods, like public health, law enforcement, and public schools. We don't accept this argument for two main reasons.

First, in our view the external benefits provided by these other public goods are not comparable with those provided by Sydney public transport services. All NSW citizens receive substantial benefits from public health, public education and law enforcement activities. In contrast, citizens' access to Sydney's public transport services varies depending on where they live and a relatively small proportion use the services. For example, even if they live in the Sydney area, people's access to Sydney Trains (formerly CityRail) services depends on their proximity to a train station, and past studies have shown that only around 21% of Sydney residents can be considered 'regular users' of rail, where 'regular user' is defined as someone who used rail at least once in the last week.[7] Table 2.1 shows that the proportion of trips by each transport mode is dominated by private vehicles on an average weekday. We consider it appropriate that those who benefit most from public transport, namely passengers, contribute more towards the cost of providing it.

Table 2.1 Proportion of trips by mode (average weekday) 2011/12

Mode	Proportion %
Vehicle driver	46.9
Vehicle passenger	21.1
Train	5.5
Bus[a]	5.9
Ferry	0.3
Walk only	18.2
Bicycle	0.5
Other (includes taxi)	1.4

a Includes public and private buses.

Note: Percentages do not add to 100 due to rounding.

Source: Bureau of Transport Statistics, *2011/12 Household Travel Survey Summary Report*, *2013 Release*, p 31.

7 Bureau of Transport Statistics, *Compendium of Sydney Rail Travel Statistics, 8th Edition, v1.1,* November 2012, p 27.

Second, we don't consider that full subsidisation would necessarily lead to significantly greater benefits for society, even though it may provide greater personal benefits to the people who use public transport. As indicated above, providing a subsidy is justified if it creates an incentive for people to behave in a way that is beneficial to the community – in this case using public transport instead of driving.[8] However, this approach is only worthwhile if:

- people would not undertake as much of the beneficial activity without that subsidy
- the external benefits society receives as a result of people undertaking more of the beneficial activity exceeds the net cost of providing the subsidy.

Based on the analysis we have done to date, these conditions would not be met if Sydney's public transport services were fully subsidised. These services are already heavily subsidised, to a level that represents a significant amount of taxpayer funding. For example, in 2011/12, the level of Government funding for transport Public Trading Enterprises[9] was $3.7 billion, or around $25 per week from each household in NSW.[10]

Given a particular level of service, increasing the subsidy to 100% (so users do not contribute anything to the cost of providing the services) would not necessarily result in large numbers of people switching from driving to public transport because fare levels are only one factor in a person's decision to use these services. Factors such as convenience, accessibility, frequency, reliability and comfort of service also influence this decision. On the other hand, many people may be willing to use public transport even if the current subsidy was reduced or removed – for example, if a return journey fare doubles. This is because even at the higher cost, the fare reflects the benefits to them of using the service. That is, it may still be cheaper or more convenient than making the journey by car.

For these reasons, while we do agree that some Government subsidy of public transport is justified, we consider that the level of the subsidy should be linked to the value of the external benefits that public transport provides.

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8 The external benefits we have included to date are those associated with avoiding the congestion and pollution associated with driving.

9 In 2011/12, transport Public Trading Enterprises included RailCorp, the State Transit Authority and Sydney Ferries, but not agencies such as Transport for NSW or Roads and Maritime Services that also contribute to providing public transport services, or private bus operators who receive Government contract payments.

10 IPART calculations; the ABS census data on number of dwellings in NSW was used to calculate weekly household cost in NSW (from the ABS's Table Builder); net Budget funding to transport agencies is taken from *NSW Budget Statement 2014-15, Budget Paper No. 2*, Table 9.3. The Budget funding figure does not include capital funding for new buses which is allocated through Transport for NSW.

2.3 What external benefits have we considered to date?

Since 2008, we have engaged a consultant – Sapere Research Group (formerly LECG) – to provide expert advice on what external benefits are relevant for fare setting, and to estimate the value of those benefits for each mode of transport. In line with this expert advice, we have:

- incorporated only the external benefits that arise when people use public transport instead of travelling by car (avoided car travel)
- included the value of two such external benefits:
  - lower road congestion, and
  - lower air pollution and greenhouse gas emissions
- adjusted this value to account for the fact that people already face some of the external costs of driving through various tolls, levies and other road user charges.

2.3.1 Benefits of avoided car travel

Our focus on the benefits associated with avoided car travel reflects our view that when people use public transport instead of walking or cycling no material external benefits arise, since these alternative modes do not impose significant costs on the community.

It also recognises that most people decide between driving themselves and using public transport based on the costs and benefits to them of each option, without considering the external costs and benefits each option imposes on the community. One way to encourage more people to make the socially efficient decision is to ensure that the costs of car travel reflect the true costs of car use, which include road congestion and air pollution.

From an economic perspective, this could be done via a system of road use pricing that made the internal cost of car travel equal to both the internal and external costs it imposes. If this were the case, there would be no need to take into account the external costs of car travel (ie, the external benefits of public transport) in setting public transport fares. However, without such a system, lowering public transport prices is another way to encourage better travel choices that benefit everyone.

2.3.2 Valuing lower road congestion, pollution and emissions

In our previous reviews, we have measured several external benefits associated with using public transport instead of car travel, including lower road congestion, lower air pollution and greenhouse gas emissions, and lower external road accident costs.

We included lower road congestion (which was by far the greatest external benefit) and lower pollution and emissions only. (Chapter 3 explains these benefits, their value and shows how we currently estimate them.) We found that the value of avoided accident costs to the community was too small to warrant including in our estimate of the external benefits for fare setting purposes.

2.3.3 Adjusting for road user charges

As noted above, if the internal cost of car travel was equal to both the internal and external costs it imposes, there would be no need for us to consider these external costs (ie, the external benefits of avoided car travel) in setting public transport fares. While this is not currently the case, the Government does impose some additional costs on car users that effectively 'internalise' some of the external costs that their car travel imposes on society. These include road user charges that are directly proportional to a person's car or road usage, such as the fuel excise and road tolls.

Because these road user charges increase the internal cost of a person's car travel they lower the Government subsidy required to improve the relativity between the internal cost of car travel and the internal cost of public transport. To account for this, we subtract the estimated value of these charges from the value of the 'positive external benefits' (ie, lower road congestion and lower air pollution and emissions), effectively treating them as a 'negative external benefit'.

2.4 What other external benefits are we considering?

As part of this review we will consider whether there is a wider set of external benefits (positive and negative) that are relevant for setting public transport fares, beyond those of avoided car use. For example, in past reviews, some stakeholders have suggested we should consider:

- agglomeration and wider economic benefits
- social accessibility and inclusion benefits.

We have also identified several other positive external benefits, as well as some additional negative external benefits (external costs) that we would like to consider for inclusion. (Chapter 4 provides a detailed discussion of these other possible external benefits and costs and sets out our preliminary views on each.)

To help us decide whether an external benefit is relevant for setting public transport fares, we propose to assess it against a set of criteria. Our proposed criteria are listed in Box 2.1. At this stage, we consider that an external benefit (positive or negative) should meet all these criteria to be included in our new 'best estimate' of the external benefits of public transport.

Box 2.1 Proposed criteria for assessing whether external benefits should be included in the new 'best estimate'

1. **It needs to be external** – not a private cost or benefit that goes directly to the user, as those are already taken into account when making a decision on how to travel.
2. **It should not be available only to a particular subset of people** – benefits that are only available to some people (such as, benefits to those who own property close to a train station) do not provide justification for lowering fares for everyone.
3. **It needs to be measurable** – we need to be able to estimate the value of the benefit; it would be enough that we could determine a reasonable range.
4. **It needs to change materially in response to changes in public transport use, brought about by changes in fares** – the value of the net benefits of public transport use to society (external benefits + fare revenue - the cost of providing the services) should change in response to changes in fares.[a]

[a] It is important that the benefit increases as the usage of public transport increases because the purpose of subsidising fares is to increase the use of public transport by lowering its price (relative to not having a subsidy) in order to realise greater benefits for society.

IPART seeks comments on the following

1 Do you agree with our proposed criteria for deciding whether a benefit should be included in estimating the external benefits of public transport for fare setting purposes?

2.5 How have we used the external benefit value in setting fares to date?

In making our fare determinations for each mode of transport since 2008, we decided it was appropriate to share the efficient costs of providing the services concerned between the Government and passengers so that:

- the Government contributed funding equal to the value of the external benefits of the services (plus additional funding for journeys taken on concession tickets), and
- passengers contributed the difference between the efficient costs and the value of the external benefits.

Thus, the approach we used to set maximum fares for each mode involved:[11]

1. Estimating the efficient costs of providing the services using a 'building block' model.
2. Estimating the value of the external benefits associated with these service – that is, the benefits (positive and negative) discussed in section 2.3 – and taking into account the expected use (or patronage) of those services.
3. Subtracting this estimated value from the efficient costs to determine the amount of revenue to be generated through fares (the 'revenue requirement').
4. Calculating how much fare levels need to change to generate an amount equal to the revenue requirement in the final year of the determination period (or some other target date), taking into account forecast changes in the use of the services (patronage) for this period.
5. Considering the implications of the fare changes for passengers, the Government and the environment before determining the maximum fares to apply.

Any difference between the efficient costs we have estimated and the amount actually being spent by the transport provider is not allocated to fares or our calculation of an appropriate Government subsidy, but is a matter for Government either to continue to subsidise (over and above the 'appropriate subsidy') or to make service provision more efficient in future. The level of any inefficient costs does not affect our **fare** calculations.[12]

In the past, the consultant we engaged to advise us on the value of the external benefits, Sapere Research Group, has also provided a view on the 'optimal fare' for each mode of transport. The fare optimisation process takes into account both the external benefits of the public transport services concerned and the fact that the price of these services is below the cost of providing it (that is, that Government subsidy is required). The optimal fare that comes out of that process is the fare level for the particular mode of transport being considered that would result in the optimal amount of usage of that mode – that is, the usage that would maximise the net benefits to society. While we had regard to this view, we did not rely on it in our decision-making because we had concerns about the data used to estimate the optimal fare, particularly the cost data used.[13]

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11 See IPART, *Review of maximum fares for Sydney Ferries services from January 2013 - Final Report*, November 2012; *Maximum fares for metropolitan and outer metropolitan buses from January 2014 - Final Report*, November 2013; *Review of maximum fares for CityRail services from January 2013 - Final Report*, November 2012.

12 See, for example, IPART, *Review of maximum fares for CityRail services from January 2013 – Final Report*, November 2012, p 4, which estimates that, "if CityRail continues to spend more than the allowances we consider efficient, … over the next 3 years NSW taxpayers will also need to subsidise CityRail services by around $1.5 billion more than is justified…".

13 For more information see IPART, *Review of CityRail fares, 2009-2012 - Final Report*, December 2008, p 110.

2.6 How the new 'best estimate' of the external benefits will affect the level of fares

As Chapter 1 discussed, we expect that this review will result in a new 'best estimate' of the value of the net external benefits of each mode of public transport, which we will use as inputs to our next round of fare determinations. At this stage, we expect this estimate will be in the form of a reasonable range for the value of the external benefits, and will be expressed in dollars per passenger journey per mode.

This reasonable range may be higher or lower than the estimated values we have used in making the current fare determinations. All other things being equal:

- a higher estimated external benefit value would suggest that greater Government subsidy is appropriate and that fares should be lower, while
- a lower estimated external benefit value would suggest a lower level of subsidy and higher fares.

However, when we make our next round of fare determinations we will update all aspects of our analysis including cost estimates, forecast patronage and our approach to setting fares. This makes it difficult to forecast what impact a change in the external benefits estimate will have on fares prior to our next round of fare determinations.

If we find in our next round of fare determinations that current fare levels are too high or too low relative to where we think they should be, we will aim to ensure that they transition towards the target level over time (in line with our usual practice). This is because large changes in fares, either up or down, are undesirable as they are likely to have an unreasonable impact on either passengers or the level of Government funding required. We are formally required to consider the impacts of any fare changes on passengers, the level of Government funding required and the environment in making our determinations.[14]

IPART seeks comments on the following

2 Do you have any concerns about our current approach to using the value of the external benefits of public transport for fare setting purposes?

[14] The factors we must consider when making a fare determination are set out in section 15 of the *Independent Pricing and Regulatory Tribunal Act 1992*, and sections 16AE and 28J of the *Passenger Transport Act 1990*.

3 What external benefits do we currently include and how have we estimated them?

As Chapter 2 outlined, since 2008 we have engaged Sapere Research Group to provide expert advice on the external benefits relevant for fare-setting, and to estimate the value of those benefits for each of Sydney's public transport modes. In line with Sapere's advice, the current approach focuses on valuing three elements, all of which relate to the external costs of car use that are reduced or avoided when people use public transport instead. These three elements are:

- avoided road congestion
- avoided air pollution and greenhouse gas emissions, and
- an adjustment to account for road user charges (a negative external benefit).

The section below shows our current estimate of the value of the external benefits for each public transport mode broken down into each element. The following sections provide an overview of the approach we used to derive these values, and then discuss each step in this approach, highlighting the issues we propose to consider as part of this review.

3.1 Current estimated value of the external benefits

We have estimated the value of external benefits for our fare determinations for metropolitan and outer metropolitan buses, CityRail and Sydney Ferries for several years. Table 3.1 summarises the values we used for the most recent determinations. These values are expressed in dollars per passenger trip in this table in order to show the relativities between the external benefits for the different modes more clearly. We have also expressed the value of the external benefits as a percentage of the total efficient costs of each mode.

For each mode of public transport, the avoided cost of road congestion is the most significant of all the external benefits. For rail and bus services there are also positive external benefits associated with reduced air pollution and greenhouse gas emissions. However, under the current estimates for Sydney Ferries the pollution created by ferries is worse than the pollution avoided when the same number of passengers travel by alternative modes of transport, leading to a negative benefit (an external cost).

Table 3.1 Summary of the external benefits included in IPART's current fare determinations ($ per passenger trip)

	Metro buses ($2013)	CityRail ($2013)	Sydney Ferries ($2013)
External benefits			
- Avoided road congestion	1.24	6.55	0.47
- Reduced pollution & greenhouse gas	0.43	0.18	-0.22
- Road charges adjustment	-0.14	-0.15	-0.16
Total external benefit per passenger trip	**1.52**	**6.58**	**0.09**
Total external benefit per passenger km[a]	0.23	0.39	0.01
Total external benefit as a % of total efficient costs	36%	65%	1%

[a] The sample size for average trip distance data for ferries was small.

Note: Average fare paid is based on actual fares charged in 2013. We have not previously reported the external benefits on a per passenger trip basis for Sydney Ferries.

Source: IPART, *Review of maximum fares for CityRail services from January 2013 – Final Report*, November 2012, p 43; *Review of fares for metropolitan and outer metropolitan bus services from January 2010 – Final Report*, December 2009, p 78; *Review of maximum fares for Sydney Ferries services from January 2013 – Final Report*, November 2012, p 54; Bureau of Transport Statistics, *2011/12 Household Travel Survey Summary Report*, 2013 *Release*, p 35; IPART calculations.

3.2 Overview of the approach we used to form these estimates

The approach we have used to value the external benefits to date involves estimating how much car use is avoided when people use Sydney's train, bus or ferry services instead of driving, and then quantifying the net value of this avoided car use to the community.

When we first adopted this approach for rail fares in 2008, it was the first time we had attempted to quantify the value of external benefits and take them into account when determining fares. As far as we know, it was also the first time a regulator or government had explicitly attempted to take external benefits into account when setting public transport fares.

Over the next five years, we progressively applied the same approach in setting fares for public bus and ferry services. As we did this, we made minor changes to the approach to adapt it to these other modes. We also learnt from experience and made incremental improvements to the approach where they seemed sensible.

However, over this time the fundamental approach has not changed. It involves three main steps:

1. Estimating how much car use is avoided when people use a particular mode of public transport, and the implications of this for traffic speed (and hence time spent driving by existing drivers), and total distances travelled by car on Sydney roads.

2. Based on these estimates, quantifying the external benefits associated with this avoided car use – including avoided road congestion (the value of time saved for existing drivers) and reduced pollution and greenhouse gases (the value of the emissions avoided when less distance is travelled by car). We then add these values together to give the total value of the external benefits.
3. Estimating the adjustment required to account for the road user charges drivers pay (the value of the external costs of car use that drivers already pay). We then subtract this amount from the result of Step 2 to give the net value of the external benefits.

3.3 How we estimated how much car use is avoided when people use public transport (Step 1)

To work out how much car use is avoided – and thus road congestion and pollution and emissions – by a particular mode of public transport we estimated:

- how many people currently using that mode of transport would choose to drive if they didn't use that mode (ie, the number for whom driving is the next best transport alternative)
- what impact this number of additional drivers would have on the travel times of existing drivers
- what impact this number of additional drivers would have on the total kilometres driven.

We used the Sydney Strategic Travel Model (SSTM) to make each of these estimates.[15] The SSTM is a well-regarded model for measuring the impacts of different pricing scenarios on travel at a citywide level. It was developed and is maintained by the Bureau of Transport Statistics (BTS), which is part of Transport for NSW. It projects travel patterns in the Greater Metropolitan Area of Sydney under different land use, transport and pricing scenarios. It uses data gathered by the Sydney Household Travel Survey conducted by BTS as well as ABS data on household composition and employment.[16]

For each mode of transport, we started from the 'status quo' – that is, we assumed the mode's existing patronage levels and fares and the existing network of public transport and roads did not change. Then we modelled what would happen under a range of scenarios – including removing the mode as a travel option altogether (or a subset of it, such as bus services in a particular region), and increasing fares for that mode by various amounts (eg, 50% to 200%). We then considered the results under each scenario and the status quo scenario to form the final estimates.

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15 More information about the Sydney Travel Model can be found at <http://www.bts.nsw.gov.au>.

16 For more information on the SSTM see BTS's publication *Sydney Strategic Travel Model (STM), Modelling future travel patterns – Technical documentation*, February 2011.

More detail about how we used the SSTM to form these estimates is provided in Appendix A.

3.3.1 The pros and cons of using the SSTM as the basis for these estimates

One of the main benefits of a multimodal strategic travel model like the SSTM is that it models the current Sydney transport infrastructure, its current capacity and its level of use. This allows us to incorporate differences in the costs avoided by each mode of transport, which depend on these things. For instance, the SSTM takes into account the fact that each mode of public transport in Sydney relieves congestion along different roads – the same volume of traffic has a greater impact on traffic speed when it replaces ferries than when it replaces buses or trains because additional congestion caused when ferries are unavailable affects the already very congested arterial roads into the city, such as Military Road.

Without the SSTM we would need to make assumptions about how many people would switch to driving and what impact this would have on the delay experienced by other road users and the total number of kilometres driven. In our view, whatever else we could do in this regard would be less robust and less relevant than using the SSTM.

However, we consider that there are three disadvantages associated with using the SSTM as we have to date:

1. some of the scenarios we have used represent quite a departure from the status quo, with potential implications for the reliability of some of the results
2. as with any model, there may be inaccuracies as a result of simplifying assumptions contained within the model
3. the SSTM is updated regularly by BTS and this creates the potential for inconsistencies between estimates over time.

Each of these issues relates to how we have used the SSTM to inform our analysis rather than being criticisms of the SSTM itself. Our preliminary view is that we can manage each of these issues by relatively minor changes to our approach. This is discussed further below.

Some scenarios may depart too much from the status quo to produce reliable results

As indicated above, the SSTM is a well-regarded model relied on by NSW transport planners. But like any model, it has limitations. In particular, as the scenarios it models move further from the status quo, the less confidence can be had in the predictions it makes. A stakeholder, in response to our last review of fares for Sydney Ferries, raised concerns about the suitability of the SSTM for

estimating the external benefits of ferry travel.[17] Specifically, he submitted that the SSTM would not be able to predict with accuracy what would happen when the Manly Ferry services were removed. This is a complex issue and it is not easy to determine the extent to which the scenarios we have modelled are too great a departure from the current situation to yield reliable results. However, we have less confidence in the results the SSTM produces under the scenarios that are most different from the status quo, for example, a scenario that assumes there is no rail system, than those it produces under scenarios closer to the status quo.

Our preliminary view is that changes in travel modes associated with modest fare changes provide sufficient and robust data to form the basis of our external benefit estimates. As a result, we do not intend to include model results from scenarios that involve more significant changes from the status quo in future reviews.

There may be inaccuracies as a result of simplifying assumptions

Also like all models, the SSTM necessarily involves simplified assumptions. The SSTM could not possibly take into account all the interrelationships that affect people's travel patterns. For example, when it predicts that a change in fares or service availability in one mode will result in a large increase in rail or bus usage, it allocates the extra passengers to the existing train or bus services as if the capacity of these services is unlimited. In reality, the extra passengers using the services would be constrained by crowding on trains and buses[18] unless additional services were provided.[19]

In general, we consider it is good practice to cross-check the outputs of any modelling with information from other sources, to check that the results are sensible. For example, we may be able to check the implied elasticity of demand for public transport (that is, how responsive people are to fare changes) in the SSTM with estimates from other sources. But we can only do this if comparable information is available. The SSTM is unique and extremely complex in many ways. This might make cross-checking some of the results difficult.

We think this issue of oversimplifying assumptions can probably be addressed by estimating changes 'off model' and then adding these changes back into the model, where this appropriate. We intend to work with BTS to determine whether there are any other simplifications in the SSTM that we need to 'account for' and the most appropriate way of doing this. We will consult on any specific issues and methods for addressing them as part of the draft report.

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17 M Flapan, correspondence to review of fares for Sydney Ferries, August 2012.

18 Another example of this was raised in correspondence with IPART by a stakeholder in our last review of Sydney Ferry fares. Mr Flapan raised concerns that our methodology for estimating external benefits does not account for the congestion caused by additional buses if commuters transfer from ferries and in particular the impact this would have on the Spit Bridge. (M Flapan, correspondence to review of fares for Sydney Ferries, August 2012.)

19 Note that if we were to take into account additional services, we would also need to ensure that our cost estimates captured the increased costs associated with these services.

The SSTM is updated regularly which may lead to inconsistencies over time

BTS updates its modelling and releases new versions of the SSTM on a regular basis to improve the functionality and specification of the model. Some of the differences between the versions are driven by updating data (eg, to reflect the most recent ABS census data), and as a result the updates are likely to lead to more accurate results. However, these differences may also be driven by changes in the specifications of the model (for example, BTS has advised that it is considering changing the SSTM from a 'work day' model to a 'school day' model). The BTS may make changes to the SSTM at any time.

The most important consideration for us is that the estimates we use for different modes of public transport are consistent. We intend to ensure this is the case by modelling the external benefits for all modes (train, bus and ferry) at the same time. Using the latest version of the model ensures that our external benefit estimates are the best available. However, it also means that comparing different estimates of the external benefits over time will be difficult.

IPART seeks comments on the following

3 Do you have any concerns with our use of the SSTM that would not be overcome by the modifications we have suggested? If so, are there any alternative approaches that we should consider?

3.3.2 What additional analysis could we consider in estimating the amount of avoided car use?

We are considering taking two additional pieces of analysis into account in forming our estimates of how much car use is avoided when people use public transport:

- the estimated external benefits for the public transport network as a whole
- the estimated external benefits at different times of day.

Both analyses would be obtained from the SSTM, and are discussed below.

Estimating the external benefits for the whole public transport network

Currently we estimate the amount of avoided car use associated with each mode of transport individually. This means that in areas serviced by more than one mode – eg, buses and trains, or buses and ferries – the SSTM generally predicts that a lot of people will move to trains when bus services are reduced or made more expensive, and vice versa. This results in a smaller overall estimate of the external benefits than it would if all areas were serviced by only one mode of transport. However, if we were to estimate the amount of avoided car use when both bus and train, or both bus and ferry services in these areas are reduced or

made more expensive, it would predict that many people would drive, resulting in a larger external benefit.

We don't intend to consider modelling what would happen if all of the existing modes of public transport in Sydney were 'switched off' at once for several reasons:

- First, this scenario is a drastic change from the status quo, which means (as discussed above) the SSTM is unlikely to provide reliable results.
- Second, the location and availability of public transport is one of the things that have shaped the way people live, work and travel in Sydney. Therefore, the absence of public transport may lead to significant changes in the location of housing and employment, the capacity of the road network and in the overall level of travel. As discussed above, the SSTM would not take these resulting changes into account.

For these reasons, there is support for our current mode-by-mode approach in academic literature.[20]

However, we are considering whether we can inform our analysis by modelling what would happen to travel patterns if a smaller, more realistic change were made to all the existing modes at once, such as a moderate fare increase. We expect that the external benefit value per public transport passenger we obtain from this analysis would provide an upper value in the reasonable range for the total external benefits, as this approach focuses on the change in relative prices between public transport and its alternatives, rather than between different modes of public transport.

IPART seeks comments on the following

4 Do you support considering the external benefits of the public transport network as a whole in addition to a mode-by-mode analysis?

Estimating the external benefits at different times of day

The external benefits of public transport are likely to differ depending on when services run. That is, they will be higher for services that run during peak periods (weekday morning and evening peak) and lower for those that run during off-peak periods (day, late night and weekend services). Currently, we estimate the proportion of trips that occur in different periods via the SSTM modelling, which is based on when and where trips occur and takes into account the volume of road traffic at different times of the day. However, we have not separately estimated the external benefits of peak and off-peak public transport.

[20] Parry, I and Small, K *Should urban transit subsidies be reduced?,* American Economic Review, Vol. 99, no 3, June 2009, p 717.

We consider that there might be value in trying to separately identify peak and off-peak benefits, particularly as the introduction of electronic ticketing makes differentiating fares in peak and off-peak periods simpler. However, IPART currently does not determine individual fares. Our current fare determinations provide Transport for NSW with the flexibility to determine how individual fares are set – we only set a limit on how much fares can change on average. Thus, we couldn't use the separate estimates to set differential peak and off-peak fares unless we changed this approach.

We could use the differentiated external benefit to provide information to assist Transport for NSW to set fares for different times of the day. However, there would be a significant amount of complementary work involved in doing this as the value of the external benefit alone is not sufficient. We expect that external benefits are higher in peak times as roads are more congested and the impact of additional cars on the road is likely to be greater. However, this does not necessarily mean that fares should be more highly discounted in peak periods. This is because:

- **Costs differ by time of day.** The costs of providing services in the peak are likely to be higher as greater capacity is required (more buses/trains, more drivers). To date we have not separately identified peak and off-peak costs.
- **Demand differs by time of day.** In peak periods demand is likely to be less elastic (less responsive to price changes) than it is in off-peak periods.
- **Patronage differs by time of day.** Services carry more people in peak periods than in off-peak periods. Depending on the cost structure of the service, it may be more efficient to set fares at lower levels in the off-peak (or on contra-peak services).

IPART seeks comments on the following

5 Do you support separately estimating external benefits in peak and off-peak periods?

3.4 How we quantified the benefits of the avoided road use (Step 2)

The next step in the process was to put a dollar value on the external benefits of avoided car use. As discussed above, we included two types of benefit – avoided road congestion and reduced pollution and emissions:

- We quantified avoided congestion benefits by multiplying the increased travel time for car drivers (obtained in Step 1) by the estimated value of time (discussed below).
- We quantified the reduced pollution and emissions benefits by:
  - working out how much extra fuel is consumed (based on extra kilometres travelled estimated in Step 1)

- estimating the additional amount of air pollution and greenhouse gas emissions created by consuming this fuel, and
- multiplying this amount by the cost those emissions impose on society.

3.4.1 How we quantified avoided congestion benefits

In order to calculate the benefit public transport has in relieving congestion, it is necessary to not only quantify the additional travel time that would have been taken without public transport but to put a value on it. There are two elements to this:

- the travel time saved (in hours)
- the value of time (in $ per hour).

To work out the travel time saved we use the relationship between the number of cars on the road (traffic density) and travel time. This is derived from the SSTM results discussed in Step 1 above. To work out the value of time we used the approach discussed below.

How we estimated the value of time

Individuals may value their time differently, and even for an individual this value may vary depending on the circumstances. However, it is possible to generalise and there are commonly accepted ways of developing such estimates. These include stated preference surveys (asking people questions about how they would trade time and money) and revealed preferences (observing the choices people make).[21]

To date, we have adopted a value of time ($ per hour) that represented half the average wage rate. We have updated this figure over time to reflect changes in the average wage rate but retained the same approach. The ABS's most recent figure for the average hourly earnings (from May 2012) is $34.30.[22] Therefore, following this approach, the value of time consistent with our approach would be $17.15 per hour.

This is broadly in line with international studies, though sometimes the value of travel time is split into working time and non-working time. For example, the United States Department of Transport recommends 35% to 60% of wages for personal travel and 80% to 120% of wages for business travel.[23]

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21 For example, how much are people willing to pay in tolls to save five minutes of travel time.

22 Latest figures of average hourly cash earnings for ordinary work of full-time non-managerial adult employees in NSW ABS 6306.0, Table 1.2, 23 January 2013.

23 Victoria Transport Policy Institute, *Transportation Cost and Benefit Analysis II – Travel Time Costs*, August 2013, p 5.2.12.

Transport for NSW has established estimates for the value of travel time that it uses to evaluate infrastructure projects. In 2012/13, Transport for NSW used a value of time of $14.51 for private travel and $46.45 for business travel for urban areas. This is based on Austroads guide to project evaluation.[24] These estimates are linked to adult ordinary earnings. The Transport for NSW guidelines have higher values for walking and waiting time which lessens the difference between our calculated value of $17.15 per hour for all components of travel and the Transport for NSW value of $14.51 for in-vehicle time.

Sapere undertook a sensitivity analysis that found the results of the external benefit calculation are sensitive to changes in the value of time.

IPART seeks comments on the following

6 Do you support us continuing to adopt a value of time equal to half the average wage rate? Should we differentiate between private and business travel?

3.4.2 How we quantified reduced pollution and emissions benefits

Every litre of fuel consumed by motorised transport contributes to air pollution and carbon emissions. High levels of pollution are associated with adverse health effects, such as respiratory and cardio-vascular problems[25], and carbon emissions impact climate change. This imposes a clear cost on society.

We have estimated how much more pollution would be emitted without public transport and quantified the costs of this. There are three elements to this calculation:

- extra fuel consumed by fuel type (eg, what impact the extra distances driven by car would have on the amount and mix of fuel consumed taking into account any reduction in the amount of fuel used by public transport)
- air pollution cost associated with the change in fuel consumption
- carbon emission cost associated with the change in fuel consumption.

24 Information provided by Transport for NSW, 28 May 2014.
25 Watkiss, *Fuel Taxation Inquiry: The air pollution costs of transport in Australia,* March 2002, p 1.

We used the following data for this calculation:[26]

- the costs of pollution per vehicle kilometre for a pre European-standard[27] petrol car in a dense urban area[28]
- the fuel efficiency of cars from the Climate Change Authority's fuel guide
- the level of carbon dioxide emissions (kgs) per litre of petrol estimated by the Climate Alliance
- the carbon price set by the Federal Government
- modelled estimates from the SSTM about how many more people would drive, and how far, if each mode of public transport was not available (from Step 1).

The estimates have also been adjusted to take into account the pollution created by public transport itself.

The results of the pollution calculation were positive external benefits for buses and trains but negative external benefits for ferries. Sapere found that emissions per person-kilometre travelled were nearly the same for private car and for ferry.[29] This arises because ferries are not a particularly fuel-efficient means of travelling, and because average seat utilisation on ferries (on a 24-hour basis) is quite low. Thus, there is no emission externality advantage to ferries compared to private cars. In contrast, rail and bus modes of transport are quite fuel-efficient and experience higher seat utilisation factors than ferries.[30] Therefore, the emission performance of these two public transport modes is superior to both ferries and cars.[31] In addition to this, approximately half of all ferry travel takes place outside the commuter peak when traffic congestion is less of an issue.[32]

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26 LECG (now Sapere Research Group), *Value of Sydney Bus externalities and optimal Government subsidy, Final Report prepared for IPART*, 24 September 2009, pp 52-56 and Sapere Research Group, *External benefits of CityRail services – Final Report*, October 2012, p 12.

27 Australia has had emission standards for petrol cars in place since 1972. It has progressively introduced more stringent standards, largely in line with United Nations regulations. Australia adopted the Euro 2 standard for all new cars from 1 January 2004, the Euro 3 standard in 2006 and the Euro 4 standard in 2010. Since 2013, all new petrol passenger cars in Australia must meet Euro 5 emission standards. See *Summary of emission requirements for new petrol passenger cars in Australia 1972-2018* available from <http://www.infrastructure.gov.au>.

28 Watkiss, *Fuel Taxation Inquiry: The air pollution costs of transport in Australia,* March 2002, Table 29, p 46. The air pollution costs of pre-Euro 1 standard petrol cars.

29 Sapere Research Group, *External benefits of Sydney Ferry services - Final report to IPART*, 23 August 2012, pp iii-iv.

30 Sapere Research Group, *External benefits of Sydney Ferry services - Final report to IPART*, 23 August 2012, p iii.

31 A stakeholder in our recent review of Sydney Ferries fares raised concerns with our estimate of emissions and in particular that emissions per passenger per kilometre of travel on ferries are over 12 times that of the emissions on buses and are nearly the same as emissions for private cars (correspondence from Mr Flapan 30 April 2014).

32 Sapere Research Group, *External benefits of Sydney Ferry services - Final report to IPART*, 23 August 2012, pp iv-v.

Over time, the external costs of pollution have diminished as vehicle standards have led to major improvements to air quality, particularly, in the last 10 years.[33] As such, the information used in this calculation can change relatively quickly. Because the outcome of this calculation, even whether it is a net cost or benefit, is heavily dependent on the efficiency of vehicles and the costs associated with pollution, it is important that the inputs reflect best available information and current estimates of these. Therefore, we will update these as part of this review. We will also consider the emissions from all modes of transport to ensure that our estimates reflect appropriate relativities between modes. In addition, we will need to revise how we estimate the cost of carbon emissions as the carbon price has been repealed.

IPART seeks comments on the following

7 What information is available to us to update our estimates of the efficiency of vehicles and the costs associated with pollution?

8 How should we quantify the costs associated with carbon emissions?

3.5 How we adjusted the total value of the external benefits to account for road user charges (Step 3)

Road user charges offset some of the external costs that people's decision to drive imposes on the community. These charges increase the price on roads above the private cost of the trip, which internalises some of the external costs the individual imposes on society. They also increase the cost of driving relative to the cost of other modes of transport. This means that people are already taking into account some of the external costs of driving when they make their decision to drive.

We have received submissions that do not support this adjustment.[34] However, we need to account for the external costs internalised by road user charges, because if we didn't we would 'double count' some of the external benefit of public transport. This is because in our approach, the external benefits of public transport and external costs of car use are essentially the same thing. Or, to put it another way, the external benefits of public transport depend on the gap between the social cost of car use and the private price drivers pay towards this social cost.

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33 Australian Government, Department of Infrastructure and Regional Development, *Vehicle Emissions Standard,* accessed 21 August 2014. https://www.infrastructure.gov.au/roads/environment/emission/index.aspx

34 For example, a stakeholder in our latest review of fares for Sydney Ferries, objected to an estimate of road user changes being deducted from our estimate of external benefits on the basis that it is against good public policy that a public transport service should be denied subsidy while car commuters continue to receive a subsidy (M Flapan, correspondence to review of fares for Sydney Ferries, August 2012).

3.5.1 What road user charges do we include?

Motorists pay some taxes to both the State and Federal Governments that are directly proportional to the amount of driving they do. It is these taxes that raise the private or out-of-pocket cost of car use so that it moves towards (but does not reach) the social cost of car use. We have based our estimate of the road user charge adjustment on:

- the fuel excise
- the tax levied on parking spaces in and around the Sydney CBD, and
- the toll on the Sydney Harbour Bridge and Harbour Tunnel.

However, we have only included the proportions of these taxes that do not go towards paying the costs of car use, as it is only this amount that closes the gap between the private cost and social cost of car use. For example, a proportion of the fuel excise is used directly for road maintenance and construction and this is considered to be a contribution towards a direct cost of the individual's car use, not a contribution towards the social cost, and thus is not included in the adjustment.

3.5.2 How do we estimate the value of the adjustment?

These types of calculations, known as resource corrections, are standard in cost benefit analysis of transport initiatives. To estimate the value of the adjustment, we have included:

- The proportion of the fuel excise that is not spent on roads. This is calculated as being around 19 cents per litre of the excise (ie, the fuel excise less the avoidable cost of road usage). As stated above, this proportion of the fuel excise is considered a user contribution toward the marginal external costs of private car usage.
- The Sydney Harbour Bridge and Harbour Tunnel tolls which only apply to Southbound journeys. These tolls vary and from $4 for the AM and PM peak, $3 for the Inter Peak period and $2.50 at night.
- The NSW Government levy on parking spaces in the Sydney CBD and North Sydney as well as Bondi Junction, Chatswood, Parramatta, and St Leonards.[35]

Sapere then calculated each of these elements of road user charges in units of average price per person-kilometre. The overall road price was calculated as a weighted average across various types of car journeys. While all journeys incur fuel excise tax, only a small proportion of journeys incur either the parking levy or the toll on the harbour crossing.[36]

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35 Sapere Research Group, *External benefits of CityRail services – Final report to IPART*, 31 October 2012, pp 25-26.

36 Sapere Research Group, *External benefits of CityRail services – Final report to IPART*, 31 October 2012, pp 26-28.

This value is then subtracted from the total value of the external benefits, as it represents the external cost of car travel that has already been taken into account when people decide how to travel.

IPART seeks comments on the following

9 Do you agree with the road user charges we have included? Should we expand the number of tolls that are included?

4 Other possible external benefits and costs of public transport

As Chapter 2 discussed, as part of this review we will consider whether there is a wider set of external benefits (positive and negative) that are relevant for setting public transport fares – in addition to those related to road congestion, pollution and emissions and road user charges. As Chapter 2 also discussed, our preliminary view is that any additional external benefit (or cost) should meet the following criteria before we would consider including it:

- **It needs to be external** – not a private cost or benefit that goes directly to the user, as those are already taken into account when making a decision on how to travel.
- **It should not only be available to a particular subset of people** – benefits that are available to only some people (such as, benefits to those who own property close to a train station) do not provide justification for lowering fares for everyone.
- **It needs to be measurable** – we need to be able to estimate the value of the benefit; it would be enough that we could determine a reasonable range.
- **It needs to change materially in response to changes in public transport use brought about by changes in fares** – that is, the value of the net benefits of public transport use to society (external benefits + fare revenue - total costs of providing the services) should change in response to changes in fares.[37]

The sections below discuss a range of other possible external benefits we could consider, and sets out our preliminary views on whether they meet these criteria and so should be considered further. They include both positive benefits and negative benefits (ie, external costs) associated with public transport which may justify a larger (or smaller) government subsidy:

- benefits from fewer road accidents
- benefits or costs associated with higher or lower public transport patronage and the resulting change in either the frequency of public transport services (scale benefits) or crowding on existing services
- benefits from improved social mobility and inclusion
- benefits from agglomeration and other wider economic benefits

[37] It is important that the benefit increases as the usage of public transport increases because the purpose of subsidising fares is to increase the use of public transport by lowering its price (relative to not having a subsidy) in order to realise greater benefits for society.

- costs of raising funds to subsidise public transport.

4.1 Benefits from fewer road accidents

To date, we have not included a value for the external benefits associated with fewer road accidents in our estimates of the external benefits.

Sapere's analysis indicated that additional vehicles do not increase the rate or severity of accidents, despite increasing the absolute number of accidents. It also indicated that the vast majority of costs associated with the higher absolute number of accidents are internalised by drivers (that is, taken into account by them when they make the decision to drive). Given this, Sapere found that the estimated external benefit from fewer road accidents that is avoided by public transport was small, and advised that it was too small to warrant inclusion in our total external benefit estimate. We accepted this advice.

However, we now consider there is merit in reconsidering whether it is appropriate to include a positive external benefit from reduced accident costs as a result of public transport. To determine whether there are external accident costs that are avoided when people use public transport instead of driving, we will consider the following questions:

- Do additional cars on the road impose additional accident-related costs?
- If so, how much of these costs are internalised by drivers and how much is borne by the rest of the community?

Our preliminary views on these issues are set out below.

4.1.1 Do additional cars on the road impose additional accident related costs that are not fully internalised by drivers?

The answer to this question is likely to be different for single-vehicle accidents (including collisions that affect cyclists, pedestrians and property) and multi-vehicle accidents.

Recent additional research undertaken by Sapere suggests that as more drivers come onto the road, the increased number of single-vehicle accidents is likely to impose additional costs on society.[38] For single-vehicle accidents, any increase in the absolute number of accidents will impose an external cost because drivers do not fully internalise the costs they impose on others (as these are costs to cyclists, pedestrians and other people's property). As a result, there is likely to be an external benefit associated with people using public transport instead of driving.

[38] Sapere Research Group, *Response to peer review of ferry externality report – prepared for IPART*, 26 September 2013, p 3.

Our preliminary view is that we should recognise this in our estimate of external benefits.

For multi-vehicle accidents, the situation is more complicated. We are still of the view that the available evidence supports no increase in the rate or severity of accidents as additional cars come onto the road. In other words, existing drivers are not more likely to have an accident, or a worse accident, when there are more cars on the road.[39] However, the absolute number of accidents does increase as extra cars come onto the road. If (and only if) any of those costs are not internalised by the drivers of those extra cars there may also be an external benefit associated with avoiding multi-vehicle accidents that should be taken into account in our estimate. Our preliminary view is that there may be some increase in accident costs associated with the higher absolute number of accidents that are borne by the community and not internalised by drivers. The cost of increased traffic congestion caused by a higher number of accidents is one such example.

IPART seeks comments on the following

10 Do additional drivers impose additional accident-related costs on existing car users, or pedestrians and other victims of accidents?

11 Are there other accident-related costs to society that are not fully internalised by drivers? If so, how could these be measured?

4.2 Benefits or costs related to changes in public transport patronage - user scale benefits and crowding

One potential external benefit not related to avoided car use is the impact on existing public transport users when the overall patronage or usage of public transport changes as a result of changes to fares. Previously we have not attempted to include scale-related benefits in the calculation of external benefits.[40]

Increased patronage may result in an external benefit (scale benefit) if service frequency is increased in response to the higher patronage. The value of the external benefit is equal to the travel time savings of existing public transport users (these savings are possible because the higher service frequency reduces waiting times). If service frequency is not increased, there may be either no external benefit or there may be an external cost (crowding).[41]

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39 For a more detailed discussion of this issue, see Sapere Research Group, *External benefits of CityRail services – Final report to IPART*, 31 October 2012, p 13.

40 We do not consider that the modelled scenarios done using the SSTM would have adequately captured these due to the simplifying assumptions within the model (see section 3.3.1).

41 Note that there are producer economies of scale in public transport as well, as higher passenger density allows services to be operated with higher density, potentially costing less per passenger transported.

On the other hand, reductions in patronage (for example, as a result of fare increases) may impose external costs in the form of higher travel times, if it results in service cuts.

The extent of scale benefits depends on the interactions between fares, patronage, service frequency and cost. These interactions are complex. The Government is responsible for transport planning, investment and service levels and the existence and quantum of scale benefits depends heavily on these factors.

Nevertheless, our preliminary view is that we should attempt to take these benefits into account in fare setting by considering the likely impact of an incremental change to fares. We may be able to run a range of patronage and service frequency scenarios under the SSTM that would enable us to quantify the potential impact of user scale benefits that could be expected under moderate fare changes. We may then be able to match these results to predicted patronage and service frequency forecasts within a determination period in order to select the most relevant scenario.[42]

To quantify the external benefit associated with scale economies we would also need to estimate the relationship between service frequency and waiting times for users and put a value on the resulting reduction in travel time by applying an appropriate value of time (similar to our approach to valuing the cost of avoided congestion).

4.2.1 Scale benefits where service frequency increases with patronage

If the Government responds to increased patronage by running more public transport services, all passengers see improvements in the frequency of their services and experience shorter waiting times. As waiting time is a major component of the total journey time of public transport this leads to travel time savings for public transport users. If there is a strong link between the level of public transport services and demand, each new public transport passenger increases the frequency of the service and thus has an effect on waiting times.

This effect, known as the Mohring effect, basically means that the user's costs of waiting for or accessing public transport decrease as service frequency or route density increases (ie, there are increasing returns to scale). This provides a benefit to existing users that is external to them, as each new passenger that can be enticed onto public transport creates a benefit to those existing passengers who now have to wait less time for their bus, train or ferry.

[42] We would need to ensure that if increases in patronage and service frequency are included in the external benefits estimate that the cost associated with this is factored into our efficient cost estimates.

4.2.2 Crowding and congestion where service frequency does not increase with patronage

If transport services are not increased in response to increases in demand, there may be a reduction in the cost of providing services per person but there will not be an external benefit from scale economies. In some cases, increased patronage with no corresponding increase in services will actually impose external costs as a result of an increase in public transport crowding.

When a bus or train is crowded, services become less comfortable and, in some cases, waiting times will rise as passengers are forced to wait for the following bus or train. An increase in the number of passengers using public transport in peak times imposes a cost on other users that is not currently taken into account. In addition, this cost limits the number of people who can be moved off the road network when congestion is at its worst. Thus, it potentially reduces the effectiveness of the public transport subsidy that is aimed at reducing road congestion. The extent and impact of crowding is likely to be different for each of the modes of public transport:

- On rail – investment in new infrastructure to increase capacity on the network is expensive and there are long lead times. As a result, crowding on rail services is a problem (similar to the problem of traffic congestion on roads). Currently in Sydney, crowding is primarily an issue in the morning train commute (see Figure 4.1).
- On buses – it is possible to run additional services to alleviate crowding on buses compared to trains without adding significantly to costs, on average.[43] This means that while individual buses may get full, crowding is likely to be less of a problem than it is on the rail network. However, increasing the number of buses to alleviate crowding contributes to road congestion (although the external cost associated with buses' contribution to road congestion is less than car travel because buses carry more people per square metre).
- On ferries – it is also possible to run additional services to alleviate crowding, in the same way as buses. Unlike buses, ferries do not contribute to road congestion so putting in place additional services is likely to impose fewer external costs.

[43] Studies have found that the cost of increasing bus services is roughly constant. For example, see Small and Verhoef, *The economics of urban transportation*, 2007, p 65.

Figure 4.1 Crowding on morning train lines

Morning peak - to the City

Line	Measured at	Trains	Passengers	Average load	Max load
Eastern Suburbs	Kings Cross	15	7,986	63%	108%
Illawarra	Sydenham/ Hurstville(1)	15	15,541	123%	144%
Airport & East Hills	Green Square/ Sydenham	11	12,572	128%	158%
Bankstown	Erskineville/ Campsie	6	7,792	144%	161%
Inner West	Redfern	5	4,799	106%	128%
South	Redfern	7	7,402	118%	146%
Northern via Strathfield	Redfern	4	5,200	145%	165%
North Shore(2)	St Leonards	18	16,362	104%	131%
Western	Redfern	16	16,308	121%	152%
Total Suburban		**97**	**93,961**	**112%**	**165%**
South Coast	Hurstville(3)	3	2,390	92%	108%
Blue Mountains	Parramatta	3	2,183	86%	94%
Newcastle & Central Coast(4)	Strathfield	4	3,659	108%	125%
Total Intercity		**10**	**8,231**	**97%**	**125%**
Total Suburban and Intercity		**107**	**102,192**	**110%**	**165%**

Note: 100% is every seat taken.

Data source: Sydney Trains, *Train Load*, http://www.sydneytrains.info/about/our_performance/train_loads.jsp. Accessed 22 August 2014.

IPART seeks comments on the following

12 What is your view on the outlined approach for considering the external benefits and costs associated with the scale of public transport services? What are the alternatives?

4.3 Benefits from improved social mobility and inclusion

In previous fare reviews, stakeholders have often suggested we should consider the external benefits from improved social mobility and inclusion that public transport provides. Many stakeholders argue that these benefits are significant for those on lower incomes, with fewer transport options.

People with low incomes tend to live further away from jobs and may have fewer transport options. Reducing transport costs improves accessibility to jobs, as well as services and options for leisure and entertainment.

We agree that public transport provides a benefit to society by improving access to transport for those who are less mobile and have lower incomes, and consider that this benefit may be significant. However, this benefit is largely restricted to particular and identifiable groups within society, such as people with a disability, pensioners and the unemployed. Therefore, it does not meet the second of the proposed criteria listed at the start of this chapter.

In our view, the benefit of improved social mobility and inclusion can only be used to justify government subsidy of public transport fares for the identifiable groups that receive this benefit. That is, the benefit of improved social mobility and inclusion justifies the provision of concessional fares only – not greater subsidisation of the full fares paid by passengers outside these groups.

Concession policy is determined by the Government, not by IPART. Consistent with the view we have taken for our previous fare determinations, we still consider that the social benefits of improving mobility for specific groups are best considered by the Government when it determines the availability of services and formulates its concession policies, rather than through an increase in the subsidy for all passengers. This approach enables the Government to deliver a suitable regime that is tailored to the needs of particular groups.

IPART seeks comments on the following

13 The external benefit associated with increased mobility and social inclusion is best addressed through the Government's targeted concession policy. Do you agree?

4.4 Agglomeration and other wider economic benefits

Transport creates economic benefits in addition to those that accrue to direct users. The UK, in particular, has been a leader in developing techniques to estimate the value of transportation projects to the wider economy. For appraisal purposes, the UK Department for Transport considers the following wider economic benefits:[44]

- agglomeration (which is the most significant of these benefits, see Box 4.1)
- output changes from lower transport prices
- taxation revenue from labour supply impacts
- improved productivity from competition amongst service providers.

[44] UK Government, Department for Transport, *Transport Analysis Guidance - Wider Impacts*, January 2014, p 1. Note that the UK Department for Transport no longer considers increased competition (point four above) as a wider benefit of better transport as the UK has well developed transport systems so transport is unlikely to be a significant constraint to competition.

Box 4.1 Estimating agglomeration benefits in the UK

The measurement of agglomeration benefits is still in its infancy, and credible methodologies have only been developed recently, led by the United Kingdom. The framework for appraising transport projects in the UK includes a 3-step approach to assessing the benefits of agglomeration:

1. Calculate the effective density. The effective density reflects the accessibility of firms and workers to each other. It is a function of the generalised cost for travel.
2. Apply the elasticity of productivity with respect to effective density[a] for each economic sector.
3. Take the relative changes in productivity by sector and estimate the absolute change in productivity by using the GDP per worker and employment levels for the sector in the area being assessed.

However, there are several significant issues with measuring the elasticity of productivity with respect to effective density. This is because it is difficult to establish causality between the agglomeration measures and productivity growth, while ensuring that other factors, such as exogenous improvements to human capital, are properly taken into account.

a That is, how much productivity changes when effective density changes.

Source: UK Government, Department for Transport, *Transport Analysis Guidance - Wider Impacts*, January 2014, p 4.

4.4.1 Agglomeration benefits

Agglomeration refers to the benefits associated with people locating near each other. The benefits include better matching of skilled workers with jobs (division of labour), knowledge transfers between firms, and sharing infrastructure and inputs. These factors attract people to cities as they are drawn to the higher wages and profits.[45] We know that agglomeration provides a private or internal benefit to firms. However, it is less obvious that agglomeration provides broader external benefits to society, or that there is a link between subsidisation of public transport fares and the realisation of agglomeration benefits.

The main argument for including agglomeration benefits when setting fares is that subsidising public transport facilitates travel to job clusters by reducing transportation costs. This promotes improved productivity and leads to economic growth – that is, higher profits, land values and wages, the benefits of which accrue to society in general.

45 See for example Paul Krugman, *Increasing returns and economic geography,* The Journal of Political Economy, June 1991.

We have previously considered whether to include agglomeration benefits and decided not to because, on balance, we found that these benefits "are not readily quantifiable and the role of public transport services in attaining agglomeration benefits is not established".[46]

Even assuming there is a broader external benefit from agglomeration and that this is affected by public transport costs, this is an argument that would apply to both car travel and public transport. That is, agglomeration provides an argument for subsidising travel in general, not public transport in particular.

There is no clear policy on whether agglomeration benefits should be considered for new investments in Australia. The current NSW guidelines on economic appraisal do not include agglomeration in cost/benefit analysis. Infrastructure Australia does not have a clear policy on whether agglomeration warrants inclusion in cost/benefit analysis but in its appraisal guidelines, it states that it concentrates on the direct costs and benefits identified in State guidelines on economic appraisal but it also considers agglomeration and other wider economic benefits to "add texture to the decision making process".[47]

Our preliminary view is that agglomeration benefits should not be included in our estimate of external benefits.

4.4.2 Other wider economic benefits

There are a number of wider economic benefits associated with improved and/or lower cost transport. These items are not widely considered in either setting fares or analysing the cost and benefits of transport projects in other jurisdictions. They include:

- **Output changes from lower prices.** Reduced road congestion provides a cost saving to business, which is then passed on to consumers through lower prices. The lower prices stimulate demand in the economy and this creates a consumer surplus that is not fully reflected by the initial saving in cost.
- **Tax revenue from labour supply impacts**. For those looking for a job, transport costs influence where and even whether to work as people weigh travel costs against the wages available. Lower travel costs open up more jobs to job seekers. Increasing the level of employment in the economy has benefits for everyone, including through higher income tax receipts and lower welfare payments.

46 IPART, *Review of CityRail fares 2009-2012 - Final Report*, December 2008, p 102.

47 Infrastructure Australia, *Reform and investment framework templates for use by proponents* - Templates for Stage 7 solution evaluation (transport infrastructure), December 2013, p 11.

- **Improved productivity from competition among service providers.** Better and cheaper transport frees up access to services by improving mobility between areas (for example, more accessible transport gives people the ability to use a doctor from another district). Freeing up access to services encourages greater specialisation, which leads to productivity gains that benefit everyone. It may also create economies of scale where greater number of people can access a single site, for example a large shopping mall.

Our preliminary view is that we should not take into account any of these wider economic benefits. These benefits are either inappropriate to include or, like agglomeration, relate to transport more broadly and do not provide an argument for further subsidising public transport fares.

IPART seeks comments on the following

14 The external benefits associated with agglomeration and other wider economic benefits do not meet the criteria for inclusion. Do you agree?

4.5 Cost of raising funds to subsidise public transport

The NSW Government funds the difference between the cost of providing public transport services and the fares people pay for using those services. It raises these funds through taxes and other sources. There is a cost associated with raising funds to subsidise public transport as taxes have incentive effects and are distortionary. This creates economic inefficiencies (see Box 4.2) and imposes a cost on the whole of society ('excess burden of taxation').

We need to consider whether or not to make an adjustment to the external benefit to account for these costs. If we did make an adjustment, we would calculate a 'net external benefit' by deducting from the external benefit the costs associated with funding it.

Ideally, all transport services (private and public) would be priced at their own marginal social cost. Under this approach, there would be a system of road pricing under which motorists pay the full marginal costs of usage including the marginal external costs of congestion and pollution. If such a system was in place the external benefits associated with avoided car use would no longer support making a subsidy to public transport.

We have previously argued that this supports the case for not making an adjustment, based on a beneficiary pays argument. In our latest report on CityRail fares we said:

> It is our view that the excess burden of taxation can be seen as a type of 'transaction' cost. The question is, who should bear this cost: rail passengers or taxpayers (largely as a proxy for road users)? By definition, the value of the external benefit generated by rail services accrues to the general public (in particular road users), and not to rail passengers. Under a beneficiary pays approach, the general public (as a proxy for

road users) should bear the cost and hence no adjustment should be made to the total external benefits when estimating the appropriate Government subsidy of CityRail services.[48]

However, failing to account for the burden effects of taxation potentially overstate the true external benefits of public transport and may result in subsidies that are too large and fares that are too low. Reports prepared for us by Sapere,[49] and Harrison and Ergas (who undertook a review of Sapere's report on external benefits for Sydney Ferries)[50] argued that it is appropriate to make this adjustment to the external benefit.

There is a wide range of estimates of the burden of taxation, as different taxes distort consumer welfare unevenly. For the Henry Tax Review, KPMG Econtech estimated the economic impact of 19 major taxes using a Computable General Equilibrium model. Their economic impact ranged from negative values (welfare improving) to close to 100 cents in the dollar (for every dollar of revenue raised, there is an additional dollar of welfare loss).[51]

The external cost of taxation depends in part on the effectiveness of the subsidy in motivating people to use public transport. If demand for public transport is quite inelastic, then the subsidy will have only limited impact on demand. If demand for public transport is highly inelastic, the marginal social cost of subsidising public transport could even exceed the marginal external benefit.

48 *IPART*, *Review of maximum fares for CityRail services from January 2013 – Final Report*, November 2012, p 46.

49 Sapere Research Group, *External benefits of CityRail services – Final report to IPART*, 31 October 2012, p 17.

50 Harrison and Ergas, *Review of Sapere research group's "External benefits of Sydney Ferry services – final report to IPART, 23 August 2012"*, Second Draft, July 2013, pp 8-13.

51 KPMG Econtech, *CGE analysis of the current Australian tax system*, Final Report, 26 March 2010, p 44.

Box 4.2 How do taxes distort choices and reduce welfare?

Most of the NSW Government's revenue comes from state taxes and Commonwealth grants linked to the GST.[a] Taxation leads to distortions in the decisions of individuals and firms and these distortions lead to an economic loss. The extent to which a tax reduces consumer welfare is referred to as the excess burden of taxation.

The inefficiencies created by taxes can be explained mainly by the following two principles:

- the mobility principle
- the narrowness principle.

A mobile tax base will shrink in response to being taxed, moving to jurisdictions where it won't be affected. For example, in response to business taxes, capital will move to tax havens where the business tax rate is lower. This distorts economic activity.

Taxes on narrow bases will distort choices and result in people shifting to untaxed close substitutes. For example, in response to a tax on red wine, people may move to white wine, even though they preferred. This adds to economic inefficiency and reduces the revenue yield.

These two principles move society away from the optimal allocation of resources.

[a] NSW Government, *Budget Statement 2014-15 - Budget Paper No. 2*, Chapter 6, pp 9-10.

Source KPMG Econtech, *CGE analysis of the Current Australian Tax System – Final Report*, 26 March 2010.

http://www.taxreview.treasury.gov.au/content/html/commissioned_work/downloads/KPMG_Econtech_Efficiency%20of%20Taxes_Final_Report.pdf

IPART seeks comments on the following

15 Should the excess burden of funding be included in the calculation of the net external benefit of public transport?

16 If so, what is an appropriate estimate of this excess burden? Should we use the weighted average for NSW or the marginal burden of the most efficient tax?

4.6 Other benefits

A number of other potential external benefits have been raised with us in previous reviews that we have decided do not justify inclusion in our external benefits calculation. There are also other possible external benefits that we consider are likely to be insignificant, cannot be estimated in any meaningful way or that would not be appropriate to include in fare setting.

These possible external benefits are:

- reduction in noise pollution
- health benefits of public transport related to greater exercise
- changes in car parking
- iconic value of Sydney Ferries.[52]

We do not intend to consider any of these issues further unless we receive new information that indicates they meet the criteria for inclusion as external benefits (or costs).

IPART seeks comment on the following

17 Are there additional external benefits (or costs) that we have not raised that you believe would meet the criteria for inclusion?

[52] We considered this as part of our 2012 Sydney Ferries review and concluded that the iconic value is derived from the availability of watercraft on the harbour as a whole, and not from the amount of service being offered by Sydney Ferries. See IPART, *Review of maximum fares for Sydney Ferry services from January 2013 – Final Report*, November 2012, p 50.

Appendices

A More information on how we currently estimate external benefits of public transport

IPART engaged Sapere Research Group (formerly LECG) to estimate the value of the external benefits for each of CityRail, metropolitan and outer metropolitan buses and Sydney Ferries. This appendix provides a summary of the process used by Sapere to do this. Detailed information on Sapere's estimates and the underlying methodology is contained in Sapere's (and LECG's) reports to IPART. These reports are available from our website (www.ipart.nsw.gov.au).

The following summarises the analysis undertaken for the *Review of maximum fares for CityRail services from January 2013*. There were some minor differences in inputs and assumptions used in each analysis as data was updated and the methodology was refined over time. However, the fundamental analysis is the same for all modes for which we have estimated external benefits.

A.1 Summary of process adopted for the CityRail review

A.1.1 Congestion

The *marginal* cost of congestion underlies Sapere's avoided congestion calculation. The marginal cost of congestion is the value of the time lost by current motorists from an extra driver on the road. When Sapere calculates a total cost of congestion, Sapere bases this calculation on its formulation of the marginal cost, which is outlined in Box A.1.

Box A.1 How Sapere calculates the marginal cost of congestion

Sapere's cost of congestion calculation is based on the following formula:

Marginal economic congestion cost (MECC) = Value of time (VOT) × increase in inverse car speed per added car occupant kilometre (a) × number of car occupant kilometres (Q)

Or, in short form:

$MECC = VOT \times a \times Q$

Sapere uses the results of modelling scenarios run using the Sydney Strategic Travel Model (SSTM) to estimate *a* (by establishing the relationship between traffic and travel time) and *Q* (the number of cars on the road).

The relationship between traffic and travel time (a)

For rail, the SSTM was run for the following scenarios:

- Business as usual.
- 50% reduction in rail fares.
- 100% increase in rail fares.
- 200% increase in rail fares.
- No rail network available for use.

For each scenario, the SSTM models what would happen and provides an estimate of the total number of car kilometres driven and the total number of hours spent driving.

Sapere calculates the average car speed under each scenario (kilometres divided by hours). Sapere then regresses inverse car speed (hours to drive a kilometre) against the number of kilometers driven.

Values used from SSTM:

- Car kilometers driven under all scenarios.
- Number of hours spent driving under all scenarios.

Total congestion benefit (including number of car kilometers (Q))

We asked Sapere to provide a total congestion benefit rather than an estimate of congestion on the margin. This requires the total number of cars on the road in the 'no rail' scenario (Q0 + ΔQ) compared to the total number under the 'business as usual' scenario (Q0).

Sapere integrates the marginal economic congestion cost to take into account that each new driver not only impacts those on the road in the 'business as usual' case, but also those who have progressively entered as the rail was 'switched off'. This requires integration of the marginal congestion as follows:

$$Total\ cost\ of\ congestion = \int MECC\ dQ$$

$$= \int_{Q0}^{Q0+\Delta Q} a \times value\ of\ time \times Q\ dQ$$

$$= \left(\frac{(Q0 + \Delta Q)^2}{2} - \frac{Q0^2}{2}\right) \times value\ of\ time \times a$$

Values used from SSTM:

- Total car kilometers driven in 'business as usual' and 'no rail' case.
- the relationship between speed and traffic (as calculated in the previous section).

A.1.2 Pollution

Relative pollution benefit of a rail passenger kilometer

Each transport mode emits greenhouse gases and conventional air pollution, but different modes emit at different rates per person-kilometre. Each passenger journey that uses rail represents a passenger journey not taken by some other mode. Since pollution per passenger-kilometre is lower on rail than any other mode, there is a net external benefit from a passenger's decision to take the train.

Of 100 passenger journeys by rail, let us say hypothetically that 60 may have been diverted from cars, 30 from buses and 10 from ferries. The modal diversion rates would then be 60% car, 30% bus and 10% ferry.

The pollution effect also depends on the distance travelled on each journey. Kilometres travelled per journey also vary with transport mode. Rail is generally the longest, because routes are more indirect and passengers are more likely to choose rail for longer journeys. The modal diversion rates are different when measured on a per kilometer basis than on a per journey basis.

Sapere uses the SSTM to estimate the modal diversion rates that correspond to the change in the numbers of journeys. The modal diversion rate is the increase in number of trips for each mode divided by the change in the number of rail trips. These rates are important for most aspects of the public transport externality calculation.

Using these per kilometre modal diversion rates, Sapere calculates the relative emission benefit using the following equation (the derivatives represent the modal diversion rates):

$$Relative\ emission\ benefit = (pollution\ cost\ of\ cars - pollution\ cost\ of\ rail) \times \frac{dCar}{dRail}$$

$$+(pollution\ cost\ of\ buses - pollution\ cost\ of\ rail) \times \frac{dBus}{dRail}$$

$$+(pollution\ cost\ of ferries - pollution\ cost\ of\ rail) \times \frac{dFerry}{dRail}$$

Values used from the SSTM:

- Number of journeys made using each mode in the 'no rail' scenario as well as the number of rail journeys in the business as usual scenario (modal diversion rates).

- The average lengths of rail, bus, car and ferry trips.

Total pollution benefit

The total pollution benefit is the relative benefit multiplied by the total number of passenger kilometres. The total number of rail passenger kilometers is estimated using the rail compendium of statistics (average trip length × total number of rail journeys).

A.1.3 Offsetting road pricing

The subsidy to public transport is largely justified on the grounds that automobile users do not pay the full marginal external costs they impose. While they do not fully pay for these externalities, they do make some contribution through the following mechanisms:

- Fuel excise (less the amount used to pay for road pavement damage caused by cars)
- Tolls (less the amount used to pay for pavement damage and toll road operation), and
- Parking Space Levy.

It is important to quantify these contributions, as they offset automobile external costs.

Sapere uses the SSTM to estimate the proportion of people who pay the parking levy and use the harbour crossing per day.

The SSTM is capable of estimating the number of daily kilometers driven with the CBD as a destination and the number of daily kilometers driven where Sydney Harbour was crossed southbound. Sapere uses this information to estimate the proportion of travelers who pay the parking levy, fuel excise and tolls.

Fuel excise contributions are determined from fuel consumption estimates that are also derived from the SSTM (average fuel consumption rates are applied to the total number of vehicle kilometres driven).