Independent Pricing and Regulatory Tribunal

External benefits and costs

Draft Information Paper 8

Introduction

The marginal external costs and benefits of each mode of public transport (externalities) are key inputs to our fare optimisation model.

We have previously assessed the externalities associated with public transport use. Our December 2014 Draft Report[1] explained the in-house model we developed to estimate these externalities, and presented preliminary estimates.

As part of this review of Opal fares, we updated the model and some of its inputs. We also did more analysis and considered stakeholder comments on some of the externalities.

The following slides:

- Explain what we mean by externalities, and the externalities we included in our estimates for our draft determination
- Set out these estimates for each mode, and
- Provide more detail on the updates to the model and estimates we have made since December 2014.

1 IPART *Draft Report, Review of External Benefits of Public Transport*, December 2014

Externalities of public transport

Externalities are the costs and benefits to third parties that are not reflected in the price of travel, and therefore not accounted for when people decide how they will travel (their mode of travel).

Using public transport does not always create a net external benefit. It depends on how the external costs/benefits of using the chosen public transport mode compare with the external costs/benefits of the alternative modes:

- Car travel has larger external costs than any public transport mode, so there is always a net external benefit when people use public transport if they would otherwise have driven
- However, walking and cycling have larger external benefits that any public transport mode, so there is no net external benefit when people use public transport if they would otherwise have walked or cycled.

As a result, the 'external benefit' of a public transport journey is a function of:

- The marginal external cost/benefit of travelling on the different modes of transport
- How the person making that trip would have travelled if they had not used that mode. For example, which mode they would have used if they didn't use their preferred mode, and would they have travelled at all. (These factors are known as the modal substitution factors.)
- The marginal external cost they would have imposed if they had not taken the trip on their preferred mode but had taken the alternative mode identified.

External benefits of public transport included in our estimates

External benefits	How we estimated this
Congestion: avoided traffic congestion when someone uses public transport instead of driving	• Time – the value of time saved by existing drivers • Vehicle operating cost – the value of fuel and other vehicle operating costs avoided by existing drivers • Reliability – the value of more predictable travel times for existing drivers
Emissions: avoided environmental costs when someone uses public transport instead of driving	• Value of avoided air pollution • Value of avoided greenhouse gas emissions
Accidents: avoided costs associated with road accidents when someone uses public transport instead of driving	• Value of avoided cost of taxpayer funded services • Value of avoided uninsured fatality costs of non-car occupants (pedestrians and cyclists)
Active transport: health benefits when someone walks or cycles to or from public transport	• Value of avoided health system cost savings
Service frequency: the benefit of additional services being added as more people use public transport (the Mohring effect)	• Value of time saved by existing public transport users due to increased service frequency

Our estimates of the marginal external cost/benefit of each mode

Marginal external costs/benefits in our draft model (medium run, $2014/15)

$ per passenger trip	Rail only	Bus only	Ferry only	Light rail only
Environmental externalities	0.19	-0.23	-0.21	0.33
Congestion cost (time)	3.3	0.99	1.32	2.15
Congestion cost (vehicle cost)	0.04	0.01	0.01	0.02
Congestion cost (reliability)	0.53	0.17	0.21	0.34
Accidents	0.1	0.07	0.03	0.07
Active transport	0.2	0.17	0.09	0.15
Service frequency	-0.18 - 0	0-1.24	0-1.13	0-1.33
Excess burden of taxation	-0.36	-0.31	-0.43	-0.25
Road user charges	-0.36	-0.24	-0.12	-0.24
Total	3.46-3.64	0.64-1.88	0.9-2.04	2.58-3.91

Note: As positive number means that there is a positive externality.

Note: Service frequency reduces the external benefit for rail but increases it for other modes because it diverts people from rail to bus causing greater congestion

Source: IPART externality model, December 2015

The figures in this table represent our estimate of the marginal external costs/benefits for a journey undertaken on each Opal mode, after taking into account modal substitution factors.

They are also based on the medium run elasticity (which affects excess burden of taxation only).

We updated our model to allocate the estimated externalities between PJ and pkm

- We updated our model to allocate each external cost/benefit between passenger journeys and passenger km for each mode, as required for our fare optimisation model.
- For some externalities, this allocation is straightforward. For example:
  - Emissions depend on km travelled, so 100% is allocated to pkm
  - Active transport depends on number of journeys, so 100% is allocated to PJ.
- However, for congestion (the largest externality) this allocation is complicated because it depends on where and when the avoided car travel would take place:
  - Where the congestion is in a particular location (bottlenecks), the number of cars matters, not distance travelled, so the benefit depends on the number of journeys
  - Where congestion is widespread, distance travelled matters, so the benefit depends on the km travelled.

  There is insufficient data to make an informed allocation so for this draft report, we have assumed a 50% allocation to PJ and a 50% to pkm. Our sensitivity analysis (see Information Paper 11) shows the optimal fares are quite sensitive to this allocation.
- For other externalities where the allocation is not straightforward we also assumed a 50/50 allocation. The impact on optimal fares is not as significant.

Allocation of marginal external costs/benefits between PJ and pkm

	Passenger journeys	Passenger kms
Congestion (time)	50%	50%
Congestion (reliability)	50%	50%
Congestion (vehicle operating costs)	50%	50%
Emissions	0%	100%
Accidents	0%	100%
Active transport	100%	0%
Service frequency benefits	50%	50%

We also updated our model to separately identify marginal externalities and modal substitution factors

- The fare optimisation model requires us to separately identify the:
  - marginal external costs/benefits of each mode of transport (including car travel)
  - modal substitution factors (the rate at which people switch between different modes of transport)
  - excess burden of taxation associated with subsidising public transport.
- Our preliminary externality estimates combined these into a single external benefit estimate for a trip on each mode of public transport.
- Our revised externality model separately identifies the marginal external costs/benefits and the modal substitution factors, but also generates a combined estimate of the external benefit of each public transport trip consistent with our previous model.

We adjusted some of our externality estimates

We released a draft externality model and draft report on external benefits in December 2014. This draft model and report included a set of preliminary estimates.

We used preliminary estimates as the basis for those we used in our fare optimisation. However, we also did more analysis and made adjustments to the preliminary estimates as part of this review. In particular, we:

- Made minor changes to the emissions estimates
- Adjusted the accident estimates to include our best estimate of the uninsured fatality cost for non-car occupants (pedestrians and cyclists)
- Estimated service frequency benefits (previously referred to as scale benefits) for bus, ferry and light rail and included them in modelling the range of optimal fares
- Further considered our active transport and excess burden of taxation estimates but made no change
- Further considered including estimates of crowding costs and social inclusion benefits but made no change.

Emissions

We made two minor changes to the emissions estimates:

- **We adjusted for car speed.** Consistent with TfNSW guidelines, we adopted different emissions costs depending on car speed (free flowing traffic is less polluting).
- **We adopted Arup estimates for rail emissions.** Estimates in TfNSW Guidelines are not applicable, so we used estimates from Arup (as we did for light rail).
- We did further analysis on air pollution from electricity generation but decided to continue to include emissions from electricity generation for rail and light rail at the unit cost in TfNSW Guidelines:
  - During our consultations, a stakeholder questioned whether traditional air pollution has the same cost for electricity generation as for vehicle emissions (air pollution seen as predominantly local issue and electricity generation occurs in less populated areas)
  - Evidence suggests that electricity generation emissions travel within and between regions, and complex modelling is required to estimate the impact
  - However, this input makes little difference to outcomes so on balance we decided to make no change.

Accidents

- Previously, the only accident-related externality we quantified was the avoided cost of taxpayer-funded services (eg, ambulance and police attendance). We recognised a number of other external costs that theoretically should be included, but considered that these were either too small and/or we had insufficient data to estimate reliably.
- After further analysis, we now consider one of these other accident-related externalities – uninsured fatality costs of non-car occupants (pedestrians and cyclists) – may be too significant to ignore. These costs remain difficult to estimate, but we built up a best estimate using available data as follows:
  - Value of life in TfNSW Guidelines is $6.4 million based on willingness-to-pay valuation for urban areas
  - TfNSW Guidelines also include an estimate of value of life of $2.3 million based on human capital approach
  - CTP insurance provides benefit to close relatives that covers some losses – the types of costs covered are similar to those included in TfNSW human capital value estimate
  - We used the difference between the two TfNSW valuations (approx $4 million) as the uninsured fatality value, and multiplied it by updated crash statistics on number of cyclist/pedestrian fatalities due to car accidents.
- We recognise that in practice, insurance benefits might be substantially different from the estimated average $2.3 million value of life in the TfNSW Guidelines. But we consider it is more accurate to include this value as an estimate than to exclude it altogether.

Service frequency

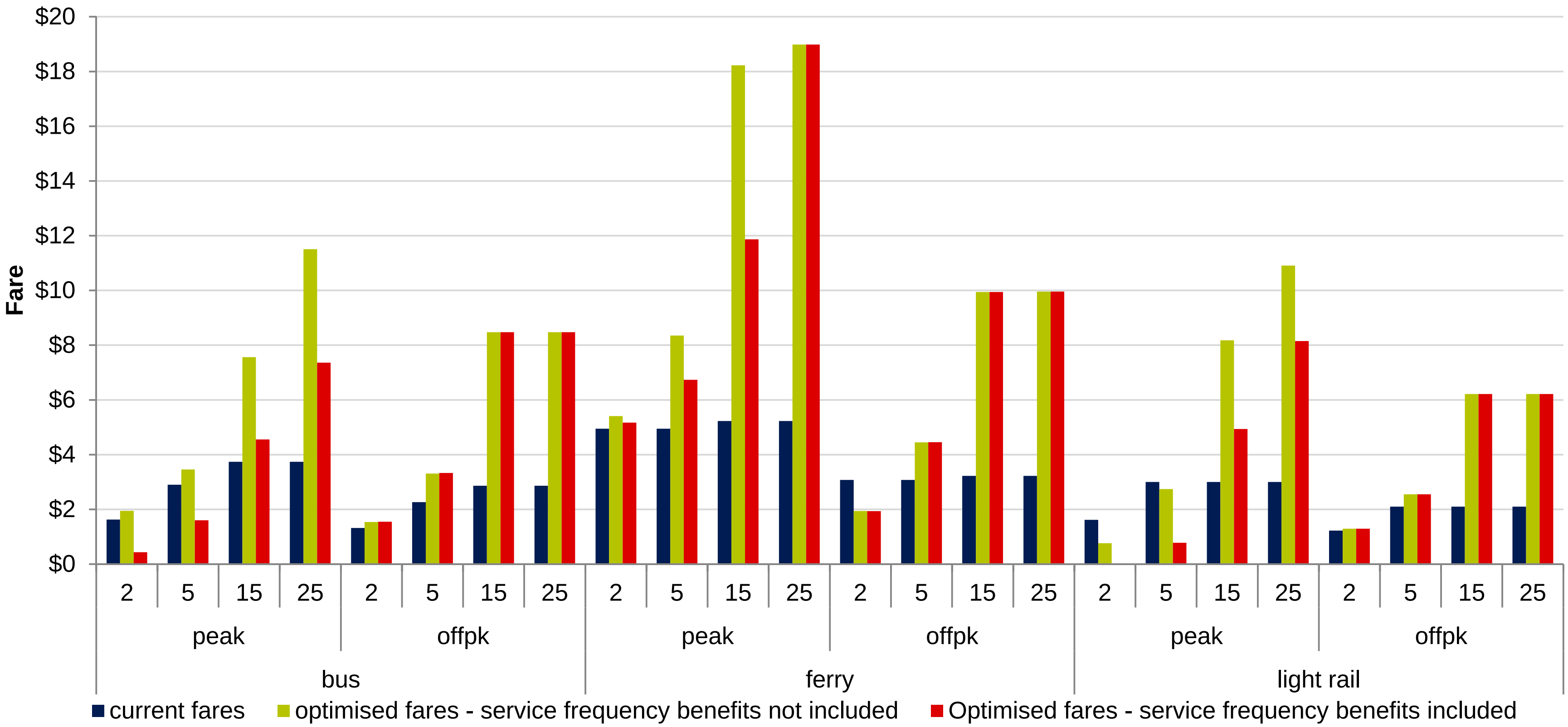
- We did more analysis on the external benefit of additional services being added as more people use public transport (resulting in increased service frequency).
- If there is a strong link between the frequency of public transport services and demand, each new public transport passenger increases the frequency of the service, therefore decreasing average waiting times for existing users.
- We have included an estimated value for service frequency in our range of draft optimal fares for buses, ferries and light rail in the medium run (where services are assumed to be variable in the medium run to accommodate changes in demand) and for all modes in the long run:
  - It only impacts the peak estimates for these services as we assume that additional passenger trips made in the off-peak can be accommodated on existing services.
- This is consistent with our optimisation model which:
  - Increases or decreases bus, ferry and light rail services in response to patronage in the medium run to maintain current level of utilisation. (In the medium run, we assumed that additional rail services are not able to be added.)
  - Increases or decreases the number, hence frequency, of all services (including rail) in the long run.

Estimated marginal service frequency benefits – bus, ferry and light rail

- In estimating the value of service frequency benefits for bus, ferry and light rail, we assumed that:
  - Outside the peak, additional demand is accommodated on existing services so there is no benefit from increasing frequency as demand rises
  - On peak services, a 1% increase in patronage results in a 1% increase in services.
- Our range of draft optimal fares for these modes includes fares that include service frequency benefits (lowest in range) and fares that don’t include them (highest in range).
- As the next slide shows, including service frequency benefits makes a big difference to optimal fares for bus services. In particular, it reduces the optimal fare for peak bus trips substantially.

Estimated marginal service frequency benefits – bus, ferry, light rail

- The following chart shows the impact of including frequency benefits for bus, ferry and light rail on our estimate of optimal fares in the peak and the off-peak (offpk) for 2km, 5km 15km and 25km trips – see Information Paper 11 for more information.



Active transport

- The main external benefit that accrues directly from public transport use is the avoided cost to the health system as a result of greater levels of physical activity when people walk or cycle to or from public transport. (Note that the health benefit to the public transport user is not an externality).

- We decided to adopt our preliminary estimate of this external benefit, and continue to consider that the remainder of the total health benefit is likely to be private/internal and should not be included.

Crowding

- An increase in demand for a public transport service could result in more people using existing services. Potentially, this could impose a cost on existing users, by making the service more crowded and less comfortable.
- In our Methodology Paper, we proposed to estimate this crowding cost. However, after further analysis we have decided not to include this externality for any mode:
  - The optimisation varies services supplied to maintain existing level of utilisation
  - Because the level of crowding does not change, there is no cost associated with this.
- The optimal fares for rail are above their current levels in peak and lower in off-peak and our recommendations are consistent with this direction:
  - As a result we do not expect levels of crowding to increase over the determination period.

Marginal excess burden of taxation

- We include the marginal excess burden of taxation in our optimisation:
  - The marginal excess burden of taxation represents the costs of taxes in terms of economic efficiency, which are over and above the amount of the taxes themselves. Taxes distort the economic decisions of labour, consumers, investors and producers by changing the incentives to work or invest, and influencing consumption and production patterns. These distortions reduce economic efficiency and lead to a loss in consumer welfare, referred to as the deadweight loss or excess burden of taxation. The excess burden, or deadweight loss of a tax, is a measure of the economic costs associated with these distortions.
  - We consider it is appropriate to take account of the economic efficiency losses associated with the funds used to subsidise public transport in estimating the net value of the external benefits.
- After further analysis, we decided to use a marginal excess burden of taxation of 8%. This value is:
  - consistent with an efficient tax, such as the GST
  - consistent with the conclusion of our 2014 Draft Report on externalities.

Social inclusion

- In our Methodology Paper we proposed not to include the social inclusion benefits in estimating the marginal net external cost/benefit of public transport in either the medium run or long run.

- This is mainly because many of the benefits associated with social inclusion are private. The ability of people to access resources such as education, employment, health and other services (eg, cultural, sporting activities) improves a person's well-being. These well-being benefits are not external to the user and are not appropriate to include in our estimate of external benefits.

- As many stakeholders continued to argue that these benefits should be included, we considered this further. In our view, there are two aspects to the social inclusion benefits associated with public transport:
  - Fare affordability – those who are transport disadvantaged must be able to afford to travel on public transport
  - Service provision – the minimum service level available must allow those who transport disadvantaged to participate in society. (This is more of an issue for buses where Government policy is to provide minimum level of service within 400 metres of most homes.)

Social inclusion

- In relation to fare affordability, we consider:
  - It is not appropriate to lower fares for the majority, who are not at risk of social exclusion, in order to make travel affordable for a few
  - This is best addressed through Government-funded concession programs (eg,Opal Gold).
- In relation to service provision:
  - Our optimisation model uses a marginal cost based on the current average level of utilisation and assumes that services are varied up or down to retain this
  - Ideally, the Government would fund services with low utilisation that are provided for social policy reasons rather than other transport users (through fares), but we are not able to identify these services
  - However, we have excluded outer metropolitan bus services and NSW TrainLink intercity services from our marginal financial cost estimate. These service have low utilisation and higher average costs, so including them would result in higher optimal fares for all users.

How our current estimates compare with our previous estimates

Current and previous estimates compared – $ per passenger journey ($2014-15)

	Rail	Bus	Ferry	Light rail
December 2014 estimates				
Range	$3.37 to $5.60	$1.43 to $2.49	$0.12 to $2.08	n/a
December 2015 estimates				
Range	$2.85 to $5.17	$0.16 to $3.10	-$0.03 to $3.36	$2.13 to $5.50
Range excluding frequency benefit (for bus, ferry and light rail)	$3.03 to $5.17	$0.16 to $1.33	-$0.03 to $1.74	$2.13 to $3.60

Note: December 2014 estimates come from IPART *Draft Report: Review of external benefits of public transport* , December 2014, p 8. The range reflects the short, medium and long run scenarios – these scenarios use different price elasticities of demand, which affects the marginal excess burden of taxation that is included in the estimates.

- The ranges above for the December 2015 estimates use results from both STM2 and STM3 runs for 2016 and the modal substitution factors set out in Information Paper 10.
- We used the medium run results using STM3 outputs with and without frequency benefits in our optimisation model for our draft report (as shown on Slide 5 of this Information Paper).
- Apart from the changes described elsewhere in this Information Paper other factors that have contributed to the differences between current and previous estimates are:
  - We have now included a share of environmental externalities produced by the public transport itself in order to be consistent with the optimisation model (our December 2014 marginal estimates did not include these)
  - The use of STM results from the 2016 year has led to lower congestion benefits than obtained using the 2011 STM results, which we used as the basis for the December 2014 estimates.
  - We have now included an estimate of congestion caused by buses.