IPART
New South Wales

Independent Pricing and Regulatory Tribunal

A new methodology for setting public transport fares in Sydney

Methodology

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Context of review

We propose to use the following criteria to assess our selected options for fare structure and fare levels:

1) encourages the efficient use of public transport
2) promotes the efficient delivery of public transport
3) encourages greater use of public transport
4) minimises impacts on passengers
5) is logical, predictable and stable over time, and
6) increases farebox revenue or cost recovery.

IPART’s approach

1. Estimate fares that target the first two assessment criteria:
    a. encourage the most efficient use of public transport and
    b. promote the most efficient delivery of public transport.

    These are the ‘socially optimal’ fares.

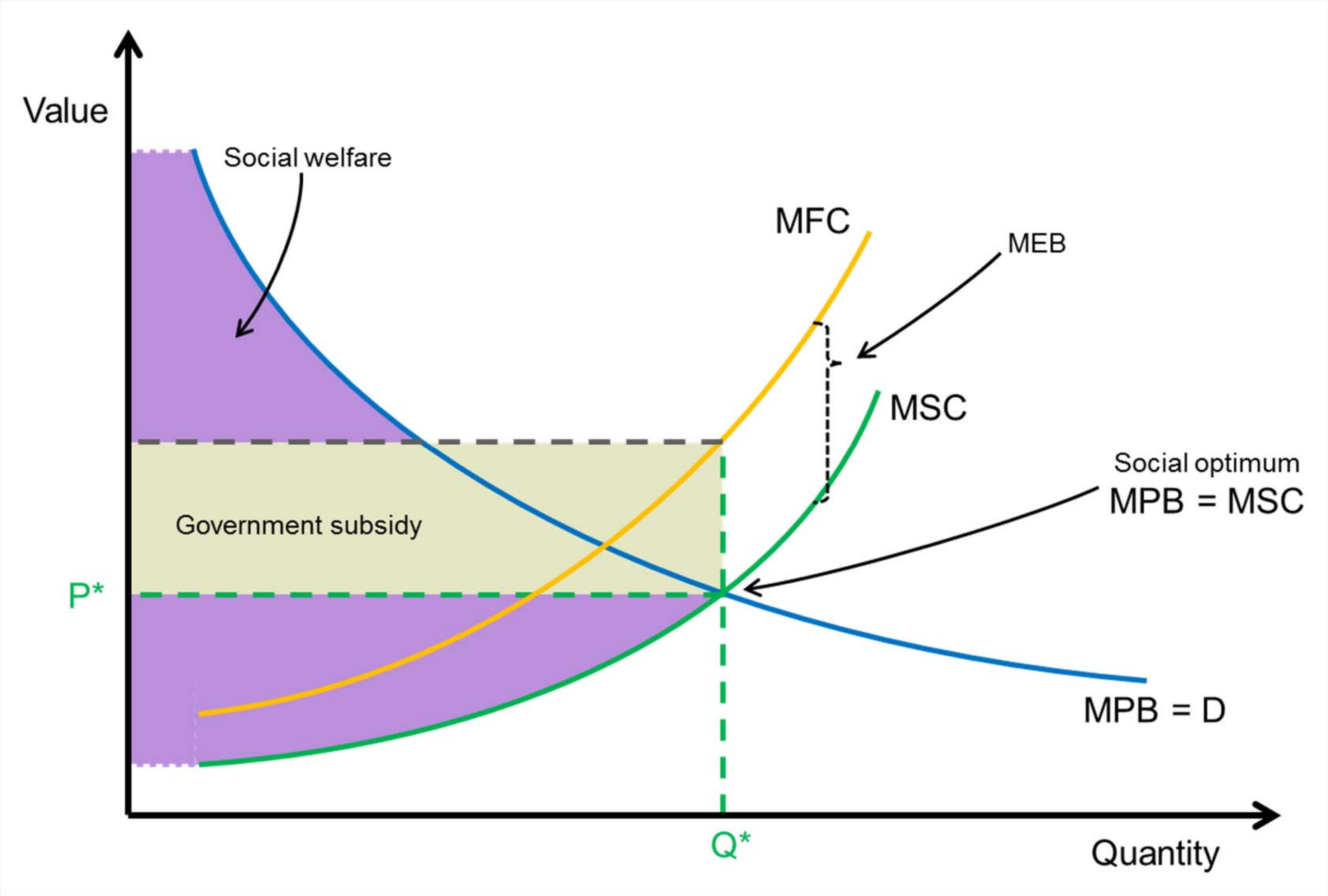
2. Develop additional fare options that would allow us to consider impacts on passengers and taxpayers (assessment criteria 4 and 6).

    Also consider options for more integrated fares across modes (assessment criteria 3 and 5).

3. Assess all these fare options against the full set of assessment criteria.

4. Decide what form our fare determination should take - in particular whether we should
    1. continue setting average fare changes, or
    2. set maximum fares for each individual fare.

How we estimate socially optimal fares



First order condition for optimal fares

Under plausible conditions the price for mode j that maximises welfare is given by:

$$\partial \text{ Welfare}/ \partial p^j = F(p^j, p^{i<>j}, c^i, m^i, Z^i_j, V^i_j, \lambda, e^{jj}) = 0$$

Modal subscripts, i and j can refer to any permutation of

- vehicle type (automobile, train, bus, ferry or light rail),
- time of day (peak or off-peak), and
- journey distance (2km, 5km, 15km, or 25km).

To solve for p, must find

- marginal financial costs, c,
- marginal external costs, m,
- own-price elasticity, e^{jj},
- modal substitution factors, Z and V, and
- marginal excess burden of taxation, λ.

Modal substitution effects

How much does usage of mode k change relative to mode j when the price of j changes?

$Z = (\partial X^k / \partial p^j) / (\partial X^j / \partial p^j)$

How much does usage of mode j change when price k changes relative to the changed usage of j when price j changes?

$V = (\partial X^j / \partial p^k) / (\partial X^j / \partial p^j)$

k			j			Z
TOD	distance	mode	TOD	distance	mode	
a	b	c	a	b	c	1
a	b	c	a	v <> b	c	0
a	b	c	a	b	w <> c	Z^c_w *(Based on STM runs)*
a	b	c	u <> a	b	c	-0.1
a	b	c	u <> a	v <> b	c	0
a	b	c	a	v <> b	w <> c	0
a	b	c	u <> a	v <> b	w <> c	0
a	b	c	u <> a	b	w <> c	0

Solution method

The optimal prices for each mode are inter-dependent, so it is necessary to solve for all of them simultaneously. Express all first order conditions in vector notation:

A p = RHS

Diagonal elements of matrix A are equal to $(1 + 2\lambda)$.

Off-diagonal elements of A are $(\lambda V^i_j + (1+\lambda) Z^i_j)$.

Element j of the RHS vector is equal to

$$\sum_{i<>auto} Z^i_j(m^i + c^i(1+\lambda)) + \sum_{i = auto} Z^i_j(m^i + (c^i - p^i)(1+\lambda)) + \lambda \left[p^j_0 (1-1/e^{jj}) + \sum_{i<>j,auto} V^i_j\, p^i_0\right]$$

Optimal prices can be found by inverting matrix A:

p* = A^{-1} RHS

Welfare changes when prices deviate from optima

In moving from optimal prices p* to alternative prices p^0 for mode j, welfare changes to reflect three issues:

$\Delta W^j =$	$\lambda\,[p^{j*}X^{j*} - p^j{}_0 X^j{}_0 - c^j \Delta X^j]$	(tax distortions to fund subsidy)
	$+\ \Delta X^j\,[(p^{j*} + p^j{}_0)/2 - m^j - c^j]$	(output effect in PT market)
	$-\ \Delta X^j\,\Sigma_{i<>j}\, Z^i{}_j(m^i + (1+\lambda)(c^i - p^{i*}))$	(cross-modal effects)

Tax distortions arise because of the marginal excess burden of taxation.

Output effects refer to the deadweight loss when PT output is different from p = msc.

Cross-modal effects refer mainly to the reduction in external costs of motoring that a shift to PT would cause. These include congestion, emissions and accident externalities.

Marginal financial costs

- Previously (IPART's consultant approaches):
  - Rail: econometrics on annual report data
  - Bus: econometrics on contract data
  - Ferry: cost model constructed

- Now, to reflect peak/off-peak differences
  - Use cost accounting data
  - Distinguish between capacity and usage costs
  - Consider actual and efficient costs

Time of day-sensitive marginal costs

Literature on the peak-load pricing problem (see Crew, Fernando and Kleindorfer (1995)) notes that if two conditions are satisfied:

- only one type of production technology is in use in all time periods; and
- no (or minimal) peak-shifting in response to price signals,

then the welfare-optimal price is equal to:

1. b in the off-peak period; and
2. b + β in the peak period.

b is the efficient marginal financial usage costs per journey, and

β is the efficient marginal financial capacity costs per peak journey.

Can be estimated from annual report data, but scope for efficiency improvements should also be examined.

Short Run or Long Run?

Costs and externalities vary with output differently in Short Run vs Long Run. Which perspective should we take?

LRMC is more useful, but harder to quantify where infrastructure investment can change.

We propose to adopt both “Medium Run” and Long Run perspectives.

In the Medium Run, marginal financial costs include:

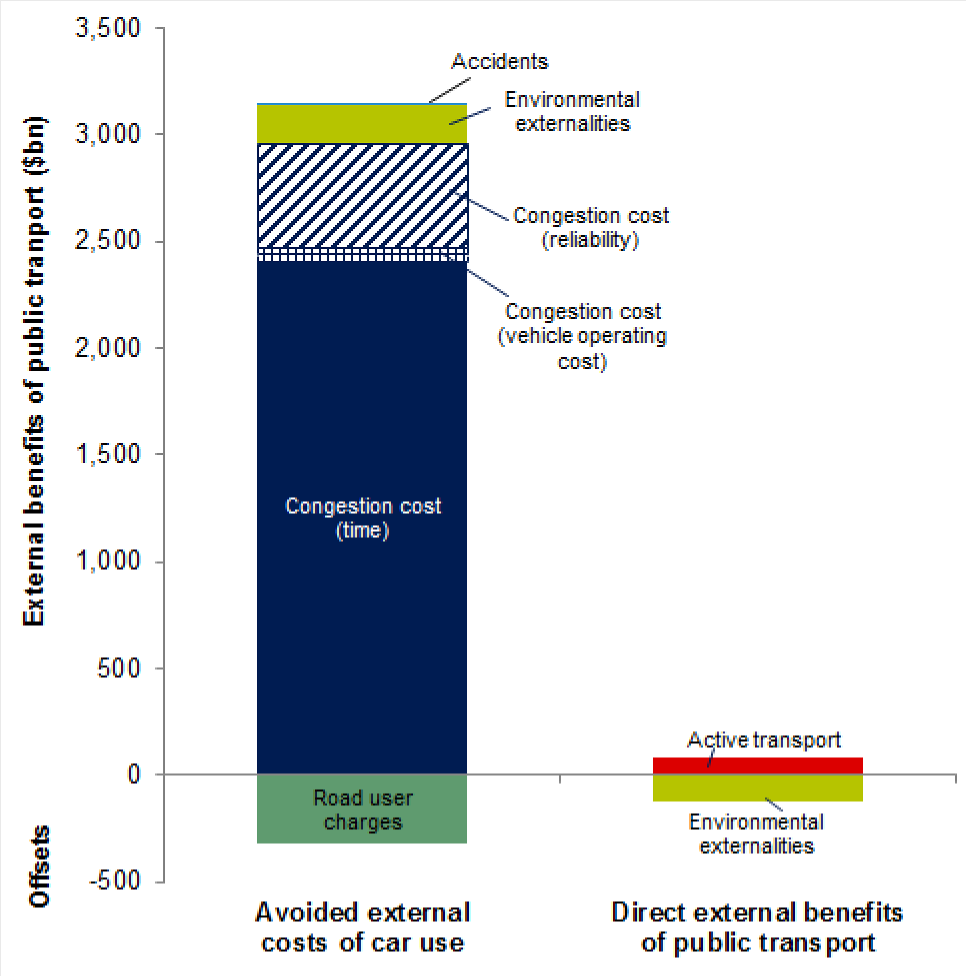
- All OPEX, including accruals for MPM, and
- Vehicle capital costs for buses, ferries, light rail and train sets
- However, capital costs of road and rail infrastructure are excluded because that infrastructure capacity is fixed.

In the Long Run, road and rail infrastructure capacity can change.

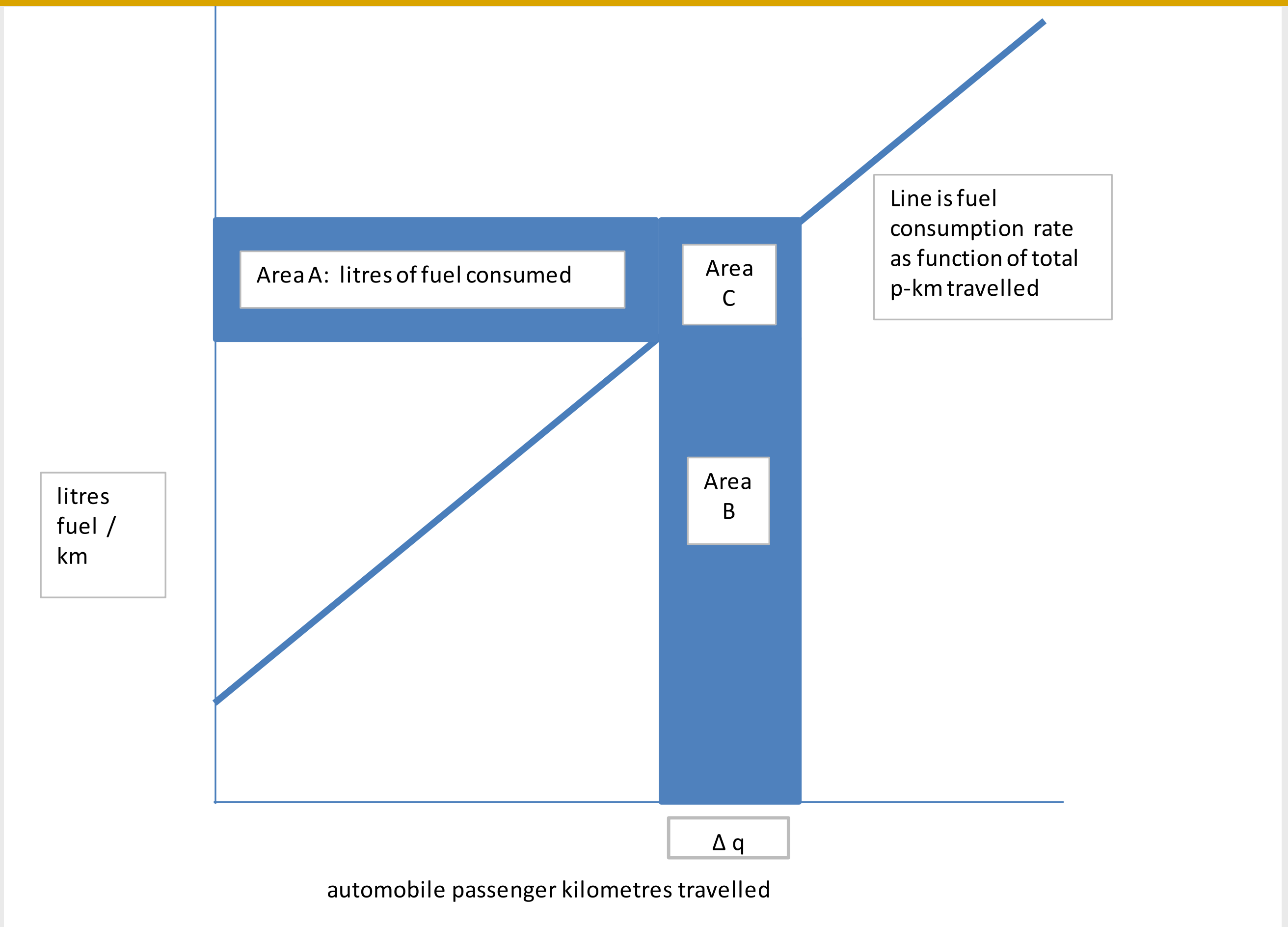
Marginal external costs and benefits

- Previously used building block approach
  - Total external costs and benefits roughly equated to taxpayer contribution to total costs
- Now using marginal approach
  - How much cost does a marginal journey impose on others?
  - Theoretical points
  - Method of estimating based on traffic simulation

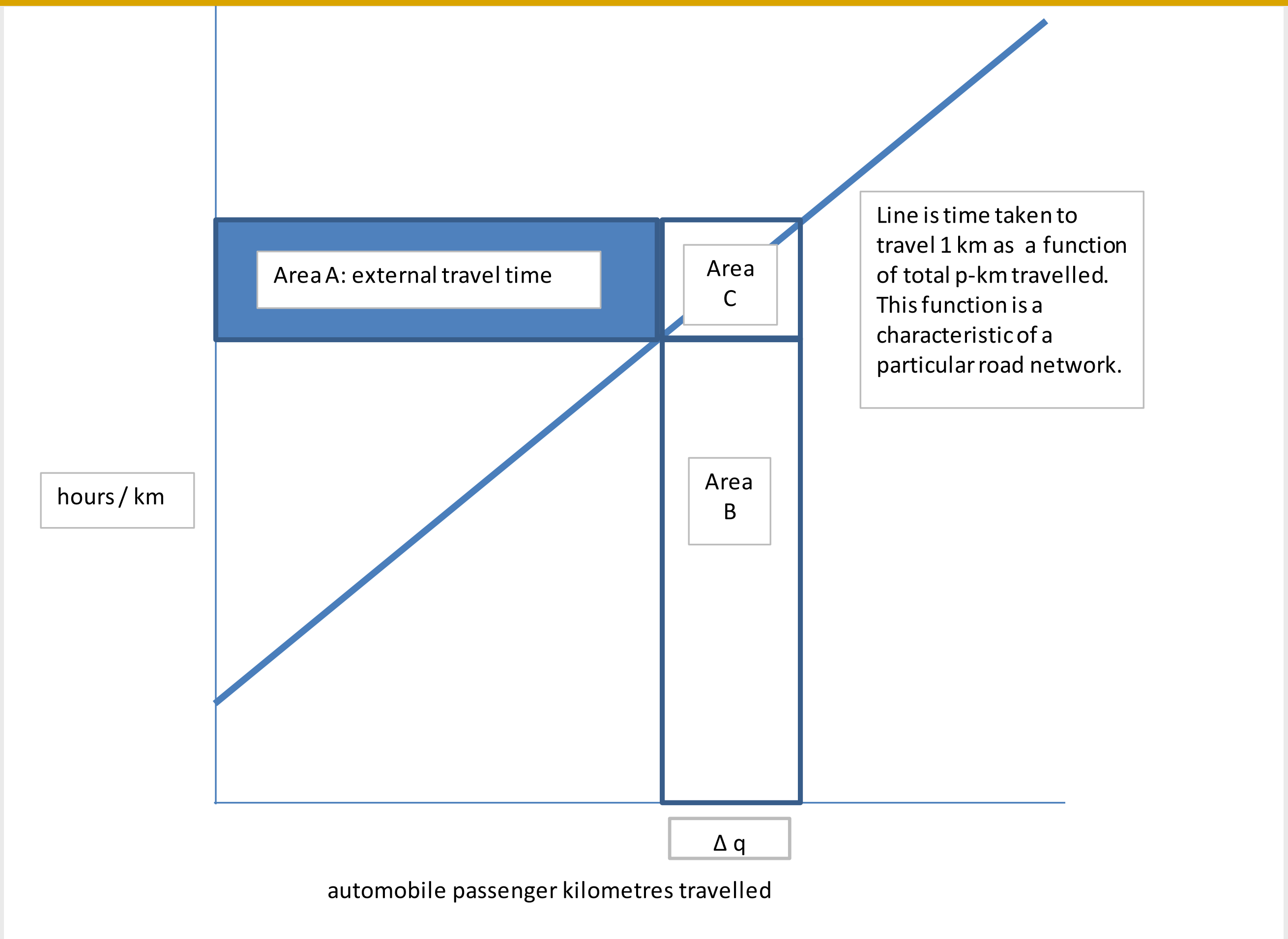
IPART's December 2014 estimates of total external costs and benefits



External costs borne by non-car occupants (marginal approach)



External costs to car occupants (marginal approach)



Method

Traffic simulations: BTS STM

- Congestion effect
- Fuel consumption (emissions)
- Modal substitution rates

Estimating demand for public transport

- International and Australian surveys of the price elasticities of demand for public transport consistently found:
  - average of short-run and long-run elasticities is -0.3 to -0.4
  - long-run estimates are approx. twice short-run estimates, and
  - estimates of price elasticities are sensitive to choice of approach.
- Australian average estimates tend to be lower: -0.2 to -0.4
- Peak own-price elasticities based on the outputs of STM2 are lower, as one would expect.

Mode	AM peak
Rail	-0.13
Bus	-0.16
All public transport	-0.11

- We propose to assume linear functional form for demand, extrapolating from status quo using a point elasticity based on STM or published studies.

Marginal excess burden of taxation

We propose to use a central estimate of 8%,
based on an efficient tax, such as GST.

Do you agree with using an estimated marginal excess burden of taxation equal to 8%?

How you can comment

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

Submissions are due by 9 October.

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 mail to:

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