Independent Pricing and Regulatory Tribunal
New South Wales

OPAL FARES
2020 - 2024
PATRONAGE AND ELASTICITY ESTIMATES

Technical Paper

February 2020

Demand for public transport

We have considered two components of the demand for public transport services:

- Underlying growth in demand as a result of external factors – such as population growth and changes in where and how people live and work
- Response to changes in the price of public transport – known as the price elasticity of demand.

Our key findings are that:

- Public transport use has grown significantly in recent years and is expected to continue to grow by around 5% per year over the determination period, above the expected rate of population growth (predicted to be around 2% per year)
- Demand for public transport is not very sensitive to changes in fares with demand in peak periods being less sensitive than demand outside the peak and demand for long distances generally more sensitive than demand for shorter distances.

We have taken both of these into account in the review. Our analysis on each aspect is discussed below.

Underlying growth in public transport patronage

In recent years, we have observed significant increases in public transport patronage. For example, average annual growth in patronage has been about 7% per year over the past five years (Table 1 below). Recently, over the past three years when fares have increased broadly in line with inflation, average annual growth in patronage has been about 5% per year. Population growth has been about 2% on average over the past three years in Sydney and is also expected to grow by about 2% per year going forward.[1]

1 https://www.abs.gov.au/ausstats/abs@.nsf/lookup/3218.0Media%20Release12016-17, growth from June 2015 to June 2018, accessed 11 November 2019. NSW DPE forecasts – main series to 2036 (https://www.planning.nsw.gov.au/Research-and-Demography/Demography/Population-projections)

Table 1 Growth in public transport use 2013-14 to 2018-19

	Current number of annual trips	Annual average growth (past 3 years) 2015-16 to 2018-19	Annual average growth (past 5 years) 2013-14 to 2018-19
Train (including metro)	424 million	4.6%	6.1%
Bus	349 million	5.2%	9.3%
Ferry	16 million	0.2%	0.1%
Light rail	11 million	5.6%	23.6%
Total	**800 million**	**4.8%**	**7.4%**

Note: The figures above include NSW trains regional patronage and estimates for unticketed travel. Growth using Opal only data from 2016-17 onwards provides similar results of about 4.8% per year on average (4.7% growth in 2017-18 and 4.9% growth in 2018-19).

Source: https://www.transport.nsw.gov.au/data-and-research/passenger-travel/all-modes-patronage-historical/all-modes-historical-patronage, accessed 22 November 2019.

Over the determination period we expect patronage to continue to increase and that growth would be supported by the additional investment that is being made in the public transport network:

- For trains, the Sydney Metro would provide additional capacity from the recent completion of the North West Metro from Tallawong to Chatswood. In the medium to longer term, the completion of the second harbour crossing, the extension of the metro to Bankstown and the Parramatta to Sydney CBD metro would provide further capacity.[2]
- For buses, the NSW Government has previously announced additional services to meet demand at least in the short term.[3]
- For light rail, the CBD and South East Light Rail recently commenced providing services from December 2019.

The NSW Government is also expecting strong growth in rail patronage (about 5% per year) to continue and that the T1 Western Line, one of the busiest lines in Sydney, would reach full capacity by 2030 based partially on population growth in the West.[4]

Using information from the Sydney Strategic Travel Model (STM) we were also able to calculate the expected growth in public transport patronage in the absence of any fare changes from 2016 to 2021.[5] We calculated that the STM outputs suggest that public transport patronage could increase by about 3.3% per year in the short term (the combined rail, ferry and light rail demand is forecast to increase by about 4.4% per year and bus by about 3.3%).[6] However, the STM outputs appear to be conservative estimates given that patronage has increased by about 5% per year on average between 2016 and 2019, when fares have increased broadly in line with inflation.

2 The Metro Stage 2 (second harbour crossing) is due to open by 2024 and in the longer term the metro extension to Bankstown and also the Sydney Metro West (Parramatta to Sydney CBD line).

3 https://nsw.liberal.org.au/Shared-Content/News/2019/COMMUNITIES-TO-GET-THOUSANDS-OF-EXTRA-BUS-SERVICES

4 TTF LEK, Public transport barometer, June 2018, p 4.

5 The STM provides outputs in five-yearly intervals. We have outputs for 2016 and 2021 for the purposes of our review.

6 The STM produces outputs at five yearly intervals, eg, 2016 and 2021, and so we have calculated the underlying annual average growth in the baseline demand for public transport services between these two years.

In the absence of significant fare changes, we consider that the underlying growth in public transport patronage is likely to continue to increase at around 5% per year over the determination period.

Elasticity estimates - How demand is estimated to respond to fare changes

People will use public transport when the benefit they receive from it is above or equal to the cost of the fare. Fare increases (decreases) are likely to place downward (upward) pressure on demand as people re-evaluate their decisions on how to travel. Different people place different value on their use of public transport services and respond differently to various fare changes. However, it is possible to estimate the likely impact on demand overall and it is this impact that is relevant for fare setting.

How responsive demand for a particular product or service is to changes in its price is known as the 'price elasticity of demand'. Economists measure this as the proportionate change in demand for a product/service in response to a change in its price.[7] Demand for a product or service is relatively inelastic (price elasticity of demand less than one) if the proportionate change in demand is less than the proportionate change in price, and relatively elastic if the proportionate change in demand is more than the proportionate change in price (price elasticity of demand more than one). For example, a price elasticity of -0.3 means that for a 10% increase in price there is expected to be a 3% decrease in quantity demand, holding all else constant.

There are a number of different ways of estimating the price elasticity of demand. For example, it can be observed by considering how people have responded to price changes in the past or it can be developed by surveying customers. In our modelling, we used the midpoint of a range of elasticities, with the lower bound being those derived by the Cambridge Economic Policy Associates and the Hensher Group (CEPA/Hensher Group) using observed Opal data and the upper bound being the outputs of the Sydney Strategic Travel Model (STM) based on the application of a modelled set of choices (which has been the basis of our estimates in our past review). We also used modal substitution estimates (how people switch transport modes in response to fare changes) from the STM.

Our key findings are that:

- Public transport demand is relatively inelastic (that is, less sensitive to price changes), with demand for train travel during peak periods being the least sensitive to price changes, compared with other public transport modes.
- Those who travel longer distances are generally more price sensitive than those who travel shorter distances.

7 If the elasticity is between 0 and |-1| then the demand for the product/service is considered to be inelastic (the change in demand in response is smaller than the change in its price). If the elasticity is greater than |-1|, then demand for the product/service is considered to be elastic and there is a greater proportionate change in demand compared with the change in price.

- Demand for trains is least sensitive in the pre-peak (before 7 am) and peak periods and most sensitive in the post peak periods.

It is important to consider price elasticities so that we can understand the potential impact of fare changes on patronage. While it is difficult to accurately predict how people will respond to various fare changes the available literature on public transport elasticity estimates is wide ranging and range from -0.01 to -1.10.[8]

In the sections below, we present the following estimates that we have used in our modelling:

- Own-price elasticity – the change in demand for a service when its own-price changes
- Modal substitution – the change in demand for other services when the price of a particular service changes.

Own-price elasticities

CEPA/Hensher Group elasticities

We commissioned CEPA/Hensher Group to review Opal usage data to see how people respond to changes in Opal fares. CEPA/Hensher Group estimated the likely change in adult journeys in response to an increase in fares for different user groups, different distances, times of the day, days of the week and on different modes.[9]

Figure 1 shows the estimated reduction in journeys from a 10% increase in Opal fares on a typical weekday for trains and buses, by distance travelled, using the demand elasticities estimated in the study. On average, across the different distances travelled, a 10% increase in Opal fares (trains) would decrease train demand in the peak period by slightly less than 2%. It shows that that those who travel longer distances are more price sensitive than those who travel shorter distances.[10] It also shows that demand for trains is most responsive in the post-peak period and least responsive in the pre-peak period.[11]

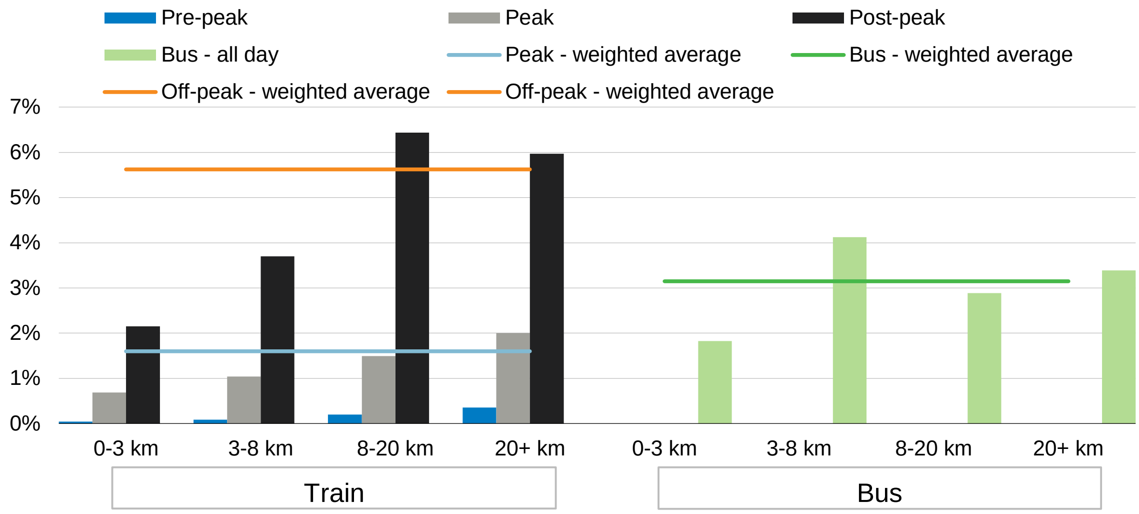
8 CEPA/Hensher Group, Elasticity of demand for Sydney Public Transport, 9 October 2018, p 33.

9 The actual time period used to calculate the elasticity estimates was from August 2016 to December 2016. CEPA/Hensher Group, Elasticity of demand for Sydney Public Transport, 9 October 2018, p 8. The increase in the average Adult fare over this period was about 3% and included the introduction of the multi-mode transfer discount of $2 and reduction in the Travel Reward from 100% to 50% after eight paid journeys in a week.https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/pricing-reviews-compliance-publications-opal-fares-compliance-201617/transport_for_nsw_pricing_proposal_-_2016-17_fare_compliance.pdf

10 CEPA/Hensher Group, Elasticity of demand for Sydney Public Transport, 9 October 2018, p 36.

11 We note that in Melbourne, myki users are able to travel for free on trains if they tap on and off before 7:15am. Whilst this has increased some usage in the pre-peak period, there is still significant patronage in the peak periods.

Figure 1 CEPA/Hensher Group - Estimated reduction in train and bus journeys on weekdays if fares were increased by 10%



Note: The CEPA/Hensher Group results do not include elasticity estimates for peak and off-peak times for buses. We have calculated the weighted average demand responses across distances using patronage in each distance band as weights.

Data source: CEPA/Hensher Group, *Elasticity of demand for Sydney Public Transport*, 9 October 2018, p 36 and model outputs from the Sydney Strategic Travel Model.

For ferries, CEPA/Hensher Group analysed information for the Parramatta to Circular Quay ferry route and found that demand was relatively elastic and ranged from 1.25 for shorter distances (3km - 8km) to 1.51 for longer distances (8km – 20km).[12] This means that demand from ferry users is more responsive compared to changes in fares (eg, a 10% increase in ferry fares would result in a 12.5% decrease in ferry demand for shorter distances and a 15.1% decrease in demand for longer distances). CEPA/Hensher Group suggested that the larger demand response may be reflective of:

- The greater number of alternative transport options available to ferry users along the Parramatta to Circular Quay route.
- Ferry fares being higher than other public transport modes, and so consumers may be more sensitive to price changes for ferries – that is, if all Opal fares are increased by a certain percentage, given the starting fares for ferries are higher, it would translate into a higher dollar increase for ferries compared with fares for other transport modes.

For these reasons, CEPA/Hensher Group noted that the elasticity results from the Parramatta to Circular Quay route may not be applicable to other ferry routes.

For light rail, CEPA/Hensher Group did not provide elasticity estimates due to the few observations available during the time period it investigated.[13]

As part of its study, CEPA/Hensher Group also undertook a literature review and found that metro/train own-price elasticities ranged from -0.19 to -0.86 and bus own-price elasticities ranged from -0.29 to -1.10 (for those on lowest incomes).[14] It also found that:

12 CEPA/Hensher Group, Elasticity of demand for Sydney Public Transport, 9 October 2018, p 30.
13 CEPA/Hensher Group, Elasticity of demand for Sydney Public Transport, 9 October 2018, p 29.
14 CEPA/Hensher Group, Elasticity of demand for Sydney Public Transport, 9 October 2018, p 33.

- Peak travel is generally less price sensitive compared with off-peak travel
- Elasticities tend to be higher if the starting fare is higher
- Elasticities can differ between income levels
- Fare increases tend to have a greater impact than on demand than fare decreases.

Strategic Travel Model elasticities

We also obtained implied elasticities from the Sydney Strategic Travel Model (STM) - the STM is a high level strategic model, managed by TfNSW that examines the interaction between public transport demand and other modes of travel (eg, private car use, walking and cycling) between one's origin and destination of travel. It is used for strategic planning purposes and is less detailed in its outputs compared with the CEPA/Hensher Group's results. We also used outputs from the STM in our externalities work (see *Technical Paper - External benefits and costs*).[15]

In Table 2 below we show the estimated reduction in train and bus journeys from a 10% increase in Opal fares on a typical weekday – a 10% increase in Opal fares (train) could decrease patronage during peak hours by 2.5%.

The STM combines train, light rail and ferry demand outputs rather than presenting them separately. As the volume of train journeys is significantly higher than light rail and ferry journeys,[16] we have used the changes in demand from this combined output to calculate our train elasticity estimates. The combined STM outputs also mean that we are not able to calculate separate elasticities for ferries and light rail using this data.

Table 2 STM – Estimated reduction in train and bus journeys if fares were increased by 10%

	Train	Bus
Peak (7am to 9am and 3pm to 7pm) – calculated from STM outputs	2.5%	4.0%
Off-peak (other times) – calculated from STM outputs	2.9%	5.5%

Note: STM outputs are presented according to high level time bands eg, peak and off-peak periods, rather than travel distance bands.

Source: IPART calculations from STM outputs.

Compared with the CEPA/Hensher Group elasticities the estimated demand response from the STM implied elasticities for trains and buses are slightly higher with the exception of off-peak travel for trains.

15 We obtained elasticity estimates by calculating the change in demand response (for different modes of travel) for different fare changes and during different times of the day.

16 There are currently about 424 million train trips compared with about 16 million ferry trips and about 11 million light rail trips.

Elasticities used in our modelling

For our modelling, we have used the mid-point (or average) of the STM and CEPA/Hensher Group elasticities as our best estimate of how people might respond to various fare changes (presented in Table 3 below).[17]

Table 3 CEPA/Hensher Group, STM and IPART selected elasticity estimates

	Train	Bus	Light Rail	Ferry
CEPA/Hensher Group				
Peak	-0.16	-0.26[a]	-0.26[b]	-1.36
Off-peak	-0.56	-0.36[a]	-0.36[b]	-1.36
STM 2019 (IPART calculated)				
Peak	-0.25	-0.40	-0.40[b]	-0.40[c]
Off-peak	-0.29	-0.55	-0.55[b]	-0.55[c]
IPART selected – mid-point				
Peak	-0.21	-0.33	-0.33	-0.88
Off-peak	-0.43	-0.45	-0.45	-0.96

a CEPA/Hensher Group only provided a single bus elasticity estimate and so we estimated peak and off-peak elasticities using the relativity between the peak and off-peak elasticity estimates for buses from the STM outputs.

b Given that we do not have specific estimates for light rail, we have assumed that the demand response to fare changes would be similar to buses.

c We also did not have specific estimates for ferries from the STM, hence we have also assumed that the demand response would be similar to buses. The overall result is that our selected mid-point estimate for ferries is reasonably lower than CEPA/Hensher Group's estimate for the Parramatta to Circular Quay corridor estimate, given that there are less alternate travel options on other ferry routes.

Source: CEPA/Hensher Group and IPART calculations from STM outputs.

Modal substitutions

In Table 4 below, we present the modal substitutions we used in our modelling.

Table 4 Modal substitution rates between various public transport modes and private car

	Train	Bus	Ferry	Light rail
Private car	-0.9	-0.6	-0.3	-0.6
Train	1	-0.05	-0.5	-0.05
Bus	-0.1	1	-0.2	-0.01
Ferry	-0.02	-0.01	1	-0.01
Light rail	-0.01	-0.01	-0.01	1

Note: We have also included private car occupancy assumptions of 1.4 people per vehicle when converting the number of public transport trips to private vehicle trips (which is an average calculated from the STM outputs).

Source: IPART calculations from STM outputs.

17 Demand can respond asymmetrically to fare changes – that is, fare increases can have a greater impact than fare decrease. However, for simplicity we have applied the same elasticity for both fare increases and decreases.

Table 4 shows that:

- If train travellers did not use the train, then on average, 87% would travel by private car, 10% would travel by bus, 2% would travel by ferry and 1% would travel by light rail
- If bus travellers did not use the bus, then on average, 60% would travel by car, 5% by train, 1% by ferry, 1% by light rail, and 33% would not travel at all.

These are our best estimates of how readily people switch their travel between different modes of transport (public transport and private car use) in response to price changes. We used these outputs in our externalities work when examining the impact of fare changes on private car use and avoided road congestion (see *Technical Paper - External benefits and costs*). We used outputs from the STM for our estimates, as we were not able to obtain a consistent set of cross-modal substitutions from the CEPA/Hensher Group study. The CEPA/Hensher Group study concentrated on Opal data and provided separate information for cross-modal substitutions from public transport to private cars – this was from prior work undertaken by Hensher unrelated to the Opal data.[18]

18 The cross-modal substitutions provided by CEPA/Hensher Group, suggest that the cross-elasticity of public transport to private car use is lower than the STM outputs.