IPART
Independent Pricing and Regulatory Tribunal
New South Wales

# OPAL FARES
## 2020-2024
# PRODUCTIVITY

Technical Paper

December 2019

# 1 How do we assess productivity?

Efficiently provided public transport lowers costs and allows the Government to either spend less for a given set of services or to provide more public transport for a given cost. As part of our fare review, we are required to consider the cost of providing public transport and the scope for reducing those costs by improving efficiency.

The bulk of funding for public transport comes from consolidated revenue. Current fares for Opal services only recover around 25% of costs. Driving productivity via achieving cost efficiencies and making improvements to how services are procured such as competitive tendering, ensures taxpayers and passengers are paying no more than necessary for public transport services. IPART has an important role to provide transparency around whether services are being delivered efficiently. Regular reporting can put pressure to contain costs.

Bus, ferry and light rail services are provided under contracts between operators and the NSW Government. Many of these contracts were awarded by competitive tender. Contract payments are largely fixed but do include some incentives, such as patronage incentive payments. Transport for NSW retains all fare revenue collected rather than the transport operator, and this fare revenue partially offsets the cost of contract payments. Any changes in productivity (both improvements and reductions) would be borne by the contractor operator during the contract period.

As part of our last Opal fare review in 2016 we engaged a consultant to review the cost efficiency of public transport services. The efficiency review involved breaking down activities into their components, identifying the costs associated with each component and considering how these costs compare with costs of other operators that provide similar services.

While this type of review is a valuable means of identifying inefficiencies, it is also relatively costly and time consuming. Differences in network characteristics and density have a significant impact on the costs of providing services so a large part of an efficiency study is correcting for these differences. In addition, where services are provided under contracts that include a single payment for construction, maintenance and ongoing operation to isolate the costs of component activities is not straight forward.

We consider that there is value in undertaking detailed efficiency studies periodically, but given we undertook such a study in 2016, we have decided to examine how the efficiency of each public transport mode has changed over time. We particularly focused on how it has changed since our most recent cost efficiency study, by undertaking a review of three different types of efficiency – allocative, technical and sales (see below).

Efficiency can also be driven by a competitive tendering process for the operation of all or parts of the transport network. We note that the NSW Government has recently announced it will invite competitive bids for 13 of Sydney's bus contract regions over the next three years

which will enable the NSW Government to reinvest more into delivering better services to commuters[1].


# 2 Rail

Rail services are funded by the NSW Government. Any improvements in productivity provides lowers costs and allows the Government to either spend less for a given set of services or to provide more public transport for a given cost.

To understand how the efficiency of Opal rail services has changed over time we undertook a total factor productivity (TFP) analysis for the rail network by analysing two different data series:

- the Sydney Trains entity, which covers the majority of Opal rail services
- a combination of Sydney Trains and NSW TrainLink services incorporating other Opal services[2].

The Sydney Trains data series covers the period 2014-15 to 2017-18. While this is a relatively short timeframe for analysis, the data series matches the period of Sydney Trains operations. Prior to this a different legal entity, CityRail operated the rail network including the intercity services that are now operated by NSW TrainLink. We have a longer timeframe for the combined series of 2004-05 to 2017-18 which we obtained by combining more recent information with that of the former CityRail entity.[3]

1 TfNSW, *New Bus contracts to drive improved services*, Media Release, 24 October 2019, https://www.transport.nsw.gov.au/news-and-events/media-releases/new-bus-contracts-to-drive-improved-services

2 NSW Trainlink also provides non-Opal services to regional customers outside the scope of this Opal fare review

3 CityRail formally ceased to exist on 30 June 2013 when it was replaced by two separate entities: Sydney Trains and NSW TrainLink. As well as incorporating the intercity services formerly provided by CityRail, NSW TrainLink provides regional train and coach services (the former CountryLink entity).

**The 2016 efficiency study** found that **Sydney Trains and NSW Trains** had improved over time but were still **around 30% less efficient** than a best practice operator

**Our updated analysis shows that the efficiency of rail services has continued to improve**

Increases in the number of train trips has lowered the costs per passenger in real terms from around **$7 per passenger** to about **$6 per passenger**, a **15% reduction**.

The number of trips on the rail network has increased substantially by around 6% per year or 30% over the past five years. This increase is substantially higher than the rate of population growth in Greater Sydney of around 2% per year.[4] This increased patronage in part is driving the improvements in our productivity analysis.

The TFP analysis takes a set of inputs and outputs for each series and compares how they have changed over time. Information on how we constructed our TFP analysis is set out in Box 2.1.

4 Australian Bureau of Statistics, *3218.0 Regional Population Growth, Estimated Resident Population - Greater Capital City Statistical Areas* 30 June 2014 and 30 June 2018. Average annual growth over the four year period.

**Box 2.1 What is Total Factor Productivity and how do we measure it?**

TFP provides an indication of how efficient an organisation is by measuring how efficiently and intensely its inputs are used to produce its outputs. A more efficient organisation will produce more outputs with fewer inputs than a less efficient organisation. Higher efficiency can result from better use of technology, better management practices or using the available resources in a better way.

A public transport provider must convert its basic inputs – labour and capital – into transport outputs – passenger journeys or passenger kilometres. We further break up outputs into two separate sub-tasks: providing transport capacity (how much public transport is available) and getting passengers onto public transport (how well the available services are used).

We collected the input and output data we used for this analysis from Transport for NSW. Although changes in ownership and responsibilities have led to breaks in some data, we are confident that the information we have used is reported on a sufficiently consistent basis to provide meaningful results and that it represents the same pool of costs/outputs from period to period.

**How we measure TFP for Sydney public transport services**

We have used the Törnqvist method to estimate TFP. Under this approach changes in TFP over time are estimated by comparing weighted geometric averages of rates of growth in outputs and inputs. In cases where there are multiple outputs and inputs with incompatible units, the Törnqvist index combines percentages in these physical units weighted by revenue shares (for outputs) or expenditure shares (for inputs). Underlying this weighting paradigm is the assumption that revenue and cost shares reflect the relative importance of each of the outputs and inputs in the production process.

The Törnqvist method can be expressed as:

$$\ln \frac{TFP_{t+1}}{TFP_t} = \sum_{x=1}^{n} \left( \frac{WO_{xt+1} + WO_{xt}}{2} \times \ln \frac{OP_{xt+1}}{OP_{xt}} \right) - \sum_{a=1}^{m} \left( \frac{WI_{at+1} + WI_{at}}{2} \times \ln \frac{IP_{at+1}}{IP_{at}} \right)$$

Where:

$TFP_1$ and $TFP_{t+1}$ represent total factor productivity in periods $t$ and $t+1$

$WO_{xt}$ *is* a weight that applies to output $x$ in period $t$

$OP_{xt}$ is a measure of output $x$ in period $t$

$WI_{at}$ is a weight that applies to input $a$ in period $t$

$IP_{at}$ is a measure of input $a$ in period $t$

## 2.1 Measures used in our analysis

The inputs and outputs we used to measure the productivity of the rail network over time are set out below.

Our analysis uses two inputs. They are:

- **Labour**, based on total labour expense (including subcontractors[5]) divided by the NSW wage price index in each period. We have also used staff headcount in our Sydney Trains series (not including subcontractors), which is measured as the number of full time equivalent workers. This data is not available for NSW TrainLink so has not been used in the combined series.
- **Capital**, based on the size of the train fleet. We have measured this by using the number of carriages operating on the electrified rail network. We considered using network size, which is measured by either the number of kilometres of track or the number of stations. We did not include this in our analysis as the size of the rail network has not grown over the past ten years.

We have used three output measures in our analysis, each reflecting a different aspect of efficiency:

- **the number of kilometres travelled** by each carriage across the network, indicating how much rail capacity is being provided
- **how many passenger journeys are taken** across the network, indicating how well utilised the available rail capacity is
- **the number of passengers exiting the CBD stations during the AM peak**,[6] indicating how well the network provides access to major employment centres, connecting communities, reducing congestion and maximising the use of the available transport infrastructure.[7]

## 2.2 Results of our productivity analysis

Our estimates of change in productive efficiency of the rail network generally show gains in allocative and sales efficiency over the study period (2014-15 to 2017-18). However, our analysis showed a slight reduction in technical efficiency. Improvements in both sales and allocative efficiency measures were strong with gains of 18% to 24% and 11% to 21% respectively. The losses in technical efficiency were smaller, from 3% to 7%.

The results were very similar for the Sydney Trains network and for our estimate of the combined Sydney Trains and NSW TrainLink networks.

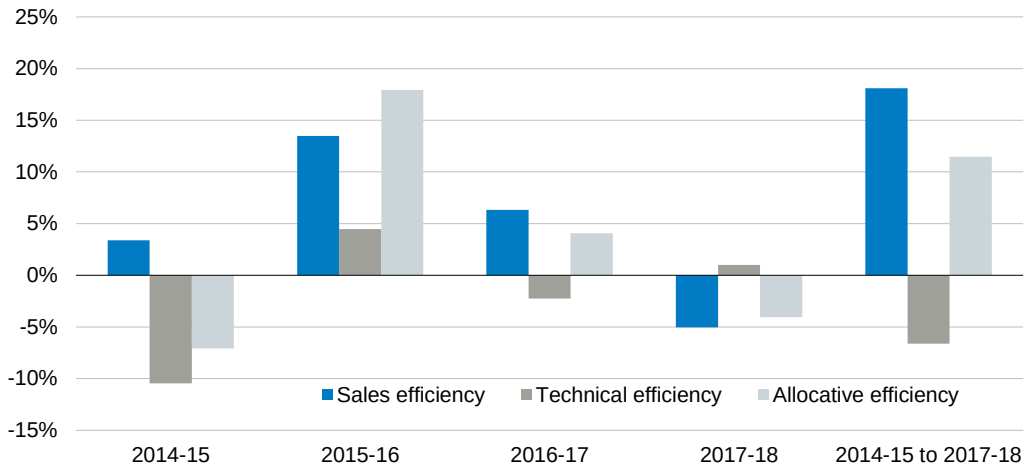
Figure 2.1 and Figure 2.2 show the results of our analysis.

5 Subcontractor expenses may overstate labour costs as they include some costs that relate to system improvements or specialist equipment. As we are comparing labour costs over time we do not consider that this affects our conclusions.

6 We have defined the AM peak to be between 0600 and 0930 on weekdays and the CBD stations as: Central, Circular Quay, Martin Place, Museum, Redfern, St James, Town Hall, Wynyard and North Sydney

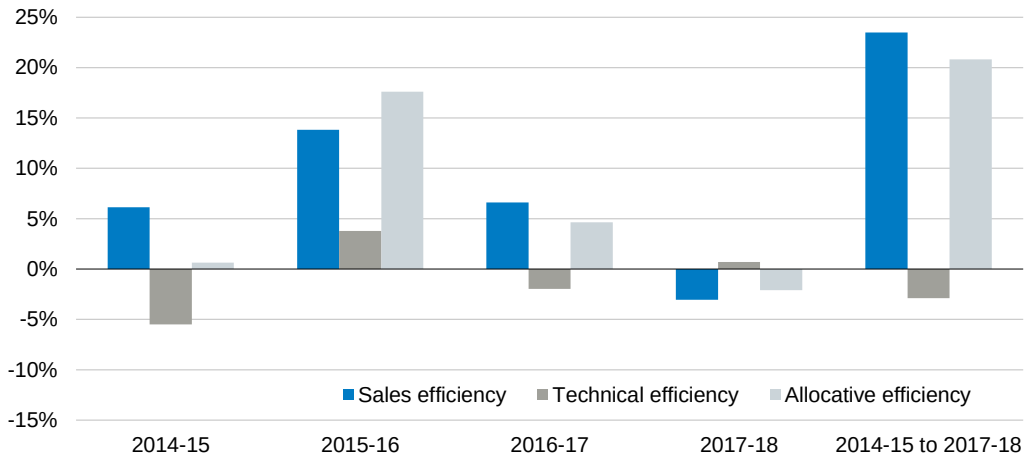
7 We have used the AM peak for this metric because the AM peak is the busiest usage on the rail network.

**Figure 2.1 Year on year change in TFP of Sydney Trains network 2014-15 to 2017-18**




**Data source:** Data provided by TfNSW and IPART calculations.

**Figure 2.2 Year on year change in TFP across the combined Sydney Trains and NSW TrainLink network 2014-15 to 2017-18**




**Data source:** Data provided by TfNSW and IPART calculations.

**Note:** Equivalent to the former CityRail network.

We consider that the substantial patronage growth experienced in recent years is likely to be a key driver of the improvements in sales and allocative efficiency.

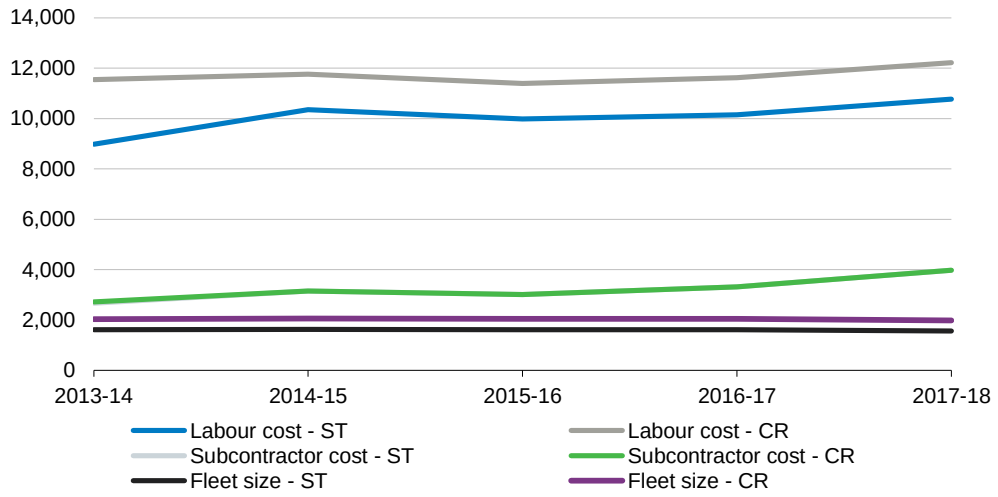
The measure for sales efficiency is directly affected by the number of journeys taken across the network and the measure for allocative efficiency by the number of passengers exiting the CBD during the AM peak (see section 2.1); both of which have increased significantly in recent years. Growth in these outputs has been stronger than the growth in the inputs (labour costs and the number of train carriages in service) resulting in measured productivity improvements.

The impact of patronage growth on technical efficiency is less direct, as it is based on the number of kilometres travelled by each carriage. While the number of services has risen over

this period in response to the increase in patronage, it has not risen as quickly as labour costs have over the past few years. This has resulted in the measured losses in technical efficiency.

Figure 2.3 and Figure 2.4 show how each of the inputs and outputs to our analysis have changed over time.

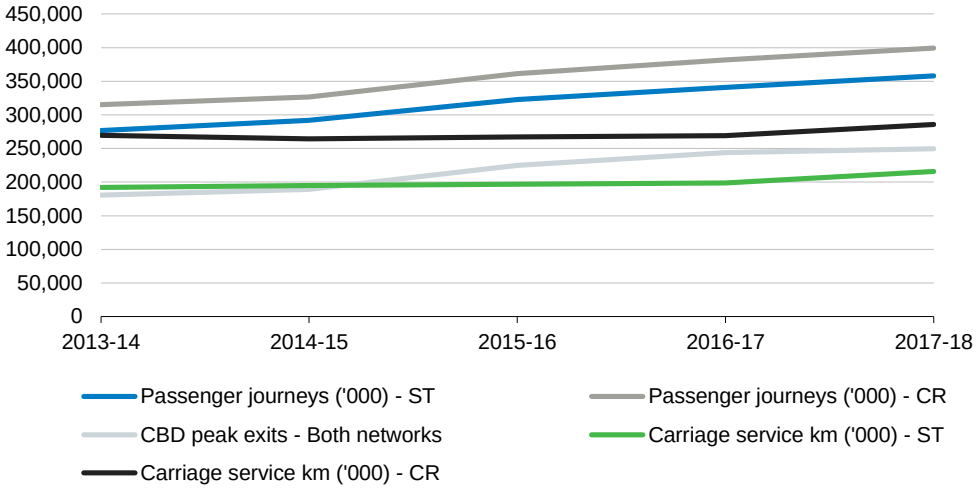
### Figure 2.3 Inputs into the Sydney Trains and combined Sydney Trains and NSW TrainLink networks 2014-15 to 2017-18




**Data source:** Data provided by TfNSW and IPART calculations.

**Note:** ST is Sydney Trains Network and CR is the combined Sydney Trains and NSW TrainLink network

### Figure 2.4 Outputs of the Sydney Trains and combined Sydney Trains and NSW TrainLink networks 2014-15 to 2017-18



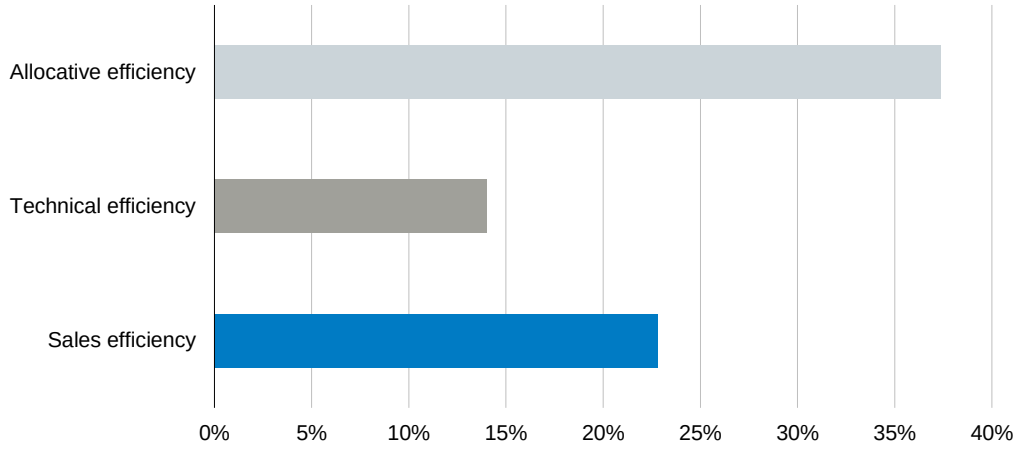

**Data source:** Data provided by TfNSW and IPART calculations.

**Note:** ST is Sydney Trains Network and CR is the combined Sydney Trains and NSW TrainLink network

While there are ups and downs over the individual years we have analysed, looking at the longer term, productivity across the combined Sydney Trains and NSW TrainLink network on

all three measures has risen since 2004-05 (which is the earliest year for which we have comparable data). Figure 2.5 shows the results over the 2004-05 to 2017-18 period.

**Figure 2.5 Year on year change in TFP across the combined Sydney Trains and NSW TrainLink network 2004-05 to 2017-18**




**Note:** Equivalent to the former CityRail network.
**Data source:** Data provided by TfNSW and IPART calculations.

# 3 Buses

Bus services are provided under contracts between operators and the NSW Government. Many of these contracts were awarded by competitive tender. Contract payments are largely fixed but do include some incentives, such as patronage incentive payments. Any improvements in productivity are enjoyed by the bus operator.

As bus services in the Opal network are provided by a relatively large number of operators our bus productivity analysis considers both the change in productivity over time (looking for improvements in passenger and taxpayer value for money) and also compares the difference in each operator's productivity. To do this analysis, we looked at each contract region's inputs and outputs and compared their performance against the average performance across regions.[8] We also prepared single factor productivity snapshots of the costs per output of each region to inform our comparative analysis. These cost per output snapshots continue on from work conducted by the CIE in 2016.[9]

8 Contract regions are split into two groups: Sydney metropolitan regions, which cover services in the city areas and outer metropolitan contract regions, which are typically the Sydney fringe and areas such as the Blue Mountains, Hunter, Newcastle and Wollongong. We have compared within groups but not across groups.
9 The CIE, *Efficiency of NSW public transport services*, April 2016, Chapter 3.

**The 2016 efficiency study** found that **an 11% reduction in costs** was needed across the metropolitan and outer-metropolitan bus network to achieve technically efficient costs

**Our updated analysis shows that the efficiency of metropolitan bus services has improved**

The metropolitan bus operators have shown collective efficiency improvements of around 2% to 8% across all efficiency measures. Outer-metropolitan operators have collectively shown efficiency losses of around 1% to 10%.

The number of trips on the bus network has increased substantially by around 56% over the past five years, though not all bus regions experienced significant growth and we note that some outer metropolitan regions experienced reduced patronage. This change in patronage contributes to the outcomes of our productivity analysis.

For the metropolitan bus operators[10] our analysis period covers 2014-15 to 2017-18. We found that all metropolitan bus operators showed improvement in at least one measure of efficiency with the sector overall showing improvement in sales, technical and allocative efficiency. This is mirrored by our cost per output snapshots where all operators showed improvement in at least one metric, with the sector as a whole showing cost reductions on all metrics.

For the outer metropolitan bus operators our analysis period covers 2015-16 to 2017-18. The change in productivity of the outer metropolitan bus operators was typically less than metropolitan bus operators though there was mixed results which means it is we are cautious in drawing a definitive conclusions about the change in productivity of these bus operators.

## 3.1 Measures used in our TFP analysis

The inputs and outputs we used to measure the productivity of the bus network over time are set out below. Our analysis uses two inputs. They are:

- **Operating costs**, which are all the costs of operating and maintaining the fleet and providing the contracted bus services. This is an input into our estimates of technical and allocative efficiency.

10 We refer to the 13 bus operators with Sydney metropolitan bus contracts as metropolitan operators.

- **Capital size**, measured by the number of buses in the fleet. This method will not capture changes in bus size but we consider that it still provides a reasonable indication of the change in capital costs of each operator. This is an input into our estimates of technical and allocative efficiency.

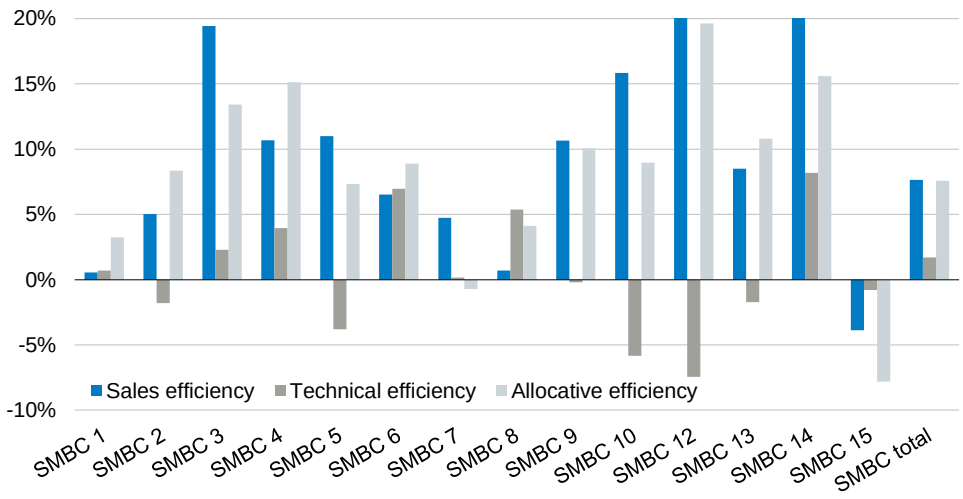
There are two main outputs of the bus network used in our analysis:

- **Timetabled services,** which is measured by both the number of kilometres travelled and the number of hours buses are operating. This measure indicates how much bus capacity is being provided and is the input into sales efficiency and the output of technical efficiency.
- **Passenger journeys**[11] is the number of journeys taken by passengers on the bus network. We have used opal trip data to measure this output. Passenger journeys measure the allocative and sales efficiency of the bus network.

## 3.2 Results of our Total Factor Productivity (TFP) analysis

We have estimated sales, technical and allocative efficiency of the bus operators individually and as a whole.[12] Productivity varied by bus operator and by contract regions however there was been an increase in productivity across the metropolitan regions by around 2% to 8%.

**Figure 3.1 TFP analysis of Sydney metropolitan regions, change from 2014-15 to 2017-18**



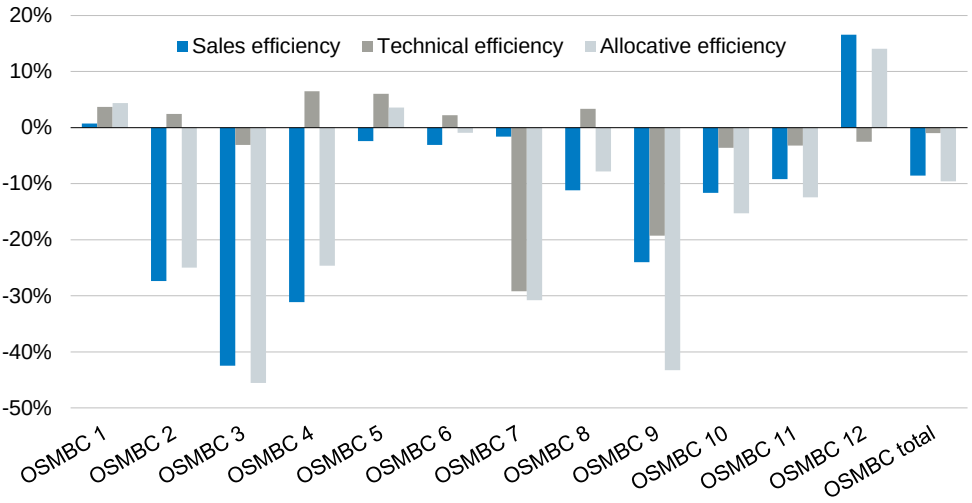

**Data source:** Data provided by TfNSW and IPART calculations.

11 The patronage used in our analysis was provided to us by TfNSW on a per contract region basis. This patronage is broadly consistent with the patronage figures used in our information paper – Elasticity and patronage growth.

12 The 'Total SMBC' entity is the sum of all the metropolitan regions. As if the whole Sydney Metropolitan bus network were operated by a single operator which incurred all the costs of the 14 current operators and generated all the outputs of those operators.

When looking at the same analysis performed for the outer metropolitan bus operators we see a very different story. Multiple regions experienced large reductions in productivity measured by changes in sales and allocative efficiency, primarily driven by reductions in the number of passenger journeys. Regions 2, 3, 4 and 9 all had reductions in patronage of greater than 20%, with the total outer-metropolitan regions having a reduction of 6%. Figure 3.24 shows the results of our analysis.

**Figure 3.2 TFP analysis of outer metropolitan regions, change from 2015-16 to 2017-18**




**Data source:** Data provided by TfNSW and IPART calculations.

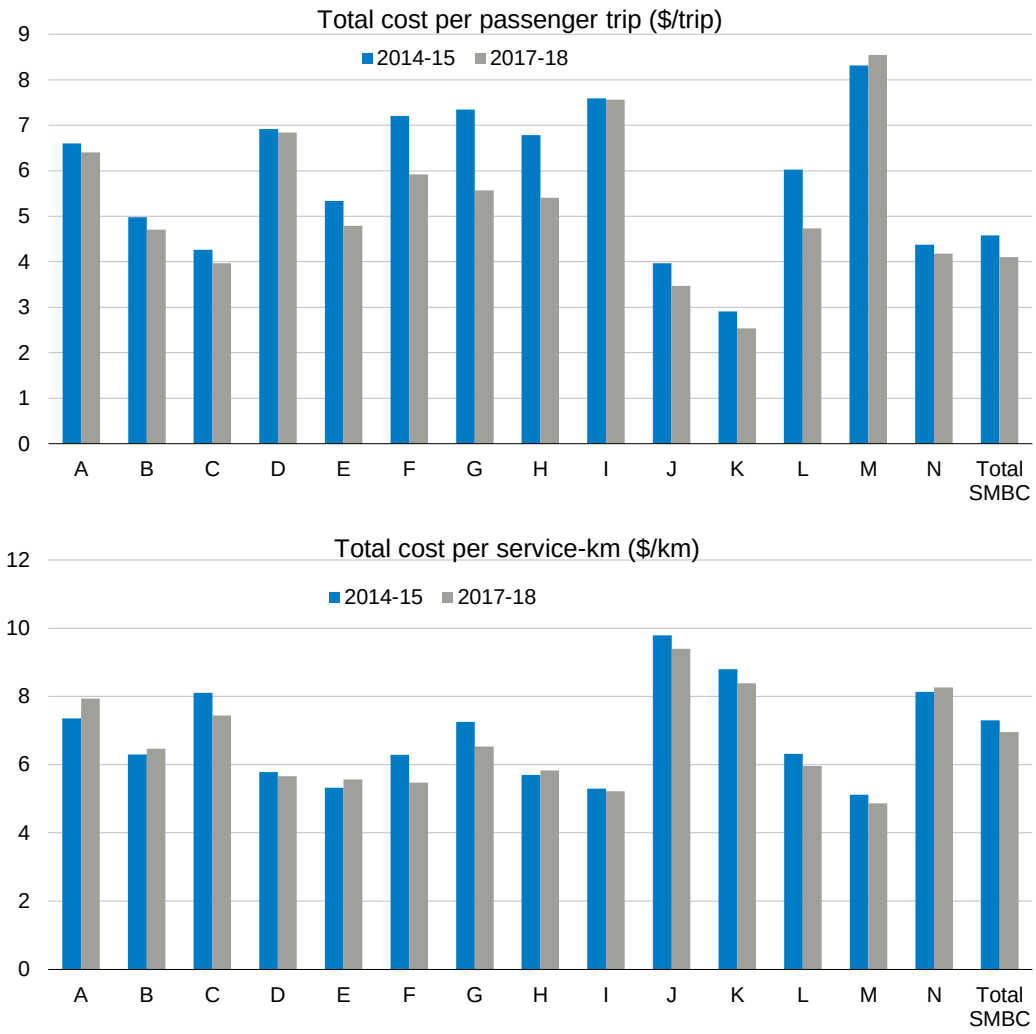
## 3.3 Results of our costs analysis

We have also estimated total cost per service km and cost per passenger trip for each of the metropolitan and outer metropolitan bus operators.[13] Comparing the change in these cost metrics from 2014-15 to 2017-18 shows that all metropolitan regions reduced real total costs on a per trip basis and around two thirds of regions also reduced costs on a per kilometre basis. When looking at outer metropolitan regions we found that the majority of operators experienced cost increases both on a per trip and per kilometre basis.

Figure 3.3 and Figure 3.4 compares the actual cost estimates for the two periods.

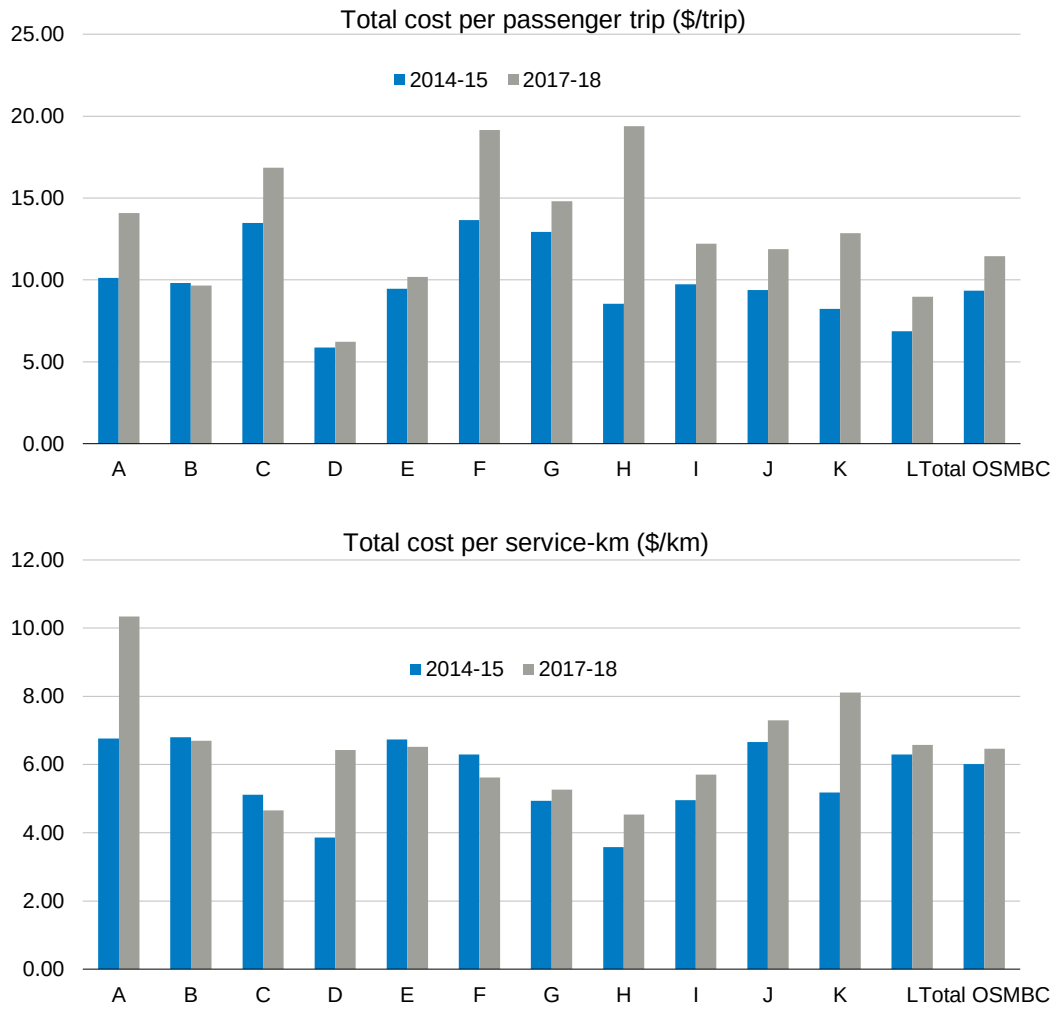
13 We have used operator reported total costs instead of contract payments to represent costs. These two data sets mirror each other closely and we have moved to total costs to maintain data continuity

## Figure 3.3 Comparison of Sydney metropolitan bus operators total cost per output estimates $2017-18




**Data source:** Data provided by TfNSW and IPART calculations. Regions have not been identified for confidentially reasons.

**Figure 3.4 Comparison of outer metropolitan bus operators total cost per output estimates $2017-18**




**Data source:** Data provided by TfNSW and IPART calculations.

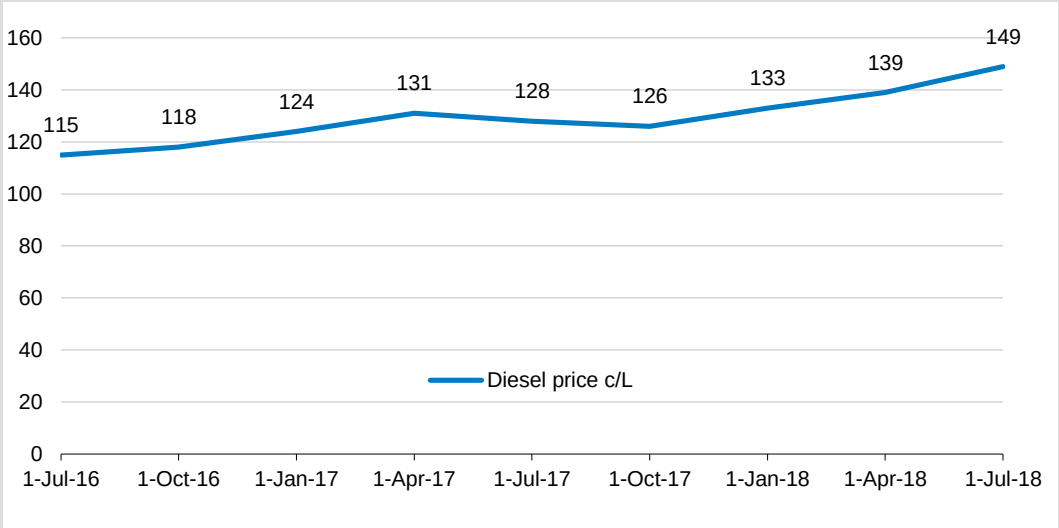
Many of the outer metropolitan bus operators exhibited large increases in costs per passenger which is likely to be at least partly a result of a reduction in patronage for these services, which fell by an average of around 10% between 2014-15 and 2017-18. All operators also saw a reduction in costs per service kilometre, and again some of these reductions were substantial. The movements in reported costs, patronage and service kilometres differ significantly across individual contract regions – being anywhere from significant increases to large reductions. This makes it very difficult to identify any underlying reasons for the measured reduction in productivity for outer metropolitan operators between 2014-15 and 2017-18.

When reviewing the results of the productivity analysis it is also important to keep in mind that not all of the factors that are taken into account in our productivity analysis are within the control of operators (see Box 3.1).

### Box 3.1 Fuel prices in recent years

Fuel costs represent around 7% to 10% of the costs of providing bus services. Fuel prices are largely outside the control of operators and can have an impact on their efficiency. We note that the average price of diesel in 2017-18 was 5% higher than in 2015-16. Figure 3.6 shows the diesel price since 2016-17.

**Figure 3.5 Australian diesel prices 2016-17 to 2017-18**




**Data source:** Department of the Environment and Energy, *Australian Petroleum Statistics*, vol. 7 no. 12, Table 8A, February 2019.

# 4 Ferries

**The 2016 efficiency study** found that **private contracting of Sydney Ferries** operations immediately **lowered costs by around 10%** with more efficiency gains expected in the future

Ferry services are provided under a contract between Transdev and the NSW Government. Which was awarded by competitive tender. Contract payments are largely fixed but do include some incentives, such as patronage incentive payments. Any improvements in productivity are enjoyed by the operator.

Our analysis of the productive efficiency the Sydney Ferries[14] network is based on the input and output data of Transdev Sydney Ferries. We have prepared our analysis to show the year on year changes in productive efficiency for the ferry network, utilising the same three measures of productive efficiency that we applied to the other modes.

Our analysis of changes in productive efficiency over the whole period show strong improvement in technical efficiency, little change in allocative efficiency and decreases in sales efficiency.

## 4.1 Measures used in our TFP analysis

The inputs and outputs we used to measure the productivity of the ferry network over time are set out below. Our analysis uses two inputs. They are:

- **Operating costs**, which are all the costs of operating and maintaining the fleet and providing the contracted ferry services. This is an input into our estimates of technical and allocative efficiency.
- **Capital size**, measured by passenger carrying capacity in the fleet. This is an input into our estimates of technical and allocative efficiency.

There are two main outputs of the ferry network used in our analysis:

- **Timetabled services,** which is measured by the number of hours ferries are operating. This measure indicates how much ferry capacity is being provided and is the input into sales efficiency and the output of technical efficiency.
- **Passenger journeys** is the number of journeys taken by passengers on the ferry network. We have used opal trip data to measure this output. Passenger journeys measure the allocative and sales efficiency of the ferry network.

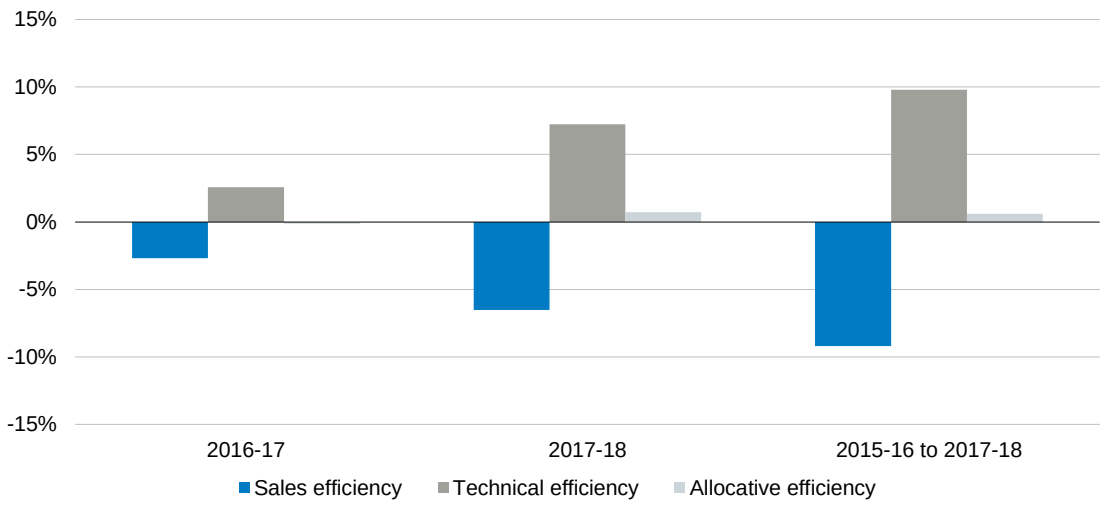
## 4.2 Results of our Total Factor Productivity analysis

Similar to our approach to assessing efficiency of rail and busses, we have looked at sales, technical and allocative efficiency of the ferry network. Unlike rail and buses there has been little patronage growth over the past five years on the ferry network.

Sydney Ferries showed strong improvement in technical efficiency over the study period. This efficiency gain is driven by a real reduction in costs of 1% and an increase in ferry service hours of 9% between 2015-16 and 2017-18. This same increase in ferry service hours is also causing the sales efficiency losses which are compounded by a 0.5% decrease in passenger trips over the same period.

14 This analysis is of only those ferry services operated by Trandev and does not include other ferry services such as Manly fast ferries or Matildas.

**Figure 4.1 TFP estimates of Sydney Ferry network 2016-17 to 2017-18**




**Data source:** Data provided by TfNSW and IPART calculations.

# 5 Light Rail

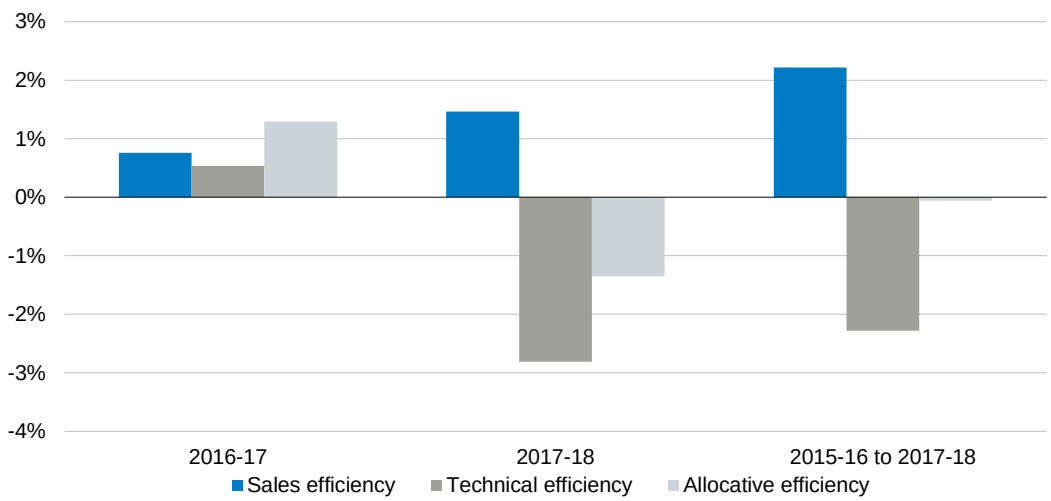
Light rail services are provided under contract between the operator and the NSW Government. The contracts were awarded by tender process. Contract payments are largely fixed but do include some incentives, such as patronage incentive payments. Any improvements in productivity are enjoyed by the operator.

Our analysis of the productive efficiency of Sydney's light rail is based on the Inner-West light rail network only. We have prepared our analysis to show the year on year changes in productive efficiency for the light rail network, utilising the same three measures of productive efficiency that we applied to the other modes.

The number of trips made on light rail services has increased by 5% and service kms increased by around 6%. Our analysis of productive efficiency shows that only sales efficiency showed consistent improvement over the past few years. The fall in technical and allocative efficiency is primarily driven by the large increase in labour utilised (18% over the period) relative to smaller increases in outputs.

Figure 5.1 shows our estimates of TFP for the light rail network.

**Figure 5.1 TFP estimates of the light rail network 2015-16 to 2017-18**




**Data source:** Data provided by TfNSW and IPART calculations.

## 5.1 Measures used in our TFP analysis

The inputs and outputs we used to measure the productivity of the Light rail network over time are set out below. Our analysis uses two inputs. They are:

- **Labour**, this is measured by the number of FTE working on the light rail network. This is an input into our estimates of technical and allocative efficiency.
- **Capital size**, measured by passenger carrying capacity in the fleet. This is an input into our estimates of technical and allocative efficiency.

There are two main outputs of the ferry network used in our analysis, as for our rail analysis, each of these targets a different aspect of efficiency:

- **Timetabled services,** which is measured by the number of service km produced by the fleet. This measure indicates how much light rail capacity is being provided and is the input into sales efficiency and the output of technical efficiency.
- **Passenger journeys** is the number of journeys taken by passengers on the light rail network. We have used opal trip data to measure this output. Passenger journeys measure the allocative and sales efficiency of the networks in producing public transport outcomes.