IPART
New South Wales

Independent Pricing and Regulatory Tribunal

Total Factor Productivity – Sydney's rail network

Final Report – Information Paper 3

What is Total Factor Productivity?

- Total Factor Productivity (TFP) is the portion of output not explained by the amount of inputs used in production. As such, its level is determined by how efficiently and intensely inputs are utilised in production.

- TFP can be used as a measure of change in organisational efficiency. Efficiency which can be the result of technological progress, improved management or more efficient utilisation of existing resources.

What are we studying?

- We are looking at changes in the entities that have made up the ‘CityRail’ network from 2004-05 to 2014-15.
- We have not split the historical CityRail network into Sydney Trains and NSW TrainLink Intercity.
- The combined inputs and outputs of Sydney Trains and NSW TrainLink Intercity have been used to represent the CityRail network from 30 June 2013 onwards.

How have we gathered information?

- Input and output data reported to IPART as part of it's reviews of rail fares has been utilised.
- Publically available information on the rail network has also been incorporated into this analysis.
- IPART has consulted with TfNSW and Sydney Trains to ensure that the data we have used is reported on a consistent basis and that it represents the same pool of costs/outputs from period to period.

How is TFP determined?

The Törnqvist method is used to estimate TFP

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

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

How is TFP determined?

- For TFP, or any measure based on aggregating quantities of inputs and outputs that are measured in different units, an indexing process is used to add diverse sets of outputs and inputs together.

- Can be more easily explained as the weighted sum of the rate of change in outputs minus the weighted sum of the rate of change in inputs.

Outputs of the rail network

- Seat kilometres – This is the number of service km travelled by each seat on each carriage in the electrified rail network
  - Measures the technical efficiency of the network
  - The dataset on carriage service km and average seats per carriage is available over the study period.

Outputs of the rail network

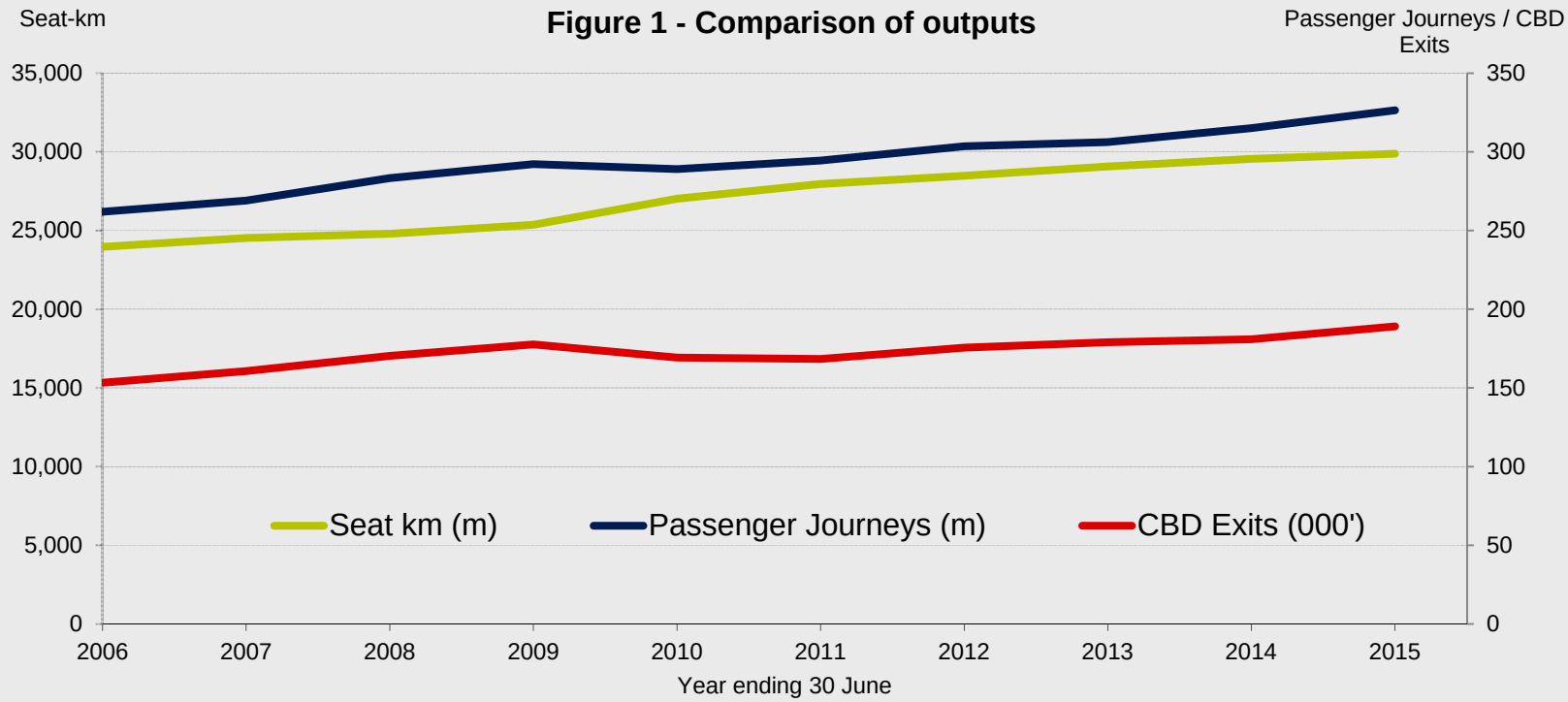
- Passenger journeys – This is the number of journeys taken by passengers on the rail network
  - Is used to measure the allocative efficiency of the network
  - Historical number of passenger journeys for the CityRail network is available for the study period.

Outputs of the rail network

- Congestion reduction – This is measured by the number of passengers exiting CBD stations in the AM peak
  - Measures the allocative efficiency of the network in peak periods
  - Data is available on CBD station exits for the entire study period
  - For this study CBD stations are defined as: Central, Circular Quay, Martin Place, Museum, Redfern, St James, Town Hall, Wynyard and North Sydney

Outputs of the rail network

Figure 1 shows movement in seat-km, passenger journeys and CBD station exits over the study period, seat-km is measured against the left axis with passenger journeys and CBD exits against the right axis.



Other potential outputs of the rail network

- Non-passenger, non-government revenue
  - For example, advertising revenue
  - This revenue is of too small a proportion of the overall revenue/cost of the rail network to impact the analysis.

- Measures of quality of service
  - For example, on-time running or air-conditioning levels
  - Data is not available on a consistent basis for the duration of the study period.

Inputs into the rail network - Labour

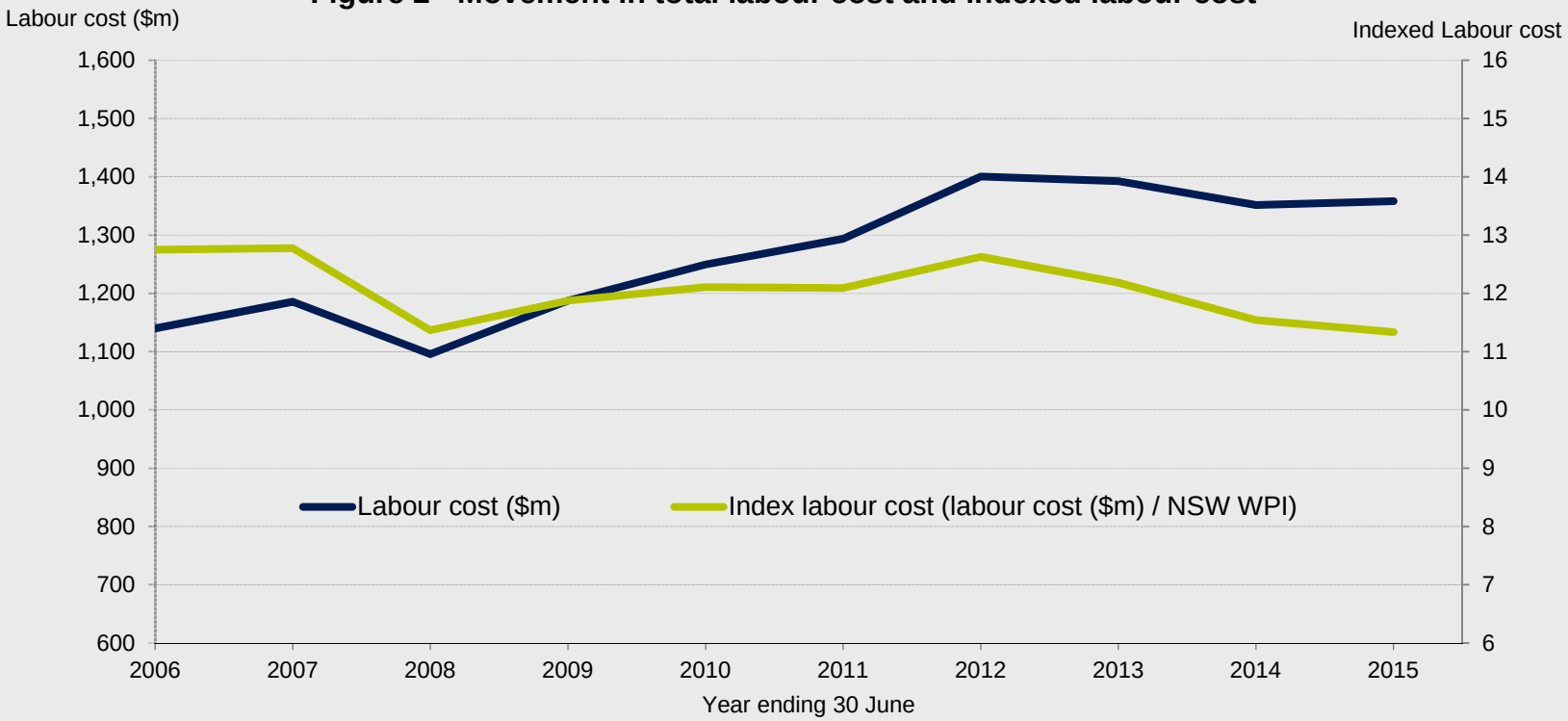
Labour input into the rail network during each period is measured using labour expense during that period

- This is measured using the total labour expense divided by the NSW Wage price index in each period
- The data available on labour cost is of consistent quality over the study period
- The labour input is weighted as labour expense proportion of total Opex cost (excl. finance costs, depreciation, amortisation and night rider bus costs).

Inputs into the rail network - Labour

Figure 2 shows the movement in total labour cost and the indexed labour cost

Figure 2 - Movement in total labour cost and indexed labour cost



Inputs into the rail network – Subcontractor expense

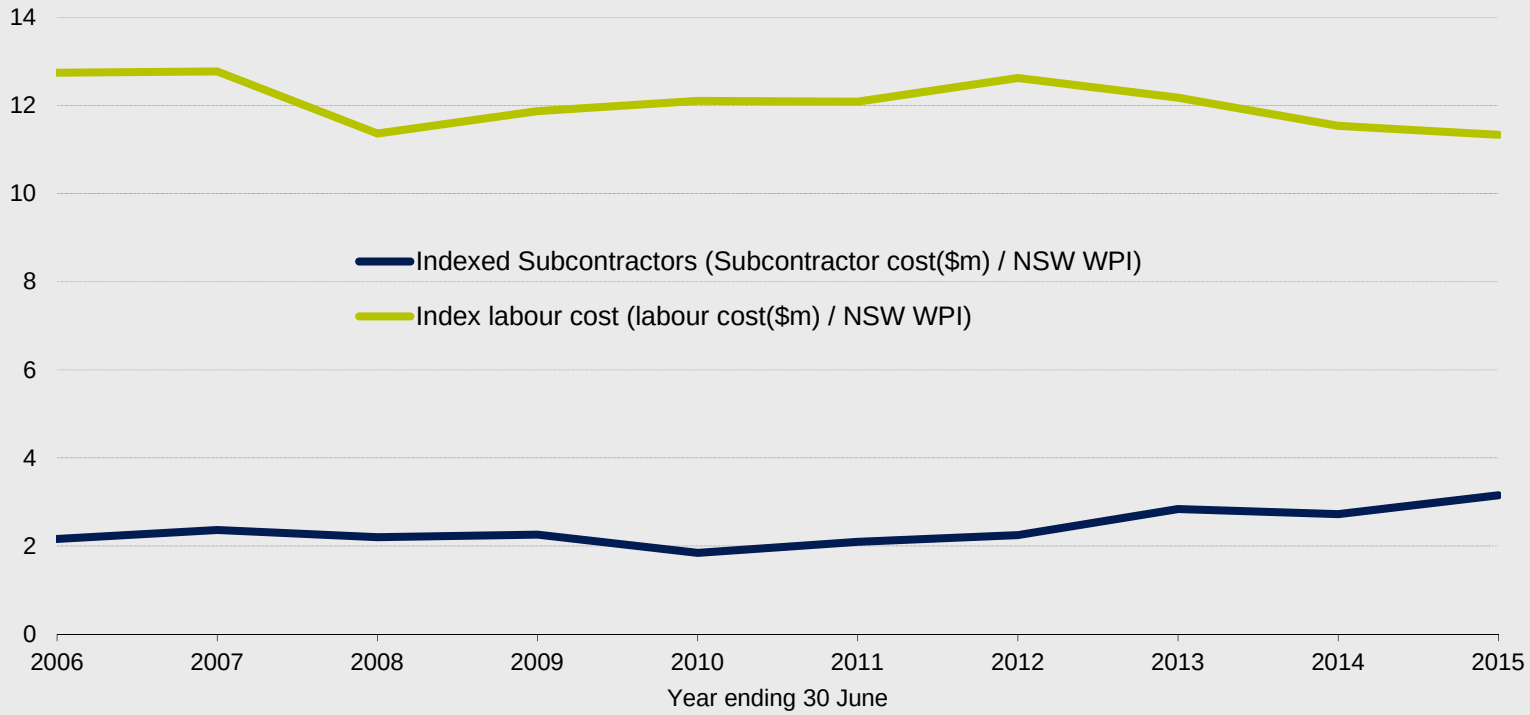
Subcontractors can be thought of as labour replacing and therefore a non-capital input into the rail network

- This input is measured by the spending on subcontractors in the period, indexed using the NSW Wage price index
- Subcontractor cost data is readily available over the study period
  - Data prior to 2007-08 is RailCorp data
- Subcontractor cost input is weighted as its proportion of total opex cost (excl. finance costs, depreciation, amortisation and night rider bus).

Inputs into the rail network – Subcontractor expense

Figure 3 shows the movement in indexed labour costs and indexed subcontractor costs over the study period

Figure 3 - Movement in indexed labour cost and indexed subcontractor costs



Inputs to the rail network - Capital

The rail network's capital input is being represented by the size of its Rolling Stock fleet

- This is measured using the number of seats in electrified rail carriages operating on the network (electric seats)
- Electric seats captures improvements in carriage size or design over time that are not reflected in carriage numbers
- This input is weighted as the remainder after labour and subcontractors.

Inputs into the rail network - Capital

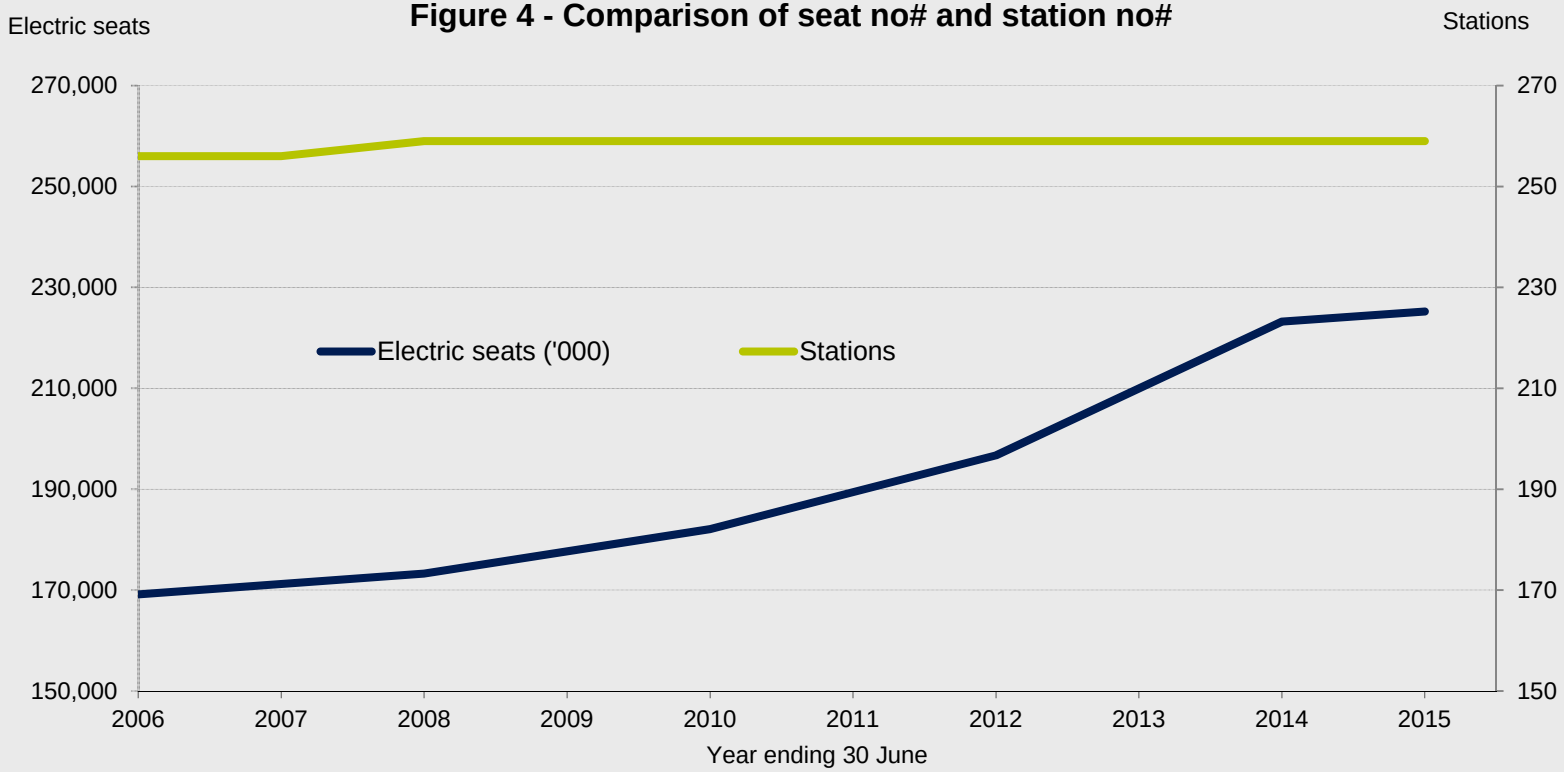
Other Capital inputs not used in this analysis:

- Network size can be measured using the number of stations on the network or the number of track km in the network
- The track km and number of stations move together over the study period
- This has not been included in the calculation of TFP estimates due to the number of stations remaining constant from 2007-08 onwards.

Inputs into the rail network - Capital

Figure 4 compares the movement of seats in electric carriages and station numbers over the study period

Figure 4 - Comparison of seat no# and station no#



Estimating TFP – Technical efficiency

Scenario 1 – Technical efficiency

- This scenario uses seat-km as the sole output of the rail network
- Indexed labour cost is used as the labour cost input
- Indexed subcontractor costs are used as subcontractor cost input
- Seats in electric carriages will be used as the capital cost input
- TFP estimates are based on year on year TFP change

Estimating TFP – Allocative efficiency

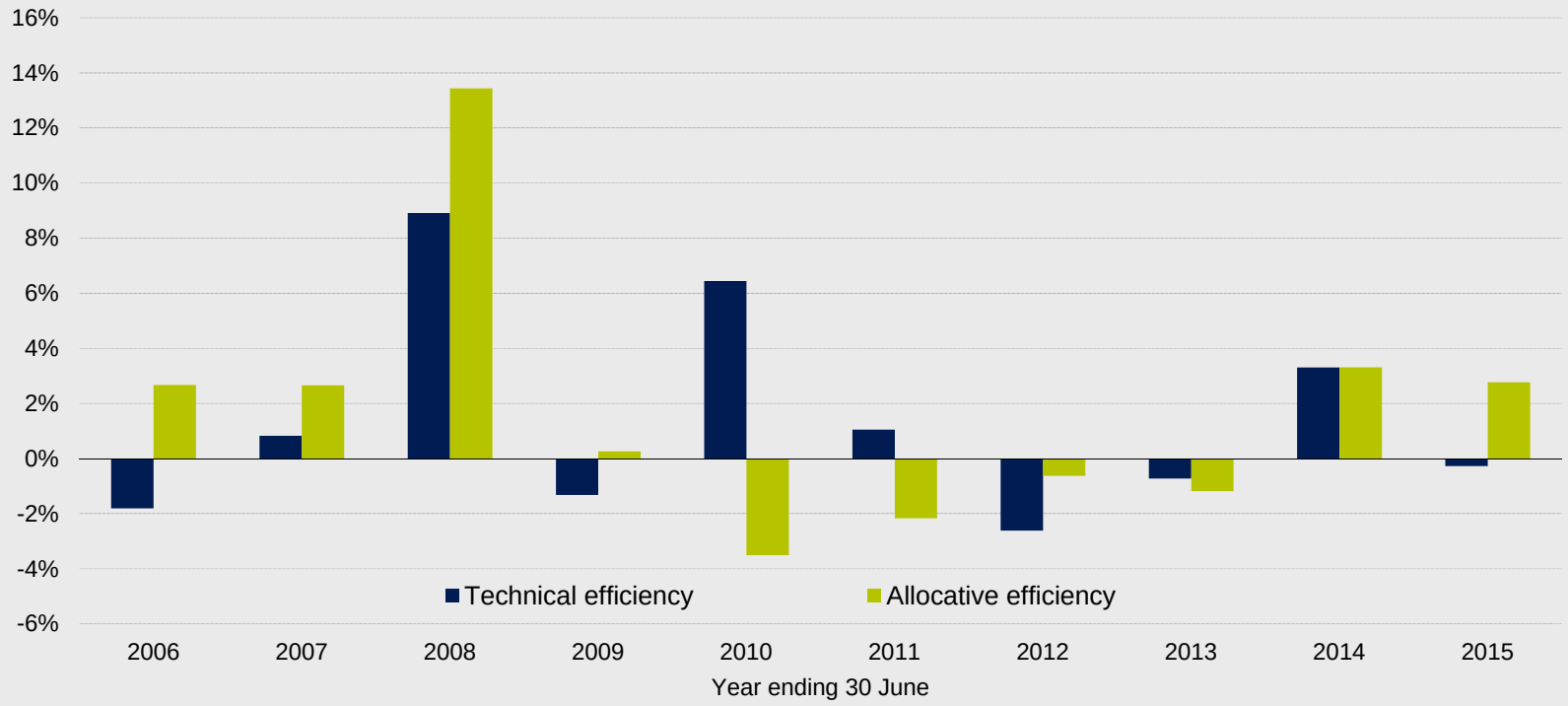
Scenario 2 – Allocative efficiency

- This scenario uses passenger journeys and CBD exits as the outputs of the network
- Passenger journeys share of output is weighted as the farebox revenue share of combined farebox revenue and government subsidies (excl. capital grants and transition subsidies)
- CBD exits are weighted as the remainder of output
- Indexed labour cost is used as the labour cost input
- Indexed subcontractor costs are used as subcontractor cost input
- Seats in electric carriages are used as the capital cost input
- TFP estimates are based on year on year TFP change

Comparison of Scenarios

Figure 5 compares the year on year technical and allocative efficiency TFP estimates

Figure 5 - Comparison of technical and allocative TFP estimates



Estimating TFP – Sales efficiency

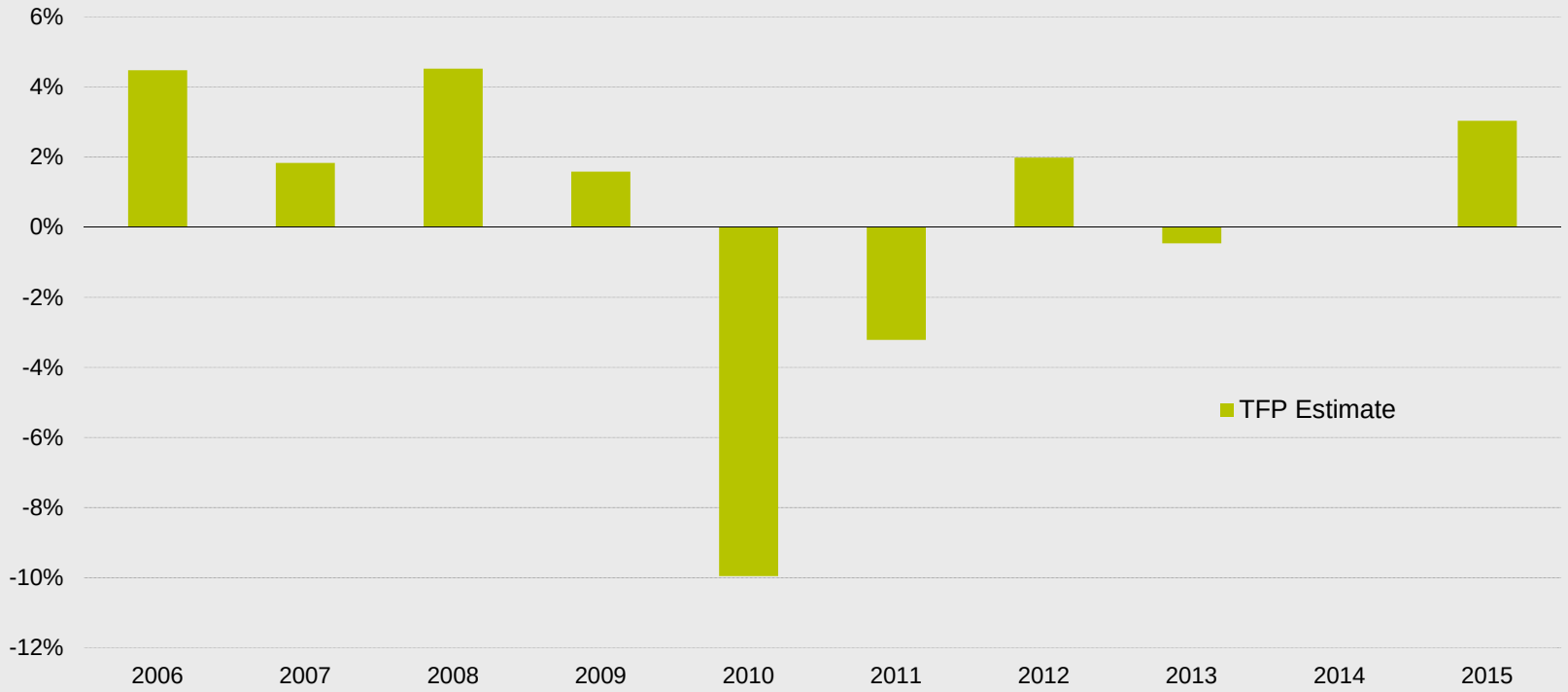
Scenario 3 – Sales efficiency

- This scenario uses passenger journeys and CBD exits as the outputs of the network
- Passenger journeys weight of output is weighted as the farebox revenue share of combined farebox revenue and government subsidies (excl. capital grants and transition subsidies)
- CBD exits are weighted as the remainder of output
- Seat-km is used as the only input
- TFP estimates are based on year on year TFP change

Estimating TFP – Sales efficiency

Figure 6 shows estimates for sales efficiency TFP

Figure 6 - Sales efficiency TFP estimate



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