

Transport

Overview

- 1 On 27 June 2023, the Commission issued a [consultation paper](#) on the transport assessment. The Commission considered changes since the 2020 Review and their implications for the assessment method.
- 2 The Commission proposed several changes to the 2020 Review assessment method.
- 3 A summary of state and territory (state) responses to each consultation question is included below, as well as the Commission's draft position and the draft 2025 Review assessment method.
- 4 State submissions can be viewed [here](#).
- 5 The Commission is currently analysing state data. The positions in the Draft Report may change based on the results of this analysis. Further details will be provided in an addendum to the Draft Report (see paragraph 28 for more information).

Consultation questions

Q1. Do states agree that the 2020 Review model for assessing urban transport needs remains appropriate?

State views – high level comments on the model

- 6 New South Wales, Victoria and the ACT said the model remains broadly appropriate for measuring urban transport needs. Victoria noted that while the model is the best available approach, COVID-19 highlighted an issue with the model's capacity to reflect what states do in response to short to medium term disruptions to demand or where 'uneconomical' services are required to ensure access and social equity. Victoria said it will be 5 to 10 years before stable long-term trends in patronage are apparent. It also outlined concerns with the inclusion of insignificant variables in the model.
- 7 While New South Wales supported the model, it recommended that a larger land area should be used for measuring population density, based on the Australian Bureau of Statistics' (ABS) Statistical Area Level 2s (SA2s).
- 8 Queensland, Western Australia, South Australia and Tasmania did not support the model.
- 9 Queensland considered that the 2020 Review process was rushed and that the changes over the last 4 updates, combined with COVID-19, have highlighted

- weaknesses in the model. It said the model lacks a conceptual foundation, as it assumes diseconomies of density despite evidence in academic literature of economies of density and scale in transport provision. The sensitivity of the model to state policies was also seen to challenge its conceptual foundation.
- 10 Queensland raised concerns about the population-weighted density variable, suggesting that it lacks explanatory validity due to the influence of the dominant significant urban areas, Sydney and Melbourne. The measure was not seen as being comparable between states, with evidence provided of differences in the treatment of non-residential land, urban area boundaries and development policies (urban sprawl).
 - 11 Queensland suggested that the inability of the model to respond to changes in commuter habits and work from home arrangements undermines its contemporaneity. Queensland considered that the use of policy-affected net expense data, the inability to use all significant urban areas in the regression due to unavailable data, and a reliance on proxies in the model indicate design limitations in the model.
 - 12 In its tranche 2 submission, Queensland also raised the inability of the model to reflect the role states play in providing public transport as a social service for equality of mobility and transporting students. It noted that the reliance of the model on commuters ignores students and concession users.
 - 13 In its tranche 1 submission, Queensland proposed replacing the model with an assessment based on state shares of urban populations (consistent with the 2015 Review approach). This position was revised in its tranche 2 submission, which recommended a separate assessment of urban and non-urban school transport. For the remaining urban transport expenses Queensland suggested replacing the regression model with an assessment based on state shares of concession card holders and urban populations.
 - 14 Western Australia considered the model to have fundamental problems. These include the influence of the Sydney data point on the model and the passenger number and population-weighted density variables. Western Australia also said the inability of states to access the net expense data used in the regression limits their ability to test the reasonableness of the model, restricting genuine consultation. This view was shared by Victoria and Queensland.
 - 15 South Australia suggested that COVID-19 has caused significant disruptions in the transport market, which will not be captured under any of the proposed approaches in the consultation paper. It also raised problems related to policy neutrality and the measurement of population-weighted density.
 - 16 Tasmania raised concerns about the effect of COVID-19, the inability of the model to account for economies of density, and the use of public transport for non-commuting purposes.

- 17 Queensland, Western Australia and South Australia supported a detailed review of the model in consultation with states.
- 18 The Northern Territory considered the model to have significant limitations but did not specify improvements.

Commission response – high level

- 19 The Commission recognises the complexity of the transport assessment and the impact that COVID-19 has had on the use and provision of public transport services. Beyond the impact of COVID-19, a number of states said the current assessment is not fit for purpose and have significant reservations with the current approach. These concerns have been carefully considered and are discussed below.
- 20 The Commission recognises that states' transport needs vary significantly. For example, in large cities the task is mainly driven by commuters and the influence of peak demand on infrastructure and service requirements (see Appendix A). In smaller cities transport services are particularly focused on the travel requirements of non-commuters to ensure equality of access, with key user groups including the elderly, low socio-economic status persons and students. However, the bulk of spending is in the larger cities, which is reflected in the design (and outcomes) of the assessment.
- 21 To identify whether the variables currently used in the assessment remain appropriate, the Commission examined the relevant theoretical principles and academic literature. Studies were found to support the impact of demand, supply, network complexity and topography variables as significant drivers of transport spending (see Appendix A).
- 22 In response to state comments, the Commission has identified improvements to the current assessment. The Commission considers that, with the changes outlined below, the current approach remains appropriate, and is preferable to a return to using state shares of urban populations or adopting a measure that captures spending needs based on shares of concession card holders and urban populations.
- 23 The Commission notes the concern of Victoria, Queensland and Western Australia relating to the inability to view some state data used to inform the regression. Wherever possible, the Commission encourages states to allow data to be shared with other states. This facilitates transparency, scrutiny and more robust assessments. As some states did not allow all of their data to be shared, the Commission was unable to provide states all the data informing the 2020 Review regression.
- 24 Following the 2026 Census, when fit for purpose data become available, the Commission will conduct further analysis to test the model's capacity to reflect the post-COVID-19 public transport task faced by states. This process will be undertaken in close consultation with the states.

25 The Commission's responses to detailed issues raised by states under Question 1 are provided below.

Commission draft position

26 The Commission considers the regression model, incorporating the proposed changes listed below, remains appropriate for assessing urban transport needs. It is preferable to alternatives based solely on urban population shares or shares of urban populations and concession card holders.

27 The proposed improvements to the urban transport model include:

- updating the regression with new state net expense data for 2022–23 and 2023–24
- calculating population-weighted density using the square kilometre grid instead of Statistical Area Level 1s (SA1s)
- indexing 2016 Census passenger numbers using Bureau of Infrastructure, Transport and Research Economics kilometres travelled
- modelling passenger numbers using a regression model.

28 The Commission is in the process of collecting, validating and transforming the net expense data for use in the urban transport regression model. These data will be used to update the model coefficients and retest the assumptions underpinning the variables. The positions in the Draft Report may change based on the results of the analysis.

29 The results of this analysis and any change to the positions in the Draft Report, along with quantitative impacts, will be provided in an addendum to the Draft Report.

30 In response to some states' concerns relating to the urban transport assessment, the Commission will seek external advice on the urban transport assessment prior to the next methodology review. The advice would include retesting the assumptions underpinning the urban centre characteristics regression model. Relevant 2026 Census data that would be needed to inform the advice will likely be available progressively in 2027 and 2028.

Detailed consideration of issues

Issue 1 – Conceptual foundation and impact of COVID-19 and model contemporaneity

State views

31 Western Australia said that COVID-19 highlighted its long-held belief that equilibrium between supply and demand in the public sector is not a realistic assumption and that the sector alternates between excess supply and excess demand. It said supply would be better approximated by the capacity of public transport than by passenger numbers. It also recommended the Commission use

new data to explore the alternate models provided by the 2020 Review consultant, Jacobs and Synergies Economic Consulting.

- 32 Victoria noted that COVID-19 has highlighted that states do not aim to equalise demand and supply in the short or medium term.
- 33 Queensland similarly noted that COVID-19 has changed commuting patterns, with a permanent shift in working from home. It said the use of commuters in the model is no longer justified and hence the model is no longer contemporaneous.
- 34 Queensland's position is that the regression model should not be used in the assessment. In its tranche 2 submission Queensland recommended that the assessment should separately assess school transport, with remaining expenses assessed based on state shares of urban population and concession card holders.

Commission response

- 35 The Commission recognises that COVID-19 has changed the nature of service use and challenged the assumption that supply equals demand in the short term. During the pandemic, states maintained public transport services to minimise the risk of transmission and provide transport for essential workers, despite steep declines in demand. While public transport usage is recovering, the evidence from Transport New South Wales and Infrastructure Victoria suggests that it is likely that the demand will remain below pre COVID-19 levels due to a sustained uptake in working from home arrangements.^{1,2}
- 36 Over time, the Commission expects that states will adjust their supply to account for changing use patterns by adjusting services (for example greater use of public transport outside peak periods) and deferring or reconsidering existing investment plans.³ While the relationship between demand and supply was temporarily disrupted as a result of COVID-19, the Commission expects states will eventually reach a new 'normal' for transport provision.
- 37 Further, as Victoria suggested, it takes a number of years (5 to 10 years) for states to make significant adjustments to service provision. It is too early to ascertain the impact of COVID-19 on long-term trends in public transport provision.
- 38 The Commission agrees with Western Australia that public transport provision varies between excess supply and excess demand. However, the Commission

¹ Infrastructure Victoria (2021). The post-pandemic commute – The effects of more working from home in Victoria. <https://www.infrastructurevictoria.com.au/resources/the-post-pandemic-commute>

² Transport for NSW (2021). Technical Note on assessing the impacts of COVID-19 for business cases. <https://www.transport.nsw.gov.au/news-and-events/reports-and-publications/tfnsw-technical-note-on-assessing-impacts-of-covid-19-for>

³ PWC (2020). Where next for transport? How Australia's transport sector can be rebooted for a sustainable future. <https://www.pwc.com.au/government/where-next-for-transport.pdf>

considers that, in the long run, states will adjust supply to respond to demand. A model that equates supply and demand therefore remains appropriate.

39 The Commission considers that the re-estimation of the model with new net expense data will allow the assessment to reflect the post-COVID-19 environment.

40 The Commission has considered Queensland's recommendation to remove the regression model from the assessment and instead use state shares of urban populations and concession card holders. While COVID-19 has caused challenges with updating the model variables, the model was designed to reflect the features of urban areas influencing transport demand that could not be solely captured through population numbers.

41 This was supported by an analysis of the data provided in the 2020 Review. The predicted expenses obtained using the regression model were much closer to actual spending for each significant urban area than the amount based on urban population shares.⁴ This is evidenced by the fact that the national median difference between the actual expenses and the regression model was 24%, whereas the median difference between actual expenses and the urban population share was around 865%. When both concession card holders and urban populations were used, the median difference rises to around 1,200%.

Commission draft position

42 The Commission considers that, despite the disruption caused by COVID-19, states will over time adjust their supply to account for any change in use patterns. This means that the key assumptions underpinning the regression model remain valid.

43 The Commission considers the regression model, incorporating the proposed changes outlined below, remains appropriate for assessing urban transport needs. When compared with an alternative based solely on urban population shares or shares of urban population and concession card holders, the regression approach is more accurately able to represent the transport task faced by states.

Issue 2 – Economies of density

State views

44 Queensland, Western Australia, South Australia and Tasmania outlined concerns that the model does not account for economies of density.

45 Queensland and South Australia considered that the observed diseconomies of scale in the regression model are due to the cost recovery policies of individual

⁴ The root mean squared error and median absolute error were much smaller for the regression model (55 and 40 respectively) compared with the amount based on urban population shares (339 and 373 respectively).

states, while Western Australia provided evidence that heavy rail has a lower per kilometre cost compared with other modes.

- 46 In a supplementary submission, New South Wales said that the economies of density and scale in urban transport, which were cited in other state submissions, are already captured in the regression. The inclusion of the log of passenger numbers in the model recognises that costs per passenger grow more slowly as passenger numbers increase. New South Wales said that the population-weighted density variable captures both changes in unit costs per service (economies of scale) as well as changes in the required volume of services.

Commission response

- 47 The Commission has examined the literature provided in Queensland's and Tasmania's submissions (see Appendix A). Studies by Giacomo and Ottoz (2010), Savage (1997), Bitzan and Karanki (2022), Farci et al. (2007), Mizutani and Uranishi (2013), Li et al. (2019), Anupriya (2020), Gschwender et al. (2016), Batarce and Galilea (2018), Karlaftis and McCarthy (2002), Karlaftis, McCarthy and Sinha (1999) and Viton (1981) found evidence of the existence of economies of density in public transport systems.
- 48 In these studies, after holding the size of the public transport network fixed, economies of density were measured using the cost savings per public transport passenger. These cost savings reflect greater usage of public transport systems. The usage in these studies was measured using the number of passengers on public transport or the number of kilometres travelled on a fixed bus route or rail line.⁵
- 49 The Commission agrees that, as the density of passengers on public transport increases, the marginal cost per passenger should decline. In the Commission's regression these economies are captured through the passenger number variable. Applying a logarithmic form to passenger numbers implies that the impact on net expenses per capita decreases as additional passengers are added to a transport network. Thus, the Commission considers that these economies of passenger density are accounted for in the model, a view supported by New South Wales.
- 50 To determine if economies exist with regard to population density of an area, the Commission examined the available literature. Studies by Tsai, Mulley and Merkert (2015), Vigren (2016), Cooke and Behrens (2017), Li et al. (2019), and Nerhagen (2023) did not find significant evidence of cost savings resulting from population density. One explanation for this can be found in Li et al. (2019), which concluded that, when passenger numbers were captured separately in a regression model, population density did not exhibit significant economies.

⁵ Other measures included train and bus hours, train and bus kilometres or passenger kilometres.

51 As studies such as Vigen (2016) show, increased population density can result in lower cost recovery. This can occur as the increased congestion on road networks necessitates the need for more frequent and complex public transport services (such as moving from bus networks to heavy rail, or the need to invest in elevated rail tracks) to handle the additional capacity. This increase in complexity drives the linear increase in costs that is captured in the Commission's current measure of population density. Similar evidence was also presented in the Consultant's report commissioned for the 2020 Review.⁶

Commission draft position

52 The Commission considers the model adequately captures economies of passenger density through the log treatment of passenger numbers in the regression.

Issue 3 – Calculation of population-weighted density

State views

53 New South Wales, Queensland, South Australia and Western Australia said that the volatility of the SA1 measure indicated that it is not fit for purpose to calculate population-weighted density.

54 Queensland said that problems with inconsistencies in the measurement of population-weighted density support its proposal that the regression model should no longer be used in the assessment. Western Australia considered that the problems with the density variable justify a discount to the variable in the regression or a discount to the method overall.

55 These concerns were also raised by states as part of the 2024 Update New Issues process. Queensland, Western Australia and South Australia supported retaining the 2016 Census boundaries for SA1s given the large revisions to the population-weighted density when the 2021 Census data were incorporated (ranging from 0.4% to 21.8% for capital cities). They said that this volatility demonstrated the problems with the current assessment.

56 Queensland stated that expense assessments should not be this volatile between methodology reviews and that changes resulting in a material redistribution of GST should not be made during update years. South Australia questioned whether the methodology was accurately capturing underlying changes in density rather than boundary issues or factors irrelevant to transport demand.

⁶ While the Jacobs and Synergies Economic Consulting Stage 1 report examined the theoretical drivers of public transport spending and available data, the Stage 2 report assessed the suitability of potential proxies for use in the model with regard to the theory.

- 57 New South Wales suggested that SA1 be replaced with SA2 because it is more closely aligned with ‘neighbourhood’, the level at which areas experience population density and public transport is designed.
- 58 As part of its tranche 2 submission, Queensland provided evidence against the use of the SA2 areas suggesting that, similar to the SA1 areas, inconsistencies exist in the residential and non-residential land included in individual SA2s between states.
- 59 As an alternative to the SA1 measure, in its 2024 New Issues submission, South Australia proposed a measure of population-weighted density using the ABS’ square kilometre grid, saying that this approach was not impacted by arbitrary drawing of boundaries. In its [supplementary submission](#), New South Wales also supported this measure. It said that population-weighted density would be best measured using consistently sized and shaped sub-areas. However, New South Wales noted that the square kilometre grid does not exactly align to urban centres.
- 60 Queensland, Western Australia and South Australia also said that the size and features of SA1s are not comparable across urban areas due to differences in zoning and greenfield development.⁷

Commission response

- 61 As part of the 2020 Review, the transport consultant identified that population density was an important determinant of transport demand. This was due to higher density increasing traffic congestion, lowering private vehicle ownership and influencing the location and frequency of urban public transport infrastructure.
- 62 The consultant selected a population-weighted density measure based on SA1 areas because this was the smallest practical area available and had significant explanatory power. Mesh Block areas were also considered by the consultant to measure population-weighted density. They were not practical for use in the assessment as they produce a population-weighted density measure that is highly volatile to small changes in population.⁸
- 63 A measure of population density is needed to ensure that the model accurately reflects factors influencing the need for public transport in urban centres. In response to state concerns, the Commission investigated:
- the volatility of the population-weighted density measure caused by changes to SA1 boundaries following a census

⁷ Statistical Area Level 1 is a geographical area measure designed by the Australian Bureau of Statistics to capture similar population sizes (between 200 and 800 persons) and common geographical features. They are predominantly rural or predominantly urban in character and are typically internally connected by road.

⁸ Mesh Blocks are the smallest geographic areas defined by the ABS and form the building blocks for the larger regions of the Australian Statistical Geography Standard. They broadly identify land use such as residential, commercial, primary production and parks. Wherever possible, each Mesh Block is designed to have a single land use, for example parkland.

- the impact on the population-weighted density measure of size and composition differences of SA1 areas.
- 64 Results of the investigation reveal that the SA1-based density measure is associated with large changes following a census, with increases in density of up to 21.8% across capital cities in the 2024 Update. The SA1 areas also have statistically significant differences in the size and land composition between states.
- 65 Evidence was also found to support Queensland’s view that differences exist in the treatment of residential land included in SA1s between states. The Commission notes that this is somewhat influenced by urban development policies.
- 66 To identify if improvements to the population-weighted density measure could be made, the Commission examined alternatives based on SA2 areas and the square kilometre grid. The Commission examined the capacity of each measure to capture transport demand, minimise volatility and variation between urban areas, and address functional considerations such as the ability to capture transport networks.
- 67 For completeness, the Commission also considered Statistical Area Levels 3 and 4 (SA3 and SA4). SA3 boundaries are mainly designed for collating data by regions but can capture clusters of suburbs in more populated urban areas. SA4 boundaries are designed to capture labour markets, which could also potentially reflect employment concentration and travel patterns.
- 68 The large size of SA3 and SA4 areas proved unsuitable for use in the assessment. Outside capital cities, multiple individual urban areas are captured in the same SA3 and SA4 boundary. These measures would not be detailed enough to capture pockets of dense development within non-capital city urban areas. This would lead to an inconsistency in density measures between urban areas and an underestimation of density outside capital cities. The size of SA3s and SA4s also varies considerably by state.
- 69 The SA2 boundaries are part of the Australian Statistical Geography Standard (ASGS) produced by the ABS. They are the base unit of geography for the ABS, from which all other areas are derived (including SA1s).
- 70 The ABS defines SA1s and SA2s with consistent populations as a key criterion. For SA1s, it aims for a population range between 200 to 800 people and an average population of about 400. For SA2s, the desired population range generally is 3,000 to 25,000 and an average population of about 10,000.⁹
- 71 SA1s and SA2s are highly variable in terms of their land area size. Significant urban area SA1s range in size from 0.0005 to 92.6 square kilometres with an average size

⁹ The Australian Statistical Geography Standard Edition 3 provides a description of the technical definitions of SA1s and SA2s. <https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/main-structure-and-greater-capital-city-statistical-areas/statistical-area-level-2>

of 0.39 square kilometres. SA2s in significant urban areas range in size from 0.17 square kilometres to 119 square kilometres with an average of 10.4 square kilometres.¹⁰

- 72 As sub-areas in a population-weighted density calculation become smaller, the observed population-weighted density increases even with the same population. When using SA1s or SA2s, the sub-areas are smaller in more populated urban areas to maintain consistent populations. As highlighted by Queensland, this introduces bias in the calculation of population-weighted densities, overestimating the relative density of larger urban areas and underestimating the relative density of smaller urban areas.
- 73 While the populations used in the SA2s can be updated annually to reflect population growth, the boundaries are fixed between census years and are only updated once new census data become available.
- 74 The square kilometre grid boundaries and associated population grid files were also obtained from the ABS based on the National Nested Grid Standard developed by the Australia and New Zealand Land Information Council (ANZLIC).¹¹
- 75 The populations within each grid are constructed based on the ABS estimated resident population data matched to the ABS Address Register. Populations within square kilometres across Australia range from 0 to 32,561. The ABS updates the population of square kilometres annually while the boundaries of the square kilometres do not change.
- 76 For both measures, the SA2s and square kilometres were first mapped to Urban Centre and Locality boundaries before being aggregated to significant urban areas. This ensures that the non-urbanised areas on the fringes of larger significant urban areas (typically reserves, mountainous areas, forests and waterways) could also be removed. As square kilometres can cross urban centre boundaries, residents were allocated to each area based on the proportion of land in each urban centre boundary. While this increases the complexity and reduces the transparency of the calculations, the empirical validity is maintained.¹²
- 77 The Commission considers that both the SA2-based measure and the square kilometre-based measure of population-weighted density represent an improvement over the use of SA1s. This is because the population-weighted density calculated using the SA2 areas and square kilometre grid is less volatile than the SA1-based measure. The SA2s and square kilometre grid are also more consistent in terms of the composition of land included in areas boundaries and more closely

¹⁰ Over 99% of SA2s have an area greater than 1 square kilometre.

¹¹ The files used to construct the square kilometre grid were collected from the ABS 2021-22 *Regional Population* release and can be accessed here: <https://www.abs.gov.au/statistics/people/population/regional-population/latest-release#data-downloads>. Further information about the National Nested Grid standard can be found here: [National Nested Grid | ANZLIC](#)

¹² The calculations and necessary data will be made available to the states.

align with the areas (or populations) used to make transport planning decisions compared with SA1s.

- 78 To determine which of these approaches represents the better alternative to use in the assessment, the Commission compared the ability of the SA2s and square kilometres to respond to the concerns raised by states.

Issue 3.1 – Volatility

- 79 Currently, between censuses, population-weighted density is updated each year with new population data. The size of significant urban areas, urban centres and localities and SA1s is fixed between censuses. Updating population results in relatively small changes in density from year to year.
- 80 Following a census, the ABS revises both population and geographies. This can have a significant impact on density, resulting in volatility. This was evident in the 2024 Update when 2021 Census geography for the SA1 areas were incorporated into the method, resulting in large changes to the population-weighted density of some cities.¹³
- 81 While revisions to populations can cause changes in population-weighted density, volatility mainly occurs when the size of the areas used to calculate density changes. In the 2021 Census, the decision to split existing SA1s that were close to the upper population limit caused large increases in population-weighted density, particularly for capital cities.
- 82 Compared with the SA1s, the larger population ranges for the SA2s reduce the number of areas required to be split after each census. In the 2021 Census, boundary changes were necessary for 155 SA2s compared with 2,070 SA1s.
- 83 As the square kilometre grid is constructed to ensure a uniform area size rather than uniform population ranges the boundaries do not change. This reduces the volatility of population-weighted density calculated using square kilometre grid compared with both SA1s and SA2s.
- 84 Regardless of which measure is used, changes in density will occur due to population revisions and changes to the significant urban areas, urban centres and localities on which the SA1s, SA2s and square kilometres are mapped.
- 85 The relative volatility of each measure can be seen by comparing the change in population-weighted density between the 2016 and 2021 censuses (Table 1 provides the change by capital city as density cannot be averaged across a state).
- 86 While the SA1s have a maximum change in population-weighted density of 21.77%, the larger size of the SA2s resulted in a smaller maximum change of 4.5%. Removing the impact of boundary changes by using the square kilometre grid

¹³ The terms of reference require the Commission to use the latest available data which are fit-for-purpose wherever possible.

resulted in the smallest change in population-weighted density for most capital cities.

Table 1 Population-weighted density based on SA1 areas compared with SA2 areas and the square kilometre grid, (persons per square kilometre, 2021–22)

	Sydney	Melbourne	Brisbane	Perth	Adelaide	Hobart	Canberra	Darwin
SA1-based density measure								
2016 Census	6,393	4,209	2,999	2,566	2,507	1,911	3,006	2,564
2021 Census	7,202	5,126	3,420	2,661	2,521	1,991	3,307	2,671
Change (%)	12.66	21.77	14.04	3.72	0.55	4.23	10.02	4.16
SA2-based density measure								
2016 Census	3,567	2,642	1,920	1,771	1,835	1,227	1,894	1,657
2021 Census	3,727	2,723	1,926	1,787	1,814	1,225	1,860	1,646
Change (%)	4.50	3.08	0.30	0.92	-1.12	-0.15	-1.79	-0.69
Square kilometre-based density measure								
2016 Census	4234	3034	2381	2120	2135	1574	1975	1874
2021 Census	4244	3111	2389	2137	2140	1575	2022	1874
Change (%)	0.24	2.54	0.34	0.78	0.21	0.06	2.36	-0.01

Note: The numbers differ slightly from the 2024 New Issues paper as final population estimates have been received from the ABS.

Issue 3.2 – Consistency of areas within boundaries

- 87 States have raised concerns about the differences in the treatment of residential and non-residential land in SA1s between states and the impact this can have on population-weighted density. It was suggested that non-residential areas (such as schools, parks, commercial districts and hospitals) were more likely to be included as separate SA1s in Sydney, while being combined with residential land in other capital cities.
- 88 By using the ABS’ Mesh Blocks, which contain land use by category, and aggregating to the SA1 level, the Commission identified significant differences in zoning of land within SA1s by state ($p < 2.2e-16$). The Commission agrees that a greater consistency in the measure of population-weighted density between states would improve the assessment method.
- 89 As shown in Table 2, the aggregation of individual SA1s to create the SA2 boundaries results in a greater mix of residential and non-residential land included in each area on average. This reduces the variation between states but does not completely eliminate significant differences ($p = 0.019$). This is consistent with Queensland’s submission, which found that differences between areas were not completely eliminated if the SA2 areas were used.

90 There is no straightforward method available to determine the composition of land within the square kilometre grid. However, as the square kilometre grid is based on a uniform area size and shape, rather than population, both residential and non-residential land contribute to the composition and must be included. This results in differences in states being entirely due to natural geographic features or planning decisions rather than inconsistent treatment. The consistency of treatment of the land included in each area is one of the major benefits associated with square kilometres when compared with both the SA1s and SA2s.

Table 2 Average percentage of residential and non-residential land within SA1s and SA2s areas captured in the urban transport assessment

	NSW	Vic	Qld	WA	SA	Tas	ACT	NT
SA1s captured in the assessment								
Residential land	80	83	80	80	80	76	73	75
Non-residential land	20	17	20	20	20	24	27	25
SA2s captured in the assessment								
Residential land	60	64	62	59	60	62	57	57
Non-residential land	40	36	38	41	40	38	43	43

Source: Commission Calculation using 2021 Census data; disaggregated data on land use within square kilometres are not available. Only SA1s and SA2s included in urban areas were used to construct the table.

Issue 3.3 – Functional considerations

91 As New South Wales highlighted, the SA2 measure more closely aligns with public transport networks than SA1. This is because transport services are typically provided at the town level (in regional areas) or to suburbs (in cities), rather than to individual residential blocks. As defined by the ABS, SA2s are designed to represent a community that interacts together socially and economically.¹⁴ The design of SA2 boundaries using roads often results in one transport network being used by several surrounding SA2 suburbs.

92 However, while the SA2 areas better capture communities, they were not designed for the purpose of calculating density or to reflect transport needs. The ABS has advised that SA2s are designed for the purposes of collecting social, economic and demographic statistics.

93 In comparison, the square kilometre grid is not aligned with suburbs and localities. Typically, suburbs in major cities are captured in several square kilometres. However, the square kilometre grid is the internationally recognised base unit of

¹⁴ Australian Bureau of Statistics(ABS) Census Geography glossary. [Census geography glossary | Australian Bureau of Statistics \(abs.gov.au\)](https://www.abs.gov.au/census-geography-glossary), 2022, ABS website, accessed 3 November 2023

area used to measure population density.¹⁵ The square kilometre grid is used by Australian departments such as the Department of Infrastructure, Transport, Regional Development, Communications and the Arts and the Department of Climate Change, Energy, the Environment and Water.¹⁶

- 94 The Commission consulted with the Department of Infrastructure, Transport, Regional Development, Communications and the Arts about why it uses the square kilometre grid to measure population-weighted density. Previously it used the smallest ABS geographical area (Mesh Blocks) to provide the most detailed and spatially accurate point measure of density.¹⁷ It moved from using Mesh Blocks to the square kilometre grid because this provides more consistent area sizes and unit of measure over time.
- 95 In reporting population density statistics, the ABS considers that ‘the population grid offers a consistently sized spatial unit and gives a refined model of population distribution. It is also an established, easy to understand and readily comparable international standard which enables users to make local, national and international comparisons of population density’.¹⁸ The square kilometre grid also ensures that the size of each area does not influence its contribution to the calculation of population-weighted density. This view was reflected in the South Australia’s New Issues submission and the New South Wales’ supplementary submission. South Australia noted that by using the square kilometre grid, it is possible to create an alternative measure of population-weighted density that is not impacted by the treatment of geographical features. New South Wales considered that an ideal measure of population-weighted density would be based on consistently sized and shaped sub-areas.

Summary of Commission deliberations

- 96 The Commission agrees that the issues raised by states with the SA1-based population-weighted density measure are significant. Both the square kilometre grid and the SA2-based measures represent an improvement over the use of SA1s. Both of the alternative measures have different benefits in terms of reduced volatility, better consistency of areas and the ability to represent the characteristics of urban transport demand.

¹⁵ Australian Bureau of Statistics (ABS). (2023). Regional population methodology. <https://www.abs.gov.au/methodologies/regional-population-methodology/2021-22>

¹⁶ Bureau of Infrastructure, Transport and Regional Economics (BITRE). (2019). An introduction to where Australians live. https://www.bitre.gov.au/publications/2019/is_96. The Department of Climate Change, Energy the Environment and Water (DCCEEW) first changed to a square kilometre grid density measure in the 2016 State of the Environment report. The most recent report can be found here Department of Climate Change, Energy the Environment and Water (DCCEEW). (2021) Australia – State of the Environment: Urban. [Introduction | Australia state of the environment 2021 \(dcceew.gov.au\)](https://www.dcceew.gov.au/state-of-the-environment/urban)

¹⁷ Mesh Blocks form part of the Australian Statistical Geography Standard released by the ABS. Mesh Blocks are the smallest geographic areas, designed to capture different land use, such as residential, commercial and industrial land.

¹⁸ Australian Bureau of Statistics (2021). Regional population methodology. <https://www.abs.gov.au/methodologies/regional-population-methodology/2021-22>

- 97 There are advantages in using the SA2 areas instead of the SA1s.
- The SA2s are based on the ABS Australian Statistical Geography Standard.
 - SA2s better represent the communities that interact together socially and economically and are consequently more likely to access the same public transport services (although one transport network services multiple SA2s).
 - SA2s are constrained within a single significant urban area. This means fewer practical adjustments are required compared with using the square kilometre grid where adjustments are required if part of the square kilometre falls outside of a significant urban area or falls between 2 distinct significant urban areas.
- 98 However, there are greater advantages in using the square kilometre grid, which make it more appropriate for the purpose of calculating population-weighted density.
- Relative to SA1 and SA2, a population-weighted density measure based on the square kilometre grid is less volatile. The fixed boundaries of the square kilometre grid ensure that any changes in the measure are driven by population and better reflect changes in transport demand.
 - The square kilometre grid has greater uniformity in the treatment of land use. As both residential and non-residential land contribute to the square kilometre area requirements, it is not possible for differences between states to be due to arbitrary boundary decisions.
 - The square kilometre grid is a more internationally recognised and accepted measure of population-weighted density.
- 99 While a measure of population-weighted density based on SA2 areas may align more closely with functional areas, the Commission considers it is more important to ensure that the density measure is reliable and fit for purpose and reflects what states do. Compared with the SA2 areas, the square kilometre grid better addresses these criteria.
- 100 The use of the square kilometre grid as an international standard for measuring density indicates it has been subject to a high level of scrutiny and can be considered highly reliable. The reduced volatility, particularly following a census, indicates the square kilometre grid is more fit for purpose. As it is only driven by population movements and concentration, rather than boundary changes, it better reflects transport needs and what states do. The use of the square kilometre grid also ensures uniformity in the treatment of land between states, which was a major criticism of the existing SA1-based approach.
- 101 The GST impact of using the square kilometre grid to calculate the population-weighted density measure will be presented in an addendum to the Draft Report once the regression model has been re-estimated and updated regression coefficients obtained.

Commission draft position

- 102 The Commission proposes to calculate population-weighted density using the square kilometre grid.

Issue 4 - Policy neutrality

State views

Cost recovery policies

- 103 Queensland, Western Australia, South Australia and Tasmania had concerns about the impact of state policies on population-weighted density and costs, citing differences in urban infill and rates of cost recovery between states. In its tranche 1 and tranche 2 submissions, Queensland provided evidence suggesting that Sydney should have higher cost recovery than other Australian capital cities due to its higher population-weighted density and lower proportion of concession passengers.
- 104 Queensland and Western Australia provided evidence that supply of public transport is not uniform across cities, indicating that public transport in Sydney is provided at a higher level than average.

Density policies

- 105 Queensland, Western Australia and South Australia raised concerns relating to the impact of policies in large cities, citing the impact of Sydney on the regression model. These states considered that decisions regarding Sydney's urban transport spending would be reflected in the coefficient for the population-weighted density variable (given that Sydney has much higher density).
- 106 Queensland also said that an over-reliance of the model on population-weighted density unfairly penalises states that pursue low-density development policies, underestimating their need for public transport. Queensland provided evidence that the existence of green spaces in urban areas and greenfield development lower population-weighted density, leading to underestimation of urban transport need in these areas.
- 107 In its supplementary submission, New South Wales modelled cities with a population over 250,000, showing a similar relationship between their public transport users and population-weighted density (whether Sydney and Melbourne were included or not). From this, New South Wales argued that there was a strong case for population-weighted density as a proxy for demand and that Sydney did not unduly influence the model through the density variable.

Impact of Sydney on the regression model

- 108 Queensland and Western Australia provided evidence that the strength of the estimated relationship between population-weighted density and passenger numbers was being influenced by the Sydney data point. When Sydney was

excluded, the strength of the estimated relationship fell slightly. Removing all non-capital cities resulted in no evidence of a significant relationship.

- 109 This contrasts with evidence provided by New South Wales that the relationship between population density and public transport commuters was effectively unchanged if Sydney was excluded from the regression model.

Commission response

Cost recovery policies

- 110 While cost recovery in Sydney is low by international standards, care needs to be taken in comparing public transport systems across nations due to differences in relative income, economic development, car ownership, demographic characteristics (such as age) and social attitudes towards transport.^{19,20,21}
- 111 When compared with available data on other Australian capital cities, Sydney has similar cost recovery rates. Sydney's farebox recovery in 2015 (around 22%) is similar to Melbourne (22%) and Brisbane (23%) but below Perth (at 30%). 2015 data were not provided for Adelaide, Hobart, Canberra or Darwin.²²
- 112 The relative cost recovery in Australian states varies depending on the source and the mode of public transport. Research by the Productivity Commission (2021) and the Bureau of Infrastructure, Transport and Regional Economics (BITRE; 2014) show that Sydney's fare recovery level compared with operating expenses is comparable to or higher than other Australian capital cities.^{23,24} Other studies by the Imperial College London (2020) and the Tourism & Transport Forum (2016) show that Sydney's fare recovery is below other Australian capitals.^{25,26}
- 113 Studies by the Centre for International Economics (2020), the Independent Pricing and Regulatory Tribunal (2016) and the Bureau of Infrastructure, Transport and Regional Economics (BITRE; 2014) have shown that buses and ferries are associated

¹⁹ C Zhang and X Yu, 'Factors and Mechanism affecting the Attractiveness of Public Transport: Macroscopic and Microscopic perspectives', 2022, *Journal of Advanced Transportation*, DOI: <https://doi.org/10.1155/2022/5048678>

²⁰ D Ashmore, D Pojani, R Thoreau, N Christie and N Tyler 'Gauging differences in public transport symbolism across national cultures: implications for policy development and transfer', 2019, *Journal of Transport Geography*, 77: 26-38

²¹ J Holmgren 'An analysis of the determinants of local public transport demand focusing on the effects of income changes', 2013, *European Transport Research Review*, 5: 101-107.

²² Tourism & Transport Forum (TTF). 'Ticket to ride: Reforming fares and ticketing for sustainable public transport', 2016, TTF website, accessed 19 November 2023.

²³ Productivity Commission (PC), '[Public transport pricing](#)', PC website, 2021, accessed 15 February 2024.

²⁴ Bureau of Infrastructure, Transport and Regional Economics (BITRE), '[Urban public transport: updated trends](#)', 2014, BITRE website, accessed 19 November 2023.

²⁵ Imperial College London Transport Strategy Centre (TSC), '[Sydney Trains Update 2020: Comparison with International Benchmarking Groups](#)', TSC website, 2020, accessed 25 October 2023.

²⁶ Tourism & Transport Forum (TTF). '[Ticket to ride: Reforming fares and ticketing for sustainable public transport](#)', 2016, TTF website, accessed 19 November 2023.

with a higher cost recovery than trains, which may explain the higher cost recovery for Queensland and Perth identified in Queensland's submission.^{27,28}

114 To ensure policy neutrality across all states, a comparable indicator of cost efficiency would need to measure average state policy with regard to service levels and fare recovery.

115 The Commission has tried to develop a comparable indicator of cost efficiency but has been unable to find a reliable or internally consistent data source. As a result, there is no clear way of disentangling the effect of state decisions with fare recovery policies from non-policy influences.

116 In the 2020 Review, evidence was found that higher service levels across states (in particular Sydney) were due to higher employment density and increased congestion, rather than solely due to policy decisions. This was supported by Commission analysis, which indicated that for larger urban areas such as Sydney to provide an identical level of services to other capital cities, public transport use would need to fall by over 50% or 352,000 passengers.²⁹

117 The Commission notes that applying modelled passenger numbers (rather than actual) to the estimated regression coefficients moderates the impact of individual state policies. Using modelled passenger numbers ensures that a state cannot increase its assessed needs for transport by lowering fares or increasing services to raise the number of urban transport passengers.

Density policies

118 Queensland and Western Australia said that the model's population-weighted density variable is policy influenced. They said that urban densities are a result of state policies on urban development and sprawl, and, in the case of Sydney, its densities are the result of state planning policies.

119 Consistent with the 2020 Review, the Commission considers that the majority of the differences in population-weighted density are due to circumstances outside current state control. For example, the relatively high population-weighted density of the Sydney urban area is mainly the result of its geographic constraints as a result of the harbour, mountains and national parks surrounding the urban area.

120 In addition, there is no strong evidence that recent policies in Sydney have deviated significantly from other fast growing capital cities dealing with the consequences of increasing congestion. The *State of the Environment 2021* report compared capital city development plans and found that 70% of planned new housing developments

²⁷ Centre for International Economics, '[Measuring cost recovery of NSW public transport services](#)', 2020, Independent Pricing and Regulatory Tribunal (IPART) website, accessed 21 January 2024.

²⁸ Independent Pricing and Regulatory Tribunal (IPART), '[Cost Recovery - Public Transport Fares Final Report Part 2](#)', 2016, IPART website, accessed 23 November 2023.

²⁹ Using 2022–23 data.

in Sydney were to occur in existing urban areas. This was comparable to Melbourne (70–75% of new developments), Brisbane (60%) and the ACT (70%).

121 Further, a review of density policies across capital cities using the square kilometre grid indicates that most states have adopted policies that encourage greater density. Sydney’s population-weighted density has increased by only 4.07% between 2016 and 2022, below other capital cities such as Brisbane and Canberra (see Table 3).

Table 3 Change in population-weighted density by capital city between 2016 and 2023

	Sydney	Melbourne	Brisbane	Perth	Adelaide	Hobart	Canberra	Darwin
2016	4,299	3,097	2,165	1,963	1,981	1,435	1,748	1,882
2023	4,473	3,334	2,490	2,244	2,189	1,570	2,077	1,882
Change (%)	4.07	7.67	15.01	14.35	10.50	9.40	18.80	-0.01

Source: Commission calculation using ABS data. The square kilometre grid was used to calculate the population-weighted density, similar results were obtained using the SA1 and SA2 areas. 2021 census areas were used.

Impact of Sydney on the regression model

- 122 Sydney has significantly higher density than the other state capitals. Because of this, it has a large effect on the model’s estimated density variable. This raises the possibility that New South Wales’ policy choices may excessively influence the regression model through its impact on the density variable.
- 123 The urban transport model is designed to model public transport spending within Australian cities. Removing Australia’s largest cities, and with them the majority of spending on public transport in Australia, would fundamentally change the model and the assessment.
- 124 Given that Sydney is Australia’s largest and most dense city, with over 20% of the national population, any model of public transport need in Australia will be influenced by Sydney.
- 125 Sydney (and to a lesser extent Melbourne) represents a large share of total urban transport spending relative to the remaining states. This cannot be explained solely by policy decisions. Any model that removes the influence of Sydney from the regression would not reflect what states do and would not be a reliable predictor of overall transport spending.
- 126 The Commission notes that the proposed change to the method used to calculate population-weighted density will provide a more consistent measure of density across urban centres and will mitigate the influence of Sydney in the regression.
- 127 While the differential costs associated with sprawling cities are not accounted for through the population-weighted density variable, they are captured in the model through the distance to work variable. This occurs because residents in sprawling cities typically have higher distances they need to travel. By including both population-weighted density and distance to work in the regression model, the additional costs associated with highly dense and sprawling cities can be identified.

- 128 As cities expand transport opportunities will progress from individual motorised transport to lower cost bus or light rail transport to high-cost rail as density increases.^{30,31}

Commission draft position

- 129 The Commission acknowledges that there are limitations in the model, in particular surrounding differences in states' cost recovery policies. However, there is no reliable method of isolating the impact of these policy differences. As such, an adjustment cannot be reliably made. The approach in the 2020 Review of blending the urban centre characteristics model (75%) with state urban population shares (25%) was implemented to account for such limitations in the model and the uncertainty inherent in the assessment.

Issue 5 – Passenger and other variables

State views

- 130 Western Australia and Tasmania recommended including variables to account for non-commuter use, including socio-economic status, concession users, students (Tasmania) and the impact of remoteness (Western Australia). Western Australia suggested splitting out school transport from the transport assessment while Tasmania suggested splitting the assessment into 2 components: commuter journeys and other travel.
- 131 Tasmania said that, in contrast to the emphasis on commuters in the model as a key determinant of public transport expenditure, service levels and network complexity are driven in part by the needs of persons of low socio-economic status and the elderly. Tasmania also considered that the distance to work variable is not able to take into account the more complex journeys associated with concession travel.
- 132 Western Australia recommended that regional costs should be incorporated into the assessment to account for the substantially higher costs required to run transport services in very remote regions. Western Australia also recommended that student expenses should be separately assessed. It considered that while students in metropolitan areas can use mainstream public transport services, students in remote areas have dedicated government school bus services. The current assessment would not be able to capture the needs of these students.

³⁰ In the 2020 Review the Commission recognised that, as urban centres become significantly large, the introduction of heavy rail into the public transport mode mix becomes unavoidable. This is supported by the academic literature, see M Burke, 'Problems and Prospects for Public Transport Planning in Australian Cities', *Built Environment*, 2016, 42(1): 37-54.

³¹ The academic literature widely supports the link between increasing sprawl in Australian cities, increased car dependence and reduced access to public transportation, see BT Hiller, BJ Melotte and SM Hiller, 'Uncontrolled sprawl or managed growth? An Australian case study', *Leadership and Management in Engineering*, 2013, 13(3): 144-170. Also see G Currie, A Delbosc and K Pavkova, 'Alarming trends in the Growth of Forced Car Ownership in Melbourne', *Australasian Transport Research Forum 2018, Proceedings*, 2018.

- 133 Queensland, South Australia and Tasmania raised concerns with the capacity of the model to reflect changes in passenger behaviour and with the quality of data used in the model.
- 134 Queensland considered that the model cannot account for non-commuter travel, which is provided by states to ensure equality of mobility and student transport. Queensland highlighted the complex transport systems required to enable access to services for concession users along routes that are not necessarily accessed by commuters. Queensland also highlighted the increased costs of providing such services. It recommended that students and concession passengers should be incorporated in the method.
- 135 Queensland further recommended that the assessment should separately assess school transport, with remaining expenses assessed based on state shares of urban population and concession card holders.
- 136 Victoria recommended making the model simpler by taking out insignificant variables.
- 137 South Australia recommended that the ferry variable should be removed because of the large standard errors.

Commission response

- 138 The Commission considered variations to the current model suggested in state submissions, including models recognising remoteness, socio-economic status, concessions and student numbers (see Appendix B). To ensure the models could be accurately compared with the 2020 Review specification, 2016 Census data were used for testing. As data were not sufficiently disaggregated to distinguish between concessional and non-concessional passengers on public transport, proportions of student, low-income and elderly population groups were used.
- 139 While these variables have a strong conceptual link to transport spending, their inclusion in the regression leads to non-intuitive results. Results suggest lower transport needs for areas with higher proportions of students and the elderly, and similar net expenses regardless of socio-economic status or remoteness.
- 140 The Commission notes that while the numbers of non-commuters are not directly captured in the regression, the method of modelling passenger numbers partially captures non-commuters. It does so by applying the use rates, derived from commuter passengers, to the total population in an urban area. The Commission also notes that the current blending of the urban centre characteristics assessment with urban population shares also accounts for the limitations due to the use of proxies in the regression model. Therefore, the Commission considers the proposed model appropriately mitigates this issue and remains fit for purpose.
- 141 The Commission considers it appropriate to re-examine issues of non-commuter travel, following the release of fit for purpose 2026 Census data. This is likely to

coincide with the next review cycle.³² These data will be progressively released by the Australian Bureau of Statistics during 2027 and 2028.

- 142 Tasmania's proposal to split the assessment into commuter and non-commuter transport is not feasible as sufficiently disaggregated passenger data for all states are not available. In addition, it would be difficult to separate the proportion of urban transport costs in each significant urban area relating to each group.
- 143 Western Australia recommended that supply should be proxied by network capacity instead of passengers. This measure was considered as part of the 2020 Review consultancy. It concluded that the available data on network capacity are insufficient to include in the model and are more highly influenced by policy decisions compared to the current passenger number variable.
- 144 The Commission considers commuter numbers remain an appropriate proxy for supply. Commuter numbers were chosen to reflect peak demand. While states provide services for non-commuting purposes, the commuter peak reflects the greatest use of transport across most states. While transport in smaller urban areas is undertaken with a greater focus on access and social welfare objectives, it does not constitute a large proportion of state urban transport spending (at about 2% of total net spending on urban transport).
- 145 Victoria suggested excluding insignificant variables from the model (see Appendix B). Although bus and light rail is not a significant variable, its inclusion in the models tested was necessary to account for differences in transport service provision in small urban areas. This is necessary as only 14% of modelled urban areas have heavy rail services. The ferry variable was similarly included to account for all transport modes and to address policy neutrality concerns. The remaining variables were found to have strong conceptual links to transport spending, as they capture the complexity of transport networks and topography, which can influence the feasibility and expansion of transport modes.

Commission draft position

- 146 The Commission proposes to retain all variables currently used in the regression model if they continue to be supported by updated net expense data.

³² 2026 Census journey to work data are likely to be released progressive during 2027 and 2028.

Q2. Do states consider the urban transport net expense data from 2019–20 to 2021–22 are likely to be overstated?

Q3. If 2019–20 to 2021–22 data are not fit for purpose, do states support updating the regression with data from 2022–23? Can states provide an indication of when these data could be provided to the Commission.

Q4. If 2022–23 data are considered fit for purpose but are not available for inclusion in the 2025 Review, do states support updating the assessment in an update following the 2025 Review?

State views

- 147 All states agreed that net expense data from 2019–20 to 2021–22 are likely to be overstated.
- 148 With the exception of Victoria, Queensland and South Australia, states supported the use of 2022–23 net expense data to update the assessment. New South Wales supported using data from multiple years to avoid anomalous results. It suggested using data from 2018–19 and 2022–23 in conjunction with updated passenger data.
- 149 New South Wales and the Northern Territory said 2022–23 data would be impacted by industrial actions and ticketing system changes respectively.
- 150 Victoria and South Australia did not support using 2022–23 data. They noted that patronage levels are still increasing post-COVID-19 lockdowns and have yet to stabilise. Given this, South Australia did not support using 2022–23 as the single year of data in the assessment.
- 151 Queensland had fundamental issues with the model and did not support updating it with any data.
- 152 All states, excluding Victoria and Queensland, supported updating the assessment in an update following the 2025 Review if 2022–23 data were considered fit for purpose and not available for the 2025 Review. Victoria recommended that the model should be re-estimated in an update year but only after reliable data become available.
- 153 All states indicated they can provide 2022–23 data in April 2024.

Commission response

- 154 The Commission considers that net expense data from 2019–20 to 2021–22 are not fit for purpose for use in the urban transport assessment. While the effects of COVID-19 may still be apparent in the 2022–23 data, these data better reflect current circumstances of states compared with pre-COVID-19 data and data from

2019–20 and 2021–22. It is appropriate to update the model to capture what states do with respect to transport post–COVID-19 lockdowns and restrictions.

155 The Commission acknowledges the benefits of including more than a single year of expense data in the model. While 2018–19 data could be used, they are not likely to be representative of the current transport task and risk underestimating state transport spending needs. The transport landscape following COVID-19 is different from the one reflected in the 2018–19 data. The onset of the pandemic saw patronage and associated revenue dramatically decline, while providers retained a full, or at times increased, frequency of services.³³ Despite COVID-19 restrictions being eased, patronage has not fully recovered to pre–COVID-19 levels due to an uptake in work from home arrangements and an associated reduction in office occupancy levels in city centres.³⁴ In addition, direct spending on pandemic-related measures – such as increased cleaning, social distancing and public information campaigns – may still remain higher than pre–COVID-19 levels.

156 The Commission considers incorporating data from 2 years, 2022–23 and 2023–24, is appropriate because it mitigates the risk associated with potentially large COVID-19 impacts on 2022–23 data and better reflects current transport needs. These data are also more closely aligned with other data used in the model, the adjusted passenger numbers based on the latest Bureau of Infrastructure and Transport Research Economics data and population-weighted densities based on 2021 Census data.

157 The Commission considers it is appropriate to update the assessment with the latest, fit for purpose data when available.

Commission draft position

158 The Commission has requested 2022–23 net expense data from all states. If data are of sufficient quality and if they confirm the relationships in the model, the Commission proposes that they be used to update the assessment in the 2025 Review. Details of the changes will be provided in an addendum to the Draft Report.

159 The Commission proposes to request 2023–24 data from states for incorporation into the regression in the 2026 Update.

³³ [Sydney Trains Annual Reports | Transport for NSW](https://www.victrack.com.au/about/annual-reports), volume 1, pg. 33; <https://www.victrack.com.au/about/annual-reports>, [Annual-Report-2020-21 \(vline.com.au\)](https://www.victrack.com.au/about/annual-reports) pg.5; [Queensland Rail Annual and Financial Report 2021-22.pdf](https://www.victrack.com.au/about/annual-reports) pg.8

³⁴ PwC, *Changing Places: How hybrid working is rewriting the rule book*, 2021. <https://www.pwc.com.au/important-problems/future-of-work/changing-places-report.pdf>

Q5. Do states support retaining the 2020 Review proxy variable data in the regression model until fit for purpose net expense data are available?

State views

- 160 With the exception of Queensland and South Australia, states supported retaining the 2020 Review proxy data. South Australia pointed to the significant changes in public transport since 2016 while Queensland did not support retaining the model.
- 161 New South Wales recommended that the Commission use 2018–19 and 2022–23 data to update the regression model, citing that industrial action in 2022–23 has reduced the reliability of its net expense data.

Commission response

- 162 The Commission agrees with South Australia that the nature of public transport has changed since the model was initially estimated.
- 163 Updating the model using currently available data from 2018–19 could help to better capture changes to public transport provision and spending that have occurred since 2016. However, the data would not be reflective of the post-COVID-19 public transport task and would risk understating the net expenses faced by states.

Commission draft position

- 164 The Commission considers that it would not be appropriate to update the regression model without updating the net expense data.
- 165 Updated 2022–23 net expense data have been requested from states and will be incorporated into the regression and proxy variables updated where possible. The results will be presented in an addendum to the Draft Report.

Q6. Do states agree that the 2021 Census journey to work data were distorted by the COVID-19 lockdowns and are not a fit for purpose measure of current passenger numbers?

Q7. If the 2021 Census journey to work data are not fit for purpose, do states support the continued use of 2016 Census journey to work data in the model?

State views

- 166 All states agreed that the 2021 Census journey to work data are not fit for purpose.
- 167 New South Wales, Victoria, Western Australia, Tasmania and the ACT broadly supported the continued use of 2016 Census Journey to work data. Tasmania said

that retaining 2016 Census data is appropriate if the model continues to use commuter numbers to proxy supply.

- 168 South Australia and the Northern Territory did not support using the 2016 Census data, arguing they are too dated.
- 169 New South Wales and the ACT supported using the 2016 Census journey to work data, with an adjustment to account for the introduction of the new transport networks including the light rail since 2019.
- 170 Western Australia supported retaining the 2016 Census journey to work data but did not support its use as a proxy for supply.
- 171 Queensland did not support retaining the model, including the Census journey to work data.

Commission response

- 172 The Commission recognises that the 2016 data are dated, but a fit for purpose alternative has not been identified.
- 173 While passenger numbers have fallen following COVID-19 lockdowns and restrictions, states have not had similar reductions in supply. During COVID-19 lockdowns and restrictions, states maintained supply for essential workers.
- 174 The Bureau of Infrastructure and Transport Research Economics adjustment will make the 2016 Census passenger numbers more contemporaneous (see Q9 below for a more detailed discussion of the proposal).
- 175 The Commission would ideally remove commuter transport that was not provided or subsidised by the public sector. However sufficiently disaggregated data are not available to identify trips taken on private services not contracted by state governments. The Commission considers that non-subsidised private sector trips taken by bus, light rail and heavy rail would comprise a relatively small share of total commuter trips.

Commission draft position

- 176 The Commission considers 2016 Census Journey to work data to be the best option until 2026 Census data become available.

Q8. Do states agree that 2021 Census distance travelled to work data were not significantly distorted by COVID-19 lockdowns and are a reliable measure of network complexity?

State views

- 177 New South Wales, Western Australia, the ACT and the Northern Territory said that distance to work data were not significantly distorted by COVID-19 lockdowns.

- 178 New South Wales said that, while distance to work is a sensible proxy, the existence of multiple employment hubs may explain Sydney's shorter median distance to work compared with other capital cities. It suggested investigating a more direct measure based on actual network design measured through the number of connecting nodes.
- 179 Victoria, South Australia and Tasmania considered that the distance to work data could potentially be affected by COVID-19 lockdowns. South Australia and Victoria suggested that there is no way to test if distance to work data are COVID-19 affected.
- 180 Tasmania had concerns with the proxy being used to represent network complexity, questioning how Perth and Canberra could have more complex networks than Sydney, which has a shorter median distance to work. It suggested that complexity could already be captured in the density variable.
- 181 Queensland disagreed because of its broader concerns about the assessment.

Commission response

- 182 The distance travelled to work data were selected to reflect that relatively long-distance commutes made possible by the lack of congestion in some urban areas result in greater complexity and length for the average passenger journey regardless of density. As the complexity and length of individual journeys increases, so does the length of the public transport network required and thus their cost. The variable also accounts for costs associated with transport needs of sprawling cities. As cities extend outward commuters would be required to commute further to the central business district, which would be reflected in a higher median distance to work for the urban area. This relationship has not changed significantly since the 2020 Review, indicating that the current measure remains appropriate.
- 183 Compared with alternative measures, such as transport nodes, this measure is less easily affected by policy decisions surrounding transport networks.
- 184 The Commission notes the concerns raised by South Australia and Victoria but considers that the wording of the census question ensures reliability and consistency between census years. The 2021 Census asked respondents to record their usual place of work regardless of where they actually worked during the census period. Responses should not be significantly affected by lockdowns.

Commission draft position

- 185 The Commission considers that 2021 Census data on distance travelled to work provide a reliable measure of network complexity and are suitable for use in the 2025 Review.

Q9. Do states agree that, if material, 2016 Census journey to work data should be adjusted using the Bureau of Infrastructure and Transport Research Economics measure of passenger kilometres travelled until the 2026 Census data are available (when modelling passenger numbers to apply to regression coefficients)?

Q10. Do states agree that if net expense data are available before the 2026 Census passenger numbers it is appropriate to use Bureau of Infrastructure and Transport Research Economics data to index actual passenger numbers (when updating the actual passengers numbers in the regression)?

State views

- 186 New South Wales, South Australia, Tasmania and the Northern Territory supported using the Bureau of Infrastructure and Transport Research Economics data to adjust the modelled passenger numbers and to update the passenger numbers when re-estimating the regression model.
- 187 New South Wales supported the Commission’s proposal to use the adjusted 2016 Census data but did not support applying the capital city index to all urban areas, citing differences in public transport recovery following COVID-19.
- 188 Western Australia and the ACT supported updating 2016 Census passenger numbers but preferred ticketing data.
- 189 South Australia agreed that adjustments are needed to more accurately reflect usage. South Australia recommended that, before the Bureau of Infrastructure and Transport Research Economics data are used, further work be done to assess suitability of the index to more accurately reflect usage levels.
- 190 Western Australia and South Australia also supported, in principle, updating the regression using indexed passenger numbers but suggested that the increased uncertainty means that the regression should attract a larger discount/blending.
- 191 Queensland disagreed because of its broader concerns about the assessment.
- 192 Victoria did not support using Bureau of Infrastructure and Transport Research Economics data, stating that they are affected by COVID-19, similar to the census passenger numbers.
- 193 Victoria did not support adjusting 2016 Census passenger numbers due to concerns that the data are only collected for capital cities yet applied for all regions. The data were also considered to be COVID-19 influenced and not suitable for use in the assessment. Victoria recommended retaining 2016 Census commuter data. Victoria preferred to continue using pre-COVID-19 data.

Commission response

- 194 The Commission recognises concerns regarding the impact of using data that reflect changes in consumer behaviour post-COVID-19 lockdowns and restrictions. However, when balanced against contemporaneity issues, the Commission considers the Bureau of Infrastructure and Transport Research Economics data to be the best available.
- 195 Bureau of Infrastructure and Transport Research Economics data on passenger kilometres travelled are based on quarterly surveys of state authorities across states. The latest release covers the 2022–23 period, which can be used to ensure that the assessment remains contemporaneous and accounts for changing public transport use patterns following COVID-19.
- 196 Bureau of Infrastructure and Transport Research Economics data are collected on a national basis and are comparable across states and mode types. The data are also available for all states, unlike ticketing data which can only be obtained from 6 states. Some ticketing data are also confidential and not able to be shared with all states.

Commission draft position

- 197 When modelling passenger numbers, the Commission proposes to index 2016 Census passenger data using Bureau of Infrastructure and Transport Research Economics data.
- 198 The Commission also proposes to use the Bureau of Infrastructure and Transport Research Economics data to adjust the 2016 Census data when re-estimating the regression. Once census data unaffected by COVID-19 are available, the Commission proposes to return to using unadjusted census data.

Q11. Do states support retaining the 2020 Review blending ratio for the urban transport assessment?

State views

- 199 New South Wales proposed removing blending and using only the regression model for both the urban transport and investment in urban transport assessments. It considered that the concerns relating to the reliability of the net expense data and use of proxies in the model are not sufficient to justify blending the model. New South Wales indicated that the Commission could resolve any data quality concerns through its data request. New South Wales also viewed the proxies as well-reasoned and reliable representations of the concepts that influence public transport spending (demand and supply) and noted that it is common for proxy measures to be used in the social sciences. New South Wales considered that blending the regression model with urban populations may worsen equalisation outcomes.

- 200 In contrast, Queensland initially proposed assessing urban transport expenses and investment using only urban population shares. Queensland subsequently proposed removing the blending and recommended assessing student transport expenses differentially and assessing the remaining expenses based on urban populations and concession card holders.
- 201 Western Australia and Tasmania proposed a higher blending ratio, so that urban population shares would have a larger influence on the assessment.
- 202 Western Australia suggested the ratio should be at least 50:50 to account for data related concerns and to reflect unreliability in the method (due to a lack of external verification).
- 203 South Australia proposed that a discount should be applied to the assessment or the blending ratio of the model be increased.
- 204 The ACT proposed removing the blending and instead applying a discount to the assessment.
- 205 Victoria supported the current approach. The Northern Territory also supported the current blending ratio but noted it had less confidence in the model following the 2021 Census.

Commission response

- 206 The Commission notes that the 2020 Review method blends the urban centre characteristics model with urban populations shares (at a ratio of 75 to 25) mainly to address 2 data-related issues: the reliability of net urban transport expense data and the use of proxy variables to capture supply and demand.
- 207 The Commission acknowledges that concerns with this model (including ongoing concerns about policy influences, particularly cost recovery policies) have prompted calls for a permanent increase in the level of blending. However, the Commission considers that the proposed changes will make the model more fit for purpose such that it remains the best available method for assessing state urban transport needs.³⁵ Therefore, the Commission does not consider a permanent increase in blending is required to address issues associated with the underlying method.
- 208 Noting the additional data issues associated with this assessment due to COVID-19, the Commission recognises the case to moderate the impact of the regression model until fit for purpose passenger data become available. Blending with state shares of urban populations provides a suitable means of moderating the urban transport assessment in this case.

³⁵ Using a square kilometre grid-based measure of population-weighted density, adjusting 2016 Census data using an index based on available Bureau of Infrastructure and Transport Research Economics data to re-estimate the regression and modelling passenger numbers using a regression.

- 209 To address this issue, the Commission considers there is a case for a temporary adjustment to the existing 75% regression model and 25% urban population shares blending ratio. This would be an additional 10 percentage points for urban population shares, with the regression model weighted 65% and urban population shares 35%. This would recognise the increased data concerns due to COVID-19 rather than fundamental concerns over the regression model. The Commission considers that it is appropriate to return to the 75:25 blending levels once fit for purpose data become available.³⁶
- 210 As noted in the 2020 Review, the Commission considers that applying a discount (using total population shares), would result in an inferior outcome. A discount would attribute needs to the entire state population regardless of where they live.

Commission draft position

- 211 The Commission proposes a temporary increase to the blending ratio by 10 percentage points (to a 65:35 blend between the model and urban population shares) to account for data issues related to COVID-19. Once fit for purpose 2026 Census data become available in 2028, the blending ratio will return to the 75:25 split.

Q12. Do states support replacing the ferry dummy variable in the urban transport model with the proportion of total commuters using ferry services?

State views

- 212 Tasmania and Western Australia supported using the proposed preliminary approach. New South Wales supported changing from a dummy but would rather use the proportion of total commuters than total public transport users. New South Wales also wanted to include Newcastle's ferry.
- 213 South Australia wanted the dummy removed altogether (no assessment for ferries), while the Northern Territory and Victoria wanted to retain the current dummy variable based on concerns about the ability of passenger numbers to reflect the fixed cost of ferries and potential for the actual passenger numbers to be policy influenced. Victoria also wanted to include trips between Geelong and Docklands (Melbourne) as part of the urban transport task.
- 214 The ACT recommended that the Commission share the analysis of the proposed model based on ferry commuter proportions with states prior to reaching a position.

³⁶ Post-COVID-19 census data will not be available until 2027–28.

Commission response

- 215 The Commission recognises Victoria's and the Northern Territory's concerns about the ferry dummy variable. While the proposed measure is able to better account for the scale of ferry services in areas with ferries, the dummy variable accounts for the fact that ferry usage is not necessarily related to the overall level of transport demand.
- 216 The Commission also recognises that the measure based on passenger numbers cannot effectively account for non-state ferry services and may raise concerns about the potential for policy influence. Noting these concerns, the Commission proposes to retain the current ferry dummy in the regression model.
- 217 The Commission tested the impact of including the proportion of ferry passengers relative to total commuters (see Appendix B). While this does represent an improvement over the model based on the share of public transport users in terms of greater explanatory power, it also has the same limitations with regard to potential policy influence and an inability to account for the fixed cost associated with ferry services.
- 218 Although the ferry variable is not significant in any model tested, the Commission considers that ferry usage should continue to be accounted for in the model, as it is a necessity in certain urban areas and ensures that the assessment captures all major transport modes.
- 219 While the Commission recognises that a ferry service exists connecting Melbourne and Geelong, the ferry does not provide any services within the Geelong significant urban area. As such, it does not meet the Commission's definition of urban travel.
- 220 The ferry service in Newcastle operates solely within the urban area and will be included in the assessment.

Commission draft position

- 221 The Commission proposes that the dummy variable to reflect ferries that provide an intra-urban area service should continue to be used in the model and that Newcastle will be assessed as having a ferry service.

Q13. Do states agree that using a regression model to recognise the growth in passenger numbers in urban areas is a more suitable method for modelling passenger numbers?

State views

- 222 New South Wales, Victoria, Western Australia, Tasmania and the ACT agreed with the preliminary position.
- 223 New South Wales raised the possibility of using density to model passenger numbers. It said that the need for heavy rail is an outcome of population density

and that including heavy rail as a dummy variable is less direct than simply including population density itself. The preferred specification for New South Wales estimated public transport users per 10,000 people based on population-weighted density, a dummy to capture the different needs of areas with high density (defined as density greater than 1,750 persons per square kilometre), and an interaction term between high density areas and population-weighted density.

224 South Australia suggested that instead of using a regression model the Commission should adjust the existing value ranges to account for growth of urban centres (adjusting the lower and upper limits).

225 The Northern Territory said that the areas with the greatest population growth are also the areas with the greatest potential decline in passenger numbers due to behaviour changes following COVID-19.

Commission response

226 The Commission acknowledges that updating the value ranges has merit. However, applying a continuous approach would better capture changing rates of public transport usage as cities grow.

227 The Commission considered the suggestion by New South Wales to model passenger numbers based on population-weighted density. However, the division of urban areas into those above and below a density of 1,750 square kilometres would be arbitrary, with more urban areas crossing the boundary as time goes on. Additionally, as density is already included as a separate variable in the regression model to capture the demand for public transport, this approach would result in double counting.

Commission draft position

228 The Commission proposes to use a regression to model passenger numbers.

Q14. Do states support the following changes to the non-urban transport assessment:

- **assessing non-urban rail passenger expenses based on shares of non-urban train commuters?**
- **assessing all remaining expenses based on shares of non-urban populations?**

State views

229 Queensland, Western Australia, South Australia, Tasmania and the Northern Territory did not support the preliminary proposal, citing that actual train passenger numbers do not give a policy neutral measure of non-urban transport needs.

- 230 Differences between the share of non-urban train passengers and actual spending were also raised. A common example used was New South Wales, whose share of non-urban train passengers is much higher than its share of state non-urban transport spending.
- 231 Queensland recommended assessing all non-urban transport expenses based on shares of regional population. However, Queensland updated its position to assess non-urban expenses based on populations 400 kilometres outside greater capital city statistical areas.
- 232 New South Wales supported using passenger numbers but basing the definition of non-urban travel as travel between centres more than 100km or 2 hours apart. New South Wales also raised some issues with differences between the definition of non-urban transport used by the Commission and the classification of the functions of government classifications used to capture non-urban transport spending.
- 233 Victoria questioned the utility of having a separate non-urban component and suggested that it may be appropriate to combine the urban and non-urban assessments.
- 234 Victoria also proposed that satellite cities be counted as part of its nearby metropolitan centres for the purpose of calculating urban characteristics and that travel between geographically joined urban areas be considered urban transport.
- 235 The ACT recommended that the Commission share the analysis of Commission's proposal to use non-urban rail passengers with the states prior to reaching a position.
- 236 The Northern Territory proposed to retain the existing method for simplicity, and noted weaknesses associated with assessing non-urban transport based on a single mode.

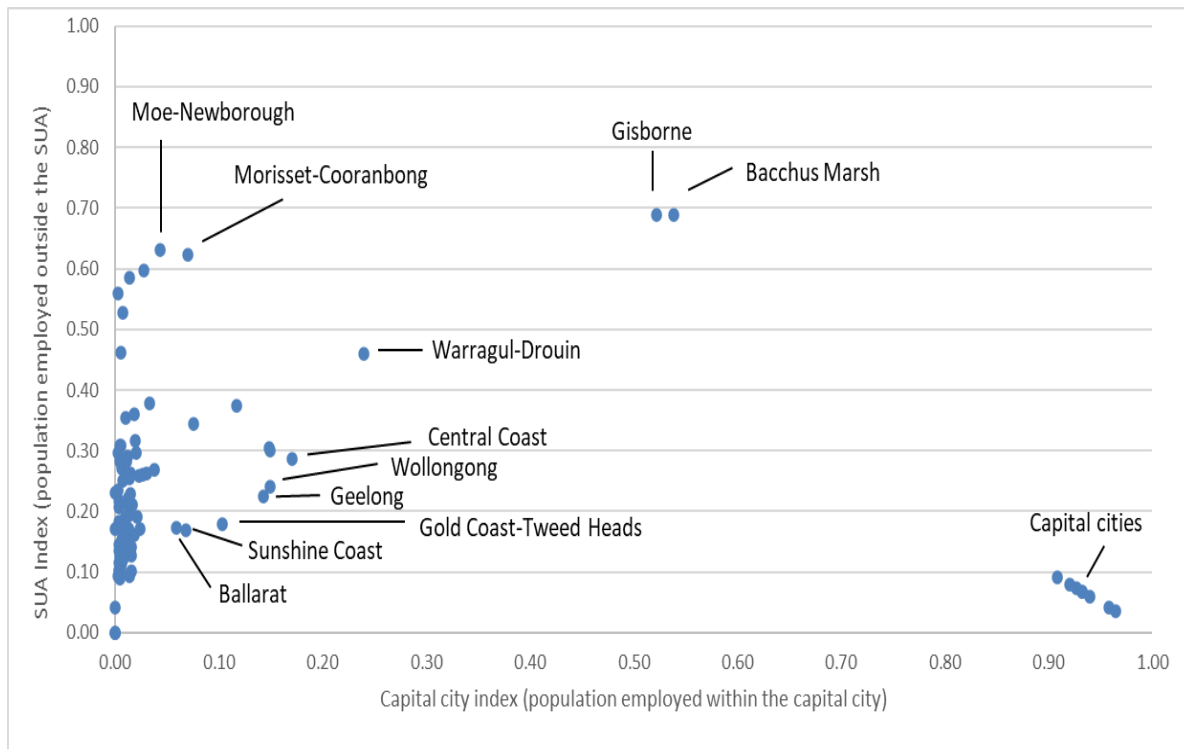
Commission response

- 237 The Commission acknowledges state concerns that actual passenger numbers may not be sufficiently policy neutral to directly include in the assessment. The Commission also recognises that the relationship between shares of non-urban train passengers does not match the shares of non-urban transport spending under the current classification of the functions of government definitions.
- 238 The Commission considered Queensland's suggestion to use populations more than 400 kilometres from a capital city. It found that this approach would not accurately reflect state needs. This is because a large proportion of non-urban spending is due to passenger travel between large urban centres (for example Geelong to Melbourne, or Gold Coast/Sunshine Coast to Brisbane). It is also possible for populations in urban areas to access non-urban transport services between urban

areas or to non-urban areas, which would not be reflected in an assessment based on non-urban populations.

- 239 In the absence of a suitable alternative, the Commission considers an equal per capita assessment of non-urban transport assessment remains appropriate.
- 240 While the Commission recognises that costs may be higher in more regional or remote locations, this is already reflected in the regional gradient applied to the non-urban transport assessment.
- 241 The Commission does not support Victoria's recommendation that travel between adjacent urban areas should be considered as urban transport. This is because geographical proximity alone is not sufficient to capture the level of integration between cities.
- 242 In the 2020 Review the Commission extensively examined the level of labour market integration between nearby urban areas, using self-sufficiency indices to measure the levels of employment outside the urban area, and employment in the relevant capital cities. For most adjacent urban areas that were not identified as satellites (Geelong, Central Coast, Gold Coast, Sunshine Coast and Wollongong) analysis revealed that fewer than 20% of residents commuted to the capital city for work. Based on the analysis Gisborne, Bacchus Marsh, Melton and Yanchep were identified as satellite cities.
- 243 The appropriateness of the current method is supported by the fact that 2 former satellites identified by the Commission (Melton and Yanchep) have since been formally amalgamated into Melbourne and Perth respectively.
- 244 As part of the 2025 Review, the Commission re-estimated the self-sufficiency indices to identify if there had been any changes warranting the inclusion of new significant urban areas. The results presented in Figure 1 do not identify any additional areas with a sufficiently integrated labour market to be considered as satellite cities. The Gisborne and Bacchus Marsh significant urban areas will be retained as satellites to Melbourne.

Figure 1 Self-sufficiency indices for all significant urban areas, 2021 Census



Source: Commission calculation using ABS data.

- 245 The Commission also considers that the drivers of urban and non-urban spending are sufficiently different to warrant separate assessments. A separate assessment of non-urban transport spending recognises that populations outside urban centres require access to transport services.
- 246 The Commission notes that some inter-urban transport expenses are captured in the urban transport Government Finance Statistics expenses to which the urban centre characteristics assessment is applied. The urban centre characteristics assessment was not designed to estimate the need for travel between urban areas. This is reflected in the measures of passenger numbers, which only include commuters within an urban area.
- 247 Therefore, the Commission considers these Government Finance Statistics costs should be allocated to non-urban transport for the purposes of the assessment. Any inter-urban travel costs should also be removed from the net expense data used to inform the regression model.

Commission draft position

- 248 In the absence of a suitable alternative, the Commission proposes that an equal per capita assessment of non-urban transport expenditure remains appropriate.
- 249 The Commission proposes that inter-urban transport expenses are best assessed in the non-urban transport assessment.

Other issues raised by states

Victoria V/Line issue

250 Victoria recommended that a greater proportion of V/Line expenses should be classified to the urban transport component to recognise travel within the Melbourne significant urban area. It provided evidence that 46% of all V/Line trips occur within the same urban area.

Commission response

251 Victoria raised the issue of the treatment of V/Line expenses in the 2021 Update, which resulted in the Commission apportioning 8% of V/Line costs to the urban transport category based on the usage of V/Line services within the Geelong significant urban area. While 2021 Census data are available to update this proportion, the data are likely to be influenced by the COVID-19 restrictions in Victoria and would not be a reliable indicator of use. The Commission proposes to re-examine the use of V/Line services and to update this proportion once fit for purpose passenger number data become available in the 2026 Census.

252 In the 2021 Update it was confirmed that most stations utilised by V/Line inbound trains within the significant urban area of Melbourne are only for alighting and not boarding.

253 Victoria provided a list of stations that are served exclusively by V/Line that allow both boarding and alighting within the significant urban area of Melbourne. However, without supporting information to inform an analysis of explicit user data by station, it would be difficult to appropriately allocate V/Line expenses to the use of these particular stations.

254 It is reasonable to suggest that the cost per user of V/Line services would be different depending on the distance travelled by individual passengers. Passengers travelling within the Melbourne urban area are likely to have a lower cost compared with passengers using V/Line services to access regional areas such as Ballarat, Bendigo, Echuca, Wodonga and Bairnsdale from Melbourne. This would not be reflected using the proportion of total passengers accessing V/Line services.

255 If disaggregated data on the costs associated with V/Line travel within the Melbourne significant urban area become available in the future, the Commission will investigate making an appropriate adjustment.

Commission draft position

256 The Commission proposes to retain the current method of allocating V/Line expenses until 2026 Census data are available.

Assessment of urban transport infrastructure

- 257 New South Wales supported the application of the urban centre characteristics model in the investment assessment and recommended the blending be removed to reduce complexity and better achieve horizontal fiscal equalisation.
- 258 Queensland, Western Australia and South Australia raised concerns with the use of urban populations squared approach when blending the urban centre characteristics model in the urban transport investment assessment.
- 259 Western Australia said that the use of squared urban populations in the urban transport investment assessment was not sufficiently resolved in both the 2015 and 2020 reviews. Western Australia recommended blending the regression model with state shares of urban populations instead of population squared, due to concerns about the strength of the relationship between per capita assets and urban populations. South Australia noted that in the 2020 Review the Commission committed to reviewing the relationship for the next review.
- 260 This view was also reflected in Queensland's tranche 2 submission, which raised concerns about the use of the population-squared variable in the transport component of the investment assessment. Queensland considered the population-squared variable represents an even more significant and inappropriate form of the incorrect approach adopted in the urban transport expense regression. It is Queensland's view that the diseconomies of scale and density that are ingrained within the population-squared variable are refuted by the academic literature.
- 261 Queensland also suggested that the data used to test the relationship between per capita asset values and density (which was used in the 2020 Review to justify the use of the population-squared term) is policy influenced. Queensland said that the population-squared variable is not fit for purpose and is distributing GST in a way that is inconsistent with horizontal fiscal equalisation.

Commission response

- 262 The Commission notes that blending was applied in the 2020 Review to address 2 main data-related issues: the reliability of net urban transport expense data and the use of proxy variables to capture supply and demand. As these concerns remain, the Commission does not think it is appropriate to reduce the level of blending used in the assessment.
- 263 As mentioned in the 'Issue 2 – Economies of density' section, the Commission reviewed the literature provided by Queensland and determined that the economies of scale and density discussed refer to the reduction in per passenger costs as the number of passengers using a transport network rises. This is distinct from economies of population density that which would occur if per capita costs fall as the population-weighted density of an area rises. Whilst the Commission

agrees that additional passengers on a fixed transport network will lead to lower costs per passenger, larger cities require more frequent, larger scale and more complex public transport networks. This would lead to the higher asset requirements per person, which the assessment captures through the density variable in the regression model, and the population-squared term.

- 264 The Commission seeks to use state data whenever possible to determine the average policy for an assessment. Any state expenditure on public transport will be to some extent policy influenced, but this does not mean the data are unsuitable in determining what drives state needs. The Commission's methods should, as far as practicable, reflect what states collectively do. The Commission does not make judgements about what states could, or should, do. Instead, the Commission bases its assessments on the average policies of all states.
- 265 The Commission has requested asset data from states to retest the relationship between asset values and urban populations. If the data continue to support the use of urban population squared the Commission will retain the current blending approach. Alternatively, if data support the use of urban populations, the Commission will apply urban population when blending in the investment assessment. Results of the analysis will be presented in an addendum to the Draft Report.
- 266 Consistent with the proposed change in the recurrent urban transport assessment, the Commission propose to temporarily adjust the blending ratio by 10 percentage points to 65% urban centre characteristics and 35% urban populations (squared).

Commission draft position

- 267 The Commission proposes to blend urban centre characteristics with urban populations squared if the updated state data support the relationship. If the data support the use of urban populations, this will be applied. Results of the analysis will be presented in an addendum to the Draft Report.

Student transport and pipeline transport expenses

- 268 Queensland recommended the classification of the functions of government – Australia (COFOG-A) items for urban and non-urban student transport should be assessed separately. It also suggested that pipeline and other transport should be reclassified as non-urban transport spending.

Commission response

- 269 The Commission agrees that pipeline and other transport expenses should be assessed as non-urban transport. Expenses in this category relate to transport of petroleum and natural gas through pipelines. It also includes the expenses related to transport systems not captured in other COFOGs, including funiculars, cable cars and chairlifts which are not commonly provided in urban areas.

270 Although separate expenses can be identified for urban and non-urban school transport there does not appear to be a relationship between state shares of student populations and the student transport expenses provided (see Table 4).

Table 4 Student transport relative to student populations, 2021–22

	NSW	Vic	Qld	WA	SA	Tas	ACT	NT
Share of student population (%)	31	25	22	11	7	2	2	1
Share of student transport expenses (%)	61	13	11	8	3	2	0.3	1

Source: Commission calculation using ABS data.

271 Further data and analysis of the school transport spending will be needed to inform any assessment of state needs. This will require further consultation with states to identify the relevant expense data within the COFOG-A framework. The Commission considers that in the meantime, the expenses should remain in the urban transport assessment.

Commission draft position

272 The Commission proposes to move pipeline and other transport COFOG-A (1171) from the urban transport component to the non-urban transport component, and to continue to assess school transport expenses in the urban transport component.

Draft 2025 Review assessment method

273 Following consideration of state views, the Commission proposes to apply the following changes to the transport assessment:

- replace the current SA1-based measure population-weighted density with a measure based on the square kilometre grid
- adjust 2016 passenger numbers using Bureau of Infrastructure, Transport and Research Economics data on passenger kilometres
- use a regression to model passenger numbers
- increase blending ratio by 10 percentage points to 65% urban centre characteristic and 35% urban population
- re-classify pipeline transport to the non-urban transport category.

274 The following positions are outstanding.

- Finalising the variables included in the urban centre characteristics regression
- Identifying the appropriate population measure to apply to blending in the investment assessment.

275 Commission proposals will be included in an addendum to the Draft Report.

276 The Commission will request 2023–24 net urban expense data from states to re-estimate the urban centre characteristics regression model.

277 Table 5 shows the proposed structure of the 2025 transport assessment.

Table 5 Proposed structure of the transport assessment

Component	Driver	Influence measured by driver	Change since 2020 Review?
Urban transport	Urban centre characteristics (a)	Recognises that the use and cost of services varies based on population-weighted density, use and presence of a public transport mode, distance to work and topography (variables included in the regression to be confirmed in an addendum to the Draft Report).	Yes*
	Urban population	Recognises that urban transport services vary by the share of the state population living in urban areas.	No
	Wage costs (b)	Recognises differences in wage costs between states.	No
Non-urban transport	Population (EPC)	Recognises that non-urban transport services vary based on state populations.	No
	Wage costs and regional costs (b)	Recognises differences in wage costs between states and in the costs of providing services to different areas within a state	No
Investment in urban transport	Urban centre characteristics (a)	Recognises that urban transport investment need varies based on population-weighted density, use and presence of a public transport mode, distance to work and topography (variables included in the regression to be confirmed in an addendum to the Draft Report).	Yes*
	Urban population squared	Recognises that urban transport investment needs per capita vary by the share of the state population living in urban areas (if supported by data – Commission proposal to be included in addendum to the Draft Report).	No*
Investment in non-urban transport	Population (EPC)	Recognises that non-urban transport services vary based on state populations.	No
	Wage costs and regional costs (b)	Recognises differences in wage costs between states and in the costs of providing services to different areas within a state.	No

(a) The Commission proposes to update the inputs into urban centre characteristics model with 2022–23 data provided by states. The Commission also proposes to use a regression to determine a policy neutral estimate of public transport users in each state. The blending between the regression model and urban populations has been increased.

(b) The Commission will separately consult with states on the wages and regional costs assessment.

* Decisions outstanding. Commission proposals will be presented in an addendum to the Draft Report.

Indicative distribution impacts

278 The impact on the GST distribution in 2024–25 from the proposed method change will be presented in an addendum to the Draft Report.

Appendix A: Relevant literature used to inform an assessment of urban transport spending

Studies which support the position that costs and public transport infrastructure need is driven by peak use

R Balcombe, R Mackett, N Paulley, J Preston, J Shires, H Titheridge, M Wardman and P White, 'The demand for public transport: a practical guide', *TRL Report TRL593*, 2004.

C Camén and H Lidestam, 'Dominating factors contributing to the high(er) costs for public bus transport in Sweden', *Research in Transportation economics*, 2016, 59: 292–296.

GT Clifton and C Mulley, 'A historical overview of enhanced bus services in Australian cities: What has been tried, what has worked?', *Research in Transport Economics*, 2016, 59: 11–25.

E Eriksson, L Winslott Hiselius and H Lidestam, 'Measures reducing travel by public transport during peak hours', *Transportation Research Procedia*, 2023, 72: 3609–3616.

S Jara-Díaz, A Fielbaum and A Gschwender, 'Optimal fleet size, frequencies and vehicle capacities considering peak and off-peak periods in public transport', *Transportation Research Part A*, 2017, 106: 65–74.

H Lidestam, C Camén and B Lidestam, 'Evaluation of cost drivers within public bus transports in Sweden', *Research in Transportation Economics*, 2018, 69: 157–164.

Studies which account for density, passengers, topography, network length (distance) and transport modes as factors which influence transport provision and cost

A Chakraborty and S Mishra, 'Land use and transit ridership connections: Implications for state-level planning agencies', *Land Use Policy*, 2013, 30: 458–469.

Y Chen, Z Li and WHK Lam, 'Modeling transit technology selection in a linear transportation corridor', *Journal of Advanced Transportation*, 2015, 49: 48–72.

S Cooke and R Behrens, 'Correlation or cause? The limitations of population density as an indicator for public transport viability in the context of a rapidly growing developing city', *Transport Research Procedia*, 2017, 3003–2016.

R Daniels and C Mulley, 'Planning Public Transport Networks – The Neglected Influence of Topography', *Journal of Public Transportation*, 2012, 15(4): 23–41.

C De Gruyter, T Saghapour, L Ma and J Dodson, 'How does the built environment affect transit use by train, tram and bus?' *Journal of Transport and Land Use*, 2020, 13(1): 625–650

M Gascon, O Marquet, E Grácia-Lavedan, et al., 'What explains public transport use? evidence from seven European cities', *Transport Policy*, 2020, 99: 362–374.

LA Guzman and SG Cardona, 'Density-orientated public transport corridors: Decoding their influence on BRT ridership at station-level and time-slot in Bogotá', *Cities*, 2021, 103071.

M Haider, 'Diminishing Returns to Density and Public Transit', *Transport Findings*, October.

- A Johnson, 'Bus transit and land use: Illuminating the interaction', *Journal of Public Transportation*, 2003, 6(4): 21–39.
- KA Kakar and CSRK Prasad, 'Impact of Urban Sprawl on Travel Demand for Public Transport, Private Transport and Walking', *Transport Research Procedia*, 2020, 48: 1881–1892.
- M Kamruzzaman, D Baker, S Washington and G Turrell, 'Advanced transit oriented typology: case study in Brisbane, Australia', *Journal of Transport Geography*, 2014, 34:54–70.
- J Mattson, 'Relationships between density, transit, and household expenditures in small urban areas', *Transportation Research Interdisciplinary Perspectives*, 2020, 8: 100260.
- R Merket, C Mulley and MM Hakim, 'Determinants of bus rapid transport (BRT) system revenue and effectiveness – A global benchmarking exercise', *Transportation Research Part A*, 2017, 106: 75–88.
- K Obeng, R Sakano and C Naanwaab, 'Understanding overall output efficiency in public transport systems: The roles of input regulations, perceived budget and input subsidies', *Transportation Research Part E*, 2016, 89: 133–150.
- D Oh, S Lee, J Park, and C Roh. 'Applying modified-data mining techniques to assess public transportation in vulnerable urban and suburban city areas', *Heliyon*, 2023, 9(11): e21213.
- H Pan, J Li, Q Shen and C Shi, 'What determines rail transit passenger volume? Implications for transit orientated development planning', *Transportation Research Part D*, 2017, 57: 52–63.
- M Pasha, SM Rifaat, R Tay and AD Barros, 'Effects of Street Pattern, Traffic, Road Infrastructure, Socioeconomic and Demographic Characteristics on Public Transit Ridership', *Journal of Civil Engineering*, 2016, 20(3): 1017–1022.
- Productivity Commission, '*Public Transport Pricing*', Research Paper, 2021, Canberra.
- J Rodrigue, 'The Geography of Transport Systems' *New York: Routledge*, 2020, doi.org/10.4324/9780429346323
- T Saghapour, S Moridpour and RG Thompson, 'Public transport accessibility in metropolitan areas: A new approach incorporating population density', *Journal of Transport Geography*, 2016, 54: 273–285.
- BD Taylor, D Miller, H Iseki and C Fink, 'Nature and/or nurture? Analyzing the determinants of transit ridership across US urbanized areas', *Transportation Research Part A*, 2009, 43: 60–77.
- C Zhang, Z Juan and G Xiao, 'Do contractual practices affect technical efficiency? Evidence from public transport operators in China' *Transport Research Part E*, 2015, 39–55.
- C Zhang, Z Juan, Q Luo and G Xiao, 'Performance evaluation of public transit systems using a combined evaluation method' *Transport Policy*, 2016, 45: 156–167.

Studies used to verify whether economies of density/scale exist in transport service provision

GM Ahlfeldt, SJ Redding, DM Sturm and N Wolf, 'The economies of density: Evidence from the Berlin Wall', *Econometrica*, 2015, 83(6): 2127–2189.

A Anupriya, DJ Graham, JM Carbo, RJ Anderson and P Bansal, 'Understanding the costs of urban rail transport operations', *Transportation Research Part B: Methodological*, 2020, 138: 292–316.

M Batarce and P Galilea, 'Cost and fare estimation for the bus transit system of Santiago', *Transport Policy*, 2018, 64: 92–101.

JD Bitzan, 'Railroad Costs and Competition: The Implications of Introducing Competition to Railroad Networks', *Journal of Transport Economics and Policy*, 2003, 37(2): 201–225.

JD Bitzan and F Karanki, 'Costs, density economies, and differential pricing in the U.S. railroad industry', *Transport Policy*, 2022, 119: 67–77.

YS Chang, SJ Jo, YT Lee, and Y Lee, 'Population Density or Populations Size. Which Factor Determines Urban Traffic Congestion?', *Sustainability*, 2021, 13(8): 4280.

S Cooke and R Behrens, 'Correlation or cause? The limitations of population density as an indicator for public transport viability in the context of a rapidly growing developing city', *Transportation Research Procedia*, 2017, 25: 3003–3016.

W Cox, 'Urban Travel and Urban Population Density', *Sustainable Urban Transport*, 2012, 19–28.

M Farci, A Fetz and M Filippini, 'Economies of Scale and Scope in Local Public Transportation', *Journal of Transport Economics and Policy*, 2007, 41(3): 345–360.

MD Giacomo and E Ottoz, 'The Relevance of Scale and Scope Economies in the Provision of Urban and Intercity Bus Transport', *Journal of Transport Economics and Policy*, 2010, 44(2): 161–187.

DJ Graham, 'Productivity and efficiency in urban railways: Parametric and non-parametric estimates', *Transportation Research-Part E*, 2008, 44: 84–99.

DJ Graham, A Couto, WE Adeney and S Glaister, 'Economies of scale and density in urban transport: effects on productivity', *Transportation Research Part E*, 2003, 39:443–458.

A Gschwender, S Jara-Díaz and C Bravo, 'Feeder-truck or direct lines? Economies of density, transfer costs and transit structure in an urban context', *Transport Research Part A*, 2016, 209–222.

DA Hensher, R Daniels, and I Demellow, 'A Comparative Assessment of the Productivity of Australia's Public Rail Systems 1971/72-1991/92', *The Journal of Productivity Analysis*, 1995, 6: 201–223.

MG Karlaftis and P McCarthy, 'Cost structures of public transit systems: a panel data analysis', *Transportation Research Part E*, 2002, 36: 1–18.

MG Karlaftis, PS McCarthy and KC Sinha, 'System size and cost structure of transit industry', *Journal of Transportation Engineering*, 1999, 125(3): 208–215.

- TE Keeler, 'Railroad Costs, Returns to Scale, and Excess Capacity', *The Review of Economics and Statistics*, 1974, 56(2): 201–208.
- H Li, K Yu, K Wang and A Zhang, 'Market power and its determinants in the Chinese railway industry', *Transportation Research Part A: Policy and Practice*, 2019, 120: 261–276.
- Y Liu, S Wang, and B Xie, 'Evaluating the effects of public transport fare policy change on together with built and non-built environment features on ridership: The case in South East Queensland, Australia', *Transport Policy*, 2019, 76: 78–89.
- F Mitazuni, 'Privately Owned Railways' Cost Function, Organizational Size and Ownership', *Journal of Regulatory Economics*, 2004, 25(3): 297–322.
- F Mitazuni and S Uranishi, 'Does vertical separation reduce cost? An empirical analysis of the rail industry in European and East Asian OECD Countries', *Journal of Regulatory Economics*, 2013, 43: 31–59.
- F Mizutani, A Smith, C Nash and S Uranishi, 'Comparing the Costs of Vertical Separation, Integration, and Intermediate Organisational Structures in European and East Asian Railways', *Journal of Transport Economics and Policy*, 2015, 49(3): 496–515.
- H McGeehan, 'Railway Costs and Productivity Growth: The Case of the Republic of Ireland, 1973-1983', *Journal of Transport Economics and Policy*, 1993, 27(1): 19–32.
- L Nirhagen, D Brandt and R Mortazavi, 'Use of public transport as a means to reach national climate objectives - On the importance of accounting for spatial differences and costs', *Transport Policy*, 2023, 131: 56–65.
- RJ Pozdena and LD Merewitz, 'Estimating cost functions for rail rapid transit properties', *Transportation Research*, 1978, 12(2): 73–78.
- I Savage, 'Scale economies in United States rail transit systems', *Transportation Research Part A: Policy and Practice*, 1997, 31(6): 459–473.
- C Tsai, C Mulley and R Merkert, 'Measuring the cost efficiency of urban rail systems', *Journal of Transport Economics and Policy*, 2015, 49(1): 17–34.
- A Vigren, 'Cost efficiency in Swedish public transport', *Research in Transportation Economics*, 2016, 59: 123–132.
- PA Viton, 'A Translog Cost Function for Urban Bus Transit', *Journal of Industrial Economics*, 1981, 29(3): 287–304.
- N Wills-Johnston, 'Cost Functions for Australia's Railways', *Journal of Infrastructure Systems*, 2011, 17(1): 1–14.

Appendix B: Supplementary models considered by the Commission

- 279 Several states requested alternative approaches to assessing needs. For example, the assessment could consider socio-economic status or removing insignificant variables.
- 280 The Commission tested a number of supplementary models involving different specifications and different ways of measuring density and passenger numbers. The results of these models are summarised below.
- 281 The validity of these models has been judged based on conceptual reasoning (whether there is a basis for including or excluding certain variables), the predictive power of the model, and whether the model provided sensible estimates for the impact of certain variables on net expenses.
- 282 The Commission notes that many of these specifications were extensively tested during the 2020 Review.

Testing exclusion of the passenger number and density variables

- 283 Given concerns about the appropriateness of retaining 2016 Census passenger numbers and the measure of population-weighted density in the model the Commission considered alternative models which separately excluded these variables. The estimated regression coefficients are provided below.

Table A-1 Regression model excluding passenger numbers and population-weighted density

Variable	R2020 model coefficients	R2020 model - no passenger variables	R2020 model - no density
Intercept	-128.63	-182.58	-70.42
Ferry	13.86	37.45	59.57
Heavy rail passengers	12.31		18.62
Bus and light rail passengers	5.60		19.34
Population-weighted density	0.085	0.12	
Mean slope	6.92	8.10	8.17
Distance to work	3.07	8.47	1.13
Adjusted R-squared	0.8303	0.7896	0.7772
Residual standard error	56.22	62.59	66.91

Note: The 2013–14 to 2015–16 net expenses data collected for the 2020 Review was used to estimate the model. 2016 census journey to work data and 2016 Geoscience data were used to estimate the models. Density is based on SA1 areas to enable comparison with the 2020 Review. The 68 significant urban areas with available data were used in the regression.

- 284 In general the models excluding either variable are not improvements over the current specification. The passenger number variables account for the cost differences between modes, which may not be sufficiently captured in the density

variable. If the density variable were to be excluded the model would fail to account for the size of the transport task facing urban areas (as measured by underlying demand).

285 The results also indicate that these models do not have a higher explanatory power than the 2020 Review regression model. This is evident from the lower R-squared value and higher residual standard error.

Testing the impacts of difference approaches to measure population-weighted density

286 Changes to the population-weighted density variable have been raised to reduce volatility and to ensure that the variables used are fit for purpose. The regression has been re-estimated with these variables included in the model to assess the indicative effects and to ensure that the proposal can be properly scrutinised by states.

Table A-2 Regression model with alternative specifications for the population-weighted density variable

Variable	R2020 model coefficients	R2020 model - SA2-based density	R2020 model - square kilometre-based density
Intercept	-128.63	-68.22	-147.71
Ferry	13.86	21.37	21.27
Heavy rail passengers	12.31	15.03	11.90
Bus and light rail passengers	5.60	9.17	4.28
Population-weighted density	0.085	0.085	0.129
Mean slope	6.92	4.78	7.20
Distance to work	3.07	1.56	3.92
Adjusted R-squared	0.8303	0.7856	0.8107
Residual standard error	56.22	63.17	59.69

Note: The 2013–14 to 2015–16 net expenses data collected for the 2020 Review were used to estimate the model. 2016 census journey to work data and 2016 Geoscience data were used to estimate the models. The 68 significant urban areas with available data were used in the regression.

287 While the model with the SA1s has the highest explanatory power, it is volatile due to census revisions. Comparing the alternative approaches considered by the Commission, the model based on the square kilometre grid outperforms the model based on SA2s in terms of explanatory power and a lower standard error. For all 3 models, the significance of the variables does not change. Heavy rail passengers and the density variable have a highly significant impact on net per capita expenses.

288 While the models can be compared using the adjusted R-squared and residual standard error values, the coefficients of the model cannot be directly compared. This is because the magnitude of the population-weighted density of the square

kilometre grid and SA2s differs from the SA1s. In the square kilometre grid model, a higher coefficient does not necessary mean that the variable has a higher influence on the predicted urban transport expenses.

Testing the impact of excluding insignificant variables

289 An additional model excluding all insignificant variables and a model excluding only the ferry variable were also tested based on comments by Victoria and South Australia respectively. The variable capturing bus and light rail passengers was retained to ensure that transport services in small urban areas could continue to be accounted for.

Table A-3 Regression model excluding insignificant variables and the ferry dummy

Variable	R2020 model coefficients	R2020 model - only significant variables	R2020 model - no ferry variable
Intercept	-128.63	-100.98	-132.23
Ferry	13.86		
Heavy rail passengers	12.31	14.18	12.44
Bus and light rail passengers	5.60	7.21	6.00
Population-weighted density	0.085	0.085	0.087
Mean slope	6.92		6.68
Distance to work	3.07		3.07
Adjusted R-squared	0.8303	0.8264	0.8325
Residual standard error	56.22	56.85	55.85

Note: The 2013–14 to 2015–16 net expenses data collected for the 2020 Review were used to estimate the model. 2016 census journey to work data and 2016 Geoscience data were used to estimate the models. The 68 significant urban areas with available data were used in the regression.

290 The results indicate that the model excluding insignificant variables does not have a higher explanatory power compared to the 2020 Review model.

291 While the ferry dummy does not improve the predictive power of the model, it was selected for inclusion in the 2020 Review to ensure that the assessment can capture all relevant forms of transport. It also recognises that the decision to introduce a ferry service into a public transport network is to address complex jurisdictional topography and to complement other transport modes.

Testing the impact of a logarithmic specification for density and the removal of non-residential land from the density measure

292 Queensland, Western Australia and Tasmania suggested that economies of density are not being captured in the model.

293 Queensland and South Australia also suggested that inconsistencies in the zoning of land within SA1s make them inappropriate for use in the model.

294 The Commission investigated models based on a logarithmic form of density (which would account for potential economies of density) and population-weighted density measures that exclude non-residential land. The results are summarised below.

Table A-4 Regression model accounting for a non-linear relationship between net expenses and population-weighted density, and density based on residential land

Variable	R2020 model coefficients	R2020 model - logarithmic form for density	R2020 model - residential land only
Intercept	-128.63	-660.91	-114.26
Ferry	13.86	52.14	22.87
Heavy rail passengers	12.31	16.77	13.76
Bus and light rail passengers	5.60	10.11	11.59
Population-weighted density	0.085	87.28	0.044
Mean slope	6.92	8.47	6.46
Distance to work	3.07	1.89	2.23
Adjusted R-squared	0.8303	0.7708	0.7934
Residual standard error	56.22	65.33	62.03

Note: The 2013–14 to 2015–16 net expenses data collected for the 2020 Review were used to estimate the model. 2016 census journey to work data and 2016 Geoscience data were used to estimate the models. Density is based on SA1 areas to enable comparison with the 2020 Review. The 68 significant urban areas with available data were used in the regression.

295 The results do not support the presence of economies of population density in the model, confirming the results from the literature and the results from prior testing by the consultant during the 2020 Review. When a logarithmic form is applied to the population-weighted density variable, the explanatory power of the model declines sharply.

296 The results do not vary considerably when non-residential land is excluded but they still do not represent an improvement over the current model in terms of its explanatory power.

Testing the impact of ferry commuter proportions

297 In response to New South Wales’ submission the Commission tested the impact of including ferry commuter proportions rather than the proportion of public transport users taking ferries.

Table A-5 Regression model accounting for different specifications of the ferry passenger variable

Variable	R2020 model coefficients	R2020 model - proportion of public transport users	R2020 model - proportion of commuters
Intercept	-128.63	-127.62	-110.29
Ferry	13.86	4.26	281.94
Heavy rail passengers	12.31	12.73	11.77
Bus and light rail passengers	5.60	5.17	6.35
Population-weighted density	0.085	0.086	0.068
Mean slope	6.92	6.48	6.45
Distance to work	3.07	3.06	3.72
Adjusted R-squared	0.8303	0.8306	0.8446
Residual standard error	56.22	56.57	62.59

Note: The 2013–14 to 2015–16 net expenses data collected for the 2020 Review were used to estimate the model. 2016 census journey to work data and 2016 Geoscience data were used to estimate the models. Density is based on SA1 areas to enable comparison with the 2020 Review. The 68 significant urban areas with available data were used in the regression.

- 298 When interpreting these models, the coefficient of the ferry variable cannot be directly compared, as the scale of the measures is different. As there is a very low proportion of total commuters taking ferry services (typically less than 1% of total commuters) compared with the public transport users only, the coefficient for the commuter proportion model is much larger.
- 299 The results suggest that a model based on the proportion of ferry passengers relative to total public transport users performs better than the other alternatives.
- 300 However, as states such as Victoria and the Northern Territory have indicated, the current measure used to assess ferry spending accounts for the fact that ferry usage is not necessarily related to the overall level of transport demand, cannot effectively account for non-state ferry services, and may raise concerns about the potential for policy influence. Noting these concerns, the Commission has elected to retain the current ferry dummy in the regression model.

Testing the impact of variables to account for non-commuter users and variables to account for remoteness

- 301 In response to Tasmania’s recommendation that the model should account for non-commuter use of transport services, models were also tested including students and other concession groups (unemployed and elderly populations) in the regression model. Although the number of individuals specific concessions can be identified, it would not be suitable to include as a variable in the model due to the potential for individuals to receive more than one concession (for example unemployment benefit payments, rent assistance and a health care card). Concession passengers on public transport were also not available for testing in the model as data are not available for the majority of significant urban areas.

302 To test the Western Australia’s position that remoteness should be accounted for, dummy variables were constructed based on whether the urban area could be classified as a major city, inner regional, outer regional and remote/very remote area. The inclusion of both remoteness categories as a single variable was necessary due to the small number of urban areas included in either category. The estimated regression coefficients are provided below.

Table A-6 Impact of including characteristics of concession and student populations in the model

Variable	R2020 model coefficient	R2020 model – including concession groups	R2020 model – including remoteness categories
Intercept	-128.63	-83.90	-163.83
Ferry	13.86	9.52	5.61
Heavy rail passengers	12.31	12.37	13.83
Bus and light rail passengers	5.60	4.36	7.15
Population-weighted density	0.085	0.088	0.086
Mean slope	6.92	8.45	7.34
Distance to work	3.07	3.73	3.48
Percentage of unemployed persons		7.23	
Percentage of students		-1.22	
Percentage of elderly (>65)		-2.36	
Inner regional			22.87
Outer regional			23.46
Remote and very remote			39.13
Adjusted R-squared	0.8303	0.8254	0.8241
Residual standard error	56.43	57.02	57.23

Note: The 2013–14 to 2015–16 net expenses data collected for the 2020 Review were used to estimate the model. 2016 census journey to work data and 2016 Geoscience data were used to estimate the models. Density is based on SA1 areas to enable comparison with the 2020 Review. The 68 significant urban areas with available data were used in the regression.

303 Compared with the original model, the model including students and concession population groups does not provide reasonable estimates. It suggests areas with higher proportions of these groups need to spend less on transport services. In addition, the coefficients for all variables were not found to be statistically significant.

304 The reason for the negative coefficients relates to the fact that the urban areas with the highest concentrations of students, unemployed persons and elderly populations are outside the capital cities and thus have relatively low spending on urban transport services. While these passenger groups use services at a higher

rate during off-peak periods, the bulk of transport services and infrastructure needs are associated with peak commuter travel.

- 305 For the remoteness categories, although the signs are positive as expected, they are not significant. This indicates that the differences between spending in regional or remote areas are not sufficiently large to warrant separate variables.