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The road to recovery from COVID-19 for Australian tourism

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The road to recovery from COVID-19 for Australian tourism

Abstract

COVID-19 has had a devastating effect on many industries around the world including tourism, and policy makers are interested in mapping out what the recovery path will look like. In this paper we focus on Australian tourism, analysing international arrivals and domestic flows. Both sectors have been severely affected by travel restrictions in the form of international and interstate border closures and regional lockdowns. We use statistical models of historical data to generate COVID-free counterfactual forecasts pretending that the pandemic never occurred. We also use survey responses from 443 tourism experts to generate scenario-based probabilistic forecasts for pessimistic, most-likely and optimistic paths to recovery. Using both sets of forecasts, we estimate the expected effect of the pandemic on the Australian tourism industry.

Keywords: Forecasting, judgemental, probabilistic, scenarios, survey.

1 Background

Tourism around the world has seen tremendous growth over the last few decades. The World Tourism Barometer January 2020 report (UNWTO 2020) had the headline "Growth in international tourist arrivals continues to outpace the economy", predicting a 3 to 4% growth in international arrivals worldwide in 2020. Similarly, Tourism Research Australia (TRA) reported that for 2017–2018 "Tourism Gross Domestic Product grew at 5.0% in real terms, much faster than the 2.8% growth reported for the economy as a whole." (Tourism Research Australia 2019).

The COVID-19 pandemic hit in late 2019 with several devastating effects. Immediate responses from governments were the partial or complete lockdown of cities, regions or even entire countries with international borders largely closed. Travel restrictions were also placed on borders within countries; such was the case for Australia with strict state border closures

in place for many months during 2020. Airlines were grounded and airports faced financial disaster (Maneenop & Kotcharin 2020; Forsyth, Guiomard & Niemeier 2020), hotels and the hospitality sector went into survival mode (Gursoy & Chi 2020), cafes and restaurants opted for either a delivery service or a complete shutdown, and many businesses relied on extended government support. News headlines such as "International border closures push businesses to the brink of collapse" became a regular feature, with the immediate future looking grim for many within the industry (Yang, Fang & Mantesso 2020).

From a statistical modelling and forecasting perspective, these disruptions cause unique challenges. The pandemic has meant that we cannot extrapolate the strong and persistent signals observed in historical tourism time series. The structural break is deep and the path to recovery remains extremely uncertain. Figure 1 shows the latest data (at the time of writing) for Australia. It highlights the devastating effect on inbound travel with international arrivals dropping to around 3,000 passengers per month (all Australian nationals returning to Australia) beginning from April 2000, down from a peak of 1.1 million international travellers in December 2019.

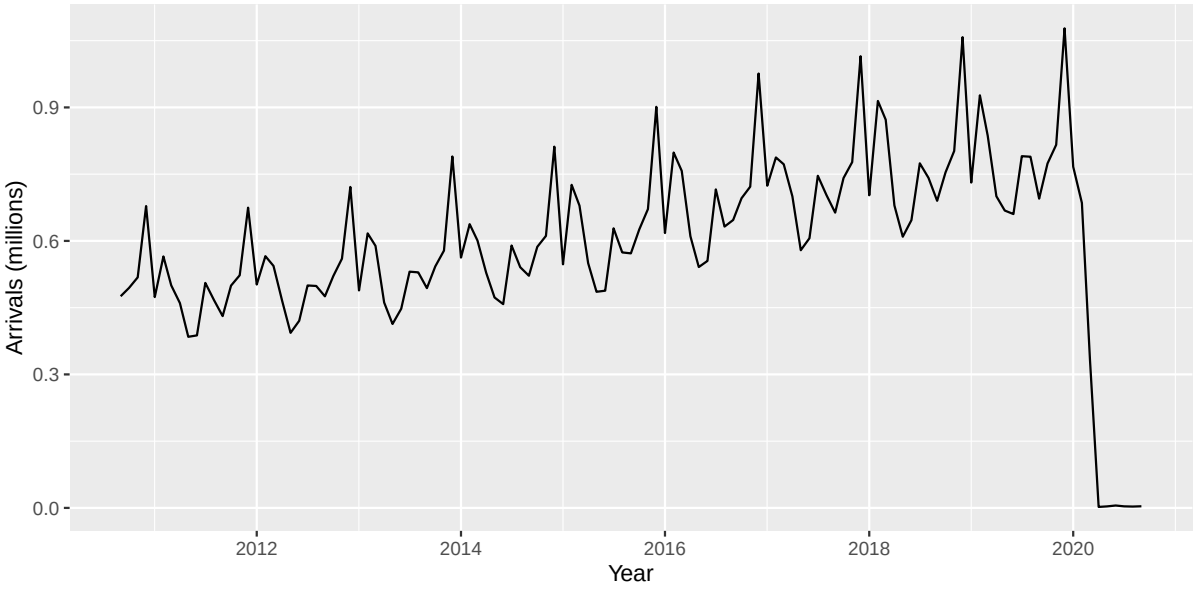

Figure 1: *Short-term international arrivals to Australia up to September 2020.*

Similar situations have been witnessed around the world (e.g., Airports Council International (ACI) Europe 2020; Richter 2020). Unlike many previous well-studied disruptions to tourism (for a comprehensive list see Bausch, Gartner & Ortanderl 2020), the COVID-19 pandemic has caused a simultaneous global disruption. This has meant that much of the existing literature on modelling and forecasting tourism demand has become irrelevant (see Song, Qiu & Park 2019, for the latest review). Even the literature that involves judgement is of limited assistance

(e.g., Song, Gao & Lin 2013; Lin, Goodwin & Song 2014) as it focuses on integrating statistical forecasts with judgement (Petropoulos, Fildes & Goodwin 2016; Arvan et al. 2019). The aim is to complement statistical forecasts with the domain knowledge of the experts via judgemental adjustments. However, at this stage the statistical signal for many components of tourism has been completely washed out.

To the best of our knowledge this paper is the first to generate scenario-based probabilistic forecasts following the onset of the COVID-19 pandemic. We concentrate on the two largest sectors of the Australian tourism industry: international arrivals and domestic tourism flows. Using historical data up to the end of 2019, we generate counterfactual "COVID-free" forecasts. The robustness and accuracy of these forecasts is evaluated against the historical data. These set a baseline expectation for what would have been had COVID-19 not occurred.

Using survey responses from experts we also generate scenario-based judgemental probabilistic forecasts for Australian tourism. The survey responses come from tourism experts within the industry drawing on first-hand experience and knowledge. We have designed the survey in order to cover market segments that are of interest to the policy maker and are expected to show diverse behaviour. The expectation is that different segments of tourism will be affected differently and will recover at different rates.

The remainder of the paper is structured as follows. Section 2 explores historical data together with the counterfactual COVID-free forecasts for both international arrivals and domestic flows for the Australian tourism sector. Section 3 presents details of the survey design and the survey participants. Scenario-based probabilistic forecasts are presented and analysed in Sections 4 and 5 for international arrivals and domestic tourism flows, along with various segments of these markets. Some discussion follows in Section 6.

2 Sectors, historical data and counterfactual forecasts

We concentrate on international arrivals and domestic tourism flows. The effect of COVID-19 is such that historical data cannot be used to project forward without accounting for the depth and length of the structural break caused by COVID-19, and the subsequent path to recovery.

However, analysing historical data gives us a good understanding of the trends and other important patterns within the Australian the tourism industry. Capturing these and projecting them into the future shows the expected paths of future tourism had COVID-19 never occurred. We label these as counterfactual 'COVID-free' forecasts.

We also use survey responses from experts to create scenario-based judgemental probabilistic forecasts that do take account of the impact of COVID-19 on the Australian tourism industry.

2.1 International arrivals

International arrivals data span the period 2005 Q1 – 2021 Q4 and include all arrivals to Australia. The source of this data is the Australian Bureau of Statistics (ABS) Catalogue 3401.0 covering overseas arrivals and departures data. The left column in Table 1 shows the nineteen source countries considered. In order to make the survey that follows in Section 3 operational, these are aggregated into six international 'Regions' of interest to the Australian tourism industry shown in the right column. Also of interest is the 'Purpose' of travel, as traveller behaviour and the impact of COVID-19 will vary across different purposes of travel. The purposes of travel for international arrivals to Australia are categorized as 'Holiday', 'VFR' (visiting friends are relatives), 'Education', 'Business' and 'Other'.

The quarterly time series for the overall aggregate, and the aggregates for regions and purposes of travel are shown in Figure 2, together with counterfactual forecasts. We present full

Table 1: *Source countries and regions for Australian international arrivals.*

Country	Region
China	China
Hong Kong	Other Asia
Thailand	
Malaysia	
Indonesia	
Singapore	
Japan	
South Korea	
India	
Other Asia	
United Kingdom	Europe
Germany	
France	
Other Europe	
New Zealand	New Zealand
United States	The Americas
Canada	
Middle East	Other World
Other World	

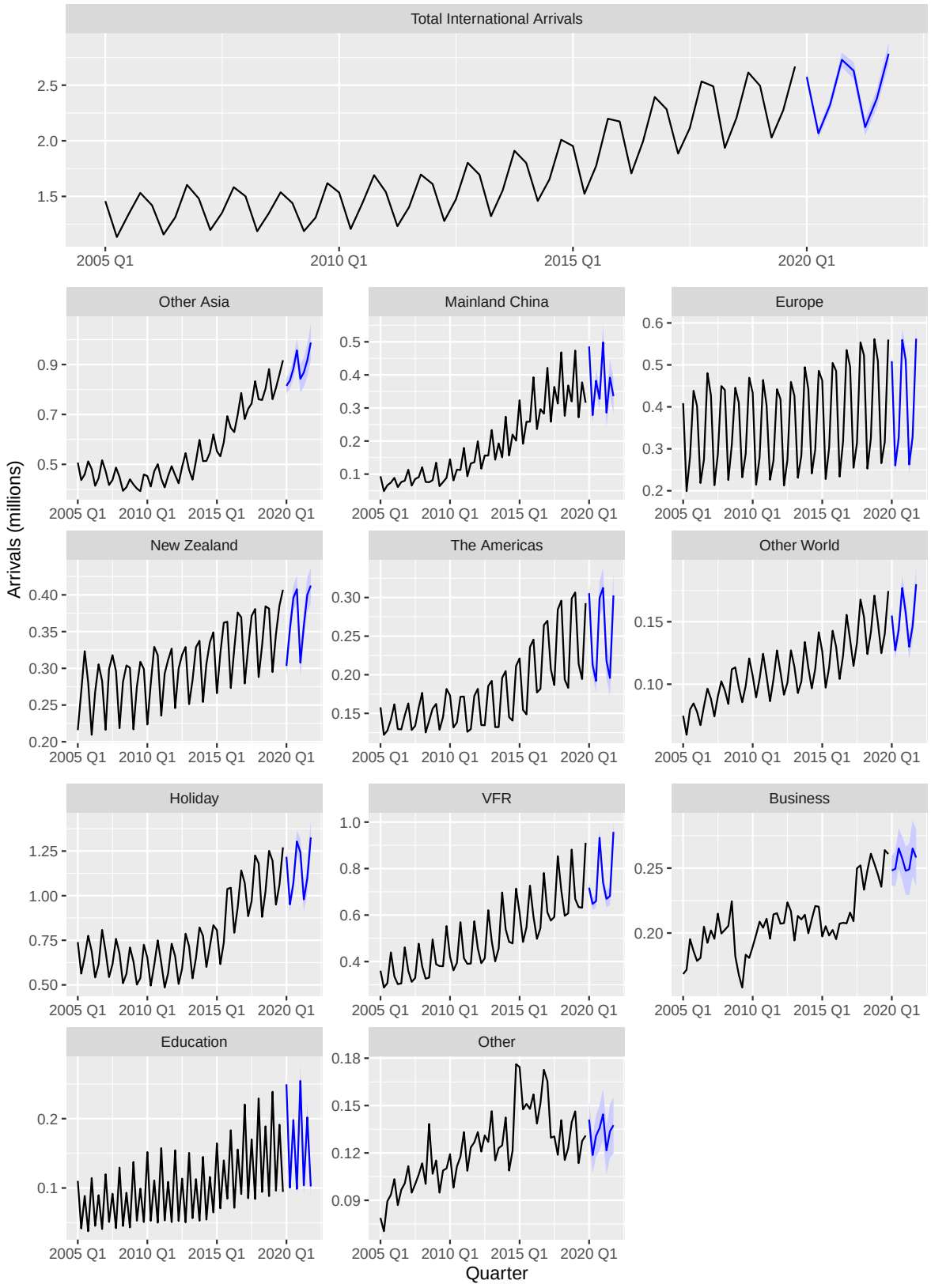

Figure 2: *Time series and counterfactual COVID-free forecasts for 2020–2021 for total international arrivals to Australia, and the same data disaggregated by state and by purpose of travel. The shaded regions correspond to 95% prediction intervals.*

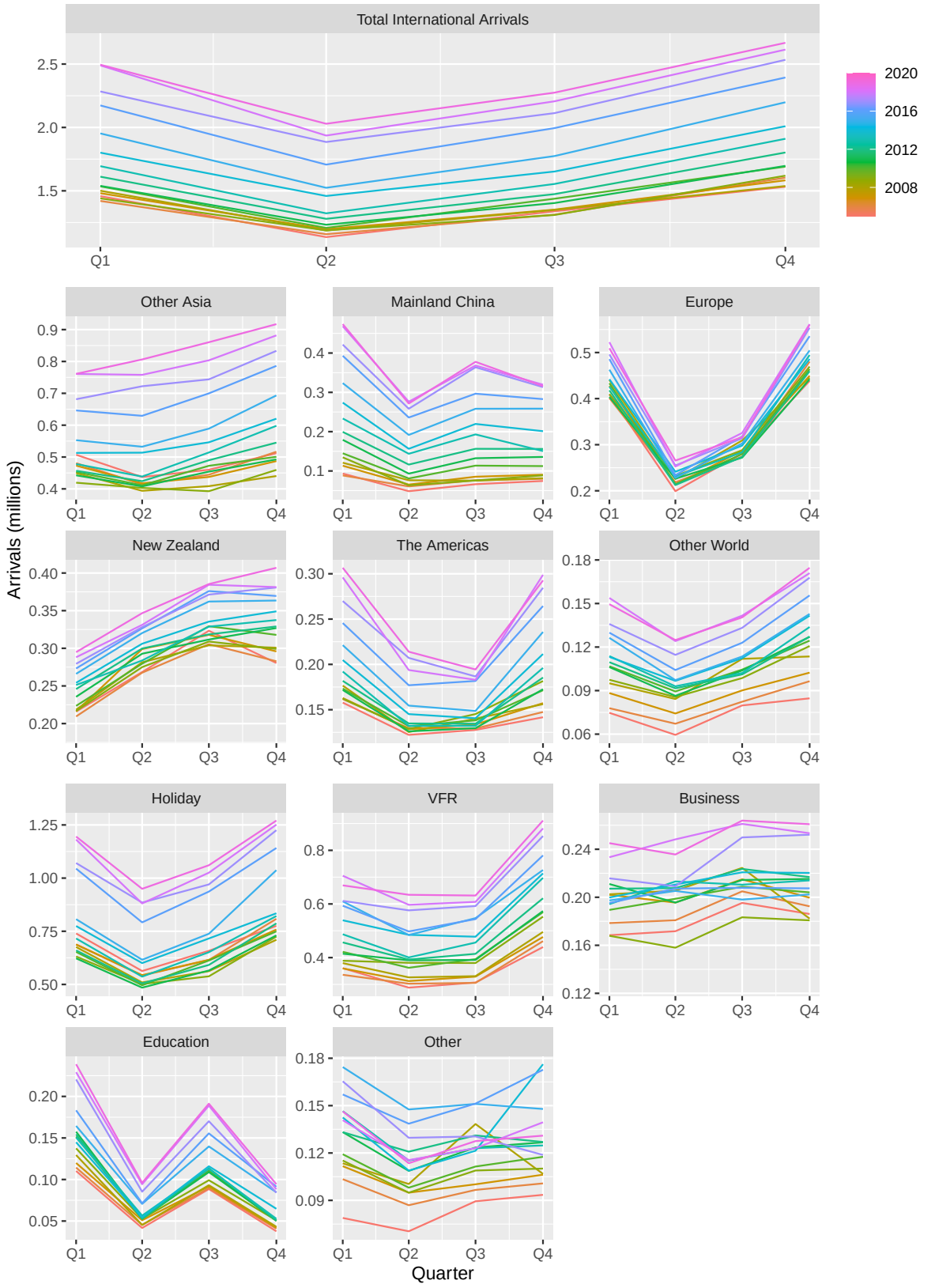

Figure 3: *Seasonal plots of total international arrivals to Australia, and the same data disaggregated by region and by purpose of travel.*

details of the process used in generating accurate and robust counterfactual forecasts in Appendix A. Some interesting and important observations emerge. International arrivals to Australia show a strong and consistent positive trend over the last few years. This is captured and projected in the counterfactual forecasts. An anomaly appears in the 'Business' and 'Other' series; there seems to be a direct substitution or redefinition between 'Business' and 'Other' travel in 2017 Q2, with an abrupt upward shift in the former matched by a downturn shift of equal size in the latter.

All arrivals also display a strong seasonal component which is reflected in the counterfactual forecasts. In almost all cases, this component appears to be multiplicative in nature, so that seasonal deviations increase proportionally to the increasing level of the series.

Figure 3 is a seasonal plot (Hyndman & Athanasopoulos 2021) providing a more detailed view of the seasonal patterns. 'Holiday' and 'VFR' seem to be the main drivers of the seasonality in the aggregate series as well as for 'The Americas', Europe and the 'Other World' series. For these series, peaks are observed in Q1 and Q4, which includes the summer period in Australia.

In contrast, the 'Education' series shows peaks in Q1 and Q3 corresponding to the beginning and the mid-point of the academic year in Australia. This seems to be the main source driving arrivals from Mainland China. One region showing asynchronous seasonality with the rest of the world is New Zealand with troughs in Q1 and peaks in Q3.

2.2 Domestic visitor nights

We consider 'visitor nights' across Australia as a measure of domestic tourism flows. The data are provided by the National Visitor Survey and are collected through telephone interviews from an annual sample of 120,000 Australian residents aged 15 years and older. The sample spans the period 1998 Q1–2021 Q4. We disaggregate these into the eight Australian states and territories, and four purposes of travel.

Figure 4 shows time plots and counterfactual forecasts for the aggregate, across each of the states and territories and for each purpose of travel. As with international arrivals, we present full details of the process implemented in generating accurate and robust counterfactual forecasts in Appendix A. The states show positive consistent trends since 2012, and these are reflected in the counterfactual forecasts. There appear to be some structural breaks in the series for the Northern Territory and Western Australia, perhaps due to changing definitions

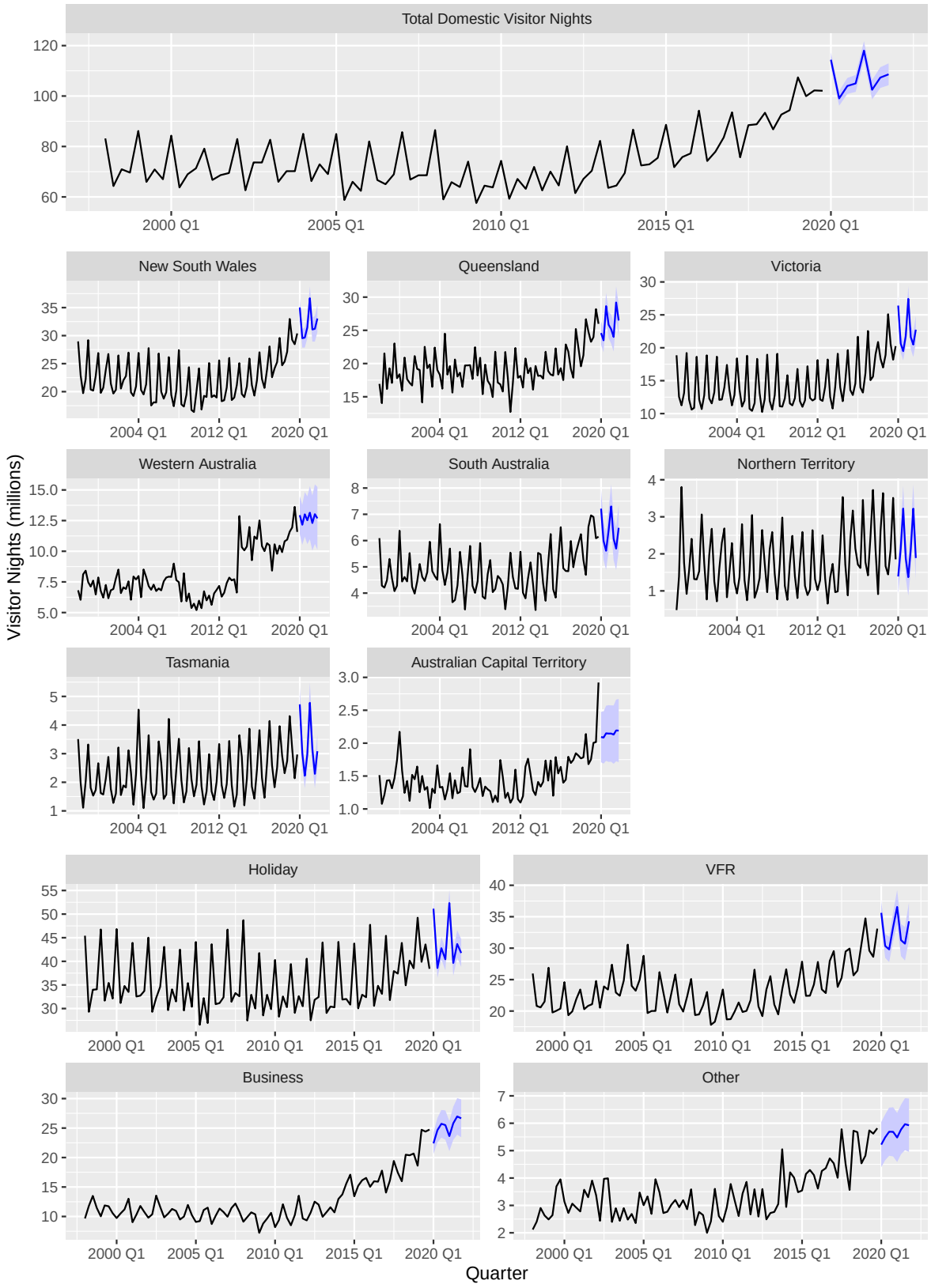

Figure 4: *Time series and counterfactual COVID-free forecasts for 2020–2021 for total Australian domestic visitor nights, and the same data disaggregated by state and by purpose of travel. The shaded regions correspond to 95% prediction intervals.*

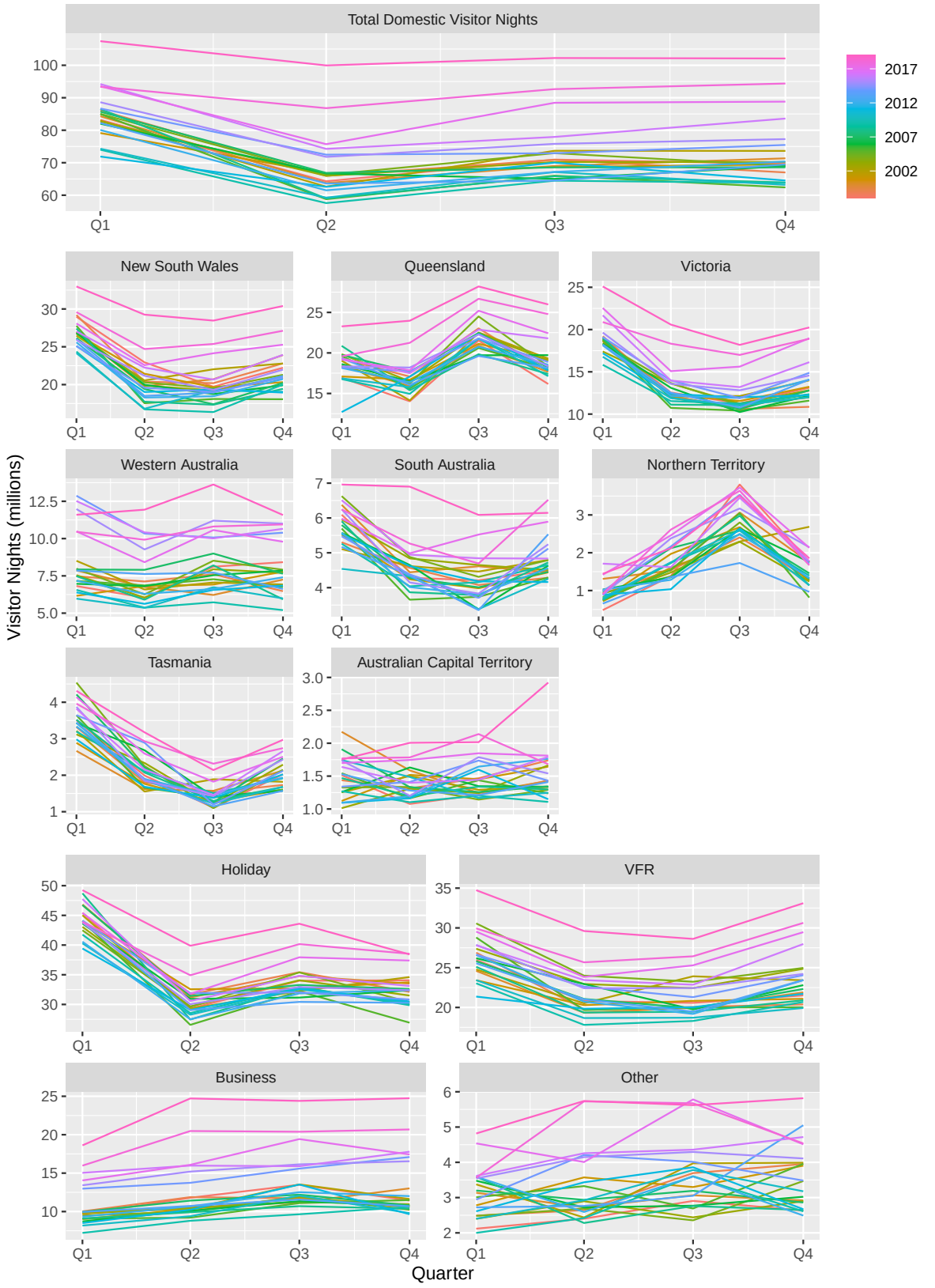

Figure 5: *Seasonal plots of total Australian domestic visitor nights, and the same data disaggregated by state and by purpose of travel.*

or data recording practices. All series by purpose of travel also show significant positive trends over the last few years.

All series show seasonal variations which are also reflected in the counterfactual forecasts. Figure 5 shows seasonal plots for each series. These highlight the variations in seasonal patterns, especially between the northern regions (Queensland and the Northern Territory) and between the southern regions (New South Wales, Victoria, South Australia and Tasmania). The northern regions have a tropical climate with the drier and cooler season of Q3 attracting the largest tourism flows. The southern regions are temperate, and attract the largest tourism flows in Q1 during the summer season.

3 Survey design and participants

In order to generate scenario-based probabilistic forecasts, we surveyed tourism experts asking them to provide judgement on the future of both international arrivals to Australia and domestic visitor nights. The survey took place during the month of September 2020 and there were 443 participants with valid responses. The survey comprised only eleven questions ensuring that it was engaging and manageable for participants. In the following sections we summarise and analyse the key results. The complete survey design and questionnaire is presented in Appendix B.

Question 1: *Which sector best describes your organisation?*

The sector distribution from which the participants came is shown in Figure 6. The left panel shows that the largest proportion of participants came from 'Industry', followed by 'Government'. The breakdown within each sector is shown in the right panel.

Question 2: *How many people are currently employed by your organisation?*

Figure 7 shows the size distribution of employer organisations for the respondents. Small industry businesses are well represented in the sample as well as larger government organisations.

Question 3: *How does this employment figure compare with the start of 2020?*

Figure 8 shows the change in the numbers employed in the organisations compared to the beginning of 2020, hence just pre-COVID-19. The top panel shows the distributions collectively. The most common response seems to be a 0–10% decrease followed by a 0–10% increase.

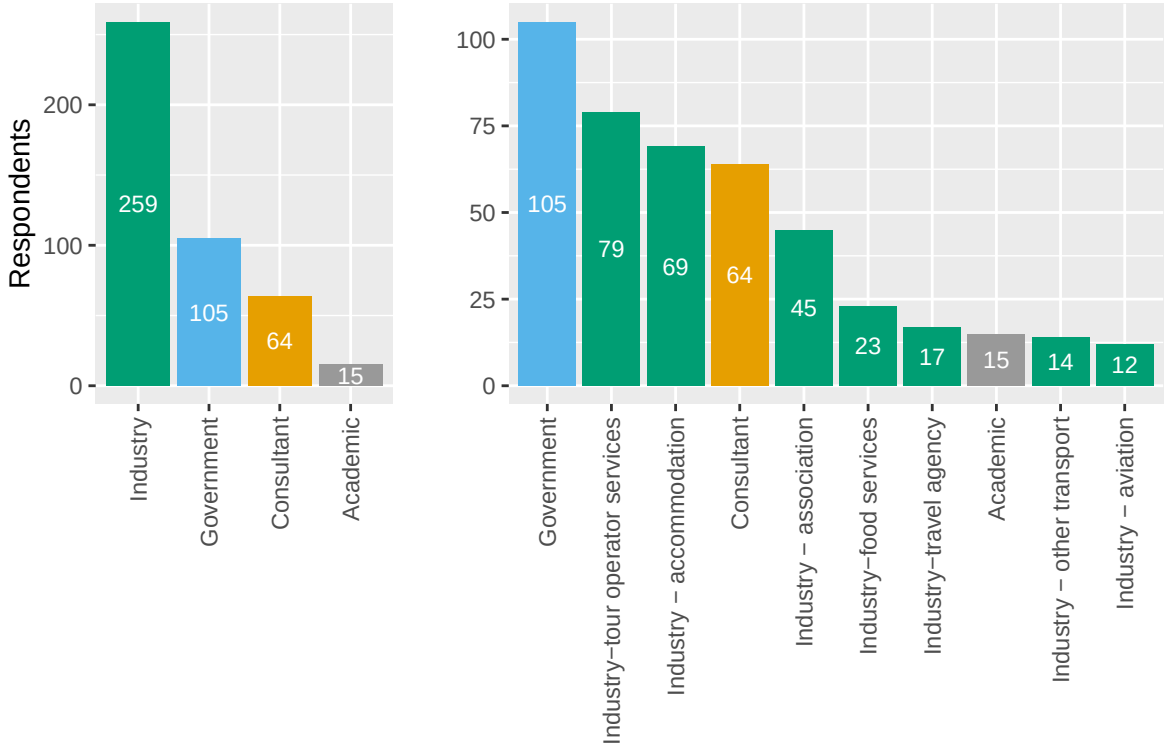

Figure 6: *Which sector best describes your organisation?*

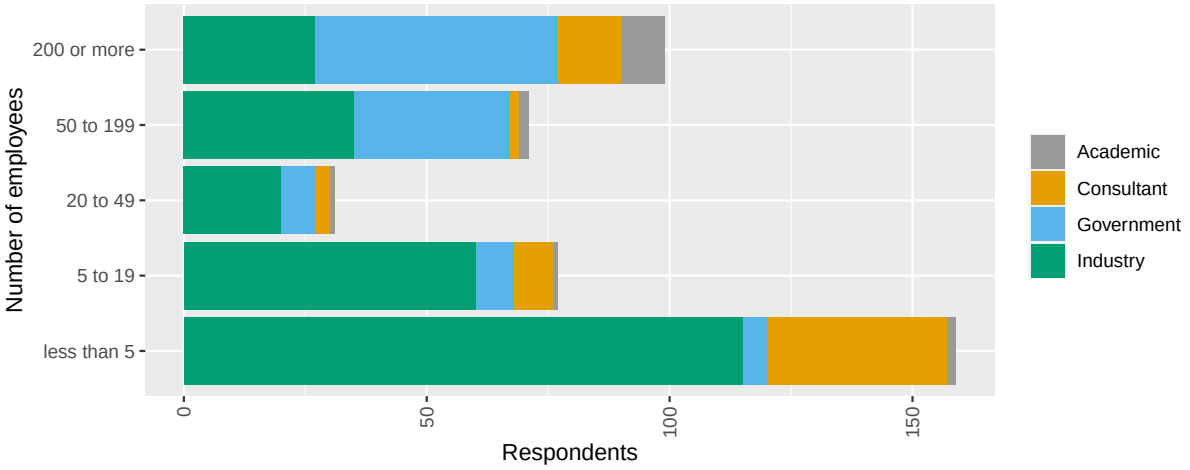

Figure 7: *How many people are currently employed by your organisation?*

Hence, overall it is most common to observe a change of up to 10% in absolute value. However, there is a long left tail to this distribution with mostly small businesses (fewer than 20 employees) taking the biggest hit. The bottom panels break this down by sector and show that most of the decreases come from organisations labelled as 'Industry' or 'Consultant', with the 'Government' sector not being significantly affected outside the 10% change range.

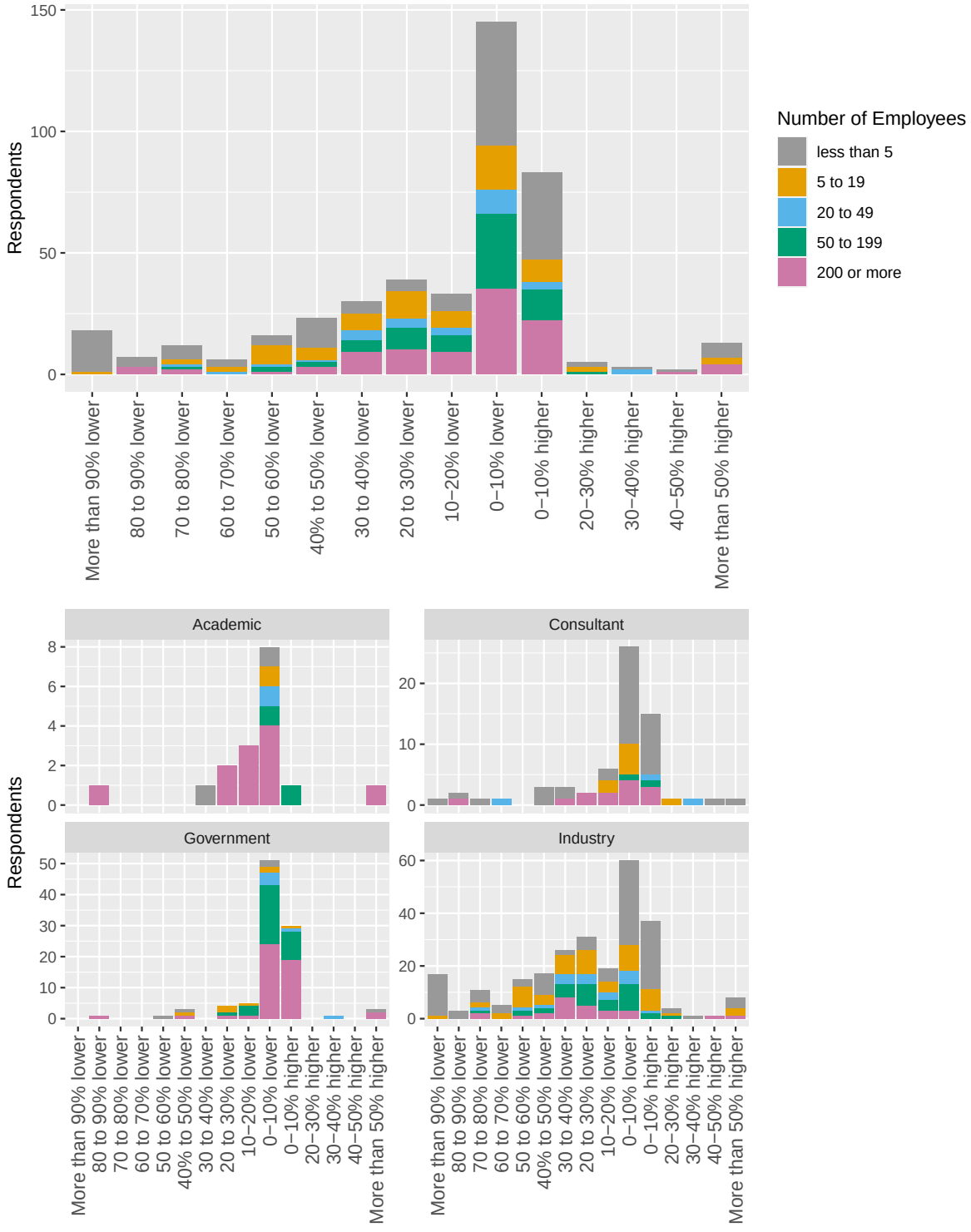

Figure 8: *How does the number of people employed in your organisation compare with the start of 2020?*

4 Scenario-based probabilistic forecasts for international arrivals

We describe the process of mapping the survey responses to scenario-based forecast distributions by presenting a detailed example for international arrivals for *Question 4*. The process is repeated for other markets and segments.

Question 4: *What will the level of international arrivals to Australia be in 2021 Q4 compared to 2021 Q4?*

Each respondent was asked to provide a high probability 'Most likely' scenario, as well as low probability 'Pessimistic' and 'Optimistic' scenarios. The top three rows of Figure 9 show bar plots and estimated probability densities of the responses for what the level of international arrivals will be in 2021 Q4 compared to the last observed quarter of 2021 Q4. The bar plots have been scaled to form probability densities, with the bar height adjusted according to the width of the corresponding interval and scaled to have area equal to 1.

We convert the discrete categories for Question 4 (as shown in the left column of Table 2) into the scaling factors shown in the right column of the same table, using the midpoint of each range. For example, a response of "Lower 90–100%" means that the respondent thinks that international arrivals in 2021 Q4 will be between 90% and 100% lower than they were in 2021 Q4. We convert this to the midpoint of "95% lower", or equivalently at 5% of what they were in 2021 Q4 giving a scaling factor of 0.05.

This gives us a discrete probability distribution, which we then convert into a continuous distribution by summing zero-truncated Gaussian kernels (Jones 1993) placed at each point

Table 2: *Scaling factors to convert survey scenario categorical responses to a continuous distribution.*

Category	Factor
Lower 90-100%	0.05
Lower 70-90%	0.20
Lower 50-70%	0.40
Lower 30-50%	0.60
Lower 10-30%	0.80
Lower 0-10%	0.95
Higher 0-10%	1.05
Higher 10-30%	1.20
Higher 30-50%	1.40
Higher than 50%	1.60

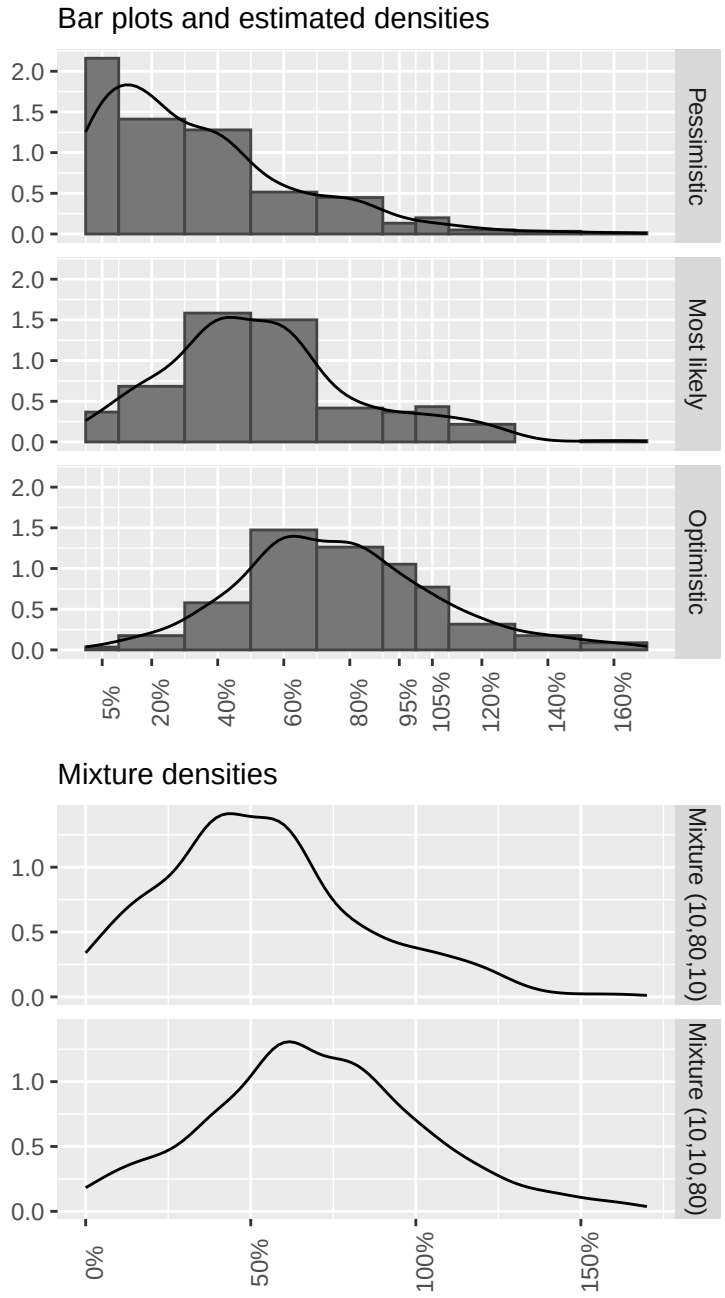

Figure 9: *Scenario-based forecast distributions for international arrivals for 2021 Q4 compared to 2021 Q4, assuming international borders reopen in mid-2021. The horizontal scale represents the scaling factor applied to 2021 Q4 arrivals in order to estimate forecast distributions for 2021 Q4.*

mass. A zero-truncated Gaussian kernel is used to ensure the distribution lies on the positive scale. The bandwidth is set to 0.1, which seems to work well for the available categories. These kernel density estimates are shown as the lines in the first three panels of Figure 9. They effectively combine neighbouring options to give a smooth density across all possible scaling factors.

We next combine the three scenarios to form a weighted mixture distribution, shown in the fourth row of Figure 9. The weights used to combine the three scenarios are 0.1, 0.8, and 0.1; that is, we give the 'Most likely' scenario an 80% probability of occurring and just 10% each for the other two highly unlikely scenarios. Combining the three scenarios using a mixture distribution accounts for both the uncertainty across the respondents and across each scenario.[1]

Our approach would also allow a policy maker to weight the scenarios asymmetrically as the circumstances change going forward. For example, if we are getting closer to a vaccine, we may choose to put more weight on the 'Optimistic' scenario by setting the weights to 0.1, 0.1, 0.8 for 'Pessimistic', 'Most likely' and 'Optimistic' scenarios respectively. The resulting mixture is shown in the fifth row of Figure 9. The choice of weights may be worth exploring further in future research as the circumstances surrounding the COVID-19 pandemic change.

Applying the estimated scaling factor density to the actual 2021 Q4 value, we produce scenario-based forecasts from the survey responses. That is, we multiply the actual 2021 Q4 value by the scaling factor densities shown in Figure 9. The resulting scenario-based forecast distributions are shown in Figure 10, together with the path and the distributions of the COVID-free counterfactual forecasts. This plot provides a good understanding of the locations of the distributions relative to the counterfactual forecasts and the last observed value, as well as an excellent visual on the differences between the distributions. Note that the counterfactual forecast distribution has been truncated in order to assist with visualisation. The figure also highlights the substantial difference in the uncertainty between the scenario-based forecasts under COVID-19 and the counterfactual COVID-free forecasts for 2021 Q4.

Some specific statistics of interest are presented in Table 3. By comparison, the value of 2021 Q4, the last pre-COVID-19 quarter, is 2.67. Under the 'Mixture (10,80,10)' distribution, the median forecast value for 2021 Q4 shows 1.30 million arrivals. This is a predicted decrease

[1] All estimations are performed in R version 4.0.3. (R Core Team 2020). Truncated Gaussian Kernels are estimated using the `truncdist` package (Novomestky & Nadarajah 2016), and the mixture distributions are estimated using the `distributional` package (O'Hara-Wild & Hayes 2020).

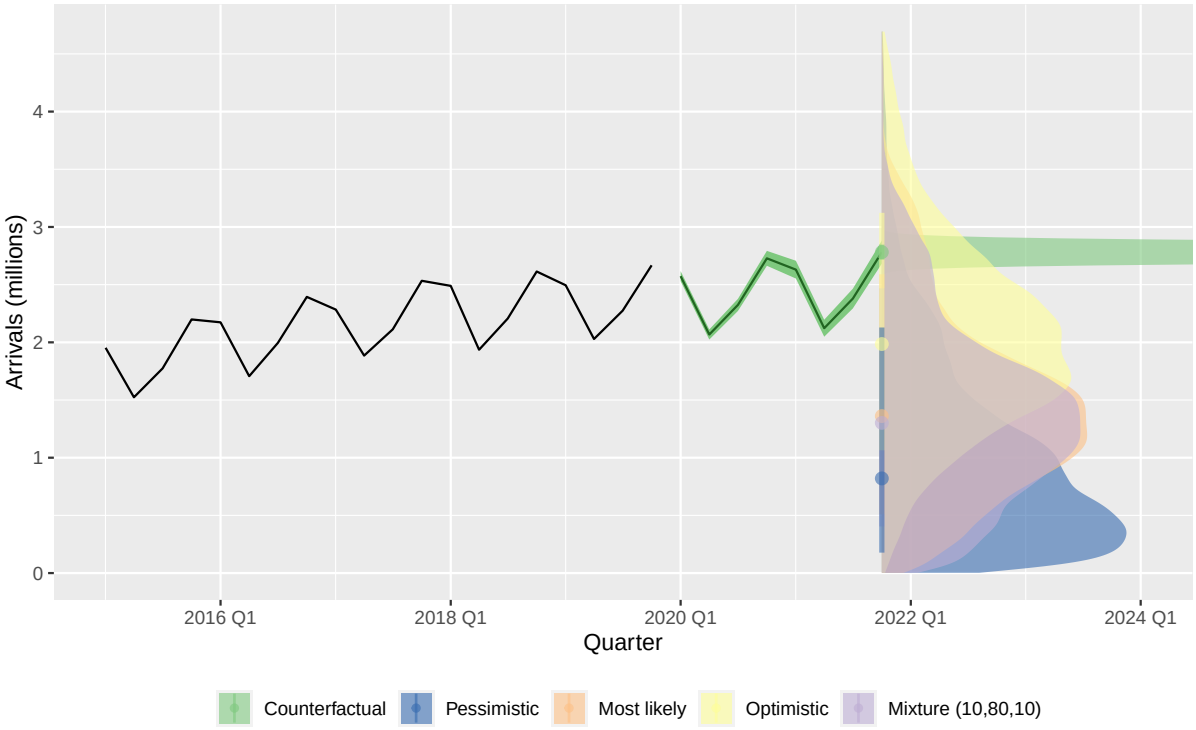

Figure 10: *Scenario-based and coutnerfactual COVID-free forecast distributions for international arrivals to Australia for 2021 Q4.*

Table 3: *Scenario-based and counterfactual COVID-free forecasts for international arrivals to Australia in (millions) for 2021 Q4. The observed value for 2019 Q4 is 2.67*

Scenario	Mean	Median	80%	95%
Counterfactual	2.78	2.78	[2.72, 2.85]	[2.68, 2.88]
Pessimistic	1.00	0.82	[0.18, 2.13]	[0.05, 2.97]
Most likely	1.45	1.36	[0.51, 2.59]	[0.19, 3.24]
Optimistic	2.05	1.99	[1.06, 3.12]	[0.56, 3.91]
Mixture (10,80,10)	1.37	1.30	[0.40, 2.47]	[0.13, 3.07]
Mixture (10,10,80)	1.70	1.69	[0.44, 2.84]	[0.12, 3.52]

of 51% compared to 2021 Q4, instead of a 4% increase shown by the counterfactual COVID-free forecast value. The 80% prediction interval for the same 'Mixture (10,80,10)' distribution scenario returns a range for the decrease in international arrivals between 7% and 85%. The width of the prediction interval further highlights the tremendous uncertainty of the future of international arrivals after the COVID-19 pandemic has hit, compared to the tightness of the counterfactual COVID-free 80% prediction interval which shows an increase between 2% and 7%.

Question 5: *In what year do you think international visitor numbers will return to 2019 levels?*

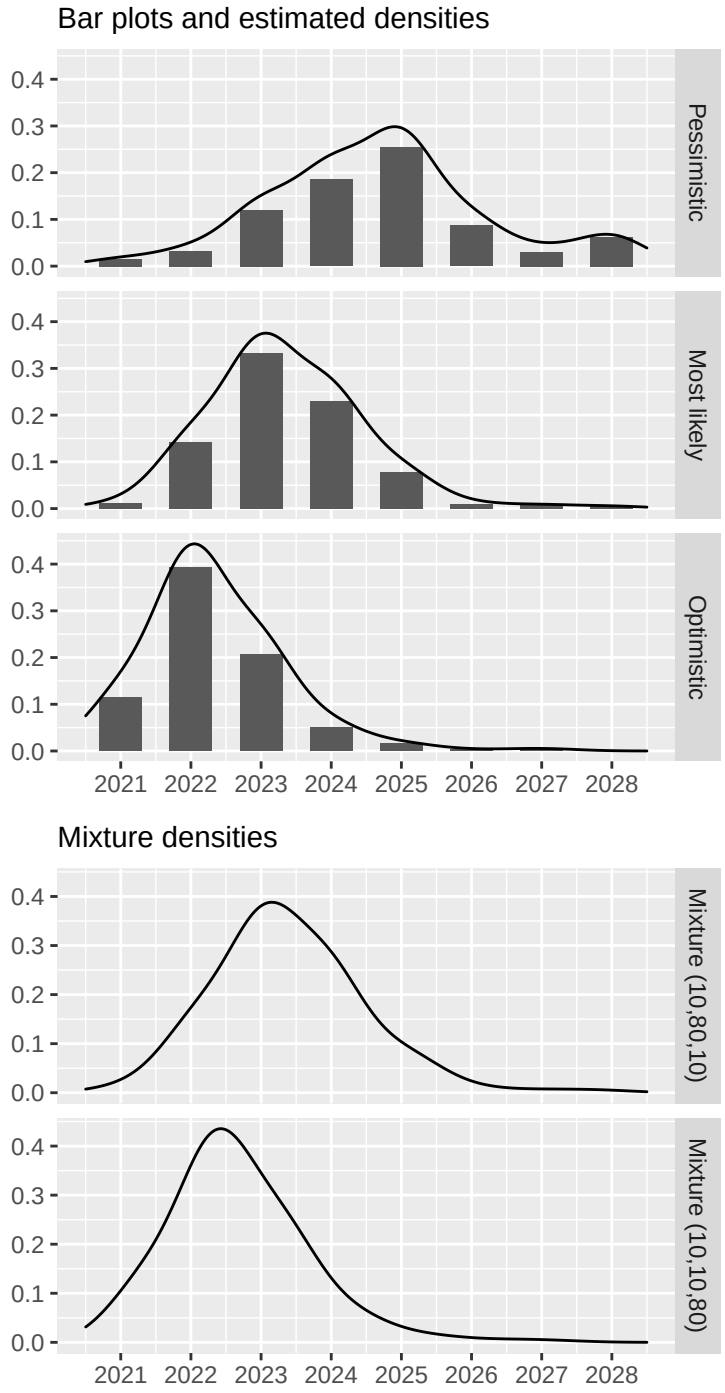

Figure 11: *Year that international arrivals will recover to 2019 levels.*

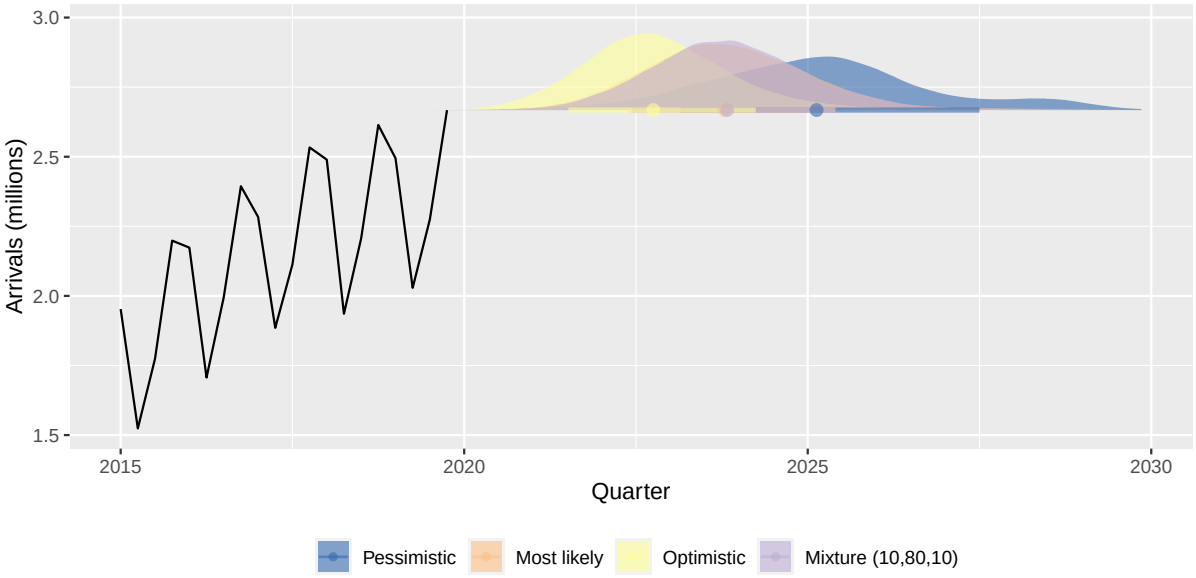

Figure 12: *Scenario-based forecast distributions for year of recovery for international arrivals.*

Figure 11 shows the raw responses, kernel density estimates (bandwidth 0.6), and the estimated mixture distributions for when respondents anticipate international arrivals to recover to 2021 Q4 levels. Figure 12 plots the estimated distributions across the time axis for international arrivals. The plot shows the contrasts between the distributions for the different scenarios as the peak of the estimated densities moves further into the future as the scenario moves from 'Optimistic' to 'Most likely' to 'Pessimistic'. Table 4 shows some specific statistics of interest. The median recovery quarter varies from 2022 Q4 in the 'Optimistic' scenario to 2025 Q1 in the 'Pessimistic' scenario. The median recovery quarter for the 'Mixture (10,80,10)' distribution is 2023 Q4 with the 80% prediction interval showing as lower bound 2022 Q2 and upper bound 2025 Q2.

Table 4: *Recovery scenarios for international arrivals*

Scenario	Mean	Median	80%	95%
Pessimistic	2025 Q1	2025 Q1	[2023 Q1, 2027 Q3]	[2022 Q1, 2028 Q4]
Most likely	2023 Q4	2023 Q4	[2022 Q2, 2025 Q2]	[2021 Q3, 2026 Q3]
Optimistic	2022 Q4	2022 Q4	[2021 Q3, 2024 Q1]	[2020 Q4, 2025 Q2]
Mixture (10,80,10)	2023 Q4	2023 Q4	[2022 Q2, 2025 Q2]	[2021 Q4, 2026 Q2]
Mixture (10,10,80)	2023 Q1	2023 Q1	[2021 Q4, 2024 Q3]	[2021 Q1, 2025 Q3]

Questions 6 & 7: *In what year do you think international visitor numbers for the following markets will return to 2019 levels? Please provide estimates only for the most likely scenario.*

In order to keep the respondents engaged and the survey manageable, respondents were required to provide estimates only for the 'Most likely' scenario for the markets segmented

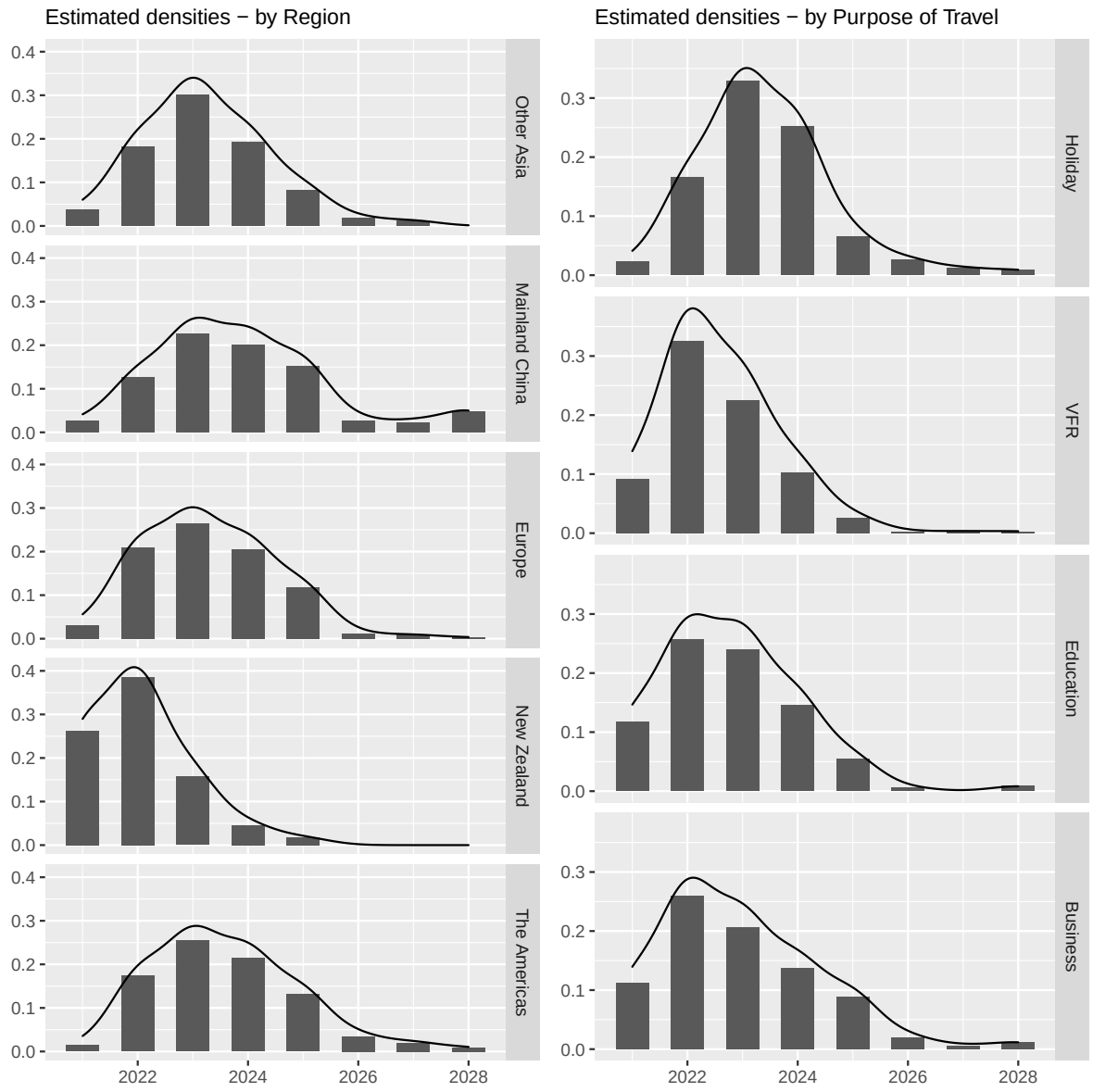

Figure 13: *Year that international visitor numbers for the following segments will return to 2019 levels.*

by the five international 'Regions' as shown in Table 1 and for the 'Purposes' of travel. The bar plots of the raw responses and fitted kernel density estimates (bandwidth = 0.5) are presented in Figure 13. Table 5 shows some specific statistics of interest. The results show that the respondents have selected New Zealand as the international arrivals source that will recover the quickest with median predicted quarter of full recovery 2022 Q2. Mainland China is selected to be the slowest to recover, with median predicted quarter of full recovery 2024 Q1. In terms of purpose of travel the results show that 'Holiday' travel will be the slowest to recover with median predicted quarter of full recovery 2023 Q4, with 'VFR' the quickest to

recover with median predicted quarter of full recovery 2022 Q4 Of course, there is high uncertainty surrounding these point predictions as indicated by the width and the asymmetry of the prediction intervals with most distributions showing a very long right tail.

Table 5: *Recovery scenarios for international markets*

	Mean	Median	80%	95%
International Regions				
Other Asia	2023 Q3	2023 Q3	[2022 Q1, 2025 Q2]	[2021 Q2, 2026 Q3]
Mainland China	2024 Q2	2024 Q1	[2022 Q2, 2026 Q3]	[2021 Q3, 2028 Q3]
Europe	2023 Q4	2023 Q3	[2022 Q1, 2025 Q3]	[2021 Q2, 2026 Q3]
New Zealand	2022 Q3	2022 Q2	[2021 Q1, 2024 Q1]	[2020 Q3, 2025 Q1]
The Americas	2024 Q1	2023 Q4	[2022 Q2, 2025 Q4]	[2021 Q3, 2027 Q2]
Purpose of Travel				
Holiday	2023 Q4	2023 Q4	[2022 Q2, 2025 Q3]	[2021 Q3, 2027 Q1]
VFR	2023 Q1	2022 Q4	[2021 Q3, 2024 Q3]	[2020 Q4, 2025 Q3]
Business	2023 Q2	2023 Q2	[2021 Q3, 2025 Q3]	[2020 Q4, 2026 Q4]
Education	2023 Q2	2023 Q1	[2021 Q3, 2025 Q1]	[2020 Q4, 2026 Q1]

5 Scenario-based probabilistic forecasts for domestic visitor nights

We follow the same approach as was used for international arrivals in analysing forecasts for domestic visitor nights.

Question 8: *What will the level of domestic visitor nights be in 2020 Q4 and 2021 Q4 compared to 2019 Q4?*

The left column of Figure 14 shows bar plots and estimated densities for the survey responses for 2020 Q4 while the results for 2021 Q4 are shown in the right column. The rows summarise the results for the 'Pessimistic', 'Most likely' and 'Optimistic' scenarios as well as the 'Mixture (10,80,10)' distribution. The peak of the 'Mixture (10,80,10)' distribution shows approximately 50% of the domestic visitor nights will be maintained compared to 2021 Q4, while moving closer to full recovery for 2021 Q4.

The scenario-based forecast distributions as well as the paths and prediction intervals for the counterfactual COVID-free forecasts are shown in Figure 15. All scenarios show a substantial decrease compared to the counterfactual forecasts for both 2020 Q4 and 2021 Q4, apart from the 'Optimistic' scenario for 2021 Q4. The shapes of the forecast distributions reflect the

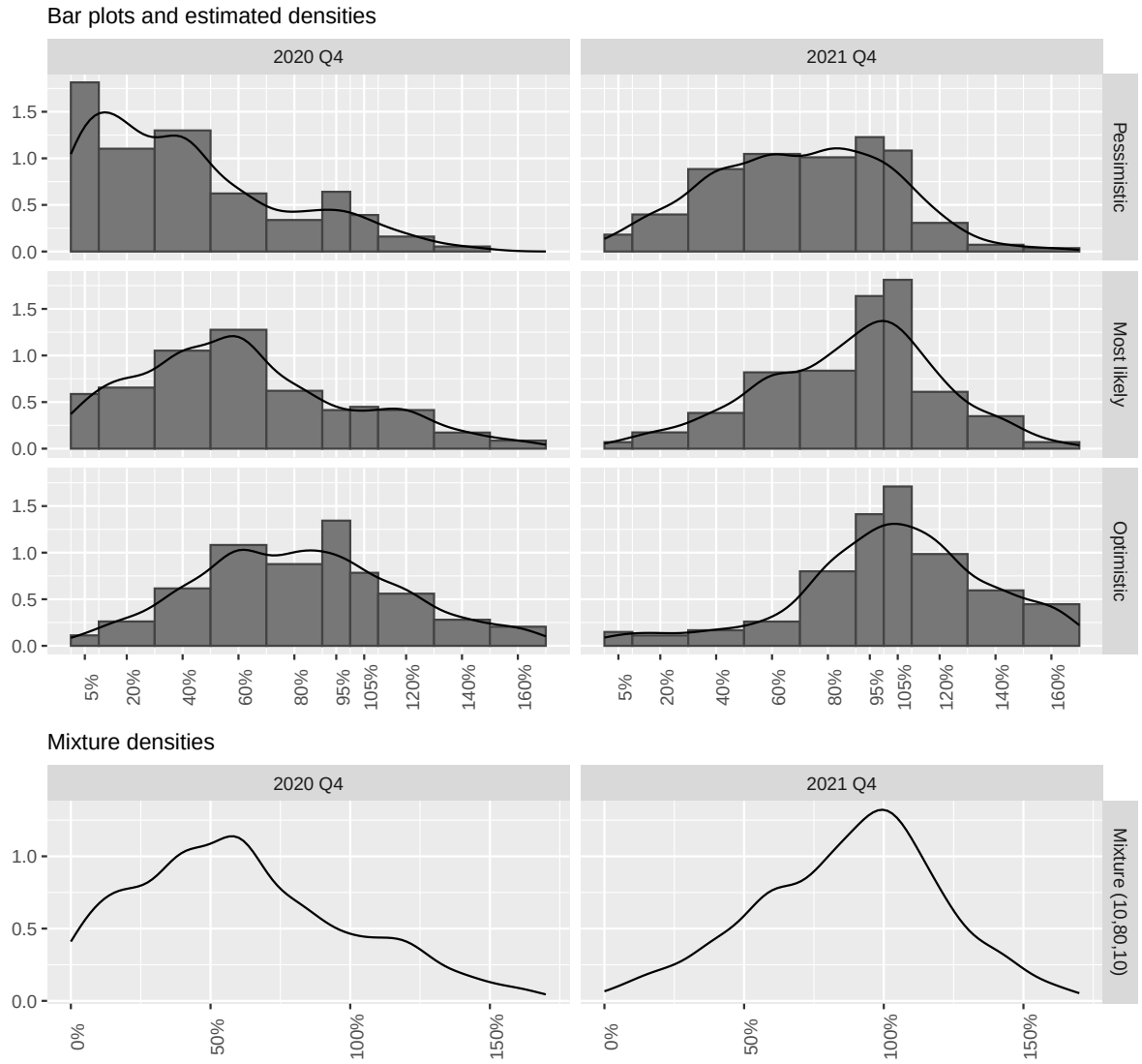

Figure 14: *Scenarios for domestic visitor nights for 2020 Q4 and 2021 Q4 compared to 2019 Q4. The x-scale for the fitted densities represents the scaling factor applied to domestic flow counts of 2019 Q4 in order to estimate forecast distributions for 2020 Q4 and 2021 Q4.*

tremendous uncertainty surrounding domestic tourism due to the COVID-19 pandemic when compared to the COVID-free counterfactual forecast distributions.

Figure 16 provides an interesting insight on the projections of the scenario based forecasts between the two years. The plot shows that the trends (both means and medians) projected between 2020 Q4 and 2021 Q4 are fairly consistent across the three scenarios and the mixture. It also shows the higher growth between the two years across all scenarios compared to the growth shown for the counterfactual COVID-free forecasts, anticipating a faster rate of recovery.

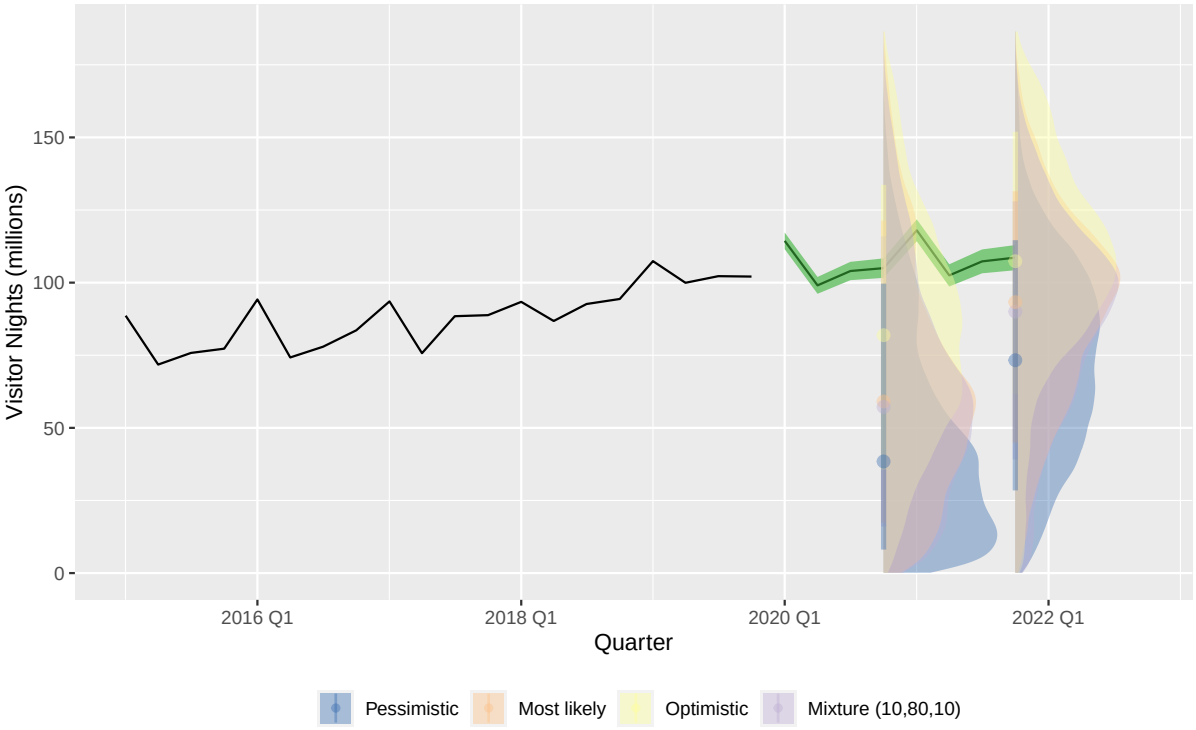

Figure 15: *Scenario-based and COVID-free counterfactual forecast distributions for Australia domestic visitor nights for 2020 Q4 and 2021 Q4*

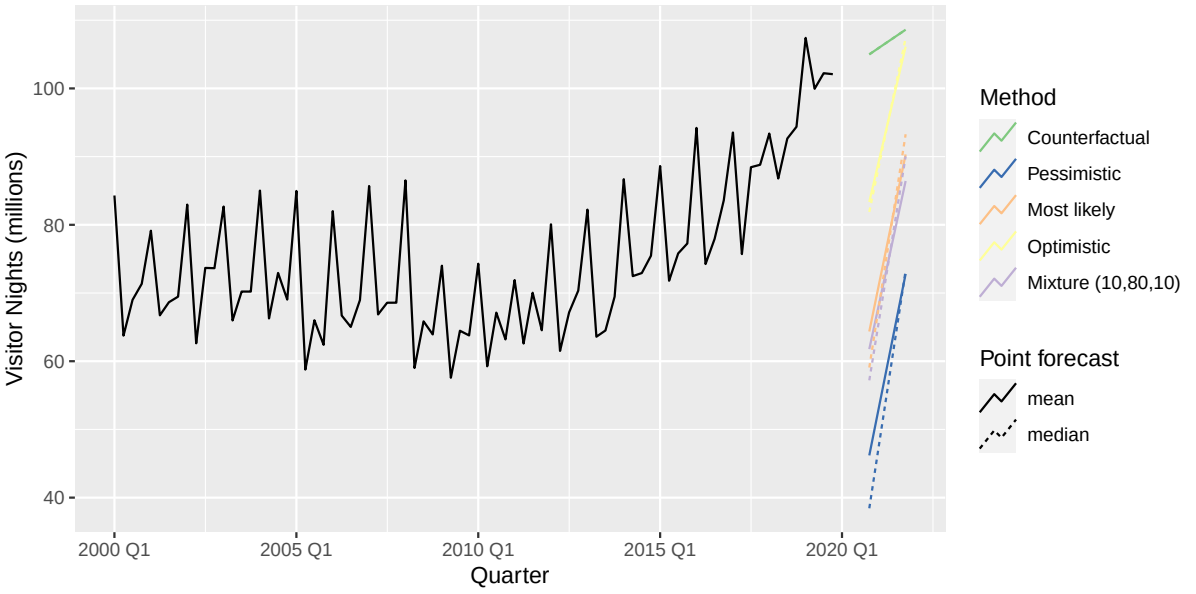

Figure 16: *Paths of projections for domestic visitor nights showing consistency in respondents*

Table 6 provides some specific statistics of interest. The median forecasts for the 'Mixture' distribution are 57.2 and 90.0 million visitor nights for 2020 Q4 and 2021 Q4 respectively. These show a decrease of 44% and 12% compared to projected increases of 3% and 6% for the counterfactual COVID-free forecasts. Hence, the expectation for domestic tourism seems to be that after the deep hit of 2020, there will be a rapid recovery for 2021 although one should always keep in mind the considerable width of the prediction intervals. Specifically, the 80% interval for the 'Mixture' distribution shows decreases ranging between 84% and 14% for 2020 Q4. For 2021 Q4, the lower bound shows a decrease of 62% while the upper bound increases by 25%.

Table 6: *Scenario-based and counterfactual COVID-free forecasts for Australian domestic visitor nights in (millions) for 2020 Q4 and 2021 Q4. The observed value for 2019 Q4 is 102.09 .*

Quarter	Scenario	Mean	Median	80%	95%
2020 Q4	Counterfactual	104.99	104.99	[102.80, 107.19]	[101.64, 108.35]
2020 Q4	Pessimistic	46.19	38.44	[8.10, 99.66]	[2.30, 124.85]
2020 Q4	Most likely	64.36	59.08	[17.34, 121.36]	[5.70, 149.34]
2020 Q4	Optimistic	83.36	81.90	[35.62, 133.67]	[15.29, 161.28]
2020 Q4	Mixture (10,80,10)	61.77	57.20	[16.03, 115.92]	[5.20, 144.31]
2021 Q4	Counterfactual	108.61	108.61	[105.78, 111.44]	[104.28, 112.94]
2021 Q4	Pessimistic	72.80	73.29	[28.47, 114.62]	[11.38, 135.70]
2021 Q4	Most likely	90.32	93.28	[44.90, 131.47]	[20.95, 152.08]
2021 Q4	Optimistic	106.12	107.39	[61.68, 151.94]	[20.51, 169.55]
2021 Q4	Mixture (10,80,10)	86.43	90.02	[39.11, 128.03]	[12.19, 147.90]

Question 9: *In what year do you think domestic visitor nights will return to 2019 levels?*

Figure 17 shows the bar plots and the kernel density estimates for when respondents anticipate domestic visitor nights to recover to 2021 Q4 pre-COVID-19 levels. Figure 18 plots together the estimated densities across the time axis for visitor nights. The plot shows the contrasts between the distributions for the different scenarios as the peak of the estimated densities moves further into the future as the scenario moves from 'Optimistic' to 'Most Likely' to 'Pessimistic'.

Table 7 shows some specific statistics of interest. The median recovery quarter varies from 2021 Q4 for the 'Optimistic' scenario to 2023 Q2 for the 'Pessimistic' scenario. The median recovery quarter for the 'Mixture (10,80,10)' distribution is 2022 Q3 with the 80% prediction interval showing as lower bound 2021 Q2 and upper bound 2023 Q4.

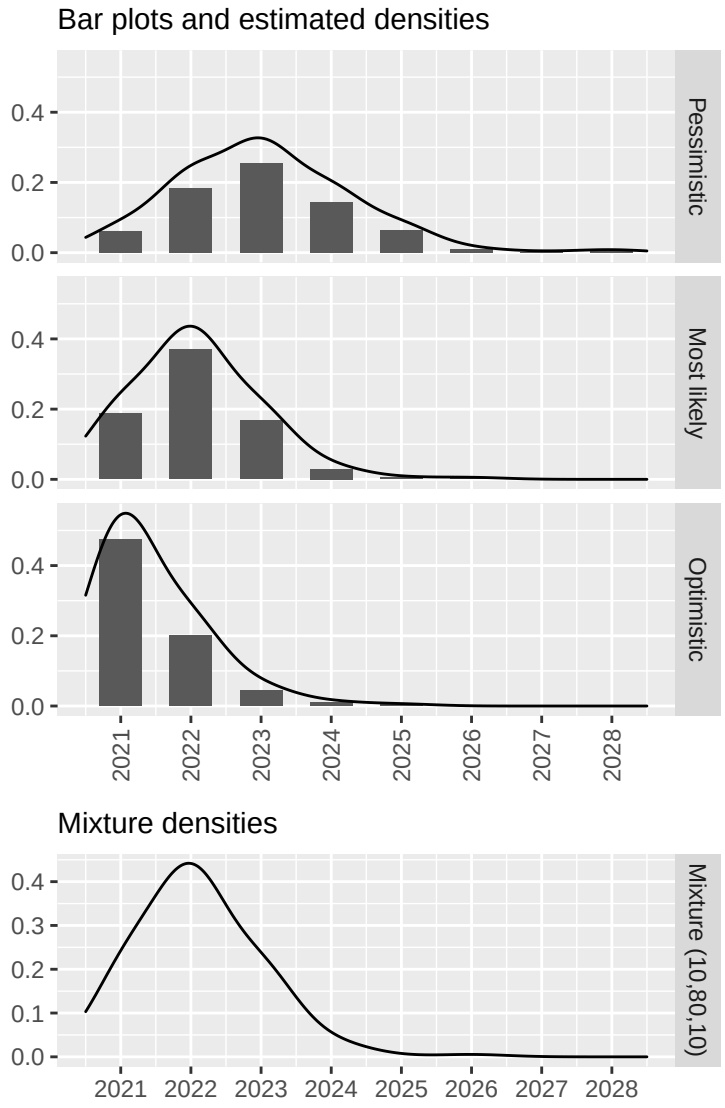

Figure 17: *Recovery scenarios for domestic visitor nights.*

Table 7: *Recovery scenarios for domestic visitor nights*

Scenario	Mean	Median	80%	95%
Pessimistic	2023 Q3	2023 Q2	[2021 Q4, 2025 Q2]	[2021 Q1, 2026 Q3]
Most likely	2022 Q3	2022 Q3	[2021 Q2, 2023 Q4]	[2020 Q3, 2024 Q4]
Optimistic	2021 Q4	2021 Q4	[2020 Q4, 2023 Q1]	[2020 Q2, 2024 Q1]
Mixture (10,80,10)	2022 Q3	2022 Q3	[2021 Q2, 2023 Q4]	[2020 Q4, 2024 Q4]

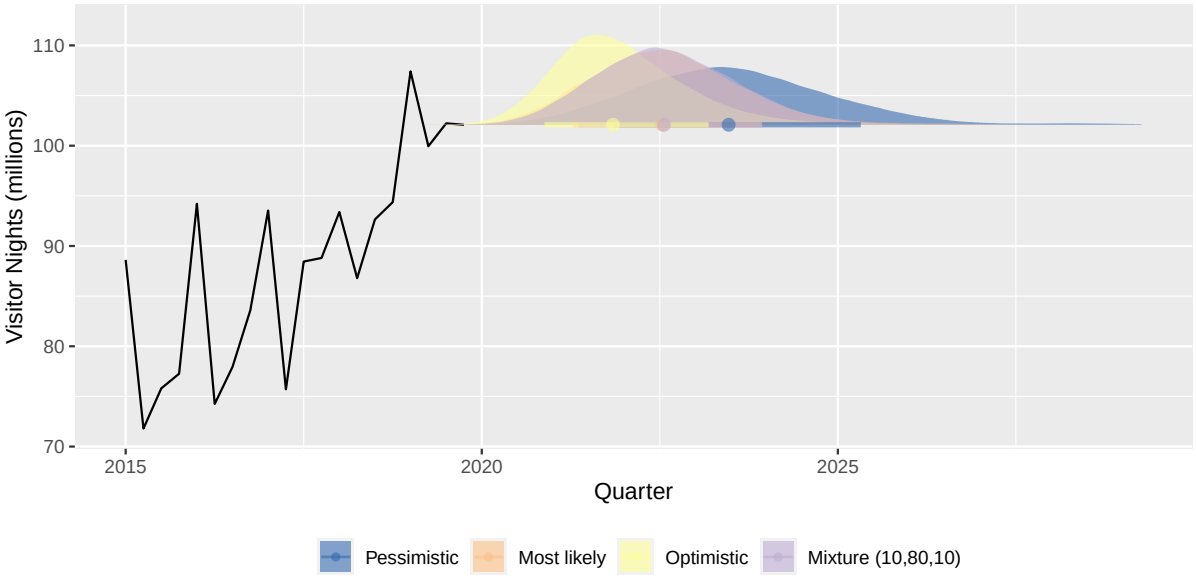

Figure 18: *Recovery scenarios for domestic visitor nights.*

Questions 10 & 11: *In what year do you think domestic visitor nights will return to 2019 levels for the following markets?*

Similar to Questions 6 and 7, respondents were required to provide estimates only for the 'Most likely' scenario for the markets segmented by 'States' and 'Purpose' of travel. The bar plots of the raw responses and fitted kernel density estimates are presented in Figure 19.

Table 8 shows some specific statistics of interest. The results do not show much variation across the states with the median expected quarter of full recovery to 2019 Q4 levels, being 2022 Q2. The only slight variations seems to be an anticipated earlier recovery by one quarter for Queensland, and a later recovery also by one quarter for Victoria. We should note that at the time of the survey being conducted Victoria was going through a second wave with severe lockdown measures and a night curfew in place.

In terms of purpose of travel, the results show that VFR is anticipated to be the quickest to recover with median predicted quarter of full recovery 2021 Q4 followed by Holiday with median predicted quarter of recovery 2022 Q2. The slowest to recover is anticipated to be Business travel with median predicted quarter of full recovery 2022 Q3. Of course, the high uncertainty surrounding these point predictions is highlighted by the width and the asymmetry of the prediction intervals with most distributions showing a considerably long right tail.

Table 8: *Recovery scenarios for domestic visitor nights.*

	Mean	Median	80%	95%
States				
New South Wales	2022 Q2	2022 Q2	[2021 Q1, 2023 Q4]	[2020 Q3, 2024 Q4]
Queensland	2022 Q2	2022 Q1	[2021 Q1, 2023 Q3]	[2020 Q3, 2024 Q4]
Victoria	2022 Q4	2022 Q3	[2021 Q2, 2024 Q3]	[2020 Q4, 2025 Q4]
Western Australia	2022 Q3	2022 Q2	[2021 Q1, 2024 Q1]	[2020 Q3, 2025 Q3]
South Australia	2022 Q2	2022 Q2	[2021 Q1, 2023 Q3]	[2020 Q3, 2024 Q3]
Northern Territory	2022 Q2	2022 Q2	[2021 Q1, 2023 Q4]	[2020 Q3, 2024 Q4]
Tasmania	2022 Q2	2022 Q2	[2021 Q1, 2023 Q4]	[2020 Q3, 2024 Q4]
Australian Capital Territory	2022 Q2	2022 Q2	[2021 Q1, 2023 Q3]	[2020 Q3, 2024 Q3]
Purpose of Travel				
Holiday	2022 Q2	2022 Q2	[2021 Q1, 2023 Q4]	[2020 Q3, 2025 Q1]
VFR	2022 Q1	2021 Q4	[2020 Q4, 2023 Q2]	[2020 Q2, 2024 Q3]
Business	2022 Q3	2022 Q3	[2021 Q1, 2024 Q2]	[2020 Q3, 2025 Q4]

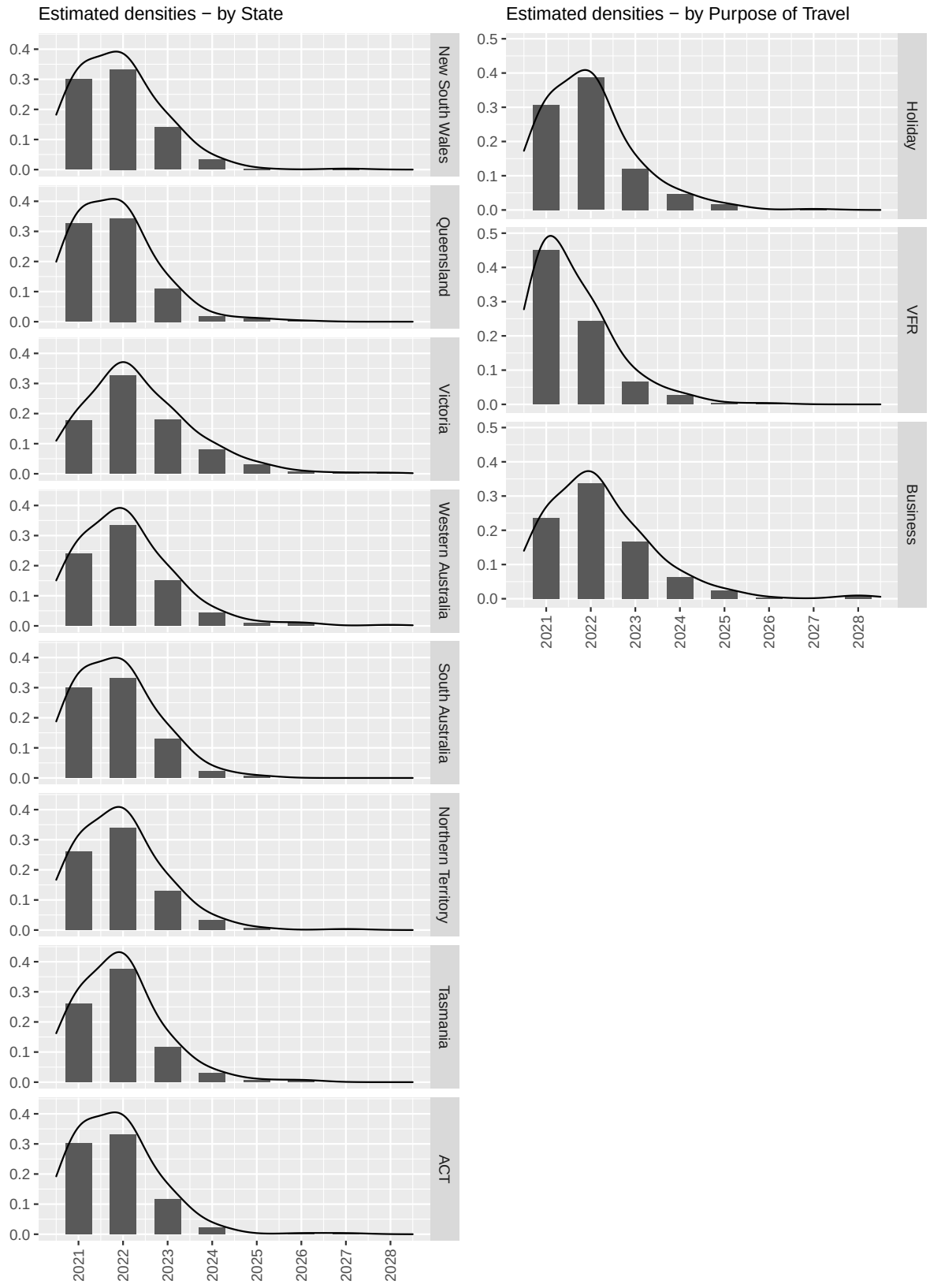

Figure 19: *Year domestic visitor nights will return to 2019 levels for states and purpose of travel.*

6 Discussion and conclusions

The onset of the COVID-19 pandemic has been arguably the greatest challenge faced by the global community over the last few decades. The necessary efforts of nations to slow down the transmission of the virus has severely affected global tourism. Understanding how the sector may recover is key for policy makers, tourism planners and destination marketers, whether they are in government or in business. The depth and severity of the disruption has meant that forecasting practice "as usual" is no longer possible.

In this paper we have provided an innovative methodology to generate probabilistic forecasts for the path to recovery that can support policy and planning. Conducting a large scale survey we asked tourism experts to provide their judgement for three alternative scenarios: 'Pessimistic', 'Most likely' and 'Optimistic'. Using their responses we built judgemental scenario-based probabilistic forecasts for numerous segments of the Australian tourism industry that are of interest to policy makers. The experts anticipated different markets to be affected at different levels and to recover at different rates.

Some general conclusions can be drawn for the Australian tourism sector. Compared to the domestic market the loss in the international arrivals market is expected to be substantially higher and the recovery period substantially longer, stretching to possibly beyond 2023. This may encourage policy makers to concentrate on turning internationally focused operations to domestic ones. In the short-term this will assist local operators to survive and recover from the current recessionary phase. Arrivals from New Zealand, Australia's fourth largest market at the country level in terms of volume, are expected to recover the quickest compared to all other international destinations. For both international and domestic markets, VFR is expected to recover the quickest with people eager to physically reconnect with family and friends. Holiday travel is expected to take longer. The uncertainty surrounding attractive destinations, the use of aviation travel, and the associated expense, may encourage people to spend money elsewhere. Somewhere in between are education and business travel, with the rapid development of an online environment for both these segments delaying and possibly permanently hindering a full recovery to pre-COVID levels.

Of course one must be mindful of the high degree of uncertainty currently surrounding the outlook of tourism. In our study this is reflected by the width of the scenario-based probabilistic forecasts compared to the counterfactual COVID-free forecasts. Dealing with the pandemic

is highly dynamic and extremely volatile. How the Australian government allows for international tourism, and the prevalence of the pandemic in different parts of the world, can result in rapidly modified dynamics. For example, the explosive nature of the second wave in Victoria, Australia, which started in July 2020, led to a second unexpected round of strict state-wide restrictions and interstate border closures.

Appendix A: Generating counterfactual forecasts

Using data up to 2021 Q4, hence concentrating only on the pre-COVID-19 period, we generate forecasts based on the modelling process we describe below. These are referred to as counterfactual forecasts as they are generated pretending that COVID-19 never occurred. Scenario-based forecasts from the surveys, provide us with judgemental probabilistic scenario forecasts compared to 2021 Q4. Using counterfactual forecasts, policy makers can estimate the loss between the judgemental scenarios under COVID-19 and the projections generated as if the pandemic never occurred.

The data for both international arrivals and domestic visitor nights form what Hyndman & Athanasopoulos (2021, Chapter 11) refer to as grouped-time series, where a geographical aggregation structure is crossed with the purpose of travel. For international arrivals there are six regions crossed with five purposes of travel, while for domestic visitor nights there are eight states and territories crossed with four purposes of travel (details are shown in Section 2). These lead to a total of 42 and 45 series respectively that follow grouped aggregation structures with 30 and 32 series at the bottom levels as a result of the two-way interactions between *Region* and *Purpose* for international arrivals, and *State* and *Purpose* for domestic visitor nights. Details are shown in Table 9.

Table 9: *Grouped structures for international arrivals and domestic visitor nights.*

Grouping	No. of Series	Grouping	No. of Series
International Arrivals		*Domestic visitor nights*	
Total aggregate	1	Total aggregate	1
Region	6	States	8
Purpose	5	Purpose	4
Region $\times$ Purpose	30	States $\times$ Purpose	32

For each international and domestic series we generate forecasts from ARIMA and ETS models, automatically selected in the `fable` package (O'Hara-Wild, Hyndman & Wang 2020) using the AICc, and also a combination (the average) of the two. The forecast combinations ensure robust and accurate forecasts for each series in the two grouped structures. We then reconcile forecasts across each structure to generate "coherent" forecasts, i.e., point and probabilistic forecasts that add up consistently across the aggregation structure, using the WLS

estimator in the Wickramasuriya, Athanasopoulos & Hyndman (2019) optimal MinT (minimum trace) forecast reconciliation approach. Further, details of the processes used here are available in Hyndman & Athanasopoulos (2021).

Out-of-sample forecast evaluation

Withholding the last two years of data across all the series as a test-set, we generate 1- to 8-step-ahead forecasts using the above approaches and evaluate their accuracy against the actual observations of the test-set. Table 10 shows the MAPE (mean absolute percentage error) and MASE (mean absolute squared error) calculated over the test-sets across all the series for each the international and domestic grouped structure. These show that for both cases the reconciled combined forecasts are overall the most accurate. Furthermore, it seems that the forecasts are more accurate for the international arrivals compared to the the domestic visitor nights.

Table 10: *1 to 8-steps ahead out-of-sample forecast accuracy evaluation over the test-set period 2018 Q1-2021 Q4 for Australian international arrivals and domestic visitor nights.*

	International arrivals		Domestic visitor nights	
Model	MAPE	MASE	MAPE	MASE
comb_wls	7.95	1.05	20.80	1.65
comb	8.35	1.10	21.38	1.68
ets	8.16	1.16	21.38	1.69
arima	10.43	1.34	21.98	1.74

Figures 20 and 21 plot the forecasts over the 2018 Q1-2019 Q4 test-set for all the international series. The forecasts and prediction intervals perform remarkably well in capturing the movements in the actual test-set data at all levels of aggregation and interaction.

Figures 22 and 23 plot the forecasts over the 2018 Q1-2019 Q4 test-set for all the domestic series. For many of the domestic series there seems to be a very strong and sudden increase in the trend during the test-set period with not enough history provided for the models to capture this. The sudden increase can be seen in the aggregate series and also throughout the various components. This highlights why the accuracy of the domestic forecasts over the test-set is lower compared to the international arrivals. We note that with another two years of history, this trend correction has been captured by the models and is included in the counterfactual forecasts shown in Figure 4.

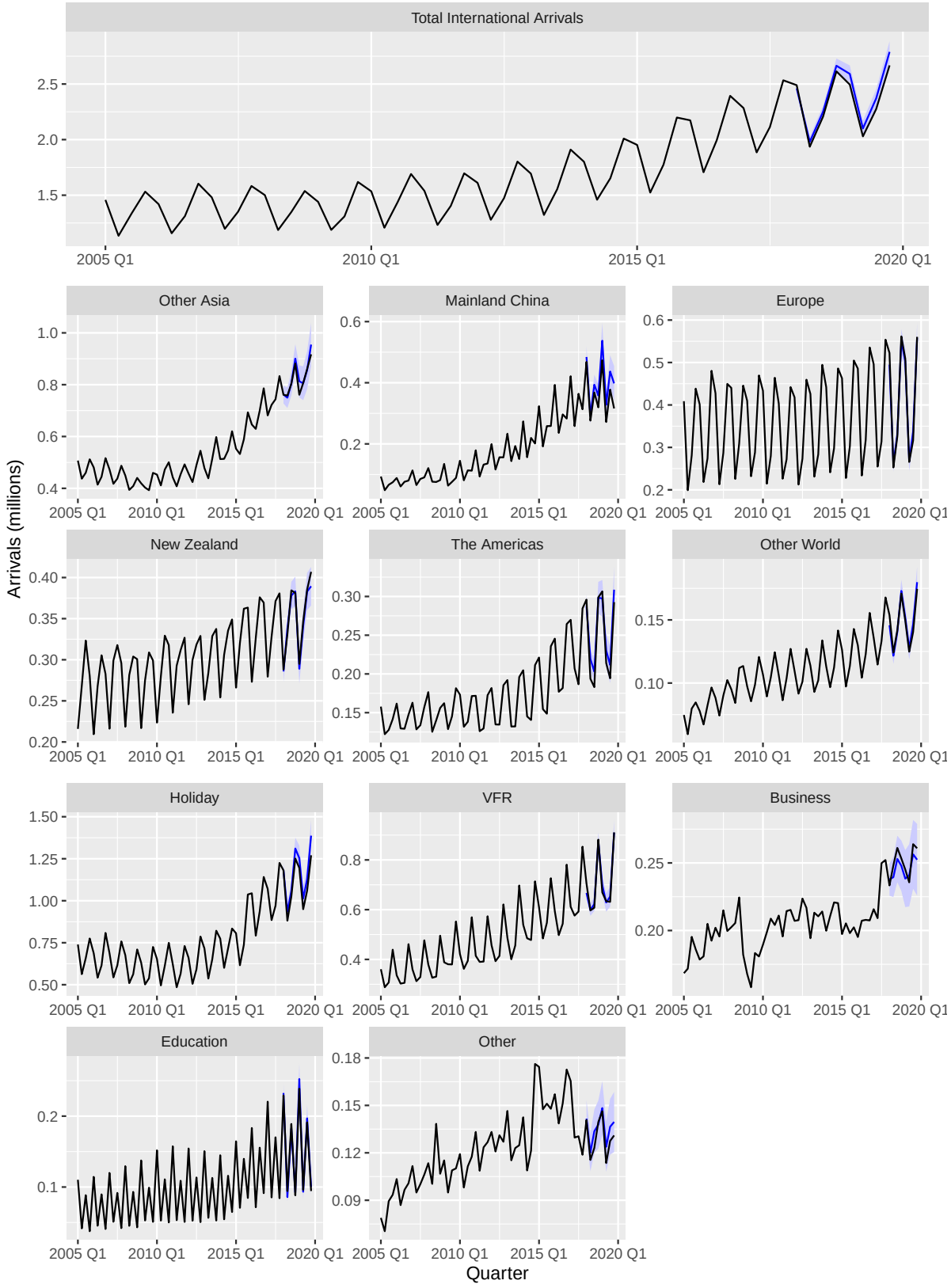

Figure 20: *Forecast accuracy evaluation over the 2018 Q1–2021 Q4 test-set for international arrivals to Australia*

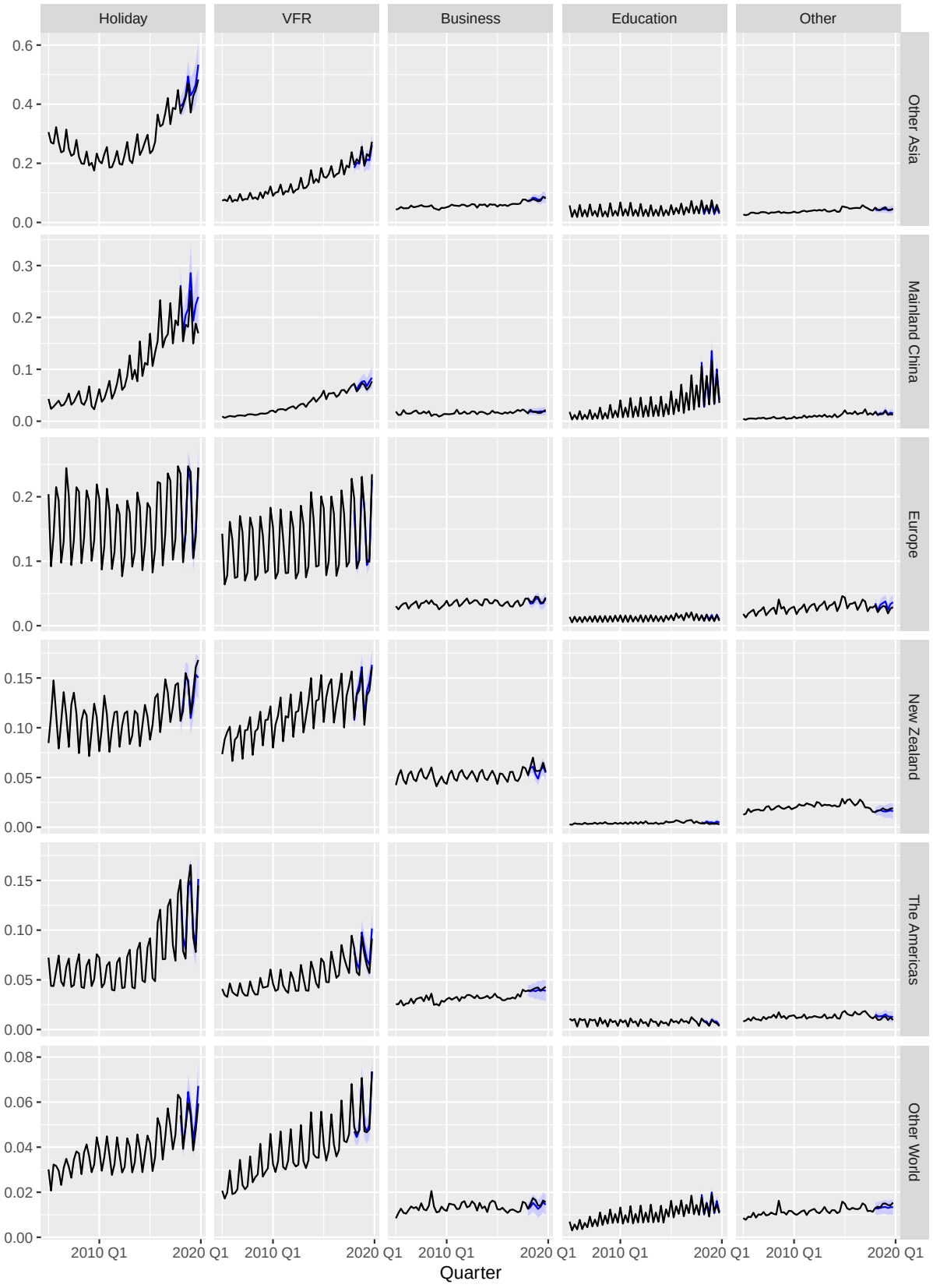

Figure 21: *Quarterly forecasts for international arrivals by state and purpose of travel over the test sample 2018 Q1-2021 Q4*

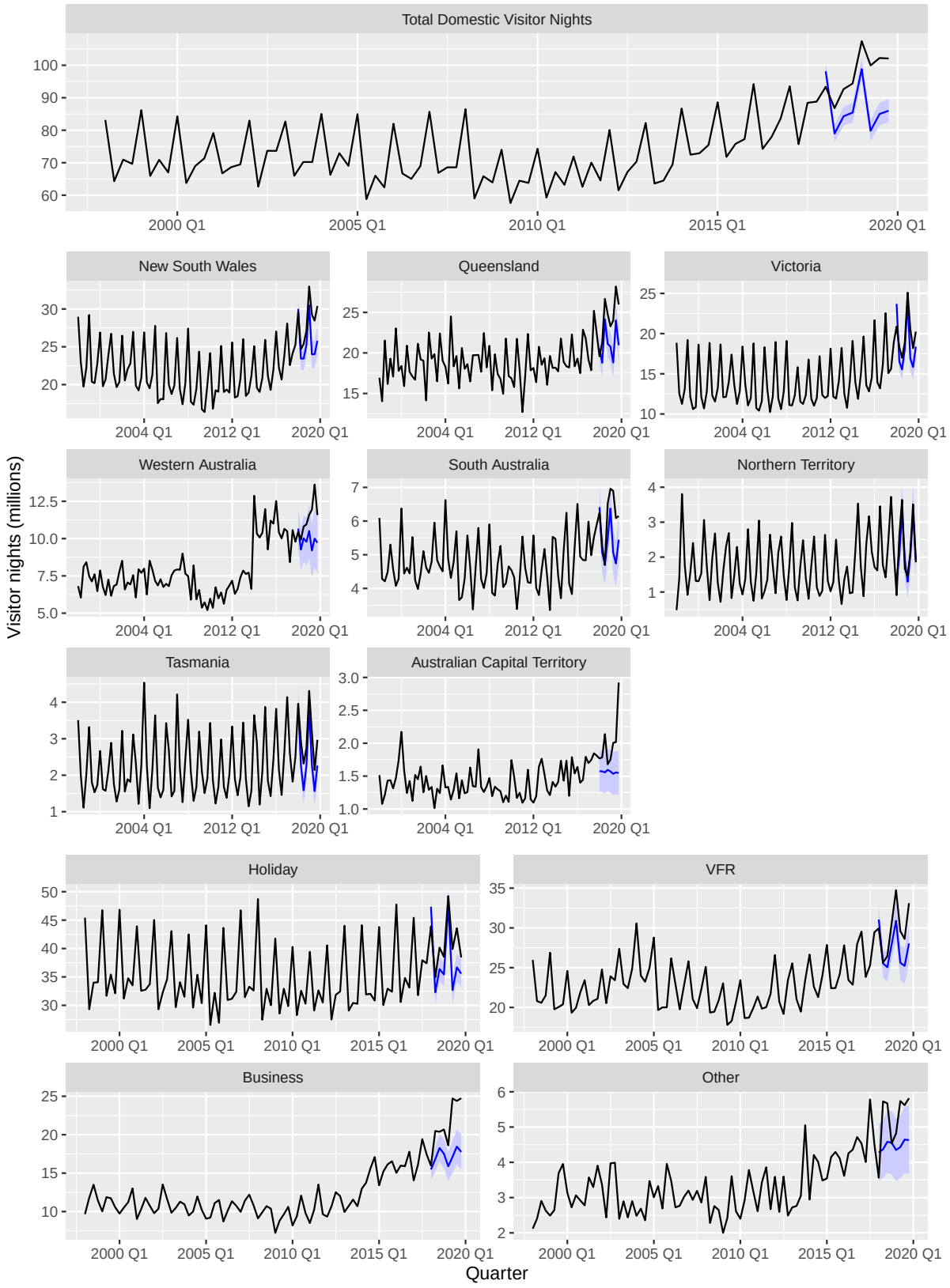

Figure 22: *Time series and counterfactual forecasts for the period 2020 Q1–2021 Q4 for Australian domestic visitor nights*

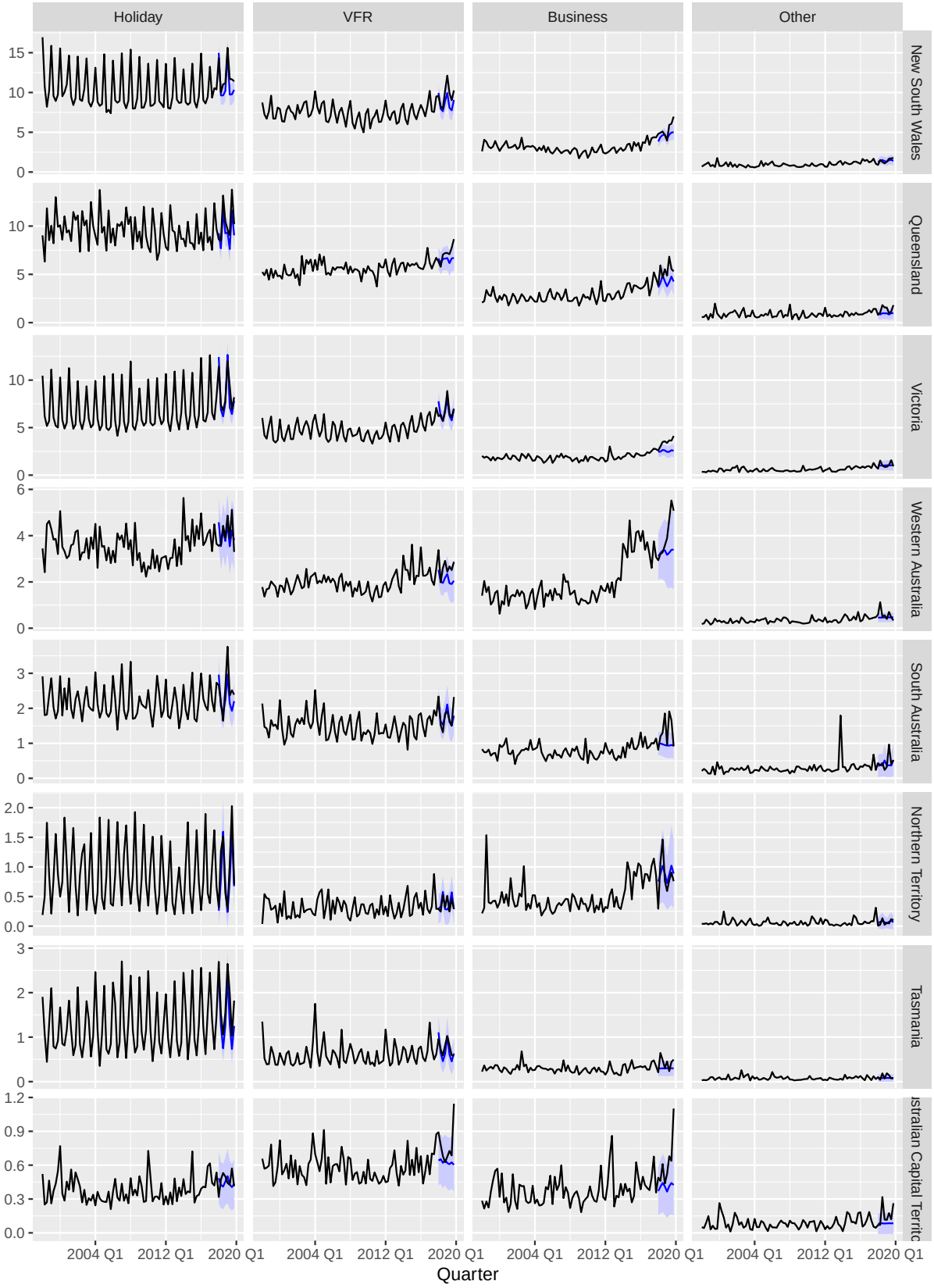

Figure 23: *Quarterly forecasts for domestic visitor nights by state and purpose of travel over the test sample 2018 Q1–2021 Q4*

Appendix B: Survey questionnaire design

In this appendix we provide the details of the questionnaire. Our aim was to make this as simple as possible for respondents in order to keep them engaged, but at the same time collect valuable information that will enable us to generate probabilistic scenario-based forecasts for the future of Australian tourism having endured the effect of COVID-19.

Background information

The COVID-19 Pandemic has resulted in massive disruptions to tourism worldwide and at this stage the timeframe for recovery is both long and uncertain. In this environment, where so much can change so quickly, producing conventional tourism forecasts is not appropriate.

There is however a need to consider the range of plausible recovery scenarios that draw on the collective views of tourism experts and practitioners. It is inevitable that tourism will eventually find its feet, and having a better understanding of how it might recover will assist with planning, policy formulation and industry advocacy.

By completing this short survey you are contributing to this information gathering process. We also understand that the uncertainty of the situation will limit the amount of information you may be able to provide and have designed the survey to reflect this.

About you and your sector

Question 1: *Which sector best describes your organisation?*

Academic
Consultant
Government
Industry - accommodation
Industry - association
Industry - aviation
Industry - other transport
Industry-food services
Industry-tour operator services
Industry-travel agency
Other (please specify)

Question 2: *How many people are currently employed by your organisation?*

less than 5
5 to 19
20 to 49
50 to 199
200 or more

Question 3: *How does this employment figure compare with the start of 2020?*

Lower 90-100%
Lower 70-90%
Lower 50-70%
Lower 30-50%
Lower 10-30%
Lower 0-10%
Higher 0-10%
Higher 10-30%
Higher 30-50%
Higher than 50%

International arrivals to Australia

The purpose of the following questions is to get your views on the recovery trajectory for international tourism in terms of visitor numbers. With so much uncertainty we'd like you to consider future scenarios that take into account factors such as changing economic conditions, concerns around travel and safety, aviation access, the price of travel and potential discovery of a vaccine.

We appreciate that some of you may have more detailed knowledge than others. Please provide estimates for specific markets and specific travel categories should you wish.

Question 4: *International arrivals to Australia have grown an average of 6% p.a. over the last 5 years. In the December quarter 2019, there were 2.7 million international visitors to Australia. Assuming that international borders reopen in the middle of 2021, what do you think international visitors will be for the December quarter of 2021 compared to the December quarter 2019 under a most likely scenario – your best estimate based on your knowledge and insight; a pessimistic scenario – reflecting a worse case highly unlikely, but still plausible outcome; an optimistic scenario – reflecting a best case highly unlikely, but still plausible outcome.*

Most likely	**Pessimistic**	**Optimistic**
Lower 90-100%	Lower 90-100%	Lower 90-100%
Lower 70-90%	Lower 70-90%	Lower 70-90%
Lower 50-70%	Lower 50-70%	Lower 50-70%
Lower 30-50%	Lower 30-50%	Lower 30-50%
Lower 10-30%	Lower 10-30%	Lower 10-30%
Lower 0-10%	Lower 0-10%	Lower 0-10%
Higher 0-10%	Higher 0-10%	Higher 0-10%
Higher 10-30%	Higher 10-30%	Higher 10-30%
Higher 30-50%	Higher 30-50%	Higher 30-50%
Higher than 50%	Higher than 50%	Higher than 50%

Note: the rows were embedded in a dropdown menu.

Question 5: *In what year do you think international visitor numbers will return to 2019 levels? Please provide estimates for the most likely, pessimistic and optimistic scenario.*

	2021	2022	2023	2024	2025	2026	2027	2028
Most likely								
Pessimistic								
Optimistic								

Question 6: *In what year do you think international visitor numbers for the following segments will return to 2019 levels? Please provide estimates only for the most likely scenario (This is an optional question- please provide information only where you have a view)*

	2021	2022	2023	2024	2025	2026	2027	2028
Holiday								
VFR								
Business								
Education								

Question 7: *In what year do you think international visitor numbers for the following markets will recover to 2019 levels? Please provide estimates only for the most likely scenario. (This is an optional question- please provide information only where you have a view)*

	2021	2022	2023	2024	2025	2026	2027	2028
New Zealand								
Mainland China								
Other Asia								
Europe								
The Americas								

Australian domestic tourism

The purpose of the questions that follow is to get your views on the recovery trajectory for domestic tourism. Factors we'd like you to consider in these future scenarios are the timing of

interstate border openings, transport access to the regions, domestic economic conditions, the price of travel, safety concerns and potential discovery of a vaccine. We appreciate that some of you may have more detailed knowledge than others. Please provide estimates for specific markets and specific travel categories should you wish.

Question 8: *Domestic visitor nights have grown an average of 7% p.a. over the last 5 years. In the December quarter 2019, there were 103.4 million domestic visitor nights around Australia. Compared to these levels what do you think the number of domestic visitor nights will be for the December quarter 2020 and the December quarter 2021 compared to the December quarter 2019 under: a most likely scenario – your best estimate based on your knowledge and insight; a pessimistic scenario – reflecting a worse case highly unlikely, but still plausible outcome; an optimistic scenario – reflecting a best case highly unlikely, but still plausible outcome.*

Same dropdown menu as in Question 4 was used but for both December quarter 2020 and December quarter 2021.

Question 9: *In what year do you think domestic visitor nights will return to 2019 levels? Please provide a most likely, a pessimistic and an optimistic scenario.*

Same options menu as in Question 5 were used.

Question 10: *In what year do you think domestic visitor nights will return to 2019 levels for the following markets? Please provide estimates only for the most likely scenario. (This is an optional question-please provide market information only where you have a view)*

	2021	2022	2023	2024	2025	2026	2027	2028
New South Wales								
Victoria								
Queensland								
South Australia								
Western Australia								
Tasmania								
Northern Territory								
ACT								

Question 11: *In what year do you think domestic visitor nights for the following markets will return to 2019 levels? Please provide estimates only for the most likely scenario. (This is an optional question-please provide market information only where you have a view).*

	2021	2022	2023	2024	2025	2026	2027	2028
Holiday								
VFR								
Business								

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