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# Allocating Bahamian visitor arrivals between air and sea

A conditional stress test for tourism forecasting systems, 2015–2025

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## Abstract

An AI system can predict the national visitor total accurately and still give an airport a poor estimate. This study isolates that risk by supplying the observed annual total to two simple rules for allocating Bahamian arrivals between air and sea. The first rule fixes the air share at its pooled 2015–2019 level. The second uses the previous year's share. Across six test years, 2020–2025, the mean absolute air-arrival errors were 495,908 and 450,313, respectively. The fixed rule overestimated the 2025 air count by 1,143,876. Both rules reproduced the national total exactly by construction. The estimates measure allocation error conditional on a known total. They do not measure the accuracy of any deployed model.

## Research question

How much air-arrival error can a national tourism total conceal when a forecasting system allocates that total using past travel patterns?

## Data and methods

The Bahamas Ministry of Tourism reports foreign visitor arrivals by the first place and mode of entry. We extracted the national air, sea and total counts for 2015–2025 from its annual series. Air plus sea equalled the published national total in all eleven years. These are arrivals. One person can enter the country more than once, and the first entry point does not establish where that visitor stayed [1].

We used two top-down allocation rules, a standard approach to producing estimates that add to a known total [2]. For the fixed rule, we summed air arrivals from 2015 through 2019 and divided by the sum of national arrivals over those five years. For the updating rule, we divided the preceding year's air count by its national total. Both rules used exact counts. The published percentages have only one decimal place.

For each test year, we multiplied the observed national total by the selected share. We assigned the remaining arrivals to sea. This deliberate use of the observed total removes national forecast error from the calculation. We subtracted observed air arrivals from the estimated air arrivals to calculate signed error. We then averaged the absolute errors over the six test years. We retained full precision until reporting.

## Results

Air accounted for 22.66% of arrivals in the five-year reference period. Its observed annual share stood at 23.31% in 2020, rose to 42.21% in 2021 and fell to 13.51% by 2025. The fixed rule underestimated air arrivals by 410,596 in 2021. Four years later it assigned 2,832,670 arrivals to air against an observed 1,688,794, an overestimate of 1,143,876 [1, calculations in this study].

Updating the share each year reduced the six-year mean absolute error from 495,908 to 450,313 air arrivals. That average conceals a reversal. Applying the unusual 2021 share to the much larger 2022 total produced an overestimate of 1,484,615 air arrivals. In 2025 the updating rule cut the error to 224,375. Each air overestimate created an equal sea underestimate because the two allocations had to sum to the published total.

## Air share of foreign visitor arrivals

% of all arrivals




National first-entry counts, 2019–2025. The fixed allocation rule used the pooled 2015–2019 share of 22.66%. Source [1].

## Discussion

A national dashboard that reports only total error would award both rules a perfect score on this experiment. An airport using the air estimate would face a different result. The case provides a test for vendors of tourism forecasting systems. Score air and sea separately. Also check whether the two published estimates add to the forecast national total.

The timing of updates matters. A recent share can adapt to a gradual change in travel patterns but can carry a short-lived mix into the following year. An operational study could compare separate air and sea forecasts against a reconciled forecast, using data that were available at each forecast date. Scheduled airline seats and cruise calls are candidate inputs. This experiment did not test them.

## Limitations

The national total is known in this experiment. A system forecasting the total would add another source of error, which could increase or offset the errors reported here. Six annual test cases do not establish which rule will work best in another period. The study uses the published historical series and does not reconstruct earlier data releases.

Annual entries cannot locate daily queues or establish room occupancy, visitor spending, island-level demand or staffing needs. The immigration count also excludes groups identified by the Ministry, including foreign residents and military or diplomatic personnel entering on official duty [1].

## Reproduce the analysis

Check that air plus sea equals total in every row. Compute the fixed share as the sum of air arrivals for 2015–2019 divided by the sum of total arrivals for the same five years.

For each year from 2020 through 2025, multiply its total by the fixed share. Repeat with the preceding year’s observed air share. Keep the results unrounded.

Subtract the observed air count for that year from each estimate. Take the absolute value of each error, then average the six errors for each rule. For the figure, divide each annual air count by its total and multiply by 100.

## Data table

| Year | Air arrivals | Sea arrivals | Total arrivals |
|---|---|---|---|
| 2015 | 1390911 | 4721182 | 6112093 |
| 2016 | 1391813 | 4873206 | 6265019 |
| 2017 | 1335613 | 4800226 | 6135839 |
| 2018 | 1558086 | 5063929 | 6622015 |
| 2019 | 1662419 | 5587110 | 7249529 |
| 2020 | 418329 | 1376193 | 1794522 |
| 2021 | 886629 | 1213989 | 2100618 |
| 2022 | 1470244 | 5530462 | 7000706 |
| 2023 | 1719980 | 7934858 | 9654838 |
| 2024 | 1716815 | 9500157 | 11216972 |
| 2025 | 1688794 | 10811077 | 12499871 |

## References

[1] The Bahamas Ministry of Tourism. Total foreign arrivals to The Bahamas by air and sea, 1971–2025. National series, first table.

[2] Hyndman, R. J., and Athanasopoulos, G. Forecasting: Principles and Practice, third edition. Chapter 11, Forecasting hierarchical and grouped time series.