thinkstep
anz

Visitor Value Versus Volume for International Tourists to New Zealand

On behalf of the Parliamentary Commissioner for the Environment

Client:	**The Parliamentary Commissioner for the Environment**
Title:	**Visitor Value Versus Volume for International Tourists to New Zealand**
Report version:	v1.0
Report date:	30 October 2020

Cover photo by Daniel Norris on Unsplash

Document prepared by

Christin Schaller
Sustainability Consultant

Jeff Vickers
Technical Director

Quality assurance by

Simon Love
Sustainability Strategy

Contact

thinkstep Ltd

11 Rawhiti Road
Pukerua Bay
Wellington 5026
New Zealand

Certified B Corporation

Web	www.thinkstep-anz.com
Email	anz@thinkstep-anz.com
Phone	+64 4 889 2520

Table of Contents

Executive Summary

Background

Tourism New Zealand has aimed for a ‘value over volume’ strategy in international tourism for the past 20 years. This strategy seems intuitively correct: having a smaller number of visitors bringing the same amount of money into the country as many low-spending visitors surely places less strain on our tourism hotspots. Yet, if these high-spending visitors fly first-class to New Zealand, eat prime steaks while here, and travel the country by helicopter, the environmental impacts per high-spending visitor could be very high. As such, there are likely to be environmental trade-offs between volume and value.

Purpose

The purpose of this research was to conduct an initial empirical exploration into the environmental merits of high-value tourism rather than high-volume tourism, with a sole focus on the carbon footprint of international visitors to New Zealand.

Approach

Three approaches were used to address this research question:

1. Domestic spending by international tourists only, based on credit card transactions.
2. International air travel only, split by country of origin and fare class.
3. Hybrid method, considering domestic spending and international air travel.

Results, conclusions, and recommendations

Higher spending visitors tend to have lower carbon emissions than lower spending visitors per dollar spent in the New Zealand economy. As such, the ‘value over volume’ strategy is appropriate to minimise the carbon footprint of tourism to New Zealand.

Using the spending categories defined in this report, the carbon intensity of high- and very high-spending tourists is less than half that of low-spending tourists. While the carbon footprint of high-spending tourists’ flights to New Zealand will often be large, as they are more likely to fly in premium seats, this is outweighed by their spending within the New Zealand economy (which has a relatively low intensity compared to their flight here).

International aviation contributes more than half of the carbon footprint of tourism across all spending segments considered in this analysis. This suggests that encouraging high-value tourists to stay longer in the country, rather than encouraging many high-value short-term tourists, is likely to be the best strategy to decarbonise New Zealand tourism.

Emissions within New Zealand come primarily from the fuel burnt in rental and private vehicles, food and beverages, accommodation, and shopping (clothing and durable goods). As a result, it will be important to transition New Zealand’s rental car fleet, and our wider vehicle fleet, to lower-carbon technologies, such as electric vehicles.

1 Introduction

For the past 20 years, Tourism New Zealand has aimed for a 'value over volume' strategy in international tourism (Tourism Ticker, 2020). This strategy seems intuitively correct: having a smaller number of visitors bringing the same amount of money into the country as many low-spending visitors surely places less strain on tourism hotspots.

On the other hand, these high-value tourists might travel to New Zealand first class or on private planes, and, while here, they may travel by private helicopters, stay in luxury lodges, and eat lavish meals. It seems plausible that the carbon footprint, waste generation and other environmental burdens associated with these activities could be considerably higher per person than lower-value activities such as staying in a backpackers' hostel and eating baked beans on toast. As such, there are likely to be environmental trade-offs between volume and value.

The purpose of this research was to conduct an initial empirical exploration into the environmental merits of high-value tourism rather than high-volume tourism, with a sole focus on the carbon footprint of international visitors to New Zealand.

The aim of this research project was to provide an initial answer the following question:

> Does a lower volume of high-value international tourists have a lower carbon footprint than higher volume of low-value tourists for Aotearoa New Zealand?

In the context of this project:

- "Value" is the amount of money spent within the New Zealand economy or with New Zealand operators (e.g. Air New Zealand) in overseas markets operating services to and within New Zealand.
- "Volume" refers to the number of international tourists entering New Zealand within a given time period.
- "Carbon footprint" includes two different things: greenhouse gas emissions within New Zealand's domestic boundaries (which aligns with our national obligations under the Paris Agreement), and also global greenhouse gas emissions.

This project relies on three main data sources:

- Marketview credit/debit card payment statistics, which include all personal credit card and debit card (EFTPOS) transactions on the Paymark and BNZ networks. These statistics excludes business and corporate cards.
- New Zealand's Tourism Satellite Account – a set of financial accounts that measures expenditure in New Zealand by both resident and non-resident tourists.
- The Eora Database – a global multi-regional input-output database, provide carbon footprint emission factors per dollar of spend.

This report looks at the research question in three ways:

1. **Domestic spending only:** Country-wide data from credit/debit cards was analysed and matched to corresponding carbon footprint emission factors calculated using economic input-output life cycle assessment (EIO-LCA). While the dataset used is incomplete (as it only includes credit/debit card transitions made using the Paymark and BNZ networks, excludes cash payments, and excludes pre-bookings made outside of New Zealand), it is still very large and very comprehensive.
2. **International aviation only:** The carbon footprint of flights to/from New Zealand were assessed based on country of origin and fare class.
3. **Hybrid method, considering domestic spending and international travel:** Domestic spending is scaled up by category to reflect total international spending from New Zealand's Tourism Satellite Account (TSA). This is then matched with total international and domestic air travel to create a combined tourism footprint.

The sections that follow outline the approach and key findings from each strategy above.

2 Domestic emissions

Emissions from spending made by international tourists in New Zealand were calculated using Marketview data. Two approaches were applied:

1. Marketview data only (which represents only a portion of total domestic spending).
2. Marketview data scaled to New Zealand's Tourism Satellite Account (which therefore represents total spending by international tourists).

Both approaches apply emission factors per dollar spent within each economic sector, also called input-output LCA (EIO-LCA) emissions factors, to the Marketview spending data.

2.1 Primary data sources

The primary data source for domestic spending from international visitors is Marketview's collation of Paymark data. Paymark operate the largest payments network in New Zealand covering approximately 70% of New Zealand retailers.

Marketview's 2018 data was used to define four visitor segments, as shown in Table 1. The four segments were defined based on daily credit/debit card spend, with the selection of the break points decided by thinkstep-anz and the Office of the PCE. 'Low value' covers the first quartile. 'Medium value' covers the second and third quartiles. 'High value' covers the lower part of the fourth quartile (approximately 20% in total) and 'very high value' covers the top 5% of tourists. (The percentages do not match the quartiles directly given that the dollar ranges were set using round numbers: $50, $200, and $600.)

Table 1*:* Visitor segments – Marketview data 2018

Visitor segment	Defined as	Average spend per day	Cardholder count	% of cardholders
Low value	≤$50 per day	$34	856,583	24.8%
Medium value	$51-200 per day	$106	1,757,748	50.9%
High value	$201-600 per day	$292	660,603	19.1%
Very high value	≥$601 per day	$929	181,159	5.2%

All transactions covered in the Marketview data are allocated to an ANZIC industry code, which indicates the type of business the payment was transacted at. The 2018 data contains transactions in 67 different ANZIC industries made by 3,456,093 cardholders from 13 countries/regions. The countries/regions were specified by thinkstep-anz and the Office of the PCE and include all New Zealand's largest markets for international tourists. Goods and Services Tax (GST) was removed from the dataset (at a blanket rate of 15%) to align it with the TSA and with Eora (below).

The EIO-LCA emission factors used for both approaches were sourced from the Eora database for New Zealand from 2015 (Lenzen, et al., 2012) (Lenzen, et al., 2013). These factors were inflated to 2018 dollars using factors from the Reserve Bank of New Zealand.

For both approaches, the ANZIC category 'Air and Space Transport' was excluded for the following two reasons:

- It is expected that international and domestic flights are mostly pre-booked, and therefore that the data supplied is not representative. (Marketview data covers only 0.3% of the spend on aviation compared to TSA aviation expenditure.)
- The economic input/output factors were not deemed to be appropriate since emissions from fuel combustion is not properly reflected.

The emission factor for 'Fuel retailing' was adjusted to include emissions from fuel combustion in addition to the EIO-LCA emissions. The value used comes from international visitor road emissions in 2017 (1,128 kt CO_2e) from Statistics New Zealand's Environmental-Economic Accounts: 2019 (Stats NZ, 2019).

2.2 Domestic emissions calculation approaches

Two approaches were applied:

(1) Marketview spending data was used as provided. This approach knowingly omits transactions not captured by the dataset, which include the 30% of retailers not on the Paymark network, all online transactions (such as flight bookings), all cash transitions, and activities pre-booked from outside of New Zealand.

(2) Marketview spending data was extrapolated to match international tourism expenditure published in Statistics New Zealand's Tourism Satellite Account for the year ended March 2018. The total 2018 TSA expenditure for international tourists excluding GST is $14,626 million compared to $2,415 million covered in the Marketview data. Therefore, the Marketview data has been scaled up to match the TSA expenditure, giving a more accurate reflection of total dollars spent by tourists. To do this, Marketview ANZIC spending categories were mapped to TSA international demand expenditure by type of product. Some TSA expenditure categories could not directly be associated to an ANSIC category, and therefore have been proportionally allocated to directly mapped categories.

3 Aviation emissions

3.1 International aviation (direct)

International aviation emissions were calculated per passenger and fare class for each of the 13 countries/regions of origin given in the Marketview data.

To determine the distances between the countries/regions of origin and New Zealand (Auckland), common routes were defined using a paper from Becken (2002) as well as distances calculated by the ICAO Carbon Emissions Calculator (ICAO, 2020).

Emissions were calculated by applying emission factors per fare class sourced from the New Zealand Ministry for the Environment to the distance travelled (MfE, 2019). The fare classes 'first', 'business', 'premium economy' and 'economy' were considered. MfE based its assumptions for differences between fare classes on UK Department for Business, Energy & Industrial Strategy (BEIS) (BEIS/DEFRA, 2019, p. 80), as shown in Table 2.

Table 2: Fare classes international aviation (BEIS, 2019)

Flight type	Cabin seating class	Number of economy seats
Short haul	Economy class	1.00
	First/Business class	1.50
Long haul	Economy class	1.00
	Economy Premium class	1.60
	Business class	2.90
	First class	4.00

To consider the differences in length of stay between international visitors from different countries/regions, the results were normalised by using average length of stay data provided by Statistics NZ (Stats NZ, 2020).

3.2 Domestic aviation (direct)

Domestic aviation emissions for 2018 were sourced from New Zealand's Greenhouse Gas Inventory published by MfE (MfE, 2020). Emissions per average domestic flight were calculated by dividing total domestic aviation emissions by domestic arrivals published by New Zealand Ministry of Transport (NZ Ministry of Transport, 2020).

To allocate domestic aviation emissions to international tourists, results from the International Visitor Survey conducted by Stats NZ were used (Stats NZ, 2020). The results include the total number of international visitors that selected domestic aviation as a mode of travel within New Zealand. It was assumed that all international tourists that indicated international travel as a mode of travel took two average domestic flights.

The so calculated total domestic aviation emissions were distributed equally amongst all international tourists, as described in chapter “Hybrid approach”.

3.3 Indirect and imported aviation emissions

Indirect and imported emissions from aviation have been calculated by applying the EIO-LCA emission factors to the estimated air fare spending per visitor segment and country. The calculation and allocation of air fares are described in chapter “Hybrid approach”.

This means that indirect and imported emissions only include emissions from aviation activities that contributed to the New Zealand economy. Indirect emissions (e.g. food production for the on-flight meal) associated with, say, a flight to New Zealand operated by a US carrier would not be included.

4 Hybrid approach

The hybrid approach combines scaled domestic emissions with international and domestic aviation emissions.

International aviation emissions have been calculated by applying a 'fill down' approach, which assumes that each country/region reflects the same fare class distribution as the seat distribution in an average plane. That means that 1% of the arrival per region/class came using a first-class ticket, 11% a business class ticket, 9% a premium economy class ticket, and 79% an economy class ticket. (These percentages were calculated from an unweighted average of the seat distribution of 10 long-haul planes operated by Air New Zealand and Singapore Airlines.)

For the hybrid approach, the Marketview cardholder number (3,456,093) per segment and country/region was scaled up to the international visitor arrivals to New Zealand in 2018 (3,790,240), using figures provided by Stats NZ (Stats NZ, 2020).

The 'fill down' approach then allocates the fare class tickets to the arrivals per visitor segment by starting with the very high-spending segment and first-class traveller and filling down to the low-spending segment and economy-class traveller. One outcome of this is that all low-spending visitors are assumed to fly economy. For each country/region and fare class, emissions from a return trip were included.

Domestic aviation emissions were distributed equally across all international arrivals.

No accurate data source was available for the aviation expenditure per visitor segment. Therefore, it was assumed that prices directly correlate with the fare class and distance of travel. This results in a universal emission factor per dollar spent on aviation (e.g. a business class ticket may cost 2.9 times of an economy ticket, but will also be responsible for 2.9 times of the emissions, meaning the kg CO_2e/$ remains consistent).

To consider spending on aviation, the 2018 TSA expenditure for 'Air passenger transport' was used, which reflects air fares that contribute to the New Zealand economy (i.e. domestic flights and international flights on New Zealand flagged carriers). The TSA dataset includes both domestic and international aviation expenditures. To assign the expenditure to visitor segment and country, the factor 'economy seat kilometre' was defined. This factor reflects the space in an aircraft compared to an economy seat as well as the distance travelled in kilometres. The percentage share of 'economy seat kilometres' per segment and country was then multiplied to the TSA expenditure for 'Air passenger transport', which reflects the calculated fare.

The emissions per dollar spent were then calculated by adding scaled domestic emissions and aviation emissions and dividing them by spend on the ground and aviation expenditure (i.e., total international demand from the TSA).

5 Results

This section presents the results of the three different approaches used in this project to consider the question of value versus volume:

1. The carbon footprint due to domestic spending only. This includes emissions which occur within New Zealand and emissions embodied in imported goods/services.
2. The carbon footprint due to international aviation only.
3. The hybrid method, considering the carbon footprint from domestic spending, domestic aviation, and international aviation.

All results expressed in dollars are in 2018 New Zealand Dollars excluding GST. Greenhouse gas (GHG) emissions are represented in kilograms or tonnes of carbon dioxide equivalent (kg CO_2e or t CO_2e) using the Global Warming Potential method of the Intergovernmental Panel on Climate Change over a 100-year time horizon (GWP100).

5.1 Results based on domestic spending only

5.1.1 Domestic emissions – Marketview data only

Figure 1 which shows that the carbon emissions intensity of domestic spending within New Zealand by foreign tourists is approximately 0.4 kg CO_2e per dollar (excluding GST). The emissions intensity increases slightly from the low spending to the medium spending segment before falling to below 0.3 kg CO_2e per dollar in the very high spending segment.

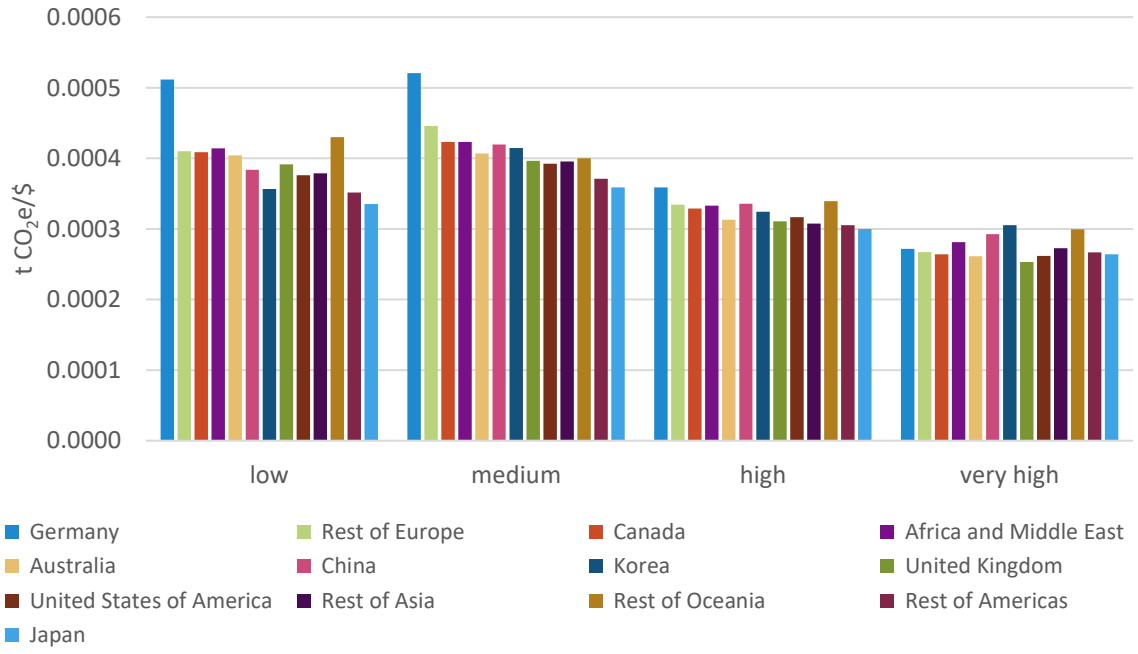

Figure 1: GHG emissions per $ by visitor segment and region – domestic spend (Marketview unscaled)

Figure 2 presents the spend (left bar) and GHG emissions (right bar) for all spending segments, moving from low to very high. The legend is too large to show all entries, so a select few are called out below instead, starting from the bottom and moving up:

- Black = Fuel Retailing
- Fuschia = Supermarket and Grocery Stores
- Purple = Cafes and Restaurants
- Violet = Takeaway Food Services
- Orange = Taxi and Other Road Transport
- Mint green = Accommodation
- Plum = Other Store-Based Retailing n.e.c.
- […]
- Light blue = Amusement and Other Recreation Activities n.e.c.
- […]
- Dark blue = Travel Agency and Tour Arrangement Services

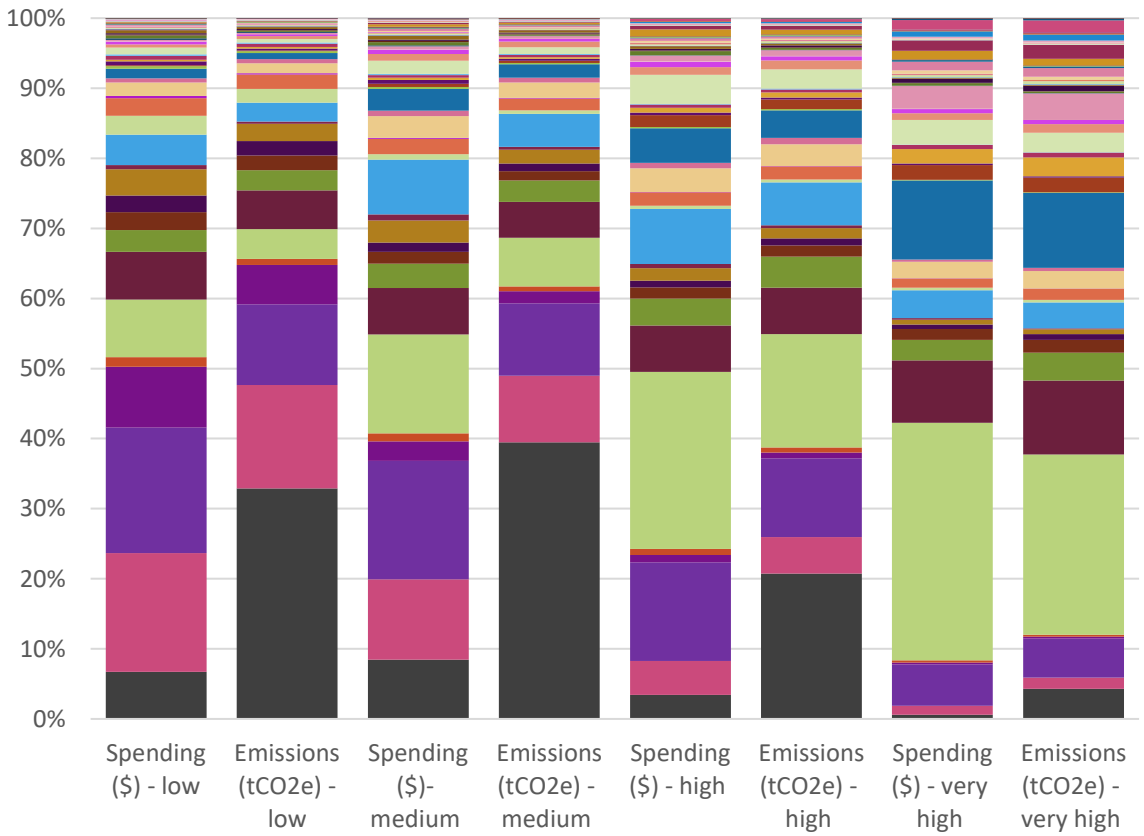

Figure 2: Relationship between spending and carbon emissions per segment (Marketview only)

It is notable that for all spending segments, the share of spend on fuel is relatively low, yet it constitutes the highest single source of emissions for the low-, medium- and high-spending segments. 'Fuel Retailing' (and, more importantly, fuel combustion) has by far the highest emission factor per dollar spent of any spending category, as virtually every dollar spent goes directly into greenhouse gas emissions from petrol or diesel combustion in a vehicle's engine. It is also notable that as you move up the spending segments (below low/medium), the proportion of total spend that goes to fuel is relatively small.

Looking across all four segments, spending patterns and therefore carbon emissions change markedly between the low-spending and very high-spending segments. Low-spending tourists predominantly spend their money on food at supermarkets, cafes, restaurants, and takeaways (almost 50% of total spend collectively), whereas very high-spending tourists spend a much larger share on accommodation (approximately one-third), private tours and retail outlets. As a result, the greenhouse gas emissions for low-spending tourists are predominantly due to fuel and food. Whereas for very high spending tourists, it is a combination of accommodation, private tours, and purchased goods.

5.1.2 Domestic emissions – Marketview scaled to the TSA to capture all activity

Scaling the Marketview data to the Tourism Satellite Account to capture total tourism activity does not change the conclusions (Table 3). Domestic emissions per dollar spent are highest for the medium-spending visitor segment, followed by the low-, high-, and very high-spending segments, respectively. The 'low visitor segment multiplier' in Table 3 compares the emissions per dollar to that of the low-spending visitor segment. This shows that emissions per dollar spent in the low-spending segment is almost double that of the very high-spending segment.

Table 3: Carbon emissions intensity of tourism per visitor segment (Marketview scaled to the TSA)

Visitor segment	kg CO_2e/$	Low visitor segment multiplier
Low	0.388	1.00
Medium	0.421	1.09
High	0.328	0.85
Very high	0.277	0.71

These values are further disaggregated in Table 4, which shows that 'Fuel Retailing' (and associated fuel combustion) remains the highest source of emissions in the low-, medium-, and high-spending visitor segments. For the very high-spending visitor segment, 'Accommodation' has the highest emissions, as before**.**

Table 4: Top 10 domestic emission sources per visitor segment (Marketview data scaled to the TSA)

	low	%	medium	%	high	%	very high	%
1	Fuel Retailing	33%	Fuel Retailing	41%	Fuel Retailing	22%	Accommodation	22%
2	Cafes and Restaurants	15%	Cafes and Restaurants	14%	Cafes and Restaurants	16%	Other Store-Based Retailing n.e.c.	21%
3	Other Store-Based Retailing n.e.c.	10%	Other Store-Based Retailing n.e.c.	10%	Accommodation	14%	Cafes and Restaurants	8%
4	Takeaway Food Services	7%	Accommodation	6%	Other Store-Based Retailing n.e.c.	13%	Travel Agency and Tour Arrangement Services	7%
5	Supermarket and Grocery Stores	5%	Clothing Retailing	4%	Clothing Retailing	6%	Clothing Retailing	5%
6	Clothing Retailing	4%	Supermarket and Grocery Stores	4%	Travel Agency and Tour Arrangement Services	2%	Fuel Retailing	5%

	low	%	medium	%	high	%	very high	%
7	Newspaper and Book Retailing	4%	Pubs, Taverns and Bars	3%	Passenger Car Rental and Hiring	2%	Other Personal Accessory Retailing	4%
8	Accommodation	3%	Takeaway Food Services	2%	Taxi and Other Road Transport	2%	Casino Operation	3%
9	Pubs, Taverns and Bars	3%	Taxi and Other Road Transport	2%	Pubs, Taverns and Bars	2%	Passenger Car Rental and Hiring	2%
10	Taxi and Other Road Transport	3%	Amusement and Other Recreational Activities n.e.c.	1%	Supermarket and Grocery Stores	2%	Car Retailing	2%
11	Other	12%	Other	13%	Other	19%	Other	21%

5.2 Results based on international aviation only

Figure 3 demonstrates that fare class and transport distance are the two key determinants of greenhouse gas emissions from international aviation. Premium air fares over longer distances (e.g. from Africa, South America, and Europe) have considerably higher impact than short-haul flights on an economy class ticket (e.g. from Australia or Oceania).

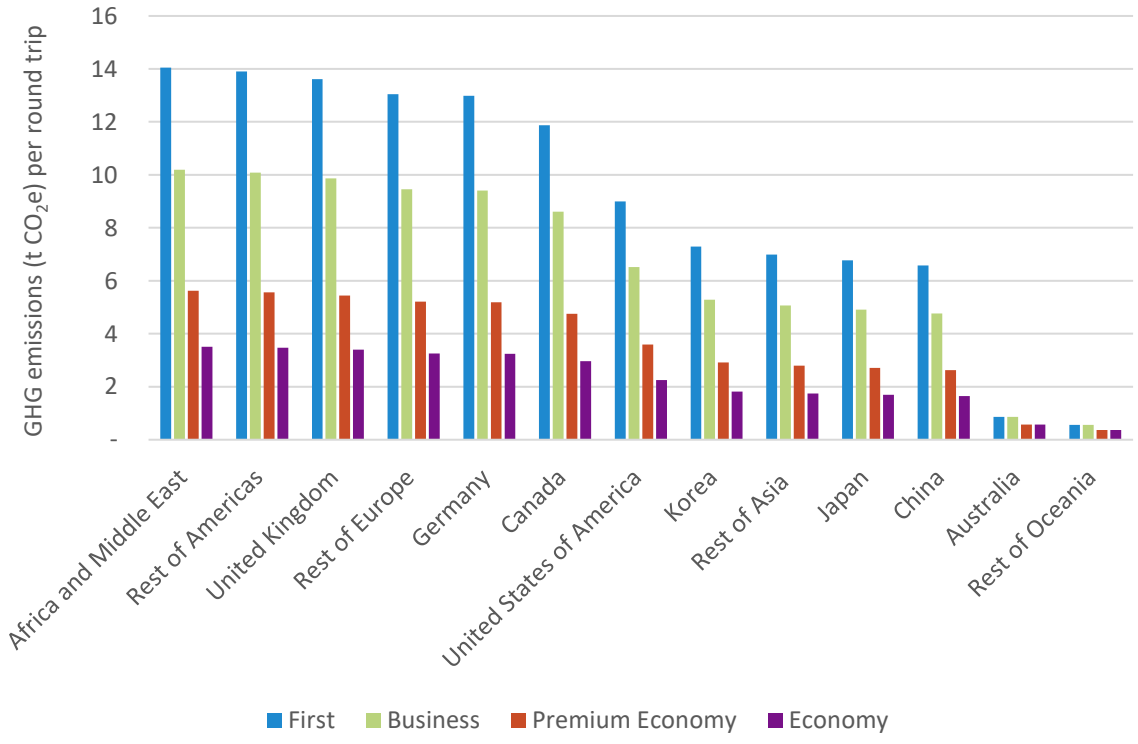

Figure 3: Greenhouse gas emissions from international aviation by region and fare class

The highest international aviation emissions come from visitors from 'Africa and Middle East' (based on a flight from South Africa via the Middle East) who travelled first-class, followed by first-class travellers from 'Rest of Americas' (based on a flight from South America), 'United Kingdom', 'Rest of Europe' and 'Germany'. The lowest international aviation emissions come from economy-class travellers from 'Rest of Oceania' followed by 'Australia', 'China', 'Japan', and 'Rest of Asia'.

When applying the length of stay of international visitors in 2018 as a normalisation factor to the absolute international aviation emissions, the results change slightly. Tourists travelling from 'Africa and Middle East', 'Rest of Americas', 'United States of America', 'United Kingdom', and 'Rest of Europe' become the highest carbon emitters for each fare class and 'Rest of Oceania' followed by 'Australia', 'Germany' (due to long stays on average), 'China', and 'Rest of Asia' become the lowest carbon emitters.

5.3 Results based on a hybrid approach

When considered in an absolute sense, higher-spending tourists have both a higher carbon footprint per trip and a higher contribution to the New Zealand economy per trip (Figure 4). This outcome was expected. The key question to be answered by this research is this: does the additional money injected into the New Zealand economy from higher-spending international tourists overcompensate for their additional carbon footprint, such that their carbon footprint per dollar spent is lower?

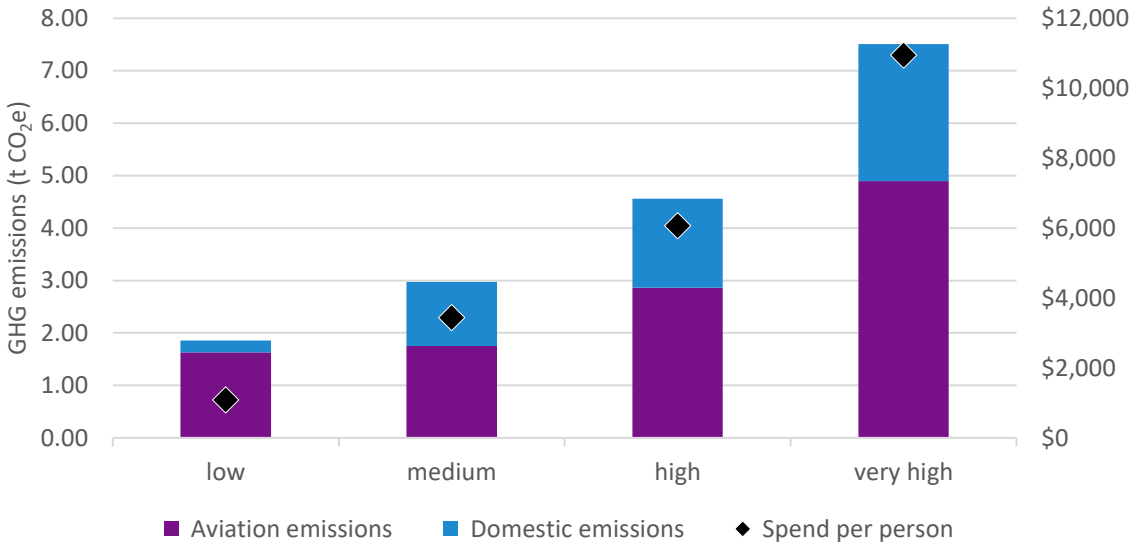

Figure 4: Absolute GHG emissions and spend per average international visitor stay

When considering domestic and aviation emissions, the highest emissions per dollar spent arise from the low-spending visitor segment, followed by the medium-, high-, and very high-spending visitor segments, respectively.

This is shown in Table 5 which also includes a 'low visitor segment multiplier' which indicates that the very high-spending visitor segment has less than half the emissions per dollar spent compared to the low-spending visitor segment.

Table 5: Carbon emissions intensity of tourism per visitor segment (hybrid approach)

Visitor segment	kg CO_2e/$	Low visitor segment multiplier
Low	1.710	1.00
Medium	0.864	0.51
High	0.752	0.44
Very high	0.686	0.40

Figure 5 combines domestic spending and international aviation (and also domestic aviation, though this plays a relatively minor role). The net effect is to reinforce the relationship seen in Figure 1 (which accounts for domestic spending only). As can be seen, low spending tourists have a considerably higher carbon footprint per dollar of spend when compared to their high-value and very high-value counterparts.

When comparing Figure 1 to Figure 5, it is important to note that the values on the vertical axis are now larger. Domestic carbon emissions (Figure 1) were between 0.25 and 0.52 kg CO_2e per dollar (with an average of 0.36). When factoring in international aviation as well (Figure 5), emissions increase to between 0.36 and 2.7 kg CO_2e per dollar (with an average 0.86) – an increase of 1.4 to 5.1 times (2.4 times on average).

This increase in emissions intensity comes for at least three reasons:

1. The significant carbon emissions (in an absolute sense) from long-haul flights to and from a remote market like New Zealand.
2. The relatively high carbon intensity per dollar of these carbon emissions.
3. A significant portion of international aviation spending does not contribute to the New Zealand economy (and is therefore not part of the denominator) because that money is spent with offshore airlines and offshore travel agents.

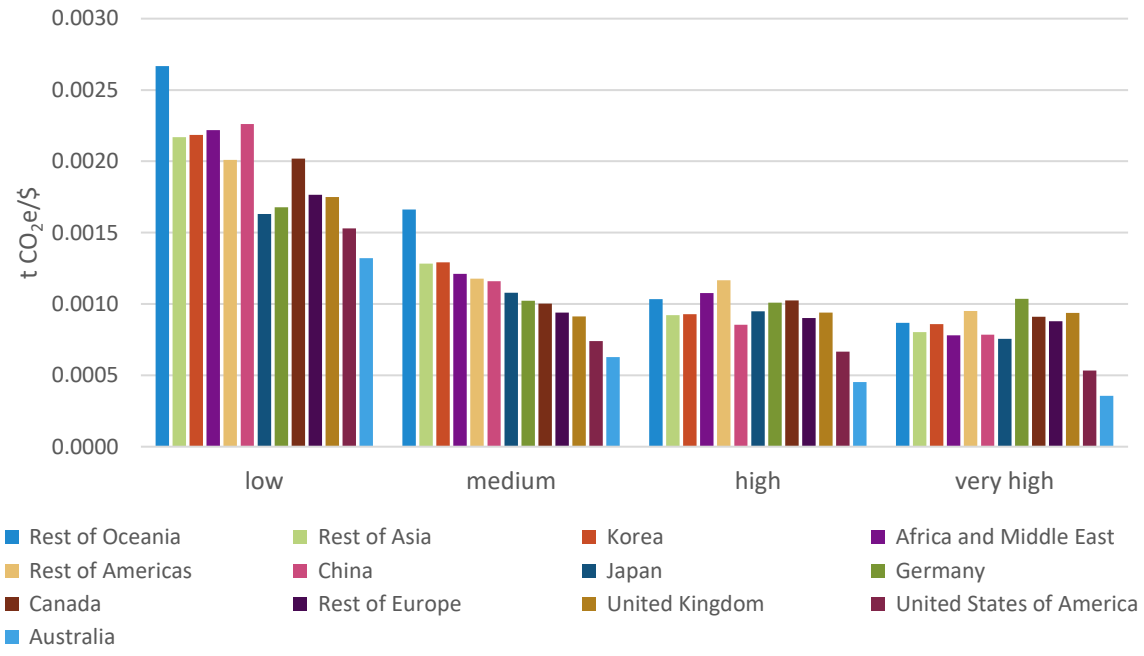

Figure 5: GHG emissions per $ by visitor segment and region – hybrid method

Two significant changes between Figure 1 and Figure 5 are:

- Low-spending visitors are now the most emissions-intensive of all spending segments, overtaking the medium-spending segment. This is because international aviation accounts for roughly 80% of their total emissions, compared to around 60% for the other spending segments (Figure 6).
- The emissions intensity of the very high-spending segment is now higher than the high-spending cases for a few markets (e.g. Germany) due to the additional emissions from international aviation, though the overall pattern remains that higher spending visitors have lower emissions per dollar than lower spending visitors.

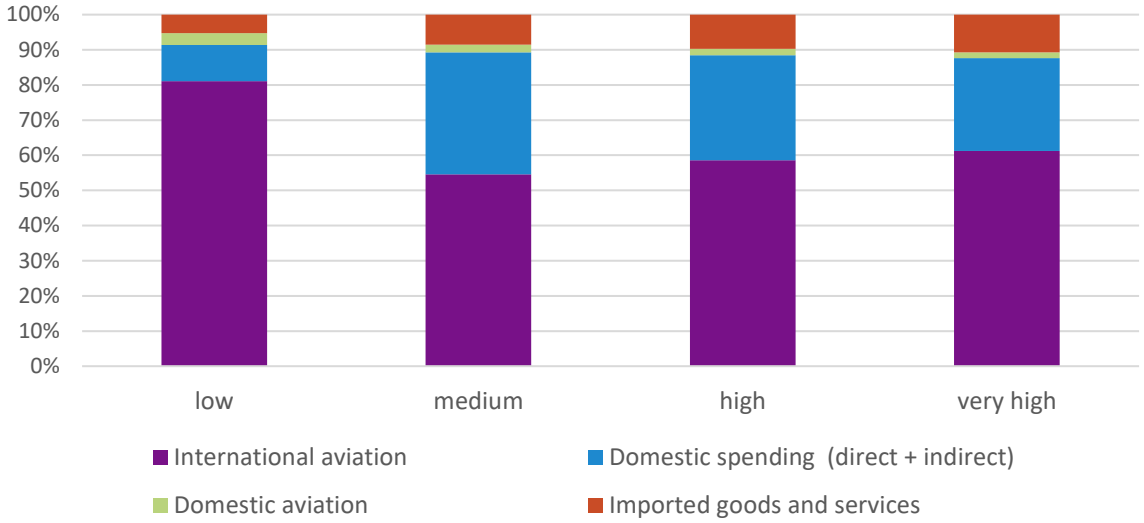

Figure 6: Breakdown of greenhouse gas emissions per spending class

6 Conclusions

The results show that higher spending visitors tend to have lower carbon emissions than lower spending visitors per dollar spent in the New Zealand economy. As such, the 'value over volume' should help to minimise the carbon footprint of tourism to New Zealand.

Total absolute emissions come from two main sources: emissions from spending on the ground (domestic emissions) and emissions from international aviation.

The majority of the emissions across the four defined international visitor segments (low-, medium-, high-, and very high-spending) come from aviation, particularly international aviation from tourists flying to New Zealand and back to their country of residence, and to a much lesser extent from domestic aviation within New Zealand.

Aviation emissions in the low-spending visitor segment account for 85%, in the medium segment for 57%, in the high segment for 60% and in the very high segment for 63% of the total emissions. Aviation emissions come primarily (>95%) from international aviation. These figures are highly dependent on distance and fare class.

Domestic emissions come primarily from fuel burnt in rental and private vehicles, food/beverages, accommodation, and shopping (both clothing and durable goods).

The above indicates that the best strategies to lower the carbon footprint of tourism to New Zealand are:

- To continue advocating for value over volume at a national level.
- To encourage high-value tourists to stay longer, helping to amortise the carbon emissions from their trip over a longer time and, for this analysis, a larger amount of money spent per trip.
- To focus on transitioning New Zealand's rental car fleet, and our wider vehicle fleet, to lower-carbon technologies, such as electric vehicles.

7 Assumptions

- International aviation:
  - The allocation of international arrivals to the visitor segments is based on average seat distribution of a plane
  - For long-haul international flights (beyond Australia and the Pacific Islands), this means that 1% of each arrival per region/class used a first-class ticket, 11% a business-class, 9% a premium economy class ticket and 79% an economy class ticket. These figures are calculated from an unweighted average of the seat plans of 10 long-haul aircraft from Air New Zealand and Singapore Airlines.
  - For short-haul international flights (Australia and the Pacific Islands), the plane is assumed to have 12% business class seats (combining first class and business class above) and 88% economy class seats (combining premium economy and economy class seats above).
- Domestic aviation: It was assumed that all international tourists that indicated international travel as a mode of travel took two average domestic flights. An average domestic flight is calculated from total domestic aviation emissions divided by the total number of passengers flying within a given year.
- Cardholders: It was assumed that the split of cardholders to visitor segments is representative. The exact number of cardholders is indicative since some tourists may use multiple credit cards or one card may be used for a group of tourists. This assumption is considered reasonable by the authors, given the large number of tourists travelling and the large number of transactions.
- Spending patterns: It was assumed that spending patterns on credit cards broadly mirrored spending via all other means (cash and pre-bookings). Put another way, the Marketview dataset was assumed to fairly represent the breakdown of spending by international tourists in each value class. A manual adjustment was made for aviation emissions, which are commonly pre-booked or booked online, given that the Marketview data captured on 0.3% of total spending in this category.

8 Limitations

- Emissions calculation using EIO-LCA emission factors does not account for price differences of the same product, which do not proportionally correlate with the emissions (e.g. premium products). This means that the carbon footprint per dollar of spend in a high-end restaurant is assumed to be the same as that of a takeaway. If it were possible to differentiate transactions based on their 'premium-ness', this would likely reinforce the existing conclusions. Take buying a 1L bottle of milk as example. The carbon footprint of producing any brand of 1L is broadly the same because most of the carbon footprint of milk production occurs on the farm and is therefore driven by the amount of milk in the pack. If the budget brand cost $2.50 per litre and the high-end brand cost $5 per litre, and both had a similar carbon footprint, the high-end brand would have roughly half the carbon footprint *per dollar* of the budget brand.
- The definition of the four visitor segments (low, medium, high, very high) is solely based on Marketview credit card data. Pre-bookings or money spent as cash may have an influence on the segment categorisation of cardholders. As no data were available to account for this, this could not be considered in this study.
- The aviation expenditure allocation approach is solely based on space taken up in an aircraft and flight distance and, therefore, does not account for differences in competition between routes or any other factors that influence air fares. Another limitation is that domestic aviation emissions have been allocated equally, though this has a minor influence on the overall results.
- International travel emissions include air travel only. No data were available for international cruise ship arrivals. These data would need to include not only fuel consumption (which would likely be small relative to air travel) but also impacts associated with food, beverages, accommodation and waste processing while on the boat (which may exceed the climate impacts of the fuel itself, depending on the length of the sea voyage to New Zealand). This affects the international inventory only, not the domestic inventory.

9 References

Becken, S. (2002). *Analysing International Tourist Flows to Estimate Energy Use Associated with Air Travel.*

BEIS/DEFRA. (2019). 2019 Government Greenhouse Gas Conversion Factors for Company Reporting. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/829336/2019_Green-house-gas-reporting-methodology.pdf.

ICAO. (2020). *ICAO Carbon Emissions Calculator*. Retrieved from https://www.icao.int/environmental-protection/Carbonoffset/Pages/default.aspx

ISO. (2006a). *ISO 14040: Environmental management – Life cycle assessment – Principles and framework.* Geneva: International Organization for Standardization.

ISO. (2006b). *ISO 14044: Environmental management – Life cycle assessment – Requirements and guidelines.* Geneva: International Organization for Standardization.

ISO. (2018). *ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification.* Geneva: International Organization for Standardization.

Lenzen, M., Kanemoto, K., Moran, D., & Geschke, A. (2012). Mapping the structure of the world economy. *Environmental Science & Technology, 46*(15), pp 8374–8381.

Lenzen, M., Moran, D., Kanemoto, K., & Geschke, A. (2013). Building Eora: A Global Multi-regional Input-Output Database at High Country and Sector Resolution. *Economic Systems Research, 25:1*, pp. 20-49.

MfE. (2019). *Measuring emissions: A guide for organisations – 2019 detailed guide.*

MfE. (2020). *New Zealand's Greenhouse Gas Inventory 1990-2018.*

Ministry for the Environment. (2019). *Measuring Emissions: A Guide fo Organisations - 2019 Detailed Guide.* New Zealand Government.

NZ Ministry of Transport. (2020). *Domestic passenger arrivals and departures through airports*. Retrieved from https://www.transport.govt.nz/mot-resources/transport-dashboard/6-air-passenger-and-freight/ar004-domestic-passenger-arrivals-and-departures-through-airports/

Stats NZ. (2019). *Environmental-economic accounts: 2019 (data to 2017)*. Retrieved from Statistics New Zealand: https://www.stats.govt.nz/information-releases/environmental-economic-accounts-2019-data-to-2017#pressures

Stats NZ. (2020). *International Visitor Survey: Transport 2018*. Retrieved from NZ.Stat table viewer: http://nzdotstat.stats.govt.nz/wbos/Index.aspx?DataSetCode=TABLECODE7571#

Stats NZ. (2020). *Visitor arrival by country of residence and purpose 2018 (Annual-Mar)*. Retrieved from Stats NZ Infoshare: http://archive.stats.govt.nz/infoshare/

Stats NZ. (2020). *Visitor arrival by country of residence, purpose and length of stay 2018 (Annual-Mar)*. Retrieved from Stats NZ Infoshare: http://archive.stats.govt.nz/infoshare/

Tourism Ticker. (2020). *How tourism can achieve value over volume – Hickton*. Retrieved from Tourism Ticker: https://www.tourismticker.com/2020/05/11/how-tourism-can-achieve-value-over-volume-hickton/