Māori household expenditure on infrastructure services –
An Investigation of the Relationship Between Māori Ethnicity and Household Infrastructure Spending

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Table of Contents

Executive Summary 4
Objective 4
Background 5
Methodological issues 5
Our approach 5
Definition of Māori and non-Māori individuals and households 7
Sensitivity analysis 8
Results 9
Decomposition analysis 10
Expected impact of limitations of this analysis 11
Technical notes - Data sources and derivation methodologies 14

Executive Summary

1. This paper assesses whether Māori and non-Māori households exhibit statistically different levels of infrastructure spending. To do this, it combines publicly available data with the empirical results from two prior papers published by the Infrastructure Commission.

2. Our central estimate is that the average Māori household spends $13,910 per year on infrastructure services; $810 per year more than the average spend of a non-Māori household of $13,100. This is equivalent to an average Māori household spending around 5.4% more of its after-tax income on infrastructure services than an average non-Māori one.

3. We were unable to conclude, however, that this is a statistically significant difference. Our sensitivity analysis suggests that we can only state with 95% confidence that Māori household infrastructure spending sits somewhere between $10,4101 and $20,950 per year (relative to a range of $9,700 to $19,540 for an average non-Māori household). We expect the reason for this is that there is greater variation in infrastructure spending between different Māori households than there is between the average non-Māori and Māori households.

4. High levels of 'within group' variation make it harder to conclude with confidence that any observable 'between group' variation reflects a real underlying difference in spending levels as opposed to natural variation arising from relatively small sample sizes and the inherent limitations of regression analysis techniques.

5. The difference in our estimates of Māori and non-Māori household infrastructure spending is explained by differences in the underlying characteristics of each type of household. Māori households exhibit some characteristics that are associated with higher levels of infrastructure spending, such as higher numbers of dependent children. However, they also exhibit other characteristics, such as lower average household incomes, that are associated with lower levels of infrastructure spending. Overall, the Māori household characteristics that drive higher levels of infrastructure spending slightly outweigh those that drive lower levels.

Objective

6. The purpose of this paper is to assess whether infrastructure spending differs between an average 'Māori household' and that of an average 'non-Māori household' (these two terms are defined in a subsequent section).

7. It should be emphasised that the primary focus of this report is to *quantify* the difference in infrastructure spending between the two types of households. It does not definitively determine *why* any differences might exist. An answer to that broader question would require a more comprehensive methodology using detailed, household level expenditure data (such as from the IDI).

[1] All estimates of household spending have been averaged to the nearest $10.

Background

8. The analysis outlined in this report draws heavily on two papers published by the Infrastructure Commission. The first of those two papers (published in mid-2023) used Household Expenditure Survey (HES) and census data in the Integrated Data Infrastructure (IDI), managed by Stats NZ, to derive household level estimates of levels of infrastructure spending. That paper is referred to as the 'how much do we pay for infrastructure' paper in the remainder of this report[2]. The second paper (published mid 2024) attempted to identify the primary factors that drive variations in household infrastructure spending, and to quantify the impact of each factor[3]. That second paper is referred to as the 'drivers of expenditure' paper for the remainder of this report. Neither of these papers examined the impact of ethnicity on household infrastructure expenditure.

9. Both of these earlier papers used data from various HES surveys and censuses contained in the IDI. This paper uses results from the earlier two papers but is not based directly on household-level data. It combines the results from those earlier two papers with publicly available data on differences between Māori and non-Māori households.

Methodological issues

Our approach

10. The 'drivers of expenditure' paper used regression analysis to analyse data from various HES surveys and censuses contained in the IDI. It identified the key factors that drive differences in levels of household infrastructure spending and provided an estimate of the size of the impact of each factor.

11. We initially explored using the IDI for this analysis on the impact of Māori ethnicity on the level of a household's infrastructure spending. However, after preliminary investigation it was concluded that the IDI was not needed, given that an alternative approach using publicly available data was available. We have used that alternative approach in this paper.

12. The key analytical output from the 'drivers of expenditure' paper was a set of four 'models' or equations that quantified (as best as the Commission was able) the relationship between different household characteristics and household expenditure on infrastructure services.

[2] See New Zealand Infrastructure Commission (2023). How much do we pay for infrastructure? Household expenditure on infrastructure services. Wellington: New Zealand Infrastructure Commission / Te Waihanga.
[3] See New Zealand Infrastructure Commission (2024). Drivers of household expenditure on infrastructure: An analysis of the factors that explain variations in household infrastructure spending. Wellington: New Zealand Infrastructure Commission / Te Waihanga.

13. In mathematical terms, those four models all took the following form:

$$Log(infrastructure\ expenditure) = \alpha + \beta 1 \log(after\ tax\ income\ and/or\ expenditure\ on\ non\ capital\ goods) + \beta 2\ (other\ variables) + \epsilon$$

Where:
α = constant
β1 = impact of income and/or wealth on infrastructure expenditure
β2 = impact of other household characteristic variables on infrastructure expenditure
ε = error term.

14. Regression analysis was used to determine which household characteristic variables to include in the various models, and to estimate the sign and size of the impact of each variable.

15. By way of example, the number of working adults in a household was found to influence infrastructure spending, with each additional working adult increasing the (log of the) household's annual infrastructure spending by a factor of 0.191[4]. The factor of 0.191 is referred to as the coefficient of the 'number of working adults' variable.

16. In this analysis we have used publicly available data to determine an average Māori and non-Māori household figure for as many as possible of the household characteristic variables that were included in those four models. We then multiplied the Māori and non-Māori household figures for each variable by the coefficient reported in the 'drivers of expenditure' paper to estimate the contribution that differences in each variable make to the overall level of infrastructure spending of a typical Māori and non-Māori household.

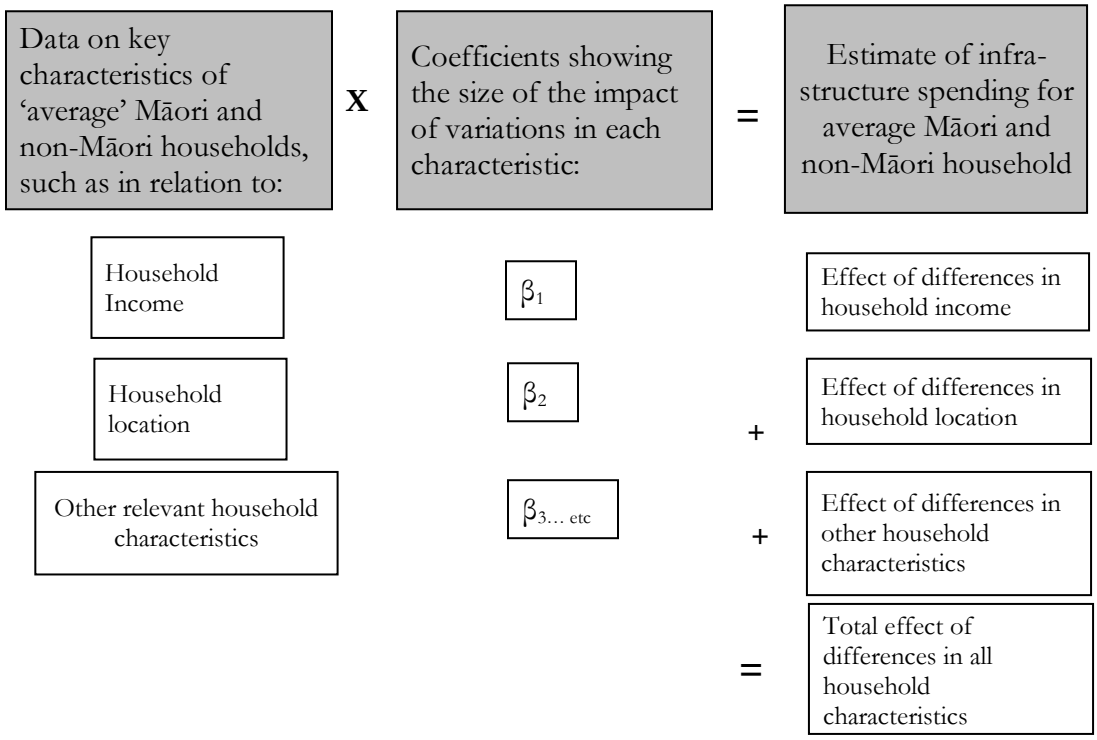
17. Returning to the example of the number of working adults in a household may help to make this clearer. We estimated from publicly available data that there are 1.32 working adults on average in a typical non-Māori household in New Zealand, and 1.21 on average in a typical Māori household. As noted above, the 'drivers of expenditure' paper concluded that each additional working adult increases (the log of) a household's annual infrastructure spending by a factor of 0.191. For this specific variable, that means that the (log of the) infrastructure spending of a typical non-Māori household will be higher than that of a Māori household by a factor of 0.021 (equal to 0.191 x (1.32 -1.21)).

18. We undertook this calculation for each variable we were able to find a non-Māori and Māori household estimate for, and then summed up the results to arrive at an overall estimate of infrastructure spending for both a typical Māori and non-Māori household.

[4] Additional non-working adults were also found to increase overall household expenditure on infrastructure, but to a lesser extent.

19. This approach is summarised in Figure 1 below.

Figure 1: Overview of methodology for estimating total average Māori and non-Māori household spending on infrastructure



20. The estimates we derived through this process were then scaled up to take account of the fact that:

- the regression models in the 'drivers of expenditure' paper only managed to explain around 60% of the total variation in household expenditure; and
- we were unable to find publicly available data for Māori and non-Māori households for a small number of the variables included in those regression models, and therefore had to exclude them from this analysis.

Definition of Māori and non-Māori individuals and households

21. There are several dimensions of ethnicity that we needed to work through in order to complete this analysis. First, ethnicity is typically seen, and reported in most public datasets, as an attribute of an individual, not a household. We therefore had to develop a clear definition of a 'Māori household' and 'non-Māori household'.

22. In turn, a distinction is frequently made by Stats NZ between Māori ethnicity and Māori descent. Māori ethnicity is largely seen as a cultural affiliation, whereas Māori descent

is seen as a genealogical concept. It is common to find differences in the number of individuals who report Māori ethnicity in any given database relative to the number reporting Māori descent.

23. Lastly, in many datasets, individuals can nominate more than one ethnicity. By way of example, a person can identify as having both Māori and Pasifika ethnicity.

24. For this analysis we have focused on ethnicity rather than descent (where the distinction between the two is made). Further we have adopted the following relatively expansive definition of individual and household ethnicity:

- an individual is defined as Māori if they have nominated Māori as one of their ethnicities, regardless of the number and nature of their other ethnic nominations;
- a household containing at least one Māori adult is identified as a Māori household, regardless of the number or ethnicity of other household members.

25. In turn we have defined a non-Māori individual as someone who has not nominated Māori as one of their ethnicities, and a non-Māori household as one that does not contain a Māori individual.

26. With that definitional approach clarified, we would note that we have sometimes had no option but to take slightly different approaches to the identification of Māori and non-Māori households for some variables. Most notably, in some instances we lacked sufficient information to calculate a figure for non-Māori households and instead had to simply use the figure for 'all New Zealanders'. We do not expect these slight differences in approach will have meaningfully impacted on our overall results.

Sensitivity analysis

27. The regression analysis results reported in the 'drivers of expenditure' paper include both a central estimate for each co-efficient, and a 95% confidence interval. The central estimate provides the best possible prediction of the exact value of each coefficient, given the available data. However, all analyses of this nature are subject to a degree of uncertainty. The confidence interval therefore shows how much variation around each central estimate is reasonably possible.

28. Returning to the example of the impact of the number of working adults in each household on infrastructure spending, the estimated co-efficient of 0.191 we reported previously is the central estimate. The upper and lower bound for the 95% confidence interval for that estimate were 0.18 and 0.202 respectively. In essence that means that while 0.191 is the best possible point-estimate of the true value of the coefficient, we can only say with 95% certainty that that coefficient sits somewhere between 0.18 and 0.202.

29. We took those upper and lower bounds from the estimated confidence interval for each coefficient and used Monte Carlo simulation to estimate a similar 95% confidence

interval for our central estimate of the total level of infrastructure expenditure for an average Māori and non-Māori household.

30. Purpose built software exists to undertake such Monte Carlo analysis. In conceptual terms, that software fits a distribution[5] between the upper and lower bounds of the confidence interval for each coefficient. The software then re-runs the core calculations a large number of times, using random probability weighted sampling to choose an exact figure to use for each co-efficient from within its 95% confidence interval. By doing that a large number of times, the software can then report a 95% confidence interval for the overall result we are interested in; in this case the total level of infrastructure spending for an average Māori and non-Māori household.

Results

31. Our central estimate is that the average Māori household spends $13,910 per year on infrastructure services; $810 per year more than the average spend of a non-Māori household of $13,100. Remembering that Māori households have lower incomes on average, that is equivalent to Māori households spending around 29.9% of their after-tax income on infrastructure services, relative to 24.5% for non-Māori households; a difference of 5.4 percentage points.

32. We were unable to conclude, however, that this is a statistically significant difference. Our sensitivity analysis suggests that we can only state with 95% confidence that Māori household infrastructure spending sits somewhere between $10,4106 and $20,950 per year (relative to a range of $9,700 to $19,540 for an average non-Māori household). Given such a wide range of possible values for the true level of infrastructure spending by each household type, an estimated difference in spending levels between them of only $810 is too small to allow us to conclude with confidence that there is a true difference between the spending levels of Māori and non-Māori households.

33. With the benefit of hindsight, our inability to demonstrate a statistically significant difference in spending levels between an average Māori and non-Māori household is perhaps not surprising. The Commission's earlier 'how much do we pay for infrastructure' paper found significant variation in levels of household infrastructure spending. Looking at the effect of household income for example, that paper reported that the average household in the highest income quintile spent around $20,600 per year on infrastructure services, while the average household in the lowest income quintile spent only around $7,400 per year. For households in the lowest income quintile that equates to spending 37% of their after-tax income on infrastructure, while for households in the highest income quintile the equivalent figure is only 12%.

34. That 'how much do we pay for infrastructure paper' ultimately concluded that "… variation [of spending levels] within groups of similar households is larger than variation

[5] In this case we used a normal distribution.
[6] All estimates of household spending have been averaged to the nearest $10.

between groups". So, the possibility that there might be relatively large variations in spending levels between different Māori households is not surprising. Unfortunately, such high levels of 'within group' variation make it harder to conclude with confidence that any observable 'between group' variation reflects a real underlying difference in spending levels as opposed to natural variation arising from relatively small sample sizes and the limitations inherent in regression analysis techniques.

Decomposition analysis

35. Some of the individual household characteristics that average Māori and non-Māori households differ in respect to would, taken on their own, suggest that Māori households should spend less on infrastructure, not more.

36. After-tax income provides a good example. The Commission's 'drivers of expenditure' paper found that higher household incomes lead to higher levels of infrastructure spending. Yet Māori households on average earn less than non-Māori ones. At face value that seems inconsistent with our central finding that Māori households appear to spend moderately more on infrastructure services than non-Māori ones.

37. The reason for this is that the characteristics that drive higher levels of infrastructure spending for Māori households outweigh those that drive lower levels. In this final section we therefore break our overall result down into its component parts, and identify which characteristics lead to higher levels of spending, and which lead to lower levels.

38. The core model from the 'drivers of expenditure' paper that we used as the basis for this analysis included 30 separate variables. However, we were unable to find ethnicity specific data for three of those, and a further 18 were dummy variables relating to either:

- the deprivation decile for the meshblock each household is located in; or
- whether a household was located in one of 9 specific territorial authorities (TLAs) that were associated with lower levels of household expenditure.

39. It makes more sense to consider the aggregate effect of all related dummy variables, rather than each dummy individually. After also removing the variables which we lacked ethnicity data for, that leaves 9 variables (or groups of variables) to consider.

40. Of those 9 variables, five had the effect of predicting a lower level of infrastructure spending by Māori households relative to non-Māori ones. Those variables were:

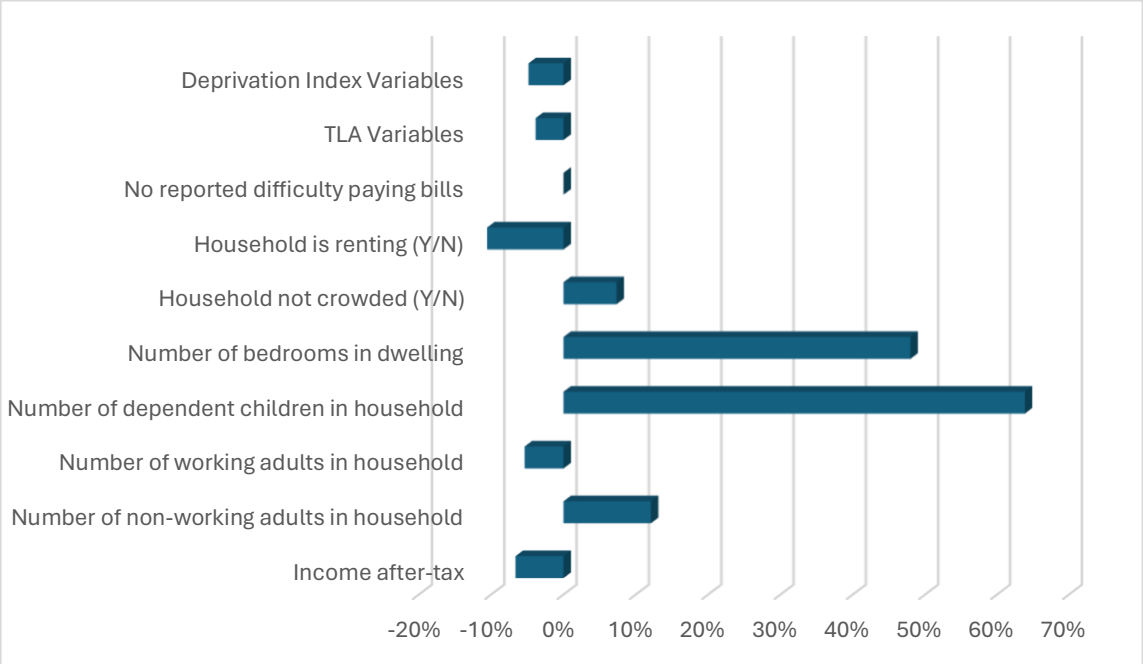
- lower levels of Māori after-tax household income;
- lower numbers of working adults in Māori households;
- higher levels of renting (as opposed to owning) by Māori households;
- a higher proportion of Māori households being based in one of the 9 TLAs exhibiting lower levels of infrastructure spending per household; and
- a higher proportion of Māori households being located in meshblocks exhibiting higher rates of deprivation.

41. In turn, there were four variables which had the effect of predicting a higher level of spending by the average Māori household. They were:

- higher numbers of non-working adults in Māori households;
- higher numbers of dependent children in Māori households;
- Māori households living in dwellings with a greater number of bedrooms; and
- a greater number of Māori households living in crowded dwellings.

42. While slightly smaller in number, these last four variables had larger impacts, and led to our central estimate that Māori households appear to spend more on infrastructure services than non-Māori ones. The respective impact of those 9 variables is shown in figure 2 below. Each of the bars shows the proportion of our estimate of the total difference between Māori and non-Māori infrastructure spending that is caused by each characteristic. By way of example, the higher number of dependent children in an average Māori household accounts for 64% of the total difference in spending between the two types of household.

Figure 2: Decomposition analysis



Expected impact of limitations of this analysis

43. As noted, there were a number of household characteristics that we were unable to find Māori and non-Māori household estimates for. They were:

- the average number of bedrooms in a dwelling
- the number of people living in non-private dwellings

- the proportion of households reporting difficulty paying bills
- the X and Y coordinate of each household
- rates of vehicle ownership; and
- levels of local government rates paid.

44. Depending on the variable, we have responded to that missing information in one of three ways. For the average number of bedrooms in a dwelling, we made an estimate based on data on the average number of children in Māori and non-Māori households. For the proportion of households reporting difficulty paying bills, rates of vehicle ownership, and levels of local government rates paid, we used the same national figure for both Māori and non-Māori households. Lastly, for the number of people living in non-private dwellings and the X and Y coordinate of each household we completely omitted the variable from our calculations.

45. It is not possible to say with certainty what effect our approach to managing that missing data will have had on our estimate of the difference between Māori and non-Māori household infrastructure spending. However, on balance our expectation is that the net effect is most likely have been to *overstate* Māori household expenditure.

46. As shown in the previous section, the number of bedrooms in a dwelling had the second largest effect of all of the household characteristics on the difference between our estimate of Māori and non-Māori infrastructure spending. There is clear evidence that a greater proportion of Māori households are crowded than non-Māori ones. However, we could not find data on the size of that difference in a form that we could use to adjust our estimate of the average number of bedrooms in each type of household. That inability to capture the effect of greater levels of over-crowding in Māori households will have led us to overstate the number of bedrooms in Māori households to some degree. That in turn will have biased our estimate of Māori infrastructure spending upwards. Unfortunately, we have no way of estimating the size of that bias.

47. Similarly, it is likely that our approach of using the same national figure for rates of vehicle ownership, and the value of local government rates paid, will also have biased our estimate of Māori infrastructure spending upwards. Our expectation would be that higher incomes are positively related to rates of vehicle ownership and the value of a household's dwelling. We know that Māori household incomes are lower than those of non-Māori, so it is reasonable to expect that if we had been able to find ethnicity specific figures for those two variables that the average Māori household figure would have been lower. That again will likely have biased our estimate of Māori infrastructure spending upwards.

48. Lastly, the only publicly available household level after-tax income figures we could find that are broken down by ethnicity had also been 'equivalised'. That means they had been adjusted to take account of the number of people in the household, with the income of larger households scaled down to reflect the fact that that household's members would be less well off in aggregate than a household with fewer members with the same income. Data that has not been adjusted in this way would have been preferable, as our model includes other variables relating to household size.

49. We ultimately concluded that it was better to include this variable than not, notwithstanding the equivalisation of the underlying data. However, doing so will have understated our estimate of the average Māori household's income, which in turn will have *understated* our estimate of the average Māori household's infrastructure expenditure. Note therefore that this limitation of our analysis works in the opposite direction to the two discussed above.

50. We have not found a way to estimate the likely net effect of these biases resulting from the limitations discussed above. However, their existence reinforces our conclusion that this analysis has *not* been able to conclude that there is a statistically significant difference between Māori and non-Māori household spending on infrastructure.

Technical notes - Data sources and derivation methodologies

These notes outlines the sources we used to collect the data for this analysis. Where relevant it also describes the additional steps we took to construct the required data series from those sources. Mirroring the approach taken in the 'drivers of expenditure' paper, we have grouped the discussion of the relevant variables into the following categories:

- Income and wealth variables
- Household composition variables
- Dwelling size and type variables
- Other socioeconomic variables
- Factors affecting rates and road user charges / fuel excise duty
- Location variables.

Income and wealth variables

The 'drivers of expenditure' analysis included two variables in this category:

- Household income after tax
- Household expenditure on non-capital items (as a proxy for wealth).

Log income after tax

For after tax income we used mean household equivalised disposable income figures from Stats NZ's report "Household income and housing-cost statistics: Year ended June 2022". It is appropriate that these figures are for disposable income, as the HES data was for income after tax. However, data that had *not* been equivalised would have been preferable. Stats NZ's equivalisation adjusts income for household size. As our analysis includes other variables that directly relate to household size, using this equivalised data will have resulted in a degree of double counting.

We have used this data regardless of this limitation. We did consider dropping the three household size variables included in our model. However, those variables differentiate between working and non-working adults, and dependent children. So, while dropping those variables would have avoided the risk of taking account of household size twice, it would also have removed information about the different impact of working and non-working adults, and dependent children.

As a result, our results are likely to slightly overstate Māori expenditure on infrastructure, as Māori household are larger than non-Māori ones on average.

Wealth

The Commission's earlier analysis on the drivers of expenditure included expenditure on non-capital items as a proxy for wealth in some, but not all, of the reported models. We used this measure as a proxy because true wealth data is not available in the HES dataset.

The model from that earlier work with the best overall fit (an overall R-Sq of 0.6989) included both an income variable and that proxy for wealth. However, the model that included income but no proxy for wealth was only modestly less powerful (with an R-Sq of 0.6428).

Ideally, we would therefore have included a wealth variable in this ethnicity analysis. However, while Stats NZ reports some wealth data that can be broken down by ethnicity[7], we could not identify any way to reconcile that wealth data with the proxy measure - expenditure on non-capital items - we used from the HES[8].

We have therefore based this ethnicity analysis on the one model from the earlier analysis that did not include a (proxy) wealth variable. For that reason, a wealth variable is not needed for this analysis.

Household composition variables

The models from the 'drivers of expenditure' analysis all included the following three household composition variables:

- the number of working adults
- the number of non-working adults; and
- the number of dependent children.

We found several sources of information on household composition outside of the IDI that were able to be broken down by ethnicity. However, they each used a slightly different breakdown than the one used in the 'drivers of expenditure' analysis.

Ultimately, we chose to use data from the Housing in Aotearoa report: 2020[9] that split all households into the following categories:

- Couple only
- Couple only with others
- Couple with child(ren)

[7] See Distribution of wealth across New Zealand households remains unchanged between 2015 and 2021 | Stats NZ

[8] Doing so would have required us to address several challenges, including that: the available wealth data is not standardised for age; and that we would have needed to convert the wealth figures into some form of annual annuity in order to sensibly use the coefficients derived from our earlier work.

[9] See Housing in Aotearoa: 2020 | Stats NZ

- Couple with child(ren) and others
- One parent with children
- One parent with children and others
- Two or more families (with or without others)
- Other multi-person household; and
- One-person household.

We combined that data with:

- data on the employment rate for men and women[10,11] (which can be broken down by ethnicity); and
- data on the average number of children per family[12] (which can be broken down by ethnicity).

In turn we adopted the following assumptions:

- where households include a couple plus "others" that there would be one additional adult in the household on average
- where a household included a couple, that each partner in the couple would have the same rate of employment as couples without children; and
- That households with 'two or more families' included one additional family of the same size as the existing family on average.

That data and set of assumptions allowed us to convert the figures from Housing in Aotearoa into numbers of Māori and non-Māori households falling into each of the three categories used in the earlier 'drivers of expenditure' analysis.

Factors affecting FED, RUC and Rates Payments

The only data we could find relating to levels of private vehicle ownership and rates payments could not be broken down by ethnicity.

We did however find NZ-wide data on rates of vehicle ownership[13] and expenditure on property rates[14]. For these variables we therefore had no choice but to use the same inputs for both Māori and non-Māori households.

[10] From Infoshare
[11] We found data on the extent to which the employment rate for women varies depending on data on the number of dependent children they have (see Mothers in the New Zealand workforce | Stats NZ). However this analysis reported higher employment rates across the board that the general rates reported by Stats NZ for women in general. So we ultimately chose not to use those figures.
[12] Source: Figure NZ. See https://figure.nz/chart/9tLV8dlA9h3iKNrl
[13] See Private vehicles per household in New Zealand - Figure.NZ
[14] See household-income-and-housing-cost-statistics-year-ended-june-2021-corrected.xlsx (live.com)

Dwelling size and type variables

The original 'drivers of expenditure' analysis included three variables in this category:

- a dummy variable indicating whether or not each dwelling was over-crowded
- the number of bedrooms in each dwelling
- a dummy variable indicating whether or not each household was located in a 'non-private' dwelling (such as a hostel).

We discuss each of those original variables in turn.

We found several possible sources of data on household crowding that were able to be broken down by ethnicity. Of those we chose to use data based on the Canadian National Occupancy Standard (CNOS), as that was also the definition of overcrowding used in the earlier 'drivers of expenditure' analysis. We found that data in the Housing in Aotearoa report[15].

We were unable to find any data outside of the IDI on the average number of bedrooms in each dwelling that could be broken down by ethnicity. Noting that the average number of children for European and Māori families is 1.79 and 2.61 respectively, we have therefore assumed an average number of 3 bedrooms for non-Māori households and 4 bedrooms for Māori households (one bedroom for each child and one for the two parents).

Lastly, we were unable to find any data outside of the IDI on the numbers of people living in non-private dwellings. We have therefore excluded that variable from this ethnicity analysis.

Other socioeconomic variables

The original 'drivers of expenditure' analysis included four variables in this category:

- a dummy variable identifying whether a household is renting
- a dummy variable identifying households that had never reported difficulty paying a bill
- a dummy variable identifying households that had been late paying multiple bills of multiple types (as opposed to just one bill or one type of bill)
- the deprivation index number of the meshblock that each household is located in.

We again discuss each of those variables in turn.

We found data on the proportion of households that rent (as opposed to own) for Māori and non-Māori in the Housing in Aotearoa report[16].

[15] See figure 82.
[16] See figure 16.

We were unable to find any data broken down by ethnicity on the proportion of households reporting difficulty paying bills. The Retirement Commission undertakes a Financial Capability Survey annually[17]. And we have found media reporting quoting that analysis as showing that Māori and young people are worst affected. However, we have not been able to find the underpinning data. For that reason, we have simply adopted the Commission's broader finding that 10% of households have reported missing a bill payment and used that figure for both Māori and non-Māori.

The only data we were able to find on the proportion of Māori and European households living in each deprivation decile is now somewhat out of date[18]. We have used the most recent data (relating to 2013) from that study.

Location variables

The original 'drivers of expenditure' analysis included two variables in this category:

- the X and Y coordinate of the centre of the mesblock that each household's dwelling is located in; and
- a dummy variable identifying households located in a selection of specific TLAs (Far North District, Whangarei District, Kaipara District, Hauraki District, Waikato District, Hamilton City, Tauranga City, Whanganui District and Manawatu District).

We were unable to find any data outside of the IDI relating to the precise X and Y coordinate location of households and have dropped this variable from our analysis.

However, NZ.Stat provides data on the population of each TLA by ethnic group. We used this data to calculate the proportion of all Māori and non-Māori respectively living in each of these TLAs.

[17] See Financial Capability Research | Retirement Commission Te Ara Ahunga Ora
[18] See [PDF] Analysis of deprivation distribution in New Zealand by ethnicity, 1991-2013. | Semantic Scholar.