Regression Analysis of Findings in the Horizon Research Ltd Survey *New Zealanders' Climate Change Actions and Attitudes*

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Summary of results[2]

In mid-2014, researchers from Motu Economic and Public Policy Research and Victoria University of Wellington collaborated with Horizon Research Ltd with support from the Sustainable Business Council to survey New Zealanders about their climate change beliefs and household actions that reduce emissions. Results are reported in Horizon Research Ltd (2014) and discussed in Leining and White (2015). This manuscript details the regression analysis of the survey data which is referenced by Leining and White. While bearing in mind that these results represent correlations between climate change beliefs and actions, and may not represent causal relationships, we find that:

1. People who do not believe their actions will make a difference to reduce climate change are*:*
    - Less likely to take low-commitment household actions[3] that reduce GHG emissions.
    - Less likely to generate renewable energy at home.
    - Less likely to change their transport behaviour (e.g. car or airplane travel) in ways that reduce GHG emissions.
    - Less likely to change their diet behaviour in ways that reduce GHG emissions.

2. People who do not believe that people like them are likely to be affected by climate change are:
    - Less likely to make low-commitment household actions that reduce GHG emissions.
    - Less likely to generate renewable energy at home.
    - Less likely to change their transport behaviour in ways that reduce GHG emissions.
    - Less likely to change their diet behaviour in ways that reduce GHG emissions.

3. There is some evidence that perceived effectiveness of personal actions to reduce climate change and perceived likelihood of climate change impacts on people like oneself act as substitute motivators rather than complementary motivators in people's decision to take some types of household mitigation actions. In some cases, if people

[2] This work was prepared during an internship and has not been fully peer-reviewed. The data set analysed in this paper was collected prior to finalisation of the survey, which means that 25 responses (out of 2246) were not included. This exclusion is not material to the high-level conclusions reached in the paper.

[3] The examples provided were installing household products to save energy, conserving water at home, reducing home energy use for air conditioning, heating or lighting, and considering energy or GHG emissions when making major purchasing decisions.

are strongly motivated to act by one of these beliefs, then the other appears to have less influence.

Dependent Variable: Low-Commitment Actions

In our survey we asked respondents four questions regarding their intentions to undertake specific relatively low-cost, low-commitment household actions; the actions selected contribute to reducing emissions. These questions were combined into one variable – *low-commitment actions* – which covers the likelihood that in the next 12 months, respondents will:

- Install household products to save energy (e.g., low-energy light bulbs)
- Conserve water at home (e.g., when cooking or showering)
- Reduce home energy use for air-conditioning, heating or lighting
- Consider energy or greenhouse gas emissions when making major purchasing decisions (e.g., house, car).

Respondents answered on a scale of 0 (not likely at all) to 5 (very likely). The variable *low-commitment actions* is defined as a person's mean response to these four questions.[4] We can think of people with a higher value recorded for *low-commitment actions* as people who are more likely to engage in cheaper and easier emission-reduction household actions in the next 12 months.

Regressions

Table 1 shows a number of different regressions of *low-commitment actions* against various independent variables.

Regression 1 (Column r1) shows *low-commitment actions* regressed against *powerlessness*. *Powerlessness* (i.e. low self-efficacy) is defined as an individual's response to the question: "Even if I do something to reduce climate change, my actions will make no difference." Answers range from -3 (strongly disagree with the statement – an expression of perceived self-efficacy) to +3 (strongly agree – an expression of perceived powerlessness).[5]

Regression 1 estimates the coefficient in the equation:

$$\textit{low-commitment actions} = \beta_0 + \beta_1(\text{powerlessness}) + \epsilon$$

The estimated coefficient on *self-efficacy* is negative and statistically significant at the 1% level. The estimated equation is:

$$\textit{low-commitment actions} = 4.574 - 0.172(\text{powerlessness}) + \epsilon$$

[4] People who did not respond to one or more of these questions were dropped from the analysis.
[5] Hence people who have a high value for powerlessness do not think their actions are very effective.

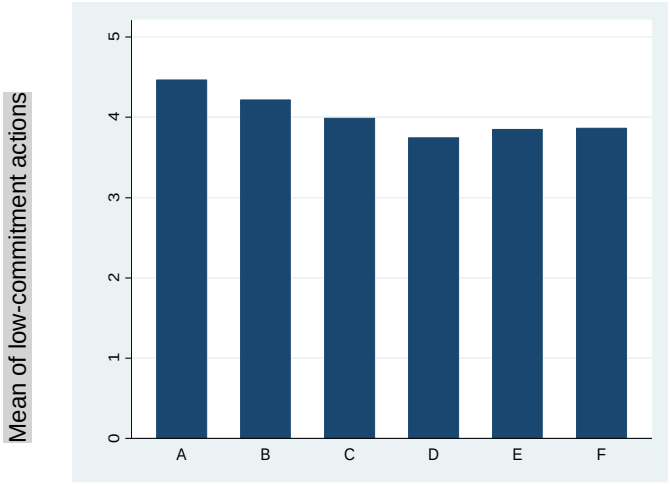
Table 1 **Low-Commitment Household Actions**

	r1	r2	r3	r4	r5	r6
Powerlessness	-0.172***	-0.134***			-0.104***	-0.207***
	(0.011)	(0.013)			(0.011)	(0.026)
Personal impacts			0.319***	0.232***	0.248***	0.121***
			(0.016)	(0.021)	(0.017)	(0.034)
Powerlessness × personal impacts						0.031***
						(0.007)
Constant (Y intercept)	4.574***	4.560***	2.891***	3.276***	3.513***	3.962***
	(0.045)	(0.048)	(0.055)	(0.079)	(0.086)	(0.135)
N	1800	1026	1799	1031	1791	1791
r2	0.129	0.098	0.182	0.109	0.22	0.228

*** p<.1, ** p<.05, *** p<.01**

Standard errors in parentheses

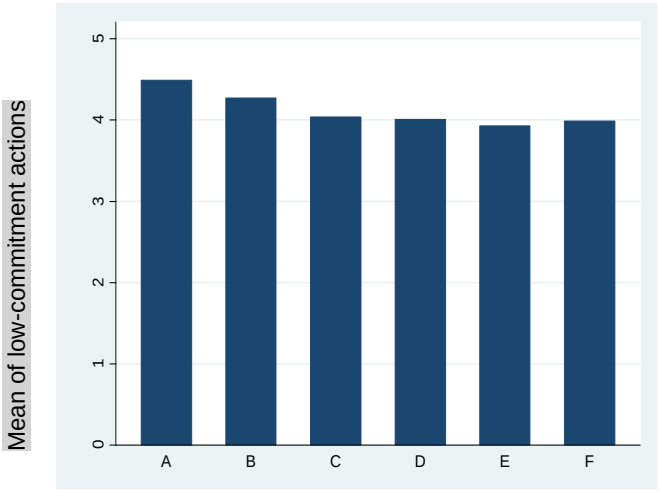
Hence the lower individuals' perceived self-efficacy is, the less likely they are to engage in 'easy' household mitigation actions. An increase of *powerlessness* by one point is correlated with a decrease in *low-commitment actions* of 0.172. Greater perceived *powerlessness* corresponds to a decrease in *low-commitment actions*. The bar graph below demonstrates the correlation between these two variables.



Regression 2 shows *low-commitment actions* regressed against *powerlessness;* however, individuals who have some uncertainty about whether climate change is happening have been removed from analysis.[6] This is defined as individuals who answered 'strongly disagree', 'disagree' or neutrally to the question "I am uncertain that climate change is really happening."

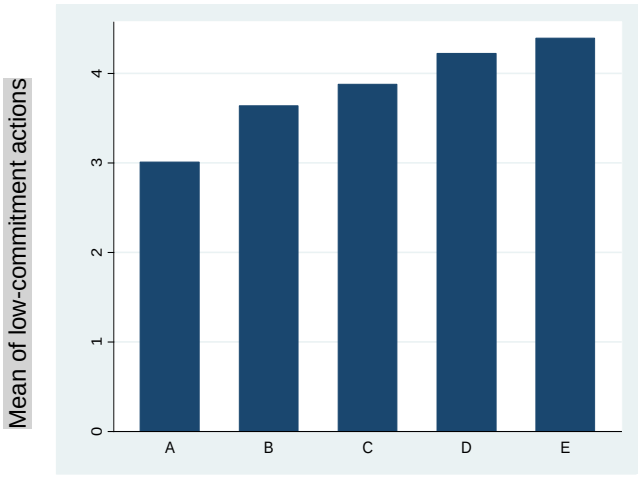
Again, the coefficient is negative and statistically significant at the 1% level. An increase of *powerlessness* by one point is correlated with a decrease in *low-commitment actions* by 0.134. As perceived powerlessness increases, this correlates to a decrease in low-commitment actions. The bar graph below demonstrates the correlation between these two variables.

[6] That is, we asked people on a scale of 1 (disagree) to 5 (agree) how much they agree with the following statement: "I am uncertain that climate change is really happening." People who responded with 3, 4 or 5 have been dropped from the analysis in regression 2. As can be seen in table 1, this drops around 770 people.



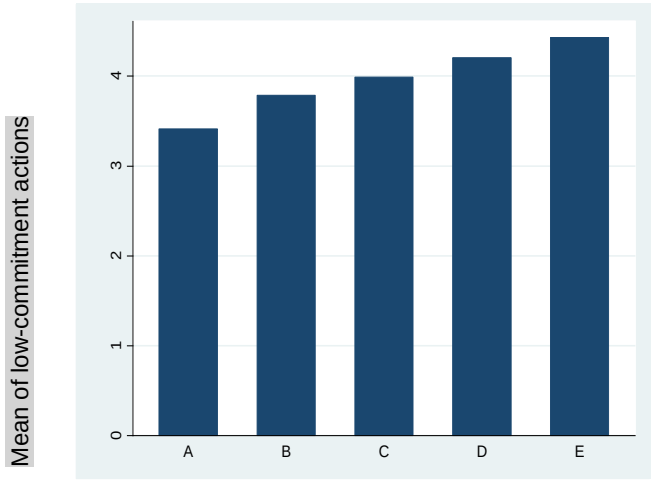
Regression 3 shows *low-commitment actions* regressed against *personal impacts. Personal impacts* is defined as an individual's response to the question "Climate change is likely to have a big impact on people like me." Answers range from 0 (strongly disagree) to 5 (strongly agree).

The coefficient is positive and statistically significant at the 1% level. An increase of *personal impacts* by one point correlates to an increase in *low-commitment actions* of 0.319. As the perceived likelihood of impacts of climate change on people like oneself increases, this correlates to an increase in low-commitment actions. The bar graph below demonstrates the correlation between these two variables.



Regression 4 again shows *low-commitment actions* regressed against *personal impacts;* however, individuals who have some uncertainty about whether climate change is happening have been removed from analysis.[7] This is defined as individuals who answered 'strongly disagree', 'disagree' or neutrally to the question "I am uncertain that climate change is really happening."

Again, the coefficient is positive and statistically significant at the 1% level. An increase of *personal impacts* by one point correlates to an increase in *low-commitment actions* of 0.232. As the perceived likelihood of impacts of climate change on people like oneself increases, this correlates to an increase in low-commitment actions. The bar graph below demonstrates the correlation between these two variables.



Regression 5 estimates the equation:

$$\textit{low-commitment actions} = \beta_0 + \beta_1(\text{powerlessness}) + \beta_2(\text{personal impacts}) + \epsilon$$

so that the coefficients on *powerlessness* and *personal impacts* have the same interpretation as they do in regressions 4-5 (namely the marginal effect/correlation of *powerlessness* on *low-commitment actions)*. Estimating both at once should be superior to estimating the coefficients separately since separate estimation will produce biased results if *personal impacts* and *powerlessness* are in fact correlated with one another. The estimated coefficients are similar to those in regressions 1- 4 and are statistically significant at the 1% level.

[7] As can be seen in table 1 this drops around 770 people.

Regression 6 estimates the equation:

$$\textit{low-commitment actions} = \beta_0 + \beta_1(\text{powerlessness}) + \beta_2(\text{personal impacts}) + \beta_3(\text{powerlessness} \times \text{personal impacts}) + \epsilon$$

and the estimated equation is:

$$\textit{low-commitment actions} = 3.962 - 0.207(\text{powerlessness}) + 0.121(\text{personal impacts}) + 0.031(\text{powerlessness} \times \text{personal impacts}) + \epsilon$$

This model allows the effect of *powerlessness* to depend on *personal impacts* and vice-versa. Hence the coefficients on *powerlessness* and *personal impacts* no longer have the same interpretation as in regressions 1-5 (they are no longer the marginal effects of these variables). Instead the marginal effect of *powerlessness* on *low-commitment actions* is now $\beta_1 + \beta_2 \times$ (personal impacts) and is estimated to be $-0.207 + 0.031 \times$ (personal impacts). This implies that when taking low-commitment actions, the effect of perceived powerlessness is smaller for people who believe that people like them will likely be affected by climate change. Likewise the marginal effect of *personal impacts* is estimated to be $0.121 + 0.031 \times$ (powerlessness). Hence the more powerless people feel, the greater the effect of their beliefs about whether climate change will likely impact on people like them.

In essence the results of Regression 6 suggest that perceived impacts of climate change on people like oneself and perceived self-efficacy are substitute motivators. When people are highly motivated by one belief, the other has little further effect on their decision to take low-commitment household actions.

Dependent Variable: Renewable Generation

In our survey we asked respondents one question regarding the likelihood that in the next 12 months, they will generate renewable energy at home (through solar, wind, geothermal or biomass). This question was covered by the variable *renewable generation.*

Respondents answered on a scale of 0 (not likely at all) to 5 (very likely). The variable *renewable generation* is defined as a person's mean response to this question.[8] We can think of people with a higher value of *renewable generation* as people who are more likely to generate renewable energy at home in the next 12 months.

[8] People who did not answer this question are coded as having a missing value for high commitment actions.

Regressions

Table 2 shows a number of different regressions of *renewable generation* against various independent variables.

Regression 7 shows *renewable generation* regressed against *powerlessness*. The coefficient is negative and statistically significant at the 1% level. An increase of *powerlessness* by one point correlates to a decrease in *renewable generation* by 0.126. Greater perceived powerlessness corresponds to a decrease in the likelihood of renewable generation at home. The bar graph below demonstrates the correlation between these two variables.

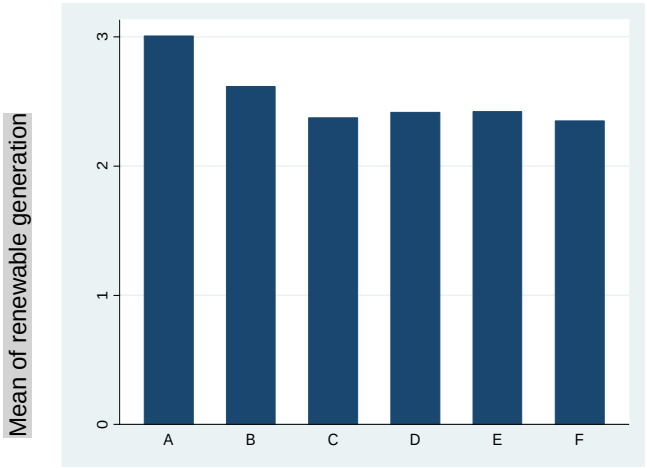


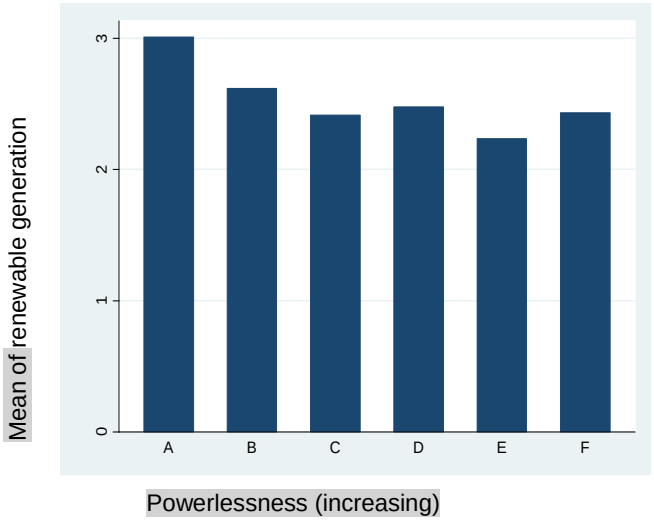
Table 2 **Renewable Generation**

	r7	r8	r9	r10	r11	r12
Powerlessness	-0.126***	-0.130***			-0.104***	-0.207***
	(0.017)	(0.023)			(0.011)	(0.026)
Personal impacts			0.252***	0.205***	0.248***	0.121***
			(0.026)	(0.038)	(0.017)	(0.034)
Powerlessness × personal impacts						0.031***
						(0.007)
Constant (Y intercept)	2.958***	2.981***	1.660***	1.802***	3.513***	3.962***
	(0.073)	(0.089)	(0.090)	(0.145)	(0.086)	(0.135)
N	1806	1020	1801	1024	1791	1791
r2	0.03	0.029	0.05	0.028	0.22	0.228

*** p<.1, ** p<.05, *** p<.01**

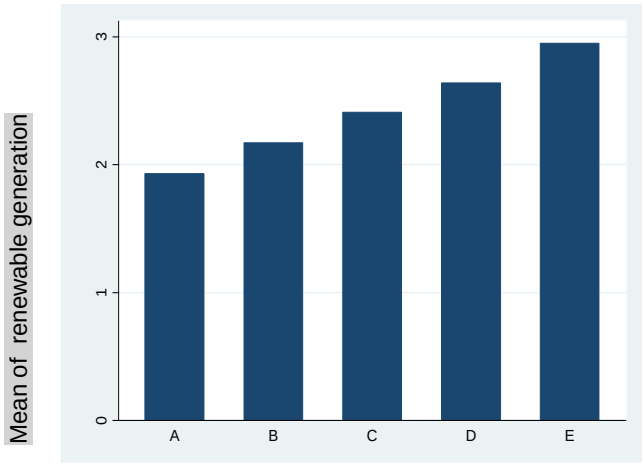
Standard errors in parentheses

Regression 8 shows *renewable generation* regressed against *powerlessness;* however, individuals who have some uncertainty about whether climate change is happening have been removed from analysis.[9] The coefficient is negative and statistically significant at the 1% level. An increase of *powerlessness* by one point correlates to a decrease in *renewable generation* by 0.130. Greater powerlessness corresponds to a decrease in the likelihood of renewable generation at home. The bar graph below demonstrates the correlation between these two variables.

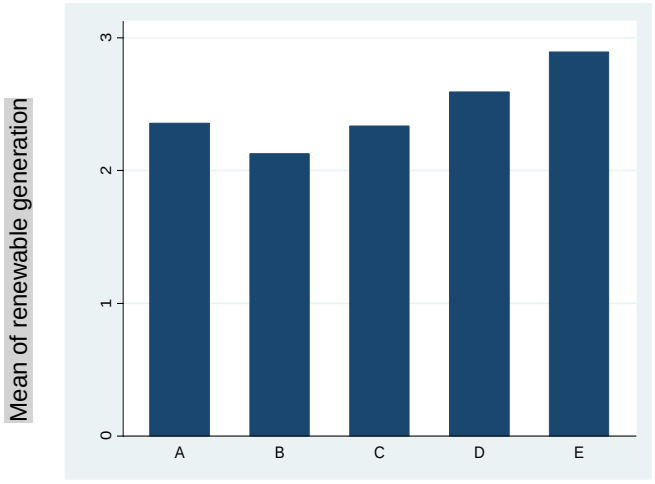


Regression 9 shows *renewable generation* regressed against *personal impacts*. The coefficient is positive and statistically significant. An increase of *personal impacts* by one point corresponds to an increase in *renewable generation* by 0.252. As the perceived likelihood of impacts of climate change on people like oneself increases, this correlates to an increase in the likelihood of renewable generation at home. The bar graph below demonstrates the correlation between these two variables.

[9] As can be seen in table 2 this drops around 786 people.



Regression 10 shows *renewable generation* regressed against *personal impacts;* however, individuals who have some uncertainty about whether climate change is happening have been removed from the analysis.[10] The coefficient is positive and statistically significant. An increase of *personal impacts* by one point corresponds to an increase in *renewable generation* by 0.205. As the perceived likelihood of impacts of climate change on people like oneself increases, this correlates to an increase in the likelihood of renewable generation at home.



[10] As can be seen in table 2 this drops around 775 people.

Regression 11 shows that when we estimate the effects of *powerlessness* and *personal impacts* on *renewable generation* in the same regressions, our earlier results are not changed. There is still a statistically significant decrease in *renewable generation* as *powerlessness* increases and likewise a statistically significant increase in *renewable generation* as *personal impacts* increase.

Regression 12 looks to see how *powerlessness* and *personal impacts* interact with one another. The positive coefficient on the interaction term shows that perceived impacts of climate change on people like oneself and perceived self-efficacy are substitute motivators. When people are highly motivated by one belief, the other has little further effect on their decision to generate renewable energy at home. The more powerless people feel, the greater the effect of their beliefs about whether climate change will likely impact on people like them.

Dependent Variable: Change Diet Actions

In our survey we asked respondents two question regarding changing diet behaviours as a way of reducing emissions. These questions becomes the variable – *change diet actions* – which covers the likelihood that respondents will:

- Avoid or reduce eating meat
- Avoid or reduce eating dairy products.

Table 3 **Change Diet Actions**

	r13	r14	r15	r16	r17	r18
Powerlessness	-0.175***	-0.171***			-0.097***	-0.095**
	(0.015)	(0.021)			(0.016)	(0.038)
Personal impacts			0.349***	0.322***	0.284***	0.287***
			(0.023)	(0.033)	(0.025)	(0.049)
Powerlessness x personal impacts						-0.001
						(0.011)
Constant (Y intercept)	2.902***	2.998***	1.111***	1.270***	1.686***	1.677***
	(0.063)	(0.079)	(0.079)	(0.128)	(0.122)	(0.194)
N	1871	1065	1865	1068	1858	1858
r2	0.07	0.06	0.114	0.08	0.131	0.131

*** p<.1, ** p<.05, *** p<.01**

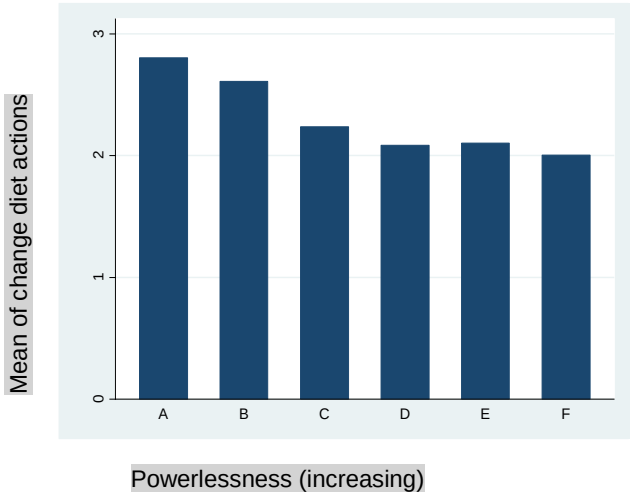
Standard errors in parentheses

Respondents answered on a scale of 0 (not likely at all) to 5 (very likely). The variable *change diet actions* is defined as a person's mean responses to these questions.[11] We can think of people with a higher value of *change diet actions* as people who are more likely to engage in diet/food emission reduction activities.

Regressions

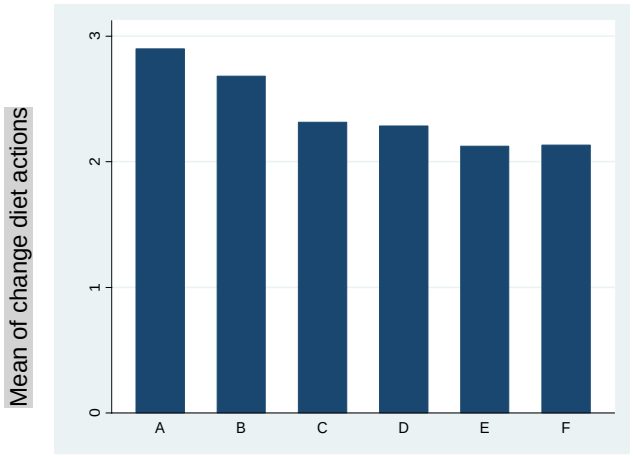
Table 3 shows a number of different regressions of *change diet actions* against various independent variables.

Regression 13 shows *change diet actions* regressed against *powerlessness*. The coefficient is negative and statistically significant at the 1% level. An increase of *powerlessness* by one point correlates to a decrease in *change diet actions* by 0.175. Greater perceived powerlessness corresponds to a decrease in diet actions. The bar graph below demonstrates the correlation between these two variables.



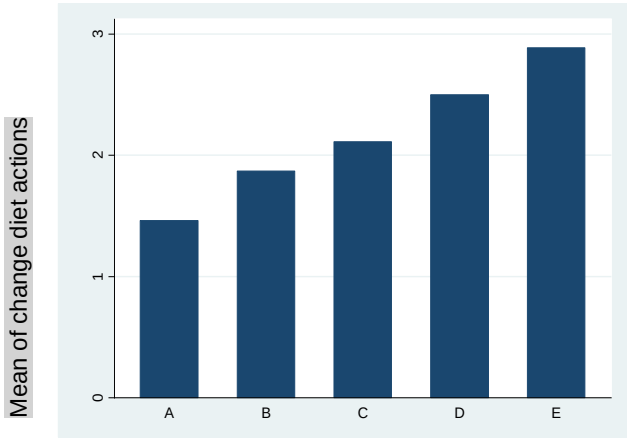
Regression 14 shows *change diet actions* regressed against *powerlessness;* however, individuals who have some uncertainty about whether climate change is happening have been removed from analysis.[12] The coefficient is negative and statistically significant at the 1% level. An increase of *powerlessness* by one point correlates to a decrease in *change diet actions* by 0.171. Greater perceived powerlessness corresponds to a decrease in diet actions. The bar graph below demonstrates the correlation between these two variables.

[11] People who did not answer either of these questions are dropped from the analysis of diet.
[12] As can be seen in table 3 this drops around 806 people.



Powerlessness (increasing)

Regression 15 shows *change diet actions* regressed against *personal impacts.* The coefficient is positive and statistically significant at the 1% level. An increase of *personal impacts* by one point correlates to an increase in *change diet actions* by 0.349. Higher perceived likelihood that climate change will impact on people like oneself correlates to an increase in diet actions. The bar graph below demonstrates the correlation between these two variables.

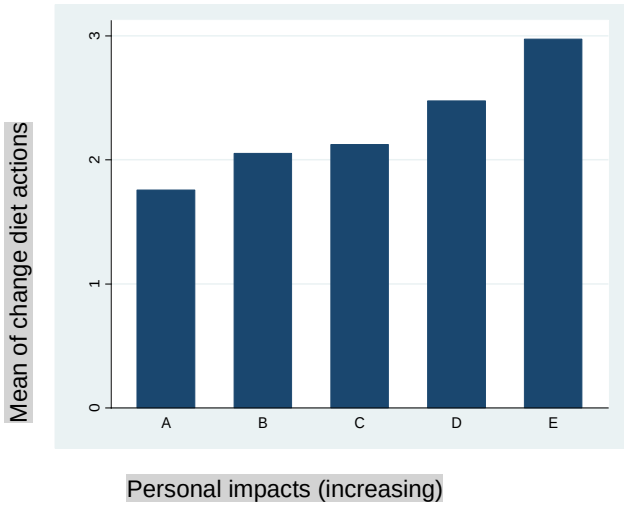


Personal impacts (increasing)

Regression 16 shows *change diet actions* regressed against *personal impacts;* however, individuals who have some uncertainty about whether climate change is happening have been removed from analysis.[13] The coefficient is positive and statistically significant at the 1% level. An increase of *personal impacts* by one point correlates to an increase in *change diet actions* by 0.322. Higher perceived likelihood that climate change will impact on people like oneself

[13] As can be seen in table 3 this drops around 797 people.

correlates to an increase in diet actions. The bar graph below demonstrates the correlation between these two variables.



Regression 16 shows that estimating the effects of *powerlessness* and *personal impacts* jointly does not change the conclusions of regressions 13-16.

The interaction term in regression 17 is not significantly different to 0; there is no evidence of an interaction effect between these two variables.

Dependent Variable: Change Transport Actions

In our survey we asked respondents two question regarding changing transport behaviours as a way of reducing emissions. These questions becomes the variable – *change transport actions* – which covers the likelihood that respondents will:

- Avoid or reduce air travel
- Avoid or reduce car travel (e.g. walk, cycle, use public transport, car-pooling).

Respondents answered on a scale of 0 (not likely at all) to 5 (very likely). The variable *change transport actions* is defined as a person's mean responses to these questions.[14] We can think of people with a higher value of *change transport actions* as people who are more likely to engage in transport emission reduction activities.

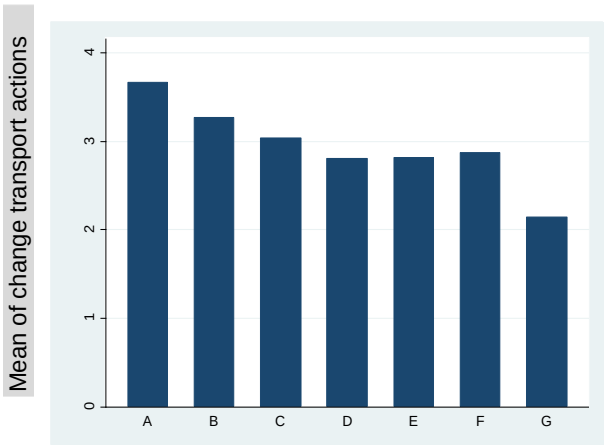
Regressions

Table 4 shows a number of different regressions of *change transport actions* against various independent variables.

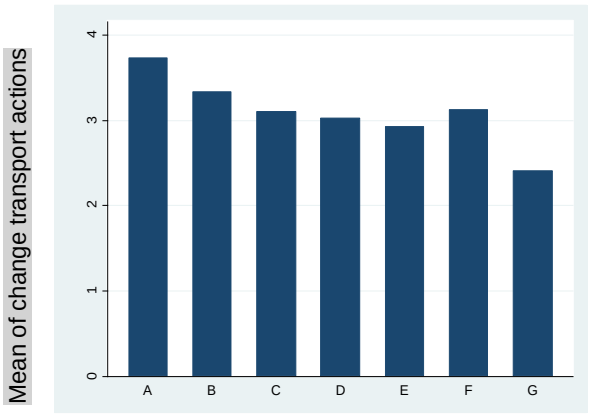
[14] People who did not answer either of these questions are coded as having a missing value for change transport actions.

Table 4	Change Transport Behaviour					
	r19	r20	r21	r22	r23	r24
	b/se	b/se	b/se	b/se	b/se	b/se
Powerlessness	-0.210***	-0.178***			-0.108***	-0.103***
	(0.014)	(0.019)			(0.015)	(0.035)
Personal impacts			0.441***	0.369***	0.366***	0.372***
			(0.021)	(0.030)	(0.023)	(0.045)
Powerlessness x personal impacts						-0.001
						(0.010)
Constant (Y intercept)	3.755***	3.778***	1.536***	1.864***	2.188***	2.167***
	(0.061)	(0.072)	(0.073)	(0.114)	(0.115)	(0.179)
N	1719	976	1714	979	1707	1707
r2	0.112	0.082	0.205	0.135	0.227	0.227
*** p<.1, ** p<.05, *** p<.01**						
Standard errors in parentheses						

Regression 19 shows *change transport actions* regressed against *powerlessness*. The coefficient is negative and statistically significant at the 1% level. An increase of *powerlessness* by one point correlates to a decrease in *change transport actions* by 0.210. Greater perceived powerlessness corresponds to a decrease in transport actions. The bar graph below demonstrates the correlation between these two variables.

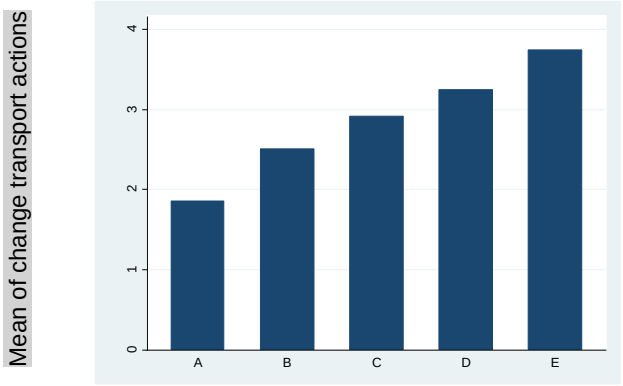


Regression 20 shows *change transport actions* regressed against *powerlessness;* however, individuals who have some uncertainty about whether climate change is happening have been removed from analysis.[15] The coefficient is negative and statistically significant at the 1% level. An increase of *powerlessness* by one point correlates to a decrease in *change transport actions* by 0.178. Greater perceived powerlessness corresponds to a decrease in transport actions. The bar graph below demonstrates the correlation between these two variables.



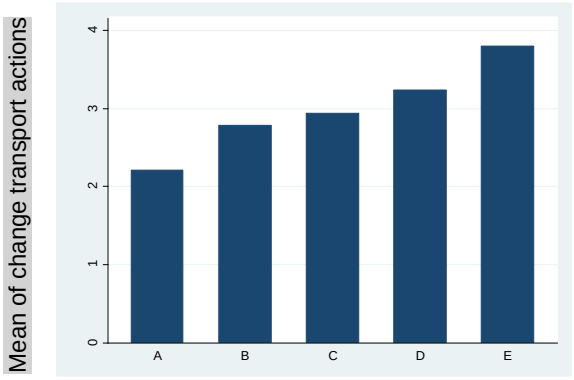
[15] As can be seen in table 3 this drops around 743 people.

Regression 21 shows *change transport actions* regressed against *personal impacts.* The coefficient is positive and statistically significant at the 1% level. An increase of *personal impacts* by one point correlates to an increase in *change transport actions* by 0.441. Higher perceived likelihood that climate change will impact on people like oneself correlates to an increase in transport actions. The bar graph below demonstrates the correlation between these two variables.



Regression 22 shows *change transport actions* regressed against *personal impacts;* however, individuals who have some uncertainty about whether climate change is happening have been removed from analysis.[16] The coefficient is positive and statistically significant at the 1% level. An increase of *personal impacts* by one point correlates to an increase in *change transport actions* by 0.369. Higher perceived likelihood that climate change will impact on people like oneself correlates to an increase in transport actions. The bar graph below demonstrates the correlation between these two variables.

[16] As can be seen in table 3 this drops around 735 people.



Regression 23 shows the results in regressions 19 -22 are robust to including both terms.

Regression 24 shows that there is no evidence of an interaction between these two variables.

References

Horizon Research Ltd. 2014. *New Zealanders' Climate Change Actions and Attitudes*. Kingsland: Horizon Research Ltd.

Leining, Catherine, and Scott White. 2015. *From Fact to Act: New Zealanders' Beliefs and Actions on Climate Change*. Motu Note. Wellington: Motu Economic and Public Policy Research.