

# An analysis of the effects of weather on pro-social behaviour

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## Abstract

This thesis researches the effect of weather variables on pro-social behaviour. Pro-social behaviour describes the behaviour that takes the utility of unrelated others into account as opposed to the selfish behaviour that traditional economics has typically assumed in the past. If there is a relation between the weather and pro-social behaviour this could mean that behaviour is erratic and economic models and expectations need to take that into account.

This research combines an existing dataset from a survey on the relation between guilt and pro-social behaviour with weather data from the The Royal Netherlands Meteorological Institute to find out what the relations are between temperature, sunshine duration, precipitation, atmospheric pressure, humidity, wind speed, and seven variables describing pro-social behaviour. In addition a factor is made out of the seven pro-sociality factors for an additional test of its relation with the weather variables.

The results show that precipitation amount has a significant positive effect on pro-social behaviour in two out of eight cases. Atmospheric pressure and temperature each have a significant positive effect on pro-social behaviour in one out of eight cases. Humidity has a negative significant effect on pro-social behaviour in one out of eight cases. Five out of eight regressions showed no relation of any of the weather variables and pro-social behaviour.

Despite these few significant findings, as a whole this research shows no clear and consistent relation between any of the weather variables and pro-social behaviour.

# Table of Contents

1. Introduction .....	3
2. Literature review.....	6
Pro-social behaviour .....	6
The impact of weather.....	8
Hypothesis.....	10
3. Data and Methodology .....	11
Data.....	11
Operationalisation .....	11
Description of tests .....	16
4. Results.....	19
5. Discussion.....	32
Conclusion.....	32
Limitations and directions for future research.....	33
Appendix .....	35
References .....	56

## 1. Introduction

Traditional economics has for the longest time used models based on the assumption of humans behaving as if they do not care for unrelated others. Behavioural economics has proposed alternative ways of looking at decision making.

Behavioural economists have created models that take the utility of oneself and others into account. Pro-social behaviour describes the behaviour of individuals that do not behave in purely self-interested ways. This pro-social behaviour occurs whenever decisions are made that affect others. Some examples of how this pro-social behaviour manifests itself are altruism, volunteering and cooperation. Fehr & Schmidt (1999) and Bolton & Ockenfels (2000) describe such pro-social models that incorporate the utility of others.

In economic experiments game theory is used to study the relation between individuals. The scenarios, often referred to as games, used in these experiments describe a set of rules under which two or more individuals interact. The findings from these games provide some of the evidence for the models in the field of behavioural economics.

Camerer (2003) is one of these researchers who have added behavioural economics to game theory. As he puts it 'Behavioural game theory is about what players *actually* do. It adds emotion, mistakes, limited foresight, doubts about how smart others are, and learning to analytical game theory.' (Camerer, 2003, p.3) None of the game types used in game theory give a complete explanation of behaviour by themselves according to Crawford. (1997) However, most behaviour can be understood by combining the ideas behind the different games with empirical observations that depend predictably on the environment.

The reason for the inclusion of pro-social behaviour in models is that research continually finds deviations from the model based on self-interest. Henrich et al. (2005) for instance performed ultimatum, public goods, and dictator games experiments in 15 different small-scale societies to see if the inclusion of fairness and reciprocity into decision making is shared amongst people all over the world. They found that the traditional model of selfishness fails for each society they studied. However, they did find much variability in behaviour indicating that behaviour is difficult to model. The ultimatum game is a game where one person gets to propose a split of a sum of money between themselves and a responder. The responder then has the opportunity to accept the proposal, in which case

the money gets divided according to the proposal, or to decline the proposal, in which case neither player gets any money. In public goods games a group of people each secretly choose to contribute an amount of money into a communal pot. The pot will then be increased by a multiplier and subsequently it will be evenly divided amongst all members of the group. Players get to keep their share of the communal pot, plus whatever part of their endowment they decided not to contribute towards the pot. In the dictator game a dictator gets to divide an endowment between themselves and a recipient. The recipient just receives whatever the dictator leaves for them and, unlike the responder in the ultimatum game, has no active role in the game.

In light of these findings that people have eye for others it is interesting to ask what determines how pro-social human behaviour is. Staub (1979, p. 9-10) gives an overview of factors that contribute to this. He describes that an unambiguous signal, the degree of help needed, the focus of responsibility on one person, the degree of the impact of stimuli, whether help is self-initiated or responsive, cost of helping, social acceptability of circumstances, relationship between giver and taker and positive and negative experiences prior to and during the decision making process all impact the degree of pro-social behaviour. With such a list of factors that all influence levels of pro-social behaviour one has to wonder how useful it is as a concept to base a model for economic predictions on.

In this research weather is the variable that will be put to the test to see if it has any effect on pro-social behaviour. It is easy to imagine that on days of fair weather moods are up and people feel generous, whereas on days of bad weather and struggling against the elements moods are down and altruism is a low priority. This will be tested to determine if our behaviour is as erratic as the weather so that it is possible to establish if existing research and models based on pro-social behaviour need updating or reconsideration.

By nature pro-social behaviour is a lot like a public good (Basu, 2010). It is behaviour based on traits that are innately present in humans and these traits can potentially be valuable to society.

In addition to those academic considerations there are also more practical implications. If the weather is a significant variable in predicting pro-social behaviour this can have many relevant economic effects. By planning tasks that are the most dependent on pro-social behaviour for periods with the best (or worst) weather forecasts, gains in efficiency might

be possible. For organisations that depend more heavily on cooperation and pro-social behaviour locating in a region with a more (less) agreeable climate might be worthwhile if the increase in days with good (bad) weather leads to more desirable behaviour. Having more knowledge on which, if any, factors of the weather influence behaviour and how they do so allows for better decision making.

When there is a better understanding of the effect the weather has on human decision making, it might also be possible to develop methods that help people make better decisions by making them more aware of the effects that are influencing them.

This leads to the following research question:

What is the effect of the weather on pro-social behaviour?

To answer this question this thesis consists of the following chapters. Chapter 2 discusses the existing literature that relates to the topic. Chapter 3 describes the data and methodology that were used for this research. Chapter 4 gives an overview of the results of the statistical tests and highlights and describes the results of importance. Chapter 5 contains the discussion of the results, it gives a conclusion in the form of an answer to the research question and describes some of the limitations and directions for future research.

## 2. Literature review

This chapter will give an overview of the existing literature surrounding this topic. The first section describes pro-social behaviour. The second section describes historical findings of the effect weather has on mood and behaviour. This historical context is what the hypotheses for this research are based on and these hypotheses are the wrap-up of this chapter.

### **Pro-social behaviour**

Frey & Meier (2004) described the nature of pro-social behaviour in a public good setting based on a large panel dataset. They found that how pro-social one is varies. They explained that different ways of framing changes levels of pro-social behaviour of students. They also found that higher levels of identification increase pro-social behaviour. Furthermore they mentioned that even after controlling for standard personal characteristics (e.g. gender and age) differences exist between levels of pro-social behaviour between types of persons. All of this is evidence that how pro-social a person behaves is not straightforward. In particular the existence of external factors that change the levels of pro-social behaviour stands out.

Bekkers (2007) reported on a field study of altruistic behaviour using an all-or-nothing version of the dictator game. With 5.7% of subjects giving away the reward they received for their participation, altruism is uncommon. This might be the result of the all-or-nothing set up of the study. He found that age, education, income, pro-social value orientation and generalised social trust are all factors that increase donations to charities. The finding that all these factors significantly influence pro-social behaviour is further evidence that the concept is a complex one with a potential for a lot of variation between individuals.

George (1991) looked into the effect of positive mood on pro-social behaviour at work. She split positive mood into an affective state and a trait, where the former is a measure of mood at a point in time and the latter describes a general disposition over time. George found evidence that positive mood as a state has significant positive relations with pro-social organisational behaviour. Positive mood as a trait was unrelated to pro-social behaviour. The increase in pro-social behaviour occurred both in tasks that are part of the job and tasks that are beyond the scope of the job.

Rosenhan et al. (1981) researched how the focus of attention affects altruism. They found that people that were primed to have a joyous affect combined with a focus on themselves and those people primed to feel sadness for others scored high on their measure of altruism. In contrast, those people primed to feel sadness with a focus on themselves and those primed to feel joy for others showed low amounts of altruism. They speculated that when the opportunity to behave pro-socially presents itself individuals compare their own situation to that of others and this evaluation mediates the likelihood to behave altruistically.

Tsang (2006) performed a laboratory experiment to research the effect gratitude has on pro-social behaviour. She elicited grateful emotions by having participants receive money either by favour or by chance. Those participants that were in the favour condition reported more gratitude and were more helpful in their own behaviour. The difference between the conditions under which participants received money means positive mood alone cannot explain pro-social behaviour. Instead, it shows gratitude and inter-personal constructs, such as indebtedness and the norm of reciprocity, play an important role in shaping behaviour.

Burnham (2003) looked into the effect of anonymity on altruism. He used three different versions of the dictator game. These are an anonymous control version, a version where the dictators' picture is given to the recipient and a version where a photo of the recipient is given to the dictator. He finds that both types of game in which a photo is shown result in significantly higher chances of giving half the money away. So, both a reduction in anonymity and an 'identifiable victim' change pro-social behaviour.

Camerer and Fehr (2006) discussed the situations where other-regarding preferences win out over the classical model of the economic man. The presence of a small number of people with other-regarding preferences can make it rational, even for self-regarding people, to behave in more pro-social ways. However, there are also cases where competition from just a number of self-regarding individuals can make it so that people with other-regarding preferences will also behave as if they are self-regarding. Which of these is the case depends on the possibilities there are for reciprocation and the strategic complementarity of the different types of behaviour.

This look at the literature on pro-social behaviour shows that pro-social behaviour is a complex concept that is influenced by a lot of factors. The finding that many factors are able



to influence pro-social behaviour leaves room for weather to be of significance. At the same time, the finding that many factors are able to influence pro-social behaviour also indicates that if weather is amongst them, it is likely to only contribute to a small fraction of that behaviour.

### **The impact of weather**

Howarth & Hoffman (1984) identified that research linking meteorological data to human behaviour is using an implicit three stage model. Weather variables work through mood which results in behaviour. Their research focussed on the link between the stages of weather variables and mood. They looked at the correlational effect of seven types of weather variables and ten types of self-reported mood variables. After stepwise multiple regression they found humidity and temperature had a significant effect on concentration. Humidity had a significant effect on potency and sleepiness. Precipitation, hours of sunshine and barometric pressure had a significant effect on scepticism. Hours of sunshine was a significant predictor for optimism. No weather variables were found to be significant predictors for anxiety, aggression, depression and control. They concluded that the most important finding is the large role humidity plays in affecting several mood dimensions.

The main takeaway from this paper is to use a comprehensive set of weather variables to look at the effect weather has on people. Several elements of the weather can have different effects on mood and consequently behaviour. Being able to split these out potentially allows for valuable insights.

Keller et al. (2005) looked into the effects of temperature and barometric pressure on mood and cognition. They found that the combination of spending time outdoors and temperature/barometric pressure is significantly related to mood and cognition. They emphasised that being outdoors is a causal factor in this finding as people that spent almost all of their time indoors show opposite results to people that spend more time outside. They also found season to be a big moderator in their findings with spring in the Northern hemisphere having positive effects in combination with higher temperatures but summer having negative effects in combination with higher temperatures.

The implications of these findings are that results for research into the relation between weather and behaviour need to be assessed with great care. The effects weather has very

much depend on the time and place they relate to and the exposure people have to that weather.

Denissen et al. (2008) also looked into the effects of weather on daily mood. They found that there is no significant main effect of weather on positive affect. Temperature (positive), wind power (negative) and sunlight (negative) did have significant main effects on negative affect.

Another look at the effect of weather on mood comes from Barnston (1988) who noted that the weather appears to have an effect on mood and productivity. This study that combined data on weather, student reports and a crisis intervention service found that students and intervention service clients with mild troubles are on average more stressed in unstable, cloudy, warm and humid conditions. However intervention service clients with severe problems had opposite reactions to weather types.

Hirshleifer & Shumway (2003) researched the effect of morning weather on the returns of stock markets for that day. They found that sunshine is strongly and significantly correlated with returns. They did not find evidence for a relation of other weather types like rain and snow with stock returns. The relation they did find they attribute to the nice weather leading to better moods which in turn cause more positive evaluations of information and consequently financial behaviour that leads to higher stock returns.

Saunders (1993) looked into the effect of weather on stock prices traded on New York stock exchanges. He found that cloud cover has a significant effect on stock prices. Less cloudy or sunnier days are related with higher index scores.

Cunningham (1979) researched the effects of weather on willingness to assist an interviewer and tipping which are both used as proxies for helpfulness. He found that during the summer sunshine (positive), temperature (negative), relative humidity (negative) and wind velocity (positive) are all significantly related to helping an interviewer. During winter sunshine (positive), temperature (positive) and wind velocity (negative) were significantly related with helping an interviewer. He emphasised the curvilinear relationship of temperature and helping that means in summer lower temperatures lead to more helpful behaviour and in winter higher temperatures lead to more helpful behaviour. Sunshine and relative humidity were both positively and significantly correlated with tipping. A further

interesting note is that weather variables accounted for only 13 percent of variance when outdoors and 4 percent of variance when indoors indicating weather variables can only explain a small part of altruistic behaviour.

Sanders & Brizzolara (1982) found significant negative correlations between relative humidity and the mood variables Vigour, Social Affection and Elation.

Kliger & Levy (2003) considered the relation between mood and risk preference where they used total cloud cover as a proxy variable for mood. Using that methodology they find evidence of a negative correlation between mood and risk aversion.

Connolly (2012) looked into the effects of weather on subjective well-being. She finds that women react more strongly to changes in weather than men. She finds that life satisfaction is negatively related to rainfall. She also finds that high temperatures reduce happiness and explains this by pointing out the research was conducted during the summer.

### **Hypothesis**

The findings of these preceding studies show that what is typically considered more agreeable weather is often related to a better mood. There has also been evidence of good moods having a positive effect on pro-social behaviour. As a result the hypothesis for the remainder of this research will be that nicer weather will have a positive effect on pro-social behaviour. Since the data for the dataset used in this research were collected in the Netherlands during the winter better weather means higher temperatures, longer sunshine duration, shorter precipitation duration, lower precipitation amount, higher barometric pressure, lower wind speed and lower relative atmospheric humidity. Because of this a positive effect of temperature, sunshine duration and barometric pressure on pro-social behaviour is hypothesised. Similarly, a negative effect of precipitation duration, precipitation amount, wind speed and atmospheric humidity on pro-social behaviour is hypothesised. It is important to realise that some of these weather variables might interact. Therefore, all of these hypotheses should be interpreted as being made under the assumption of all other variables remaining unchanged, or *ceteris paribus*.

### 3. Data and Methodology

In this chapter the data and methodology for the research are described. It starts of by describing the sources of the data used. That brief description is followed by the operationalisation that describes what variables will be used throughout this research. Lastly, this chapter contains a description of the tests used.

#### **Data**

To find an answer to the research question data from the LISS Panel Data Archive will be combined with weather data from the KNMI (The Royal Netherlands Meteorological Institute). The LISS panel dataset consists of answers to a questionnaire that examines whether parenthood affects the relation between guilt and pro-social behaviour. The dataset contains 734 responses that were collected in a 23 day period in February of 2013. Of those 734 responses 27 did not contain observations on the variables of interest here. So these were dropped leaving 707 responses. The dates of these observations will be matched with weather data from the De Bilt weather station as it is centrally located in the Netherlands and therefore likely to be a good representation of the weather in the whole of the Netherlands.

#### **Operationalisation**

To be able to research pro-social behaviour variables need to be found that represent this pro-social behaviour. This research will utilise seven such dependent variables that indicate pro-social behaviour. The first is the variable 'Donate50'. This Donate50 is the answer to the question 'Suppose you were to have €50 extra to spend this month. How much of that €50 would you donate to the Cancer Fund?' and is an integer in the range [0, 50]. The second dependent variable is 'DonateMoneyAnon'. DonateMoneyAnon is the extent of agreement with the statement 'I would like to make an anonymous donation of money to a good cause.' The third variable is Comfort which shows the agreement with the statement 'I would like to comfort someone who is emotionally distraught.' The fourth variable is 'HelpStranger' which shows the agreement with the statement 'I would like to help someone, even if it is a stranger.' The fifth dependent variable is 'HelpNoNotice' which shows the agreement with the statement 'I would like to help someone, without he or she noticing.' The sixth variable is 'DonateClothesAnon' which shows the agreement with the

statement 'I would like to help someone, without he or she noticing.' The seventh dependent variable is 'HelpHurt' which is the agreement with the statement 'I would like to help someone who has hurt him or herself.'

The agreement with these statements for each of the variables is indicated on a 5 point Likert scale where the options are 1. Completely disagree, 2. Disagree, 3. Neutral, 4. Agree, and 5. Completely agree.

Dependent Variable	Prompt	Response	Mean	Standard deviation
Donate50	Suppose you were to have €50 extra to spend this month. How much of that €50 would you donate to the Cancer Fund?	Integer in the range [0, 50].	10.82	13.72

Dependent Variable	Prompt	Completely disagree %	Disagree %	Neutral %	Agree %	Completely agree %
DonateMoneyAnon	I would like to make an anonymous donation of money to a good cause.	20.65	13.30	30.83	28.01	7.21
Comfort	I would like to comfort someone who is emotionally distraught.	2.83	4.53	24.33	53.32	14.99
HelpStranger	I would like to help someone, even if it is a stranger.	5.52	12.16	33.95	41.30	7.07
HelpNoNotice	I would like to help	4.95	9.48	28.29	48.80	8.49

	someone, without he or she noticing.					
DonateClothesAnon	I would like to make an anonymous donation of clothing or goods.	6.65	8.63	25.18	46.68	12.87
HelpHurt	I would like to help someone who has hurt him or herself.	3.54	3.54	29.28	50.78	12.87

To test the hypotheses of the effect weather has on these dependent variables the data for seven weather variables have been collected and matched with the dates of the responses of the questionnaire from which the dependent variables have been taken. The seven weather variables that will function as the independent variables for this research are 'Temperature' which indicates the daily mean temperature and is measured in degrees Celsius, 'SunshineDuration' which is the sunshine duration (in 0.1 hour) calculated from global radiation, 'PrecipitationDuration' which is the precipitation duration (in 0.1 hours), 'PrecipitationAmount' which is the daily precipitation amount (in mm)<sup>1</sup>, 'AtmosphericPressure' which is daily mean sea level pressure (in hPa) calculated from 24 hourly values, 'Humidity' which is daily mean relative atmospheric humidity (in percent) and 'Windspeed' which is daily mean wind speed (in 0.1 m/s).

Independent Variable	Description of Variable	Measurement	Mean	Standard deviation
Temperature	Daily mean temperature	In degrees Celsius	2.216	2.951

<sup>1</sup> For PrecipitationAmount 38 observations were reported as -1. This indicated an observation below 0.05mm. These 38 observations have been replaced by 0.

SunshineDuration	Sunshine duration calculated from global radiation	In 0.1 hours	31.98	24.14
PrecipitationDuration	Precipitation duration	In 0.1 hours	22.15	27.69
PrecipitationAmount	Daily precipitation amount	In mm	1.90	2.56
AtmosphericPressure	Daily mean sea level pressure	In hPa	1015.68	9.97
Humidity	Daily mean relative atmospheric humidity	In percent	81.50	8.40
Windspeed	Daily mean wind speed	in 0.1 m/s	38.81	14.69

There will also be several control variables that appear throughout this research. The first one of these is 'Condition'. This describes the condition to which respondents belonged in the original survey, which had both a guilt condition and a control condition. Participants in the guilt condition were asked to recall a situation where they felt guilty for part of the survey, whereas participants in the control condition were asked to recall a regular weekday. Control variables two through seven are 'Guilt', 'Happiness', 'Shame', 'Regret', 'Sadness', and 'Anger' which are all the responses to how strongly respondents feel that emotion at the time of the questionnaire. These 6 emotion variables were all measured on a 5 point Likert scale with the possible answers being: 1. Not at all, 2. Slightly, 3. Somewhat, 4. Strongly, and 5. Very strongly. Furthermore, Gender and Age will appear as Control variables. 'IncomeAlt' will be the control variable used for net household income in Euros. This variable has been constructed by taking the Net Household Income variable from the original dataset and replacing all values of 0 to missing observations. This transformation has been made because it is unclear whether a value of 0 represents an actual income of 0, or an unwillingness to share the actual household income. 'EduHi' will be the variable representing the highest level of education with a diploma. This is a binary variable that has value 1 if the participant has completed hbo (higher vocational education, US: college) or wo (university) education and 0 otherwise.

Control Variable	Description of variable	Measurement	Mean	Standard deviation
Condition	Dummy variable that describes the way in which participants were primed in the original questionnaire.	Binary (0 if guilt condition, 1 if control condition)	0.51	
Gender	Dummy variable that describes gender	Binary (0 if male, 1 if female)	0.55	
Age	Age of participant	In years	46.46	10.61
IncomeAlt	Monthly Net Household Income	In €	2954.63	1450.06
EduHi	Highest level of education with diploma	Binary (0 if highest level of completed education is below hbo, 1 if highest level of education is hbo or wo)	0.36	

Expanded Control Variable	Prompt	completely disagree %	Disagree %	Neutral %	Agree %	Completely agree %
Guilt	Extent of experiencing emotion during questionnaire	56.86	14.14	13.44	12.16	3.39
Happiness	Extent of	41.58	10.47	28.01	18.10	1.84



	experiencing emotion during questionnaire					
Shame	Extent of experiencing emotion during questionnaire	63.93	12.31	13.72	7.36	2.69
Regret	Extent of experiencing emotion during questionnaire	57.85	13.58	15.13	8.91	4.53
Sadness	Extent of experiencing emotion during questionnaire	61.67	15.28	13.58	5.94	3.54
Anger	Extent of experiencing emotion during questionnaire	73.69	13.15	10.61	1.70	0.85

### Description of tests

To test the hypotheses presented at the end of chapter 2 a series of different statistical tests has been performed. For the Donate50 dependent variable linear regressions with robust standard errors are used. For DonateMoneyAnon, Comfort, HelpStranger, HelpNoNotice, DonateClothesAnon and HelpHurt ordered logistic regression with robust standard errors are used. All of these regressions were run in three iterations. The first with the dependent variable and the independent weather variables, the second added a basic set of control variables and the third expanding the list of control variables. The weather variables used

for these regressions are Temperature, SunshineDuration, PrecipitationAmount, AtmosphericPressure, Humidity and Windspeed. Notably, PrecipitationDuration was left out due to concerns of multicollinearity. The basic control variables that get added in the second iteration of each regression are Condition, Gender, Age, IncomeAlt and EduHi. The control variables that are only added in the third iteration of each regression are Guilt, Happiness, Shame, Regret, Sadness and Anger.

For these dependent variables that require ordered logistic regression the additional test of marginal effects has been performed. For each of them the marginal effects at sample means have been looked at for the iteration of the regression that includes the expanded set of control variables. These analyses of the marginal effects allow for a more clear interpretation of the effect the significant variables have as the size of the effect has an intuitive meaning. The output for these marginal effects analyses can be found in the appendix (Appendix A1-A6). When relevant, these marginal effects will be discussed in the results section alongside the corresponding ordered logistic regression. For some of these additional marginal effects predictions have been made to illustrate their potential economic relevance when the scale of the original variables risked obscuring their effect. These results can be found in the appendix as well (Appendix B1-B4).

Furthermore, Exploratory Factor Analysis has been performed. As explained by Brown (2009) this method is well suited for analysis when working with hypotheses based on earlier research. This EFA has been used to reduce the number of variables and to see if there is an underlying structure to these observations. This additional analysis is valuable as several of the weather variables were moderately or strongly correlated and so were several of the variables describing pro-social behaviour. This EFA is able to take away very minor concerns about multicollinearity.

The pro-social behaviour variables have been combined into one factor that had a meritorious score of Kaiser-Meyer-Olkin measure of sampling adequacy 0.8058. The resulting factor named 'ProSociality' is an indicator of pro-social behaviour with higher scores indicating behaviour that is more pro-social. This variable ProSociality is used in three iterations of regressions similar to the original variables with just weather variables, weather variables plus basic control variables and weather variables plus expanded control variables.

The extracted factors for the weather variables are difficult to interpret in a way that makes intuitive sense. This is because the signs for some of the variables are in unexpected directions. Also, the Kaiser-Meyer-Olkin measure of sampling adequacy showed a score of 0.5161 which is very low. Because of that the results of this Factor Analysis for weather variables will be available in the appendix (Appendix C1-C7) only and will not be discussed further.

## 4. Results

The results of the statistical tests that have been done are reported here. The output of the basic regressions using the unaltered weather variables will be presented in tables containing the three iterations for each dependent variable. Alongside each of those tables will be a description of the findings. The significant results will be highlighted and when no weather variables are found to significantly influence the dependent variables that represent pro-social behaviour that result will be highlighted as well. In each of these tables the point estimates of the regressions are reported alongside (inside parentheses) the standard errors. To emphasize significant results asterisks are used to indicate different levels of significance. One asterisk (\*) indicates a result that is significant at the 90% confidence level, two asterisks (\*\*) indicate a confidence level of 95% and three asterisks (\*\*\*) indicate a confidence level of 99%. In addition to the findings reported in this section, the appendix also contains results from statistical tests. These are results from the marginal effects analysis that are used to give some more information on the size and economic meaningfulness of the logistics regressions that are reported in this section. The text will on occasion refer to these results in the appendix. For reasons of readability these are not reported in the main text.

## Donate50

Donate50	(1)	(2)	(3)
Temperature	0.114 (0.211)	0.166 (0.230)	0.133 (0.232)
SunshineDuration	-0.004 (0.027)	-0.008 (0.029)	-0.005 (0.029)
PrecipitationAmount	-0.333 (0.376)	-0.250 (0.408)	-0.263 (0.413)
AtmosphericPressure	-0.113 (0.102)	-0.089 (0.112)	-0.084 (0.113)
Humidity	0.015 (0.107)	-0.036 (0.115)	-0.035 (0.115)
Windspeed	-0.024 (0.054)	-0.044 (0.059)	-0.039 (0.059)
Condition		-1.652 (1.132)	-2.892* (1.748)
Gender		1.136 (1.154)	1.246 (1.188)
Age		0.136*** (0.050)	0.134*** (0.051)
IncomeAlt		0.001 (0.000)	0.001 (0.000)
EduHi		-1.425 (1.122)	-1.355 (1.120)
Guilt			0.358 (0.938)
Happiness			0.195 (0.621)
Shame			-0.064 (0.829)
Regret			-0.684 (0.773)
Sadness			-0.879 (0.675)
Anger			0.724 (0.859)
Intercept	125.458 (101.261)	99.628 (112.179)	95.502 (113.779)
N	707	621	621
R <sup>2</sup>	0.002	0.022	0.029

the guilt condition.

Donate50 was the variable that represented the response to the question 'Suppose you were to have €50 extra to spend this month. How much of that €50 would you donate to the Cancer Fund?'

Here none of the weather variables are significantly related to the dependent variable.

Incidentally Age is positive and significant as a control variable in both regressions and condition is negative and marginally significant in the regression with expanded control variables. This means that for each year of age the expected amount of money that is donated increases by about 13.4 cent. Also, respondents in the control condition are predicted to donate €2.89 less than respondents that were part of

## DonateMoneyAnon

<b>DonateMoneyAnon</b>	(1)	(2)	(3)
Temperature	0.012 (0.027)	-0.001 (0.030)	0.002 (0.031)
SunshineDuration	-0.004 (0.004)	-0.004 (0.004)	-0.004 (0.004)
PrecipitationAmount	0.119** (0.046)	0.099** (0.050)	0.104** (0.051)
AtmosphericPressure	0.028** (0.013)	0.024* (0.015)	0.025* (0.015)
Humidity	-0.021 (0.014)	-0.015 (0.015)	-0.015 (0.015)
Windspeed	-0.001 (0.007)	-0.002 (0.007)	-0.002 (0.008)
Condition		0.073 (0.147)	0.070 (0.234)
Gender		-0.029 (0.146)	-0.073 (0.147)
Age		0.000 (0.007)	0.002 (0.007)
IncomeAlt		0.000 (0.000)	0.000 (0.000)
EduHi		0.526*** (0.158)	0.496*** (0.162)
Guilt			0.060 (0.102)
Happiness			0.100 (0.089)
Shame			0.007 (0.124)
Regret			0.008 (0.114)
Sadness			0.149* (0.089)
Anger			-0.157 (0.132)
cut1 threshold	25.749* (13.145)	22.155 (14.587)	23.079 (14.909)
cut2 threshold	26.431** (13.143)	22.860 (14.584)	23.789 (14.907)
cut3 threshold	27.717** (13.145)	24.119* (14.586)	25.054* (14.910)
cut4 threshold	29.675** (13.154)	26.147* (14.595)	27.089* (14.920)
N	707	621	621
R <sup>2</sup>			

DonateMoneyAnon is the extent of agreement with the statement 'I would like to make an anonymous donation of money to a good cause.'

Here, precipitation amount is significantly and positively related to DonateMoneyAnon, which means that higher amounts of precipitation increase the likelihood that a person agrees or strongly agrees with the presented statement.

Additionally, atmospheric pressure is also positive and significant in the first regression and marginally significant in the regressions with control variables. This means that higher atmospheric pressure is also related to a higher likelihood that a person agrees or strongly agrees with the presented statement.

Curiously, the finding for precipitation amount is contrary to the effect hypothesised. A lower amount of precipitation was expected to lead to better moods and thus to more pro-social behaviour. The data show a higher

amount of precipitation being related to more pro-social behaviour.

The finding of higher atmospheric pressure leading to more pro-social behaviour is in line with the hypothesis.

Incidentally, EduHi, the dummy for having finished a form of higher education with a diploma is also strongly significant as a control variable showing a positive sign. This shows that people that finished higher education are more likely to agree or strongly agree with the statement as compared to people that did not finish higher education. Sadness is marginally significant as a control variable with a positive sign, meaning that people that reported to have experienced more sadness during the survey were more likely to agree with the statement as compared to people that reported experiencing less sadness.

The results of the test for marginal effects (see: appendix A1) show that an increase of one unit of precipitation amount (i.e. 1mm) decreases the chance of strongly disagreeing with the statement by 1.6%, decreases the chance of disagreeing with the statement by 0.7% increases the chance of agreeing with the statement by 1.7% and increases the chance of strongly agreeing with the statement by 0.7% *ceteris paribus*.

The results of the same test for atmospheric pressure show that an increase by one unit of atmospheric pressure (i.e. 1 hPa) decreases the chance of strongly disagreeing with the statement by 0.4%, decreases the chance of disagreeing with the statement by 0.2% increases the chance of agreeing with the statement by 0.4% and increases the chance of strongly agreeing with the statement by 0.2% *ceteris paribus*, though none of these observations are significant. With units of 1 hPa the scale might be obscuring the effect size here. To additionally illustrate the potential effect size of this variable a further test has been done that shows the probability of responding with any particular answer when atmospheric pressure is at its lowest observed value and at its highest observed value while all other variables are kept to their sample means (see: Appendix B1). This shows that the effect of going from the lowest atmospheric pressure to the highest pressure decreases the chance of belonging to strongly disagree, disagree or neutral by 13.8, 5.2 and 0.4 percentage points respectively and increases the chance of belonging to agree or strongly agree with 13.9 and 5.4 percentage points respectively.

## Comfort

Comfort	(1)	(2)	(3)
Temperature	0.046 (0.029)	0.055* (0.033)	0.063* (0.034)
SunshineDuration	0.005 (0.004)	0.003 (0.004)	0.002 (0.004)
PrecipitationAmount	0.034 (0.051)	0.014 (0.054)	0.016 (0.056)
AtmosphericPressure	0.022 (0.014)	0.007 (0.015)	0.005 (0.015)
Humidity	0.001 (0.015)	-0.004 (0.016)	-0.005 (0.016)
Windspeed	-0.001 (0.008)	-0.004 (0.008)	-0.005 (0.008)
Condition		-0.015 (0.158)	0.063 (0.254)
Gender		0.635*** (0.160)	0.555*** (0.167)
Age		0.008 (0.007)	0.011 (0.007)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.194 (0.160)	0.149 (0.161)
Guilt			0.232* (0.134)
Happiness			0.183* (0.096)
Shame			0.061 (0.133)
Regret			-0.047 (0.125)
Sadness			0.156 (0.107)
Anger			-0.232 (0.159)
cut1 threshold	19.288 (13.974)	3.658 (15.136)	2.833 (15.184)
cut2 threshold	20.292 (13.986)	4.745 (15.153)	3.929 (15.203)
cut3 threshold	22.072 (13.982)	6.533 (15.146)	5.745 (15.195)
cut4 threshold	24.604* (13.989)	9.183 (15.148)	8.447 (15.200)
N	707	621	621
R <sup>2</sup>			

Comfort describes the agreement with the statement 'I would like to comfort someone who is emotionally distraught.'

Here temperature is the only weather variable that is marginally significant. And it only becomes significant once control variables are included in the regressions.

The positive and significant result of comfort in these cases does indicate that higher temperatures increase the likelihood of strong agreement with the statement and decrease the likelihood of disagreeing with the statement. This is in line with the hypothesis.

The marginal effects analysis shows small effects of temperature. The effect of an increase of one unit of temperature (1 degree Celsius) can be seen in Appendix A2. The probability of strongly disagreeing decreases by 0.1% and disagreeing decreases by 0.2% and the probability of answering neutral decreases by 0.9%. The probability of agreeing increases by 0.6% and strongly agreeing increases by 0.7%.

When an additional test is done to look at the impact of a larger change of

temperature the effect becomes more noticeable (see: Appendix B2). This shows the effects of the difference between -2 degrees Celsius and 3 degrees Celsius. This shows that the



probability of agreeing with the statement goes up from 53.3 to 56.8 percent and strongly agreeing with the statement goes up from 10.6 percent to 14.0 percent.

Additionally, Gender is shown to have a positive sign and be highly significant and both Guilt and Happiness are also marginally significant both with positive signs. This result for gender shows that female respondents were more likely to agree or strongly agree with the statement. The marginal effects (see: Appendix A2) show that being female increases the probability of agreeing by 5.2 percent and strongly agreeing by 6.5 percent as compared to being male. The results for Guilt shows that people that experienced more guilt during the survey were more likely to agree or strongly agree with the statement as compared to people that reported to experience less guilt. Similarly for Happiness, people reporting to experience more of it were more likely to report higher levels of agreement as compared to people reporting less happiness.

## HelpStranger

HelpStranger	(1)	(2)	(3)
Temperature	0.006 (0.028)	0.014 (0.031)	0.019 (0.031)
SunshineDuration	0.003 (0.004)	0.003 (0.004)	0.003 (0.004)
PrecipitationAmount	-0.005 (0.050)	-0.022 (0.053)	-0.028 (0.055)
AtmosphericPressure	0.024* (0.014)	0.019 (0.015)	0.017 (0.015)
Humidity	0.007 (0.015)	0.002 (0.017)	0.001 (0.017)
Windspeed	0.001 (0.008)	-0.006 (0.008)	-0.008 (0.008)
Condition		0.076 (0.153)	0.386 (0.265)
Gender		0.243 (0.150)	0.168 (0.154)
Age		0.007 (0.007)	0.010 (0.007)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.292* (0.156)	0.264 (0.162)
Guilt			0.372*** (0.112)
Happiness			0.094 (0.094)
Shame			-0.039 (0.125)
Regret			-0.063 (0.113)
Sadness			0.105 (0.117)
Anger			-0.078 (0.133)
cut1 threshold	22.491* (13.603)	16.874 (14.663)	15.223 (14.948)
cut2 threshold	23.799* (13.600)	18.238 (14.660)	16.602 (14.947)
cut3 threshold	25.420* (13.597)	19.911 (14.656)	18.308 (14.943)
cut4 threshold	27.957** (13.588)	22.568 (14.652)	21.017 (14.942)
N	707	621	621
R <sup>2</sup>			

This table shows the results for the logistic regression using the HelpStranger variable. HelpStranger described the agreement with the statement 'I would like to help someone, even if it is a stranger.'

AtmosphericPressure is marginally significant in the regression without control variables. With the inclusion of these control variables none of the weather variables are significant however.

As a control variable EduHi shows a positive sign and is marginally significant in the regression with basic controls, and Guilt is strongly significant in the regression with expanded control variables also showing a positive sign. These results show that people that finished higher education with a diploma are more likely to agree or strongly agree with the statement as compared to people that did not finish a higher education. Guilt shows that people that reported experiencing more guilt during the survey were more likely to agree or strongly agree with the statement.

## HelpNoNotice

<b>HelpNoNotice</b>	(1)	(2)	(3)
Temperature	0.021 (0.029)	0.022 (0.032)	0.025 (0.032)
SunshineDuration	-0.001 (0.004)	-0.002 (0.004)	-0.002 (0.004)
PrecipitationAmount	0.057 (0.053)	0.024 (0.058)	0.032 (0.058)
AtmosphericPressure	0.024 (0.015)	0.010 (0.016)	0.010 (0.016)
Humidity	-0.002 (0.015)	-0.003 (0.017)	-0.004 (0.017)
Windspeed	0.004 (0.008)	-0.001 (0.009)	-0.002 (0.009)
Condition		0.086 (0.153)	0.253 (0.256)
Gender		0.166 (0.153)	0.102 (0.156)
Age		-0.006 (0.007)	-0.003 (0.007)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.245 (0.158)	0.257 (0.162)
Guilt			0.128 (0.116)
Happiness			0.035 (0.092)
Shame			0.137 (0.122)
Regret			-0.176 (0.116)
Sadness			0.169 (0.118)
Anger			-0.027 (0.134)
cut1 threshold	21.364 (14.476)	6.207 (15.579)	7.423 (15.691)
cut2 threshold	22.539 (14.475)	7.511 (15.582)	8.731 (15.694)
cut3 threshold	24.033* (14.477)	8.990 (15.582)	10.224 (15.694)
cut4 threshold	26.719* (14.482)	11.788 (15.586)	13.054 (15.702)
N	707	621	621
R <sup>2</sup>			

HelpNoNotice describes the agreement with the statement 'I would like to help someone, without he or she noticing.'

These results show that none of the weather variables have a significant effect in any of the regressions.

Curiously, none of the control variables have a significant effect either.

## DonateClothesAnon

<b>DonateClothesAnon</b>	(1)	(2)	(3)
Temperature	-0.027 (0.029)	-0.021 (0.033)	-0.017 (0.032)
SunshineDuration	-0.001 (0.004)	-0.004 (0.004)	-0.004 (0.004)
PrecipitationAmount	0.084* (0.050)	0.090* (0.053)	0.090* (0.054)
AtmosphericPressure	0.030** (0.014)	0.024* (0.014)	0.022 (0.015)
Humidity	-0.013 (0.015)	-0.026 (0.016)	-0.027* (0.016)
Windspeed	0.004 (0.008)	-0.003 (0.008)	-0.004 (0.008)
Condition		-0.071 (0.152)	0.160 (0.246)
Gender		0.397*** (0.153)	0.357** (0.161)
Age		-0.002 (0.006)	-0.001 (0.007)
IncomeAlt		0.000 (0.000)	0.000 (0.000)
EduHi		0.421*** (0.161)	0.407** (0.165)
Guilt			0.159 (0.110)
Happiness			-0.016 (0.087)
Shame			-0.141 (0.122)
Regret			0.081 (0.118)
Sadness			0.113 (0.112)
Anger			-0.140 (0.138)
cut1 threshold	27.182** (13.597)	19.451 (14.190)	17.998 (14.342)
cut2 threshold	28.115** (13.609)	20.458 (14.205)	19.006 (14.358)
cut3 threshold	29.449** (13.610)	21.802 (14.207)	20.359 (14.359)
cut4 threshold	31.763** (13.614)	24.219* (14.212)	22.797 (14.364)
N	707	621	621
R <sup>2</sup>			

DonateClothesAnon shows the agreement with the statement 'I would like to help someone, without he or she noticing.'

PrecipitationAmount is positively marginally significant through all three iterations of the regression. This indicates that larger amounts of precipitation increase the likelihood of a person agreeing or strongly agreeing with the statement. This effect is in the opposite direction of the hypothesis. The marginal effects analysis (see: Appendix A5) shows that only two of the five margins for Precipitation Amount are significant. These significant margins are a decrease in strongly disagreeing by 0.5% and an increase in agreeing by 1.2% for an increase in precipitation amount by 1mm.

To further illustrate the potential size of the effect of precipitation, the difference between levels of agreement with the statement are compared between 0mm and 7.5mm precipitation (See: Appendix B3). For instance, the probability of strongly disagreeing changes from 6.8% to 3.6% and the probability of strongly agreeing changes from 10.2% to 18.2% keeping all other variables fixed.

AtmosphericPressure is significant in the basic iteration of the regression and marginally significant in the iteration with basic controls. Its sign is positive which is in line with the

hypothesis. However, once the control variables are expanded AtmosphericPressure loses its significance.

Humidity is marginally significant in the regression with expanded control variables. The negative sign indicates that as humidity increases the likelihood of agreeing or strongly agreeing with the statement decreases. This is in line with the hypothesis. The marginal effects (see: Appendix A5) show that only one of the five margins for Humidity is marginally significant. This is the observation for strongly disagreeing at 0.1%, indicating that an increase in humidity by 1% increases the likelihood of strongly disagreeing by 0.1%. The additional analysis (see: Appendix B4) compares the predicted probabilities of agreement with the statement at 64 and 94 percent humidity, the lowest and highest observed values for that variable in the data. This, for instance, shows that the probability of strongly disagreeing increases from 3.7% to 7.8% as humidity changes from low to high while keeping all other variables fixed at their means.

Incidentally, Gender and EduHi are both significant control variables in both iterations of the regression in which they are included and both have positive signs in both regressions. This result for gender shows that female respondents were more likely to agree or strongly agree with the statement. The marginal effects (see: Appendix A5) show that being female decreases the chance of strongly disagreeing and disagreeing by 1.9% and 2.4% respectively, as compared to being male. The probability of agreeing and the probability of strongly agreeing increase by 4.8% and 3.7% respectively for females as compared to males. The result for EduHi shows that people that finished higher education with a diploma are more likely to agree or strongly agree with the statement as compared to people that did not finish a higher education. For Instance, the probabilities of agreeing and strongly agreeing increase by 5.4% and 4.3% respectively for people with a higher education diploma compared to those without.

## HelpHurt

<b>HelpHurt</b>	(1)	(2)	(3)
Temperature	-0.020 (0.031)	-0.031 (0.035)	-0.028 (0.035)
SunshineDuration	0.002 (0.004)	0.004 (0.004)	0.003 (0.004)
PrecipitationAmount	0.051 (0.050)	0.034 (0.052)	0.027 (0.053)
AtmosphericPressure	0.020 (0.013)	0.012 (0.014)	0.009 (0.014)
Humidity	0.017 (0.016)	0.018 (0.017)	0.018 (0.018)
Windspeed	0.011 (0.008)	0.009 (0.009)	0.007 (0.009)
Condition		0.034 (0.156)	0.153 (0.256)
Gender		0.328** (0.155)	0.283* (0.159)
Age		0.014** (0.007)	0.016** (0.007)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.012 (0.157)	-0.043 (0.161)
Guilt			0.205 (0.131)
Happiness			0.105 (0.093)
Shame			-0.015 (0.143)
Regret			0.045 (0.114)
Sadness			0.042 (0.104)
Anger			-0.214 (0.145)
cut1 threshold	19.246 (13.122)	11.672 (13.753)	8.443 (14.006)
cut2 threshold	19.978 (13.133)	12.428 (13.761)	9.202 (14.015)
cut3 threshold	22.001* (13.128)	14.480 (13.757)	11.269 (14.010)
cut4 threshold	24.490* (13.131)	17.021 (13.763)	13.835 (14.015)
N	707	621	621
R <sup>2</sup>			

HelpHurt describes the agreement with the statement 'I would like to help someone who has hurt him or herself.'

For this variable none of the weather variables display any significant effect.

As control variables Gender and Age are both positive and significant. This result for gender shows that female respondents were more likely to agree or strongly agree with the statement. The marginal effects (see: Appendix A6) show that being female decreases the probability of strongly disagreeing and disagreeing by 0.8% each and increases the probability of agreeing or strongly agreeing by 3.3% and 3.1% respectively as compared to being male. The result for age means that the older the respondent is the more likely he or she is to agree or strongly agree with the statement. For instance, an extra year of age increases the probability of strongly agreeing by 0.2%.

## ProSociality

ProSociality	(1)	(2)	(3)
Temperature	-0.005 (0.015)	-0.005 (0.015)	-0.001 (0.015)
SunshineDuration	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
PrecipitationAmount	0.034 (0.024)	0.020 (0.024)	0.021 (0.024)
AtmosphericPressure	0.016** (0.007)	0.010 (0.007)	0.009 (0.007)
Humidity	-0.001 (0.007)	-0.003 (0.008)	-0.003 (0.008)
Windspeed	0.002 (0.004)	-0.000 (0.004)	-0.001 (0.004)
Condition		-0.021 (0.072)	0.088 (0.118)
Gender		0.151** (0.070)	0.113 (0.071)
Age		0.003 (0.003)	0.004 (0.003)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.171** (0.070)	0.158** (0.071)
Guilt			0.136** (0.053)
Happiness			0.053 (0.042)
Shame			-0.001 (0.050)
Regret			-0.023 (0.046)
Sadness			0.077* (0.046)
Anger			-0.074 (0.057)
Intercept	-16.630** (6.673)	-10.362 (6.769)	-9.320 (6.687)
N	707	621	621
R <sup>2</sup>	0.011	0.021	0.052

ProSociality is the factor describing pro-social behaviour that was created using factor analysis.

AtmosphericPressure is positive and significant in the regression without control variables. This indicates that higher atmospheric pressure leads to more pro-social behaviour. This is in line with the hypothesis. However, this variable does no longer show a significant effect once control variables are included.

Of the control variables, Gender and EduHi show positive and significant effects when basic controls are included. When expanded controls are included EduHi, Guilt and Sadness show positive and significant effects on ProSociality.

This result for gender in the regression with basic controls indicates that female respondents were more likely than man to

behave in a pro-social manner. The results for EduHi show that people that have finished higher education with a diploma are more likely to behave in a pro-social way as compared to people that have not finished higher education. Guilt also shows that people that reported to experience guilt during the survey were more likely to behave in a pro-social manner.

## Overview

Of the eight regressions with expanded control variables five regressions show that none of the weather variables have a significant effect. In the three regressions that did find significant effects four out of five of these effects were only marginally significant.

Precipitation amount, atmospheric pressure, temperature and humidity all had one of these cases where they were marginally significant (i.e. at the 90% confidence level). Precipitation amount also had one observation that was significant at the 95% confidence level. This was for the statement 'I would like to make an anonymous donation of money to a good cause.' In the observations where they were significant precipitation amount, atmospheric pressure and temperature had a positive effect and humidity had a negative effect on pro-social behaviour. For atmospheric pressure, temperature and humidity this direction was as hypothesised. For the two significant observations of precipitation amount the effect was in the opposite direction of the hypothesised effect.

What stands out most from these regressions is how little the weather variables matter. Five out of eight regressions with expanded controls showed no significant effect from any of the weather variables. Sunshine duration and wind speed were never significant. Atmospheric pressure, temperature and humidity were significant in one out of eight regressions and precipitation amount in two out of eight. This means that these weather variables had no consistent effect on the dependent variables that all indicate the same underlying concept of pro-social behaviour. In particular the lack of significant results for the regression using the pro-sociality factor that combined the different indicators for pro-social behaviour stands out as it is the regression that potentially holds the most information as it combines data.



## 5. Discussion

In this section the findings of the research will be recapped in an attempt to give a clear and concise answer to the research question that was introduced at the start of this thesis. After this conclusion of the findings there is some further discussion on limitations that this research faced that might work as inspiration for future research.

### **Conclusion**

The question this thesis set out to answer was: What is the effect of the weather on pro-social behaviour?

The answer to which has to be that this research strongly indicates that the weather does not have a consistent meaningful impact on pro-social behaviour.

The series of statistical analyses performed show that despite some significant results none of the weather variables can reliably be linked to pro-social behaviour as a whole. Precipitation amount is the weather variable that can most strongly be linked to pro-social behaviour as it was positively related to pro-social behaviour in two out of eight regressions. Atmospheric pressure, temperature and humidity were each significantly related to a variable representing pro-social behaviour once. Atmospheric pressure and temperature were positively related whereas humidity was negatively so. Despite these few significant results, three of which were in line with the hypotheses, the overwhelming evidence points towards there being no significant relationship between the weather variables observed and pro-social behaviour as a whole.

This finding indicates that behaviour is not as erratic as the weather. This is a reassuring finding as it gives some support for the use of pro-social behaviour as a consistent variable in models of economic behaviour.

It also means there is no reason to start including the weather into decision making that requires pro-social behaviour. When an outcome depends on altruism or cooperation, there is no reason to assume the weather is going to have an important impact.

George (1991) found mood at a point in time, or affective state, to significantly impact pro-social behaviour. That finding cannot be upheld by this research. A possible explanation for this discrepancy is that mood as a state is not affected by weather in the assumed way. The

Howarth & Hoffman (1984) concept of weather affecting mood and mood in turn affecting behaviour has intuitive appeal but their findings also showed that the weather factors they used had a limited effect. Many of the weather variables were only related to one or two of the ten underlying mood factors they tracked and some mood factors were not related to weather. If pro-social behaviour is not related to the whole concept of mood, but rather to an underlying factor, that could help explain why this research, that did not have the ability to look at these underlying factors, did not find a consistent and reliable relation between weather and pro-social behaviour.

### **Limitations and directions for future research**

This research found little relation between weather and pro-social behaviour. And of the few significant relations that were found the two observations of precipitation amount were in the opposite direction of what was hypothesised. This does not mean that this research was unsuccessful. It does mean that this research adds some new evidence that must be critically considered.

One explanation for the finding that precipitation amount had a positive effect could be in the type of precipitation. The data analysed only looked at the amount of precipitation, not the type. If people dislike rain but enjoy snow that could help explain this particular finding of the effect of precipitation. Since part of the precipitation in February of 2013 did come in the form of snow this could be a reasonable explanation.

A part that needs careful consideration is in the dataset and its operationalisation. The dataset that was used was not designed for this research subject specifically. The data are good enough for an initial exploratory analysis of the relation between weather and pro-social behaviour, but they are not as good as they would be in case of a survey specifically designed to test this relationship. The data on pro-social behaviour and on weather come from different sources and were not collected together. As a result of this the weather data could only be matched by date to a central location in the Netherlands and not to the location of the survey participant. Ideally it is possible to match responses to more localised weather observations to increase the accuracy and potentially the variation in the data. An additional benefit that a specifically designed experiment would provide is control over presentation and priming. As the literature on pro-social behaviour indicates priming (e.g.

Rosenhan et al., 1981 or Tsang, 2006) and presentation (Burnham, 2003) can play an important role. In this research the priming applied by the original survey has been controlled for as well as possible by using a dummy variable for the type of priming respondents received. In research that is set-up to look at the effect of weather on pro-social behaviour priming could be applied to research if the effect might be conditional on specific states or emotions such as the mood factors discussed by Howarth & Hoffman (1984).

Another part that needs consideration is the nature of the pro-social behaviour variables that were used. All of these questions were presented as hypotheticals. They show how people report they would (like to) act. They are not evidence of actual behaviour. As such it is possible that these responses do not represent what people would actually do. They are the best estimates available, but should be treated with some caution. It would be interesting to repeat this type of research with factual observations of behaviour to research the effect of weather on actual behaviour. It would also be an interesting avenue for further research to combine hypotheticals and observations of actual behaviour to research the effect of weather on the truthfulness or accuracy with which the hypotheticals get answered. The accuracy of hypothetical situations is a real concern as Neill et al. (1994) researched the discrepancy between hypothetical and real economic commitment and found hypothetical willingness to pay to be consistently and significantly higher than its real counterpart.

The statistics did provide some significant results that might indicate a relationship between specific weather variables and specific parts of pro-social behaviour. These could form a starting point for future research.

# Appendix

## Marginal effects results

The following tables (A1 – A6) show the results for the analysis of marginal effects for the logistic regressions.

### A1. DonateMoneyAnon

DonateMoneyAnon	b	se
Temperature		
Change in probability of belonging to option 1	-0.000	(0.005)
Change in probability of belonging to option 2	-0.000	(0.002)
Change in probability of belonging to option 3	-0.000	(0.000)
Change in probability of belonging to option 4	0.000	(0.005)
Change in probability of belonging to option 5	0.000	(0.002)
SunshineDuration		
Change in probability of belonging to option 1	0.001	(0.001)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.000)
Change in probability of belonging to option 4	-0.001	(0.001)
Change in probability of belonging to option 5	-0.000	(0.000)
PrecipitationAmount		
Change in probability of belonging to option 1	-0.016**	(0.008)
Change in probability of belonging to option 2	-0.007**	(0.003)
Change in probability of belonging to option 3	-0.001	(0.001)
Change in probability of belonging to option 4	0.017**	(0.009)
Change in probability of belonging to option 5	0.007*	(0.003)
AtmosphericPressure		
Change in probability of belonging to option 1	-0.004	(0.002)
Change in probability of belonging to option 2	-0.002	(0.001)
Change in probability of belonging to option 3	-0.000	(0.000)
Change in probability of belonging to option 4	0.004	(0.003)
Change in probability of belonging to option 5	0.002	(0.001)
Humidity		
Change in probability of belonging to option 1	0.002	(0.002)
Change in probability of belonging to option 2	0.001	(0.001)
Change in probability of belonging to option 3	0.000	(0.000)
Change in probability of belonging to option 4	-0.002	(0.003)
Change in probability of belonging to option 5	-0.001	(0.001)
Windspeed		
Change in probability of belonging to option 1	0.000	(0.001)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.000)
Change in probability of belonging to option 4	-0.000	(0.001)
Change in probability of belonging to option 5	-0.000	(0.000)
Condition		
Change in probability of belonging to option 1	-0.011	(0.037)
Change in probability of belonging to option 2	-0.004	(0.015)
Change in probability of belonging to option 3	-0.001	(0.002)
Change in probability of belonging to option 4	0.012	(0.039)
Change in probability of belonging to option 5	0.004	(0.015)
Gender		
Change in probability of belonging to option 1	0.012	(0.023)
Change in probability of belonging to option 2	0.005	(0.009)
Change in probability of belonging to option 3	0.001	(0.001)
Change in probability of belonging to option 4	-0.012	(0.025)

Change in probability of belonging to option 5	-0.005	(0.009)
<b>Age</b>		
Change in probability of belonging to option 1	-0.000	(0.001)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.000	(0.000)
Change in probability of belonging to option 4	0.000	(0.001)
Change in probability of belonging to option 5	0.000	(0.000)
<b>IncomeAlt</b>		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.000	(0.000)
Change in probability of belonging to option 4	0.000	(0.000)
Change in probability of belonging to option 5	0.000	(0.000)
<b>EduHi</b>		
Change in probability of belonging to option 1	-0.079***	(0.026)
Change in probability of belonging to option 2	-0.032***	(0.011)
Change in probability of belonging to option 3	-0.004	(0.005)
Change in probability of belonging to option 4	0.083***	(0.028)
Change in probability of belonging to option 5	0.032***	(0.011)
<b>Guilt</b>		
Change in probability of belonging to option 1	-0.010	(0.016)
Change in probability of belonging to option 2	-0.004	(0.006)
Change in probability of belonging to option 3	-0.001	(0.001)
Change in probability of belonging to option 4	0.010	(0.017)
Change in probability of belonging to option 5	0.004	(0.006)
<b>Happiness</b>		
Change in probability of belonging to option 1	-0.016	(0.014)
Change in probability of belonging to option 2	-0.006	(0.006)
Change in probability of belonging to option 3	-0.001	(0.001)
Change in probability of belonging to option 4	0.017	(0.015)
Change in probability of belonging to option 5	0.006	(0.006)
<b>Shame</b>		
Change in probability of belonging to option 1	-0.001	(0.020)
Change in probability of belonging to option 2	-0.000	(0.008)
Change in probability of belonging to option 3	-0.000	(0.001)
Change in probability of belonging to option 4	0.001	(0.021)
Change in probability of belonging to option 5	0.000	(0.008)
<b>Regret</b>		
Change in probability of belonging to option 1	-0.001	(0.018)
Change in probability of belonging to option 2	-0.001	(0.007)
Change in probability of belonging to option 3	-0.000	(0.001)
Change in probability of belonging to option 4	0.001	(0.019)
Change in probability of belonging to option 5	0.001	(0.007)
<b>Sadness</b>		
Change in probability of belonging to option 1	-0.024*	(0.014)
Change in probability of belonging to option 2	-0.010	(0.006)
Change in probability of belonging to option 3	-0.001	(0.002)
Change in probability of belonging to option 4	0.025*	(0.015)
Change in probability of belonging to option 5	0.010*	(0.006)
<b>Anger</b>		
Change in probability of belonging to option 1	0.025	(0.021)
Change in probability of belonging to option 2	0.010	(0.009)
Change in probability of belonging to option 3	0.001	(0.002)
Change in probability of belonging to option 4	-0.026	(0.022)
Change in probability of belonging to option 5	-0.010	(0.009)
N	621	
R <sup>2</sup>		

## A2. Comfort

Comfort	b	se
Temperature		
Change in probability of belonging to option 1	-0.001*	(0.001)
Change in probability of belonging to option 2	-0.002*	(0.001)
Change in probability of belonging to option 3	-0.009*	(0.005)
Change in probability of belonging to option 4	0.006*	(0.003)
Change in probability of belonging to option 5	0.007*	(0.004)
SunshineDuration		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.000	(0.001)
Change in probability of belonging to option 4	0.000	(0.000)
Change in probability of belonging to option 5	0.000	(0.000)
PrecipitationAmount		
Change in probability of belonging to option 1	-0.000	(0.001)
Change in probability of belonging to option 2	-0.001	(0.002)
Change in probability of belonging to option 3	-0.002	(0.008)
Change in probability of belonging to option 4	0.002	(0.005)
Change in probability of belonging to option 5	0.002	(0.007)
AtmosphericPressure		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.001)
Change in probability of belonging to option 3	-0.001	(0.002)
Change in probability of belonging to option 4	0.000	(0.001)
Change in probability of belonging to option 5	0.001	(0.002)
Humidity		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.001)
Change in probability of belonging to option 3	0.001	(0.002)
Change in probability of belonging to option 4	-0.000	(0.002)
Change in probability of belonging to option 5	-0.001	(0.002)
Windspeed		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.001	(0.001)
Change in probability of belonging to option 4	-0.001	(0.001)
Change in probability of belonging to option 5	-0.001	(0.001)
Condition		
Change in probability of belonging to option 1	-0.001	(0.006)
Change in probability of belonging to option 2	-0.002	(0.010)
Change in probability of belonging to option 3	-0.009	(0.038)
Change in probability of belonging to option 4	0.006	(0.024)
Change in probability of belonging to option 5	0.007	(0.030)
Gender		
Change in probability of belonging to option 1	-0.012***	(0.005)
Change in probability of belonging to option 2	-0.022***	(0.007)
Change in probability of belonging to option 3	-0.083***	(0.026)
Change in probability of belonging to option 4	0.052***	(0.018)
Change in probability of belonging to option 5	0.065***	(0.020)
Age		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.002	(0.001)
Change in probability of belonging to option 4	0.001	(0.001)
Change in probability of belonging to option 5	0.001	(0.001)
IncomeAlt		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.000)

Change in probability of belonging to option 4	-0.000	(0.000)
Change in probability of belonging to option 5	-0.000	(0.000)
<hr/>		
EduHi		
Change in probability of belonging to option 1	-0.003	(0.004)
Change in probability of belonging to option 2	-0.006	(0.006)
Change in probability of belonging to option 3	-0.022	(0.024)
Change in probability of belonging to option 4	0.014	(0.015)
Change in probability of belonging to option 5	0.017	(0.019)
<hr/>		
Guilt		
Change in probability of belonging to option 1	-0.005	(0.003)
Change in probability of belonging to option 2	-0.009*	(0.005)
Change in probability of belonging to option 3	-0.035*	(0.020)
Change in probability of belonging to option 4	0.022*	(0.013)
Change in probability of belonging to option 5	0.027*	(0.016)
<hr/>		
Happiness		
Change in probability of belonging to option 1	-0.004*	(0.002)
Change in probability of belonging to option 2	-0.007*	(0.004)
Change in probability of belonging to option 3	-0.027*	(0.014)
Change in probability of belonging to option 4	0.017*	(0.010)
Change in probability of belonging to option 5	0.021*	(0.011)
<hr/>		
Shame		
Change in probability of belonging to option 1	-0.001	(0.003)
Change in probability of belonging to option 2	-0.002	(0.005)
Change in probability of belonging to option 3	-0.009	(0.020)
Change in probability of belonging to option 4	0.006	(0.013)
Change in probability of belonging to option 5	0.007	(0.016)
<hr/>		
Regret		
Change in probability of belonging to option 1	0.001	(0.003)
Change in probability of belonging to option 2	0.002	(0.005)
Change in probability of belonging to option 3	0.007	(0.019)
Change in probability of belonging to option 4	-0.004	(0.012)
Change in probability of belonging to option 5	-0.006	(0.015)
<hr/>		
Sadness		
Change in probability of belonging to option 1	-0.004	(0.003)
Change in probability of belonging to option 2	-0.006	(0.004)
Change in probability of belonging to option 3	-0.023	(0.016)
Change in probability of belonging to option 4	0.015	(0.011)
Change in probability of belonging to option 5	0.018	(0.012)
<hr/>		
Anger		
Change in probability of belonging to option 1	0.005	(0.004)
Change in probability of belonging to option 2	0.009	(0.007)
Change in probability of belonging to option 3	0.035	(0.024)
Change in probability of belonging to option 4	-0.022	(0.016)
Change in probability of belonging to option 5	-0.027	(0.018)
<hr/>		
N	621	
R <sup>2</sup>		
<hr/>		

### A3. HelpStranger

<b>HelpStranger</b>	<b>b</b>	<b>se</b>
<b>Temperature</b>		
Change in probability of belonging to option 1	-0.001	(0.001)
Change in probability of belonging to option 2	-0.002	(0.003)
Change in probability of belonging to option 3	-0.002	(0.004)
Change in probability of belonging to option 4	0.004	(0.006)
Change in probability of belonging to option 5	0.001	(0.002)
<b>SunshineDuration</b>		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.000	(0.000)
Change in probability of belonging to option 4	0.001	(0.001)
Change in probability of belonging to option 5	0.000	(0.000)
<b>PrecipitationAmount</b>		
Change in probability of belonging to option 1	0.001	(0.002)
Change in probability of belonging to option 2	0.003	(0.005)
Change in probability of belonging to option 3	0.003	(0.006)
Change in probability of belonging to option 4	-0.005	(0.011)
Change in probability of belonging to option 5	-0.002	(0.003)
<b>AtmosphericPressure</b>		
Change in probability of belonging to option 1	-0.001	(0.001)
Change in probability of belonging to option 2	-0.001	(0.001)
Change in probability of belonging to option 3	-0.002	(0.002)
Change in probability of belonging to option 4	0.003	(0.003)
Change in probability of belonging to option 5	0.001	(0.001)
<b>Humidity</b>		
Change in probability of belonging to option 1	-0.000	(0.001)
Change in probability of belonging to option 2	-0.000	(0.002)
Change in probability of belonging to option 3	-0.000	(0.002)
Change in probability of belonging to option 4	0.000	(0.003)
Change in probability of belonging to option 5	0.000	(0.001)
<b>Windspeed</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.001	(0.001)
Change in probability of belonging to option 3	0.001	(0.001)
Change in probability of belonging to option 4	-0.002	(0.002)
Change in probability of belonging to option 5	-0.000	(0.000)
<b>Condition</b>		
Change in probability of belonging to option 1	-0.017	(0.012)
Change in probability of belonging to option 2	-0.035	(0.024)
Change in probability of belonging to option 3	-0.045	(0.031)
Change in probability of belonging to option 4	0.075	(0.052)
Change in probability of belonging to option 5	0.022	(0.015)
<b>Gender</b>		
Change in probability of belonging to option 1	-0.007	(0.007)
Change in probability of belonging to option 2	-0.015	(0.014)
Change in probability of belonging to option 3	-0.020	(0.018)
Change in probability of belonging to option 4	0.033	(0.030)
Change in probability of belonging to option 5	0.010	(0.009)
<b>Age</b>		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.001	(0.001)
Change in probability of belonging to option 3	-0.001	(0.001)
Change in probability of belonging to option 4	0.002	(0.001)
Change in probability of belonging to option 5	0.001	(0.000)
<b>IncomeAlt</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.000)



Change in probability of belonging to option 4	-0.000	(0.000)
Change in probability of belonging to option 5	-0.000	(0.000)
<hr/>		
EduHi		
Change in probability of belonging to option 1	-0.011	(0.007)
Change in probability of belonging to option 2	-0.024	(0.015)
Change in probability of belonging to option 3	-0.031	(0.019)
Change in probability of belonging to option 4	0.051	(0.032)
Change in probability of belonging to option 5	0.015	(0.009)
<hr/>		
Guilt		
Change in probability of belonging to option 1	-0.016***	(0.006)
Change in probability of belonging to option 2	-0.034***	(0.010)
Change in probability of belonging to option 3	-0.043***	(0.014)
Change in probability of belonging to option 4	0.072***	(0.022)
Change in probability of belonging to option 5	0.021***	(0.007)
<hr/>		
Happiness		
Change in probability of belonging to option 1	-0.004	(0.004)
Change in probability of belonging to option 2	-0.009	(0.008)
Change in probability of belonging to option 3	-0.011	(0.011)
Change in probability of belonging to option 4	0.018	(0.018)
Change in probability of belonging to option 5	0.005	(0.005)
<hr/>		
Shame		
Change in probability of belonging to option 1	0.002	(0.005)
Change in probability of belonging to option 2	0.003	(0.011)
Change in probability of belonging to option 3	0.004	(0.015)
Change in probability of belonging to option 4	-0.007	(0.024)
Change in probability of belonging to option 5	-0.002	(0.007)
<hr/>		
Regret		
Change in probability of belonging to option 1	0.003	(0.005)
Change in probability of belonging to option 2	0.006	(0.010)
Change in probability of belonging to option 3	0.007	(0.013)
Change in probability of belonging to option 4	-0.012	(0.022)
Change in probability of belonging to option 5	-0.004	(0.006)
<hr/>		
Sadness		
Change in probability of belonging to option 1	-0.005	(0.005)
Change in probability of belonging to option 2	-0.009	(0.011)
Change in probability of belonging to option 3	-0.012	(0.014)
Change in probability of belonging to option 4	0.020	(0.023)
Change in probability of belonging to option 5	0.006	(0.007)
<hr/>		
Anger		
Change in probability of belonging to option 1	0.003	(0.006)
Change in probability of belonging to option 2	0.007	(0.012)
Change in probability of belonging to option 3	0.009	(0.015)
Change in probability of belonging to option 4	-0.015	(0.026)
Change in probability of belonging to option 5	-0.004	(0.007)
<hr/>		
N	621	
R <sup>2</sup>		

#### A4. HelpNoNotice

<b>HelpNoNotice</b>	<b>b</b>	<b>se</b>
<b>Temperature</b>		
Change in probability of belonging to option 1	-0.001	(0.001)
Change in probability of belonging to option 2	-0.002	(0.003)
Change in probability of belonging to option 3	-0.003	(0.004)
Change in probability of belonging to option 4	0.004	(0.005)
Change in probability of belonging to option 5	0.002	(0.002)
<b>SunshineDuration</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.001)
Change in probability of belonging to option 4	-0.000	(0.001)
Change in probability of belonging to option 5	-0.000	(0.000)
<b>PrecipitationAmount</b>		
Change in probability of belonging to option 1	-0.001	(0.002)
Change in probability of belonging to option 2	-0.002	(0.005)
Change in probability of belonging to option 3	-0.004	(0.007)
Change in probability of belonging to option 4	0.005	(0.010)
Change in probability of belonging to option 5	0.002	(0.004)
<b>AtmosphericPressure</b>		
Change in probability of belonging to option 1	-0.000	(0.001)
Change in probability of belonging to option 2	-0.001	(0.001)
Change in probability of belonging to option 3	-0.001	(0.002)
Change in probability of belonging to option 4	0.002	(0.003)
Change in probability of belonging to option 5	0.001	(0.001)
<b>Humidity</b>		
Change in probability of belonging to option 1	0.000	(0.001)
Change in probability of belonging to option 2	0.000	(0.001)
Change in probability of belonging to option 3	0.000	(0.002)
Change in probability of belonging to option 4	-0.001	(0.003)
Change in probability of belonging to option 5	-0.000	(0.001)
<b>Windspeed</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.001)
Change in probability of belonging to option 3	0.000	(0.001)
Change in probability of belonging to option 4	-0.000	(0.001)
Change in probability of belonging to option 5	-0.000	(0.001)
<b>Condition</b>		
Change in probability of belonging to option 1	-0.010	(0.010)
Change in probability of belonging to option 2	-0.020	(0.020)
Change in probability of belonging to option 3	-0.032	(0.032)
Change in probability of belonging to option 4	0.043	(0.043)
Change in probability of belonging to option 5	0.018	(0.019)
<b>Gender</b>		
Change in probability of belonging to option 1	-0.004	(0.006)
Change in probability of belonging to option 2	-0.008	(0.012)
Change in probability of belonging to option 3	-0.013	(0.020)
Change in probability of belonging to option 4	0.017	(0.026)
Change in probability of belonging to option 5	0.007	(0.011)
<b>Age</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.001)
Change in probability of belonging to option 3	0.000	(0.001)
Change in probability of belonging to option 4	-0.001	(0.001)
Change in probability of belonging to option 5	-0.000	(0.001)
<b>IncomeAlt</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.000)

Change in probability of belonging to option 4	-0.000	(0.000)
Change in probability of belonging to option 5	-0.000	(0.000)
<hr/>		
EduHi		
Change in probability of belonging to option 1	-0.010	(0.006)
Change in probability of belonging to option 2	-0.020	(0.013)
Change in probability of belonging to option 3	-0.032	(0.020)
Change in probability of belonging to option 4	0.043	(0.028)
Change in probability of belonging to option 5	0.019	(0.012)
<hr/>		
Guilt		
Change in probability of belonging to option 1	-0.005	(0.005)
Change in probability of belonging to option 2	-0.010	(0.009)
Change in probability of belonging to option 3	-0.016	(0.015)
Change in probability of belonging to option 4	0.022	(0.020)
Change in probability of belonging to option 5	0.009	(0.009)
<hr/>		
Happiness		
Change in probability of belonging to option 1	-0.001	(0.004)
Change in probability of belonging to option 2	-0.003	(0.007)
Change in probability of belonging to option 3	-0.004	(0.012)
Change in probability of belonging to option 4	0.006	(0.015)
Change in probability of belonging to option 5	0.003	(0.007)
<hr/>		
Shame		
Change in probability of belonging to option 1	-0.005	(0.005)
Change in probability of belonging to option 2	-0.011	(0.009)
Change in probability of belonging to option 3	-0.017	(0.015)
Change in probability of belonging to option 4	0.023	(0.021)
Change in probability of belonging to option 5	0.010	(0.009)
<hr/>		
Regret		
Change in probability of belonging to option 1	0.007	(0.005)
Change in probability of belonging to option 2	0.014	(0.009)
Change in probability of belonging to option 3	0.022	(0.015)
Change in probability of belonging to option 4	-0.030	(0.020)
Change in probability of belonging to option 5	-0.013	(0.008)
<hr/>		
Sadness		
Change in probability of belonging to option 1	-0.007	(0.005)
Change in probability of belonging to option 2	-0.013	(0.009)
Change in probability of belonging to option 3	-0.021	(0.015)
Change in probability of belonging to option 4	0.028	(0.020)
Change in probability of belonging to option 5	0.012	(0.009)
<hr/>		
Anger		
Change in probability of belonging to option 1	0.001	(0.005)
Change in probability of belonging to option 2	0.002	(0.010)
Change in probability of belonging to option 3	0.003	(0.017)
Change in probability of belonging to option 4	-0.004	(0.023)
Change in probability of belonging to option 5	-0.002	(0.010)
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N	621	
R <sup>2</sup>		

## A5. DonateClothesAnon

<b>DonateClothesAnon</b>	<b>b</b>	<b>se</b>
<b>Temperature</b>		
Change in probability of belonging to option 1	0.001	(0.002)
Change in probability of belonging to option 2	0.001	(0.002)
Change in probability of belonging to option 3	0.002	(0.004)
Change in probability of belonging to option 4	-0.002	(0.004)
Change in probability of belonging to option 5	-0.002	(0.003)
<b>SunshineDuration</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.000)
Change in probability of belonging to option 4	-0.001	(0.001)
Change in probability of belonging to option 5	-0.000	(0.000)
<b>PrecipitationAmount</b>		
Change in probability of belonging to option 1	-0.005*	(0.003)
Change in probability of belonging to option 2	-0.006	(0.004)
Change in probability of belonging to option 3	-0.010	(0.006)
Change in probability of belonging to option 4	0.012*	(0.007)
Change in probability of belonging to option 5	0.009	(0.006)
<b>AtmosphericPressure</b>		
Change in probability of belonging to option 1	-0.001	(0.001)
Change in probability of belonging to option 2	-0.002	(0.001)
Change in probability of belonging to option 3	-0.003	(0.002)
Change in probability of belonging to option 4	0.003	(0.002)
Change in probability of belonging to option 5	0.002	(0.002)
<b>Humidity</b>		
Change in probability of belonging to option 1	0.001*	(0.001)
Change in probability of belonging to option 2	0.002	(0.001)
Change in probability of belonging to option 3	0.003	(0.002)
Change in probability of belonging to option 4	-0.004	(0.002)
Change in probability of belonging to option 5	-0.003	(0.002)
<b>Windspeed</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.001)
Change in probability of belonging to option 3	0.000	(0.001)
Change in probability of belonging to option 4	-0.001	(0.001)
Change in probability of belonging to option 5	-0.000	(0.001)
<b>Condition</b>		
Change in probability of belonging to option 1	-0.009	(0.013)
Change in probability of belonging to option 2	-0.011	(0.017)
Change in probability of belonging to option 3	-0.018	(0.029)
Change in probability of belonging to option 4	0.021	(0.033)
Change in probability of belonging to option 5	0.017	(0.026)
<b>Gender</b>		
Change in probability of belonging to option 1	-0.019**	(0.009)
Change in probability of belonging to option 2	-0.024**	(0.011)
Change in probability of belonging to option 3	-0.041**	(0.019)
Change in probability of belonging to option 4	0.048**	(0.022)
Change in probability of belonging to option 5	0.037**	(0.017)
<b>Age</b>		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.001)
Change in probability of belonging to option 4	-0.000	(0.001)
Change in probability of belonging to option 5	-0.000	(0.001)
<b>IncomeAlt</b>		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.000	(0.000)

Change in probability of belonging to option 4	0.000	(0.000)
Change in probability of belonging to option 5	0.000	(0.000)
<hr/>		
EduHi		
Change in probability of belonging to option 1	-0.022**	(0.010)
Change in probability of belonging to option 2	-0.028**	(0.012)
Change in probability of belonging to option 3	-0.047**	(0.019)
Change in probability of belonging to option 4	0.054**	(0.023)
Change in probability of belonging to option 5	0.043**	(0.018)
<hr/>		
Guilt		
Change in probability of belonging to option 1	-0.009	(0.006)
Change in probability of belonging to option 2	-0.011	(0.008)
Change in probability of belonging to option 3	-0.018	(0.013)
Change in probability of belonging to option 4	0.021	(0.015)
Change in probability of belonging to option 5	0.017	(0.011)
<hr/>		
Happiness		
Change in probability of belonging to option 1	0.001	(0.005)
Change in probability of belonging to option 2	0.001	(0.006)
Change in probability of belonging to option 3	0.002	(0.010)
Change in probability of belonging to option 4	-0.002	(0.012)
Change in probability of belonging to option 5	-0.002	(0.009)
<hr/>		
Shame		
Change in probability of belonging to option 1	0.008	(0.007)
Change in probability of belonging to option 2	0.010	(0.008)
Change in probability of belonging to option 3	0.016	(0.014)
Change in probability of belonging to option 4	-0.019	(0.017)
Change in probability of belonging to option 5	-0.015	(0.013)
<hr/>		
Regret		
Change in probability of belonging to option 1	-0.004	(0.006)
Change in probability of belonging to option 2	-0.006	(0.008)
Change in probability of belonging to option 3	-0.009	(0.014)
Change in probability of belonging to option 4	0.011	(0.016)
Change in probability of belonging to option 5	0.008	(0.012)
<hr/>		
Sadness		
Change in probability of belonging to option 1	-0.006	(0.006)
Change in probability of belonging to option 2	-0.008	(0.008)
Change in probability of belonging to option 3	-0.013	(0.013)
Change in probability of belonging to option 4	0.015	(0.015)
Change in probability of belonging to option 5	0.012	(0.012)
<hr/>		
Anger		
Change in probability of belonging to option 1	0.008	(0.007)
Change in probability of belonging to option 2	0.010	(0.010)
Change in probability of belonging to option 3	0.016	(0.016)
Change in probability of belonging to option 4	-0.019	(0.019)
Change in probability of belonging to option 5	-0.015	(0.014)
<hr/>		
N	621	
R <sup>2</sup>		

## A6. HelpHurt

HelpHurt	b	se
Temperature		
Change in probability of belonging to option 1	0.001	(0.001)
Change in probability of belonging to option 2	0.001	(0.001)
Change in probability of belonging to option 3	0.005	(0.006)
Change in probability of belonging to option 4	-0.003	(0.004)
Change in probability of belonging to option 5	-0.003	(0.004)
SunshineDuration		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.001	(0.001)
Change in probability of belonging to option 4	0.000	(0.000)
Change in probability of belonging to option 5	0.000	(0.000)
PrecipitationAmount		
Change in probability of belonging to option 1	-0.001	(0.002)
Change in probability of belonging to option 2	-0.001	(0.002)
Change in probability of belonging to option 3	-0.005	(0.009)
Change in probability of belonging to option 4	0.003	(0.006)
Change in probability of belonging to option 5	0.003	(0.006)
AtmosphericPressure		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.001	(0.002)
Change in probability of belonging to option 4	0.001	(0.002)
Change in probability of belonging to option 5	0.001	(0.002)
Humidity		
Change in probability of belonging to option 1	-0.001	(0.001)
Change in probability of belonging to option 2	-0.001	(0.001)
Change in probability of belonging to option 3	-0.003	(0.003)
Change in probability of belonging to option 4	0.002	(0.002)
Change in probability of belonging to option 5	0.002	(0.002)
Windspeed		
Change in probability of belonging to option 1	-0.000	(0.000)
Change in probability of belonging to option 2	-0.000	(0.000)
Change in probability of belonging to option 3	-0.001	(0.002)
Change in probability of belonging to option 4	0.001	(0.001)
Change in probability of belonging to option 5	0.001	(0.001)
Condition		
Change in probability of belonging to option 1	-0.005	(0.008)
Change in probability of belonging to option 2	-0.004	(0.007)
Change in probability of belonging to option 3	-0.026	(0.043)
Change in probability of belonging to option 4	0.018	(0.030)
Change in probability of belonging to option 5	0.017	(0.028)
Gender		
Change in probability of belonging to option 1	-0.008*	(0.005)
Change in probability of belonging to option 2	-0.008*	(0.005)
Change in probability of belonging to option 3	-0.047*	(0.027)
Change in probability of belonging to option 4	0.033*	(0.019)
Change in probability of belonging to option 5	0.031*	(0.018)
Age		
Change in probability of belonging to option 1	-0.000**	(0.000)
Change in probability of belonging to option 2	-0.000**	(0.000)
Change in probability of belonging to option 3	-0.003**	(0.001)
Change in probability of belonging to option 4	0.002**	(0.001)
Change in probability of belonging to option 5	0.002**	(0.001)
IncomeAlt		
Change in probability of belonging to option 1	0.000	(0.000)
Change in probability of belonging to option 2	0.000	(0.000)
Change in probability of belonging to option 3	0.000	(0.000)

Change in probability of belonging to option 4	-0.000	(0.000)
Change in probability of belonging to option 5	-0.000	(0.000)
<hr/>		
EduHi		
Change in probability of belonging to option 1	0.001	(0.005)
Change in probability of belonging to option 2	0.001	(0.005)
Change in probability of belonging to option 3	0.007	(0.027)
Change in probability of belonging to option 4	-0.005	(0.018)
Change in probability of belonging to option 5	-0.005	(0.018)
<hr/>		
Guilt		
Change in probability of belonging to option 1	-0.006	(0.004)
Change in probability of belonging to option 2	-0.006	(0.004)
Change in probability of belonging to option 3	-0.034	(0.022)
Change in probability of belonging to option 4	0.024	(0.015)
Change in probability of belonging to option 5	0.023	(0.015)
<hr/>		
Happiness		
Change in probability of belonging to option 1	-0.003	(0.003)
Change in probability of belonging to option 2	-0.003	(0.003)
Change in probability of belonging to option 3	-0.018	(0.016)
Change in probability of belonging to option 4	0.012	(0.011)
Change in probability of belonging to option 5	0.012	(0.010)
<hr/>		
Shame		
Change in probability of belonging to option 1	0.000	(0.004)
Change in probability of belonging to option 2	0.000	(0.004)
Change in probability of belonging to option 3	0.003	(0.024)
Change in probability of belonging to option 4	-0.002	(0.017)
Change in probability of belonging to option 5	-0.002	(0.016)
<hr/>		
Regret		
Change in probability of belonging to option 1	-0.001	(0.003)
Change in probability of belonging to option 2	-0.001	(0.003)
Change in probability of belonging to option 3	-0.007	(0.019)
Change in probability of belonging to option 4	0.005	(0.013)
Change in probability of belonging to option 5	0.005	(0.013)
<hr/>		
Sadness		
Change in probability of belonging to option 1	-0.001	(0.003)
Change in probability of belonging to option 2	-0.001	(0.003)
Change in probability of belonging to option 3	-0.007	(0.017)
Change in probability of belonging to option 4	0.005	(0.012)
Change in probability of belonging to option 5	0.005	(0.011)
<hr/>		
Anger		
Change in probability of belonging to option 1	0.006	(0.004)
Change in probability of belonging to option 2	0.006	(0.004)
Change in probability of belonging to option 3	0.036	(0.025)
Change in probability of belonging to option 4	-0.025	(0.017)
Change in probability of belonging to option 5	-0.024	(0.016)
<hr/>		
N	621	
R <sup>2</sup>		
<hr/>		

The following tables (**B1 – B4**) show some additional marginal effects predictions that are used to illustrate the effect variables have over larger changes in values to illustrate their potential economic relevance.

**B1. DonateMoneyAnon with 997.2hPa and 1032hPa**

<b>DonateMoneyAnon</b>	<b>b</b>	<b>se</b>
Probability of belonging to option 1 conditional on atmospheric pressure = 997.2 hPa	0.279***	(0.059)
Probability of belonging to option 1 conditional on atmospheric pressure = 1032 hPa	0.141***	(0.032)
Probability of belonging to option 2 conditional on atmospheric pressure = 997.2 hPa	0.161***	(0.020)
Probability of belonging to option 2 conditional on atmospheric pressure = 1032 hPa	0.109***	(0.020)
Probability of belonging to option 3 conditional on atmospheric pressure = 997.2 hPa	0.296***	(0.023)
Probability of belonging to option 3 conditional on atmospheric pressure = 1032 hPa	0.292***	(0.023)
Probability of belonging to option 4 conditional on atmospheric pressure = 997.2 hPa	0.219***	(0.044)
Probability of belonging to option 4 conditional on atmospheric pressure = 1032 hPa	0.358***	(0.044)
Probability of belonging to option 5 conditional on atmospheric pressure = 997.2 hPa	0.045***	(0.014)
Probability of belonging to option 5 conditional on atmospheric pressure = 1032 hPa	0.099***	(0.025)
N	621	
R <sup>2</sup>		

**B2. Comfort with -2 degrees C and 3 degrees C**

<b>Comfort</b>	<b>b</b>	<b>se</b>
Probability of belonging to option 1 conditional on temperature = -2 degrees C.	0.030***	(0.008)
Probability of belonging to option 1 conditional on temperature = 3 degrees C.	0.022***	(0.006)
Probability of belonging to option 2 conditional on temperature = -2 degrees C.	0.054***	(0.012)
Probability of belonging to option 2 conditional on temperature = 3 degrees C.	0.041***	(0.008)
Probability of belonging to option 3 conditional on temperature = -2 degrees C.	0.277***	(0.030)
Probability of belonging to option 3 conditional on temperature = 3 degrees C.	0.229***	(0.017)
Probability of belonging to option 4 conditional on temperature = -2 degrees C.	0.533***	(0.027)
Probability of belonging to option 4 conditional on temperature = 3 degrees C.	0.568***	(0.021)
Probability of belonging to option 5 conditional on temperature = -2 degrees C.	0.106***	(0.018)
Probability of belonging to option 5 conditional on temperature = 3 degrees C.	0.140***	(0.015)
N	621	
R <sup>2</sup>		

**B3. DonateClothesAnon with 0 mm and 7.5 mm precipitation amount,**

<b>DonateClothesAnon</b>	<b>b</b>	<b>se</b>
Probability of belonging to option 1 conditional on precipitation amount = 0 mm	0.068***	(0.012)
Probability of belonging to option 1 conditional on precipitation amount = 7.5 mm	0.036***	(0.013)
Probability of belonging to option 2 conditional on precipitation amount = 0 mm	0.098***	(0.015)
Probability of belonging to option 2 conditional on precipitation amount = 7.5 mm	0.057***	(0.017)
Probability of belonging to option 3 conditional on precipitation amount = 0 mm	0.269***	(0.022)
Probability of belonging to option 3 conditional on precipitation amount = 7.5 mm	0.190***	(0.039)
Probability of belonging to option 4 conditional on precipitation amount = 0 mm	0.463***	(0.025)
Probability of belonging to option 4 conditional on precipitation amount = 7.5 mm	0.536***	(0.027)
Probability of belonging to option 5 conditional on precipitation amount = 0 mm	0.102***	(0.015)
Probability of belonging to option 5 conditional on precipitation amount = 7.5 mm	0.182***	(0.049)
N	621	
R <sup>2</sup>		



**B4. DonateClothesAnon with 64% and 94% Humidity**

	b	se
Probability of belonging to option 1 conditional on humidity = 64%	0.037***	(0.012)
Probability of belonging to option 1 conditional on humidity = 94%	0.078***	(0.017)
Probability of belonging to option 2 conditional on humidity = 64%	0.058***	(0.016)
Probability of belonging to option 2 conditional on humidity = 94%	0.110***	(0.022)
Probability of belonging to option 3 conditional on humidity = 64%	0.193***	(0.037)
Probability of belonging to option 3 conditional on humidity = 94%	0.285***	(0.027)
Probability of belonging to option 4 conditional on humidity = 64%	0.534***	(0.028)
Probability of belonging to option 4 conditional on humidity = 94%	0.438***	(0.038)
Probability of belonging to option 5 conditional on humidity = 64%	0.178***	(0.045)
Probability of belonging to option 5 conditional on humidity = 94%	0.089***	(0.019)
N	621	
R <sup>2</sup>		

The following tables (C1-C7) contain the results of the regressions using the factors extracted using exploratory factor analysis. In each of these tables the point estimates of the regressions are reported alongside (inside parentheses) the standard errors. To emphasize significant results asterisks are used to indicate different levels of significance. One asterisk (\*) indicates a result that is significant at the 90% confidence level, two asterisks (\*\*) indicate a confidence level of 95% and three asterisks (\*\*\*) indicate a confidence level of 99%. As these weather factors did not have a clear interpretation these tables are reported without further discussion.

### C1. Donate50

<b>Donate50</b>	(1)	(2)	(3)
Weatherfactor1	0.205 (0.558)	0.104 (0.593)	0.064 (0.599)
Weatherfactor2	-0.107 (0.558)	-0.211 (0.606)	-0.284 (0.605)
Condition		-1.716 (1.116)	-3.072* (1.718)
Gender		1.162 (1.144)	1.262 (1.179)
Age		0.137*** (0.049)	0.135*** (0.050)
IncomeAlt		0.001 (0.000)	0.001 (0.000)
EduHi		-1.391 (1.125)	-1.307 (1.122)
Guilt			0.317 (0.928)
Happiness			0.200 (0.620)
Shame			-0.052 (0.816)
Regret			-0.771 (0.764)
Sadness			-0.820 (0.674)
Anger			0.721 (0.859)
Intercept	10.822*** (0.517)	3.904 (2.667)	5.448 (3.467)
N	707	621	621
R <sup>2</sup>	0.000	0.020	0.027

## C2. DonateMoneyAnon

<b>DonateMoneyAnon</b>	(1)	(2)	(3)
Weatherfactor1	-0.007 (0.050)	-0.023 (0.053)	-0.017 (0.053)
Weatherfactor2	0.015 (0.050)	0.033 (0.055)	0.041 (0.056)
Condition		0.042 (0.099)	0.060 (0.154)
Gender		-0.016 (0.100)	-0.048 (0.100)
Age		-0.000 (0.005)	0.001 (0.005)
IncomeAlt		0.000 (0.000)	0.000 (0.000)
EduHi		0.341*** (0.104)	0.324*** (0.105)
Guilt			0.052 (0.070)
Happiness			0.063 (0.057)
Shame			-0.002 (0.079)
Regret			0.009 (0.075)
Sadness			0.100 (0.061)
Anger			-0.101 (0.084)
Intercept	2.878*** (0.046)	2.675*** (0.248)	2.365*** (0.317)
N	707	621	621
R <sup>2</sup>	0.000	0.022	0.033

### C3. Comfort

<b>Comfort</b>	(1)	(2)	(3)
Weatherfactor1	-0.027 (0.036)	0.008 (0.037)	0.013 (0.037)
Weatherfactor2	0.040 (0.033)	0.012 (0.035)	0.019 (0.035)
Condition		-0.025 (0.069)	0.013 (0.109)
Gender		0.255*** (0.070)	0.217*** (0.071)
Age		0.005 (0.003)	0.006* (0.003)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.098 (0.070)	0.079 (0.070)
Guilt			0.100* (0.056)
Happiness			0.080** (0.040)
Shame			0.035 (0.051)
Regret			-0.032 (0.051)
Sadness			0.086** (0.044)
Anger			-0.101* (0.058)
Intercept	3.731*** (0.033)	3.418*** (0.175)	2.998*** (0.232)
N	707	621	621
R <sup>2</sup>	0.003	0.027	0.058

#### C4. HelpStranger

<b>HelpStranger</b>	(1)	(2)	(3)
Weatherfactor1	-0.112*** (0.039)	-0.124*** (0.041)	-0.117*** (0.041)
Weatherfactor2	0.016 (0.038)	0.004 (0.040)	0.009 (0.039)
Condition		0.010 (0.076)	0.176 (0.128)
Gender		0.089 (0.076)	0.053 (0.076)
Age		0.002 (0.003)	0.004 (0.003)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.156** (0.076)	0.144* (0.076)
Guilt			0.187*** (0.054)
Happiness			0.046 (0.046)
Shame			-0.035 (0.058)
Regret			-0.009 (0.053)
Sadness			0.049 (0.053)
Anger			-0.041 (0.058)
Intercept	3.322*** (0.036)	3.137*** (0.193)	2.597*** (0.251)
N	707	621	621
R <sup>2</sup>	0.012	0.023	0.058

## C5. HelpNoNotice

<b>HelpNoNotice</b>	(1)	(2)	(3)
Weatherfactor1	-0.021 (0.039)	-0.009 (0.040)	-0.004 (0.041)
Weatherfactor2	0.027 (0.036)	0.014 (0.038)	0.020 (0.038)
Condition		-0.007 (0.075)	0.077 (0.121)
Gender		0.029 (0.075)	0.001 (0.076)
Age		-0.003 (0.003)	-0.002 (0.003)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.121 (0.077)	0.123 (0.077)
Guilt			0.072 (0.053)
Happiness			0.022 (0.043)
Shame			0.060 (0.055)
Regret			-0.076 (0.053)
Sadness			0.070 (0.050)
Anger			-0.015 (0.061)
Intercept	3.464*** (0.036)	3.617*** (0.184)	3.293*** (0.252)
N	707	621	621
R <sup>2</sup>	0.001	0.006	0.021

## C6. DonateClothesAnon

<b>DonateClothesAnon</b>	(1)	(2)	(3)
Weatherfactor1	-0.051 (0.043)	-0.043 (0.045)	-0.036 (0.045)
Weatherfactor2	-0.032 (0.041)	-0.057 (0.044)	-0.051 (0.044)
Condition		-0.068 (0.082)	0.078 (0.129)
Gender		0.176** (0.082)	0.152* (0.085)
Age		-0.001 (0.004)	-0.000 (0.004)
IncomeAlt		0.000 (0.000)	0.000 (0.000)
EduHi		0.229*** (0.085)	0.223*** (0.086)
Guilt			0.094 (0.059)
Happiness			-0.016 (0.045)
Shame			-0.071 (0.059)
Regret			0.030 (0.062)
Sadness			0.068 (0.053)
Anger			-0.068 (0.066)
Intercept	3.505*** (0.039)	3.362*** (0.189)	3.185*** (0.261)
N	707	621	621
R <sup>2</sup>	0.003	0.025	0.038

## C7. HelpHurt

<b>HelpHurt</b>	(1)	(2)	(3)
Weatherfactor1	-0.032 (0.036)	-0.021 (0.037)	-0.018 (0.037)
Weatherfactor2	0.054 (0.034)	0.042 (0.036)	0.045 (0.036)
Condition		-0.010 (0.069)	0.050 (0.113)
Gender		0.106 (0.069)	0.084 (0.070)
Age		0.006** (0.003)	0.007** (0.003)
IncomeAlt		-0.000 (0.000)	-0.000 (0.000)
EduHi		0.030 (0.071)	0.009 (0.072)
Guilt			0.108* (0.057)
Happiness			0.054 (0.040)
Shame			-0.016 (0.057)
Regret			0.022 (0.048)
Sadness			0.018 (0.044)
Anger			-0.080 (0.058)
Intercept	3.659*** (0.033)	3.332*** (0.169)	3.037*** (0.236)
N	707	621	621
R <sup>2</sup>	0.004	0.011	0.029



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