All by myself? Testing descriptive social norm-nudges to increase flood preparedness among homeowners

Jantsje M. Mol[1], W. J. Wouter Botzen[1,2,3], Julia E. Blasch[1], Elissa C. Kranzler[3], and Howard C. Kunreuther[3]

May 2020

Abstract

Social norms are rules of behavior that are commonly approved by society and personal norms represent what people believe to be appropriate behavior for themselves. Nudges based on social norms (norm-nudges) can be compelling interventions compared to traditional interventions such as taxes and regulations, but they do not work in all circumstances. We tested two empirical norm-nudge frames in an online experiment with large representative samples of homeowners ($N = 1805$) in two European countries, to evaluate the possible interactions between norm-nudge effectiveness, individual characteristics and intercultural differences. We contrasted these norm-nudge treatments with a control treatment and a norm focusing treatment, where respondents are asked to express their beliefs about what other respondents would do before making a decision relevant to their own payoff. We find no evidence of a treatment effect, suggesting that social norm-nudges do not affect flood preparedness in the context of a flood risk investment game. However, results demonstrate that investments in risk reduction measures are positively related to beliefs and personal norms as well as other variables related to risk perceptions. We discuss our contribution to the environmental nudge literature and derive policy implications.

Keywords: Flood preparedness, Homeowners, Lab-in-the-field experiment, Norm-nudges, Social information, Social norms

JEL Codes: B41, C91, C93

[1]Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, The Netherlands
[2]Utrecht University School of Economics (U.S.E.), Utrecht University, Utrecht, The Netherlands
[3]Risk Management and Decision Processes Center, The Wharton School, University of Pennsylvania

Introduction

Social norms are rules of behavior that are commonly approved by society and personal norms represent what people believe to be appropriate behavior for themselves (Bicchieri, 2006). The more deviations from a norm are sanctioned by society, the more individuals are inclined to follow the norm, and hence the behavior of others. A popular behavioral intervention based on social norms is a norm-nudge (Bicchieri and Dimant, 2019), which encourages certain behavior by informing individuals about the actions of others, for example by showing energy conservation behavior of neighbors (Allcott, 2011) or tax compliance rates of fellow citizens (Hallsworth et al., 2017). Norm-nudges may prompt people to act the way others are acting, because humans are inclined to model behavior on what others do, or what they believe others do.

Norm-nudges are compelling interventions because they are cheap, easy to implement and less prone to political resistance, compared to traditional interventions such as taxes or regulations (Benartzi et al., 2017). Nevertheless, norm-nudges do not work in all circumstances and their effectiveness depends on the design of the norm-nudge (Hummel and Maedche, 2019). Moreover, there is a risk that a norm-nudge will elicit no effects (see e.g. Mackay et al., 2019; Chabé-Ferret et al., 2019) or even backfire, if not properly tailored to the population and context of interest (Hauser et al., 2018). For example, norm-nudges may backfire when they provide information about norm-violating behavior (e.g. tax evasion), which may lower motivations for compliance (Richter et al., 2018). Thus, it is relevant to test different kinds of norm-nudges and empirically assess their effectiveness across contexts.

Many studies on norm-nudges have focused on applications for health, finances, the environment and energy (Hummel and Maedche, 2019; Abrahamse and Steg, 2013). To our knowledge, previous research has not explored the effect of norm-nudges in the context

of natural disaster risk reduction, including flood damage mitigation. Over the last decades, natural hazards such as floods have increasingly impacted society, and this trend is expected to continue in years to come due to climate change and population and economic growth in disaster-prone areas (IPCC, 2012; Munich RE, 2018). Floods are among the most costly natural disasters (UNISDR, 2015). Despite the availability of cost-effective measures that limit flood damage to buildings, few people in flood-prone areas invest in or implement such measures (Kreibich et al., 2015; Botzen et al., 2019a), this highlights the importance of studying whether norm-nudges can incentivize individuals to invest in cost-effective mitigation measures. Previous research indicates that flood preparedness behavior is driven by the risk-reduction behaviors of others (Poussin et al., 2014; Grothmann and Reusswig, 2006). For example, a survey of households in Australia found that perceived social norms had a greater influence on flood insurance purchases than homeowners' perceptions of flood risk (Lo, 2013). In a separate survey, Bubeck et al. (2013) showed a positive relationship between mitigation behavior and having neighbors and friends who have implemented flood mitigation measures. However, these studies have not examined the effectiveness of different social norm messages in stimulating individual investments in flood damage mitigation measures. In this study, we examine the efficacy of several different messages in a controlled experimental study.

Another innovation of this study is the comparison of social norms on preventive behavior across two countries characterized by different flood risk management regimes and different cultural backgrounds that may influence the effectiveness of social norm-nudges. Previous research indicates that subjective norms may exert differential effects on pro-environmental behavior across cultures (Ando et al., 2010; Oreg and Katz-Gerro, 2006). To assess such differences, we examined homeowners from the Netherlands and Spain, two countries with different cultural characteristics, for example with regard to individualism

(Pineda et al., 2015). Furthermore, we assessed whether differences in current flood risk management between those countries - with the Netherlands more focused on public flood protection through dikes and Spain on individual protection measures - influence risk attitudes and personal norms for protecting one's home.

The aim of this study is to examine the effectiveness of different norm-nudge messages with varying information in increasing individual investments in flood damage mitigation measures. Moreover, this study aims to examine heterogeneity in individual responses to these nudges as well as in the individual investment amounts, including individual characteristics and intercultural differences. We test two empirical norm-nudge frames with a large sample in two European countries and contrast these with a control treatment and a norm focusing treatment. In the latter, respondents are asked to guess what other respondents would do before making an investment decision relevant to their own payoff. This task has been shown to influence behavior in past work, namely by increasing donations to charity (Bartke et al., 2017) and encouraging pro-social behavior, such as sharing funds.

Literature review

A growing body of scientific research has identified important aspects of norm-nudge designs (see e.g. Bicchieri and Dimant, 2019). One line of research suggests that norm-nudges are only effective if the targeted behavior is interdependent; that is, when individual preferences are conditional on the empirical expectations of the behavior of others (Bicchieri, 2016). In contrast, when individuals are mainly motivated by their own basic needs or by their beliefs about what is morally right (i.e. targeted behavior is independent), individuals may expect others to behave in a certain way while maintaining another behavior themselves (Bicchieri, 2010). Note that expectations may be normative (what other people would approve of), empirical (what other people do), or both normative and empirical

(Bicchieri, 2016). In this paper, we use the terminology of Bicchieri et al. (2014). We focus on interdependent behavior under empirical expectations, or *descriptive norms* - a preference to do X following the expectation that others do X as well (see Bicchieri and Dimant (2019)). Note that the term descriptive norm is used in psychological literature in a similar, but slightly different manner (Bicchieri and Dimant, 2019). Alternatively, norm-nudges may be based on injunctive norms, or expectations of what others find appropriate behavior (Cialdini et al., 1990), such as *Most people think you should not litter* (Farrow et al., 2017).

Another important component of norm-nudge design is choosing the appropriate reference network. According to social identity theory, individuals are much more strongly affected by the actions of others if they share a certain group membership, such as gender, neighborhood or ethnicity (Tajfel, 1982). For instance, Goldstein et al. (2008) found that referring to a specific reference network in the norm-nudge message "other hotel guests who stayed in the same room" more effectively promoted towel reuse than the generic message about other hotel guests. Some research suggests that the credibility of the message or message source may alter the effectiveness of norm-nudges. For example, Gifford et al. (2018) claimed that mistrust in messages from government officials could prevent citizens from taking action to combat climate change. However, recent experimental evidence on feedback frames to increase pro-environmental behavior did not demonstrate any evidence of a messenger effect (Hafner et al., 2017). Note that citizens who believe climate change is real may also mistrust government messages if they think the problem is underestimated. Conversely, individuals may feel threatened in their freedom of choice by the nudge, which may prompt them to act in opposition to the desired behavior. For example, Arad and Rubinstein (2018) provided respondents with a nudge to increase savings, which increased the number of respondents selecting the savings arrangement. However, when respondents

were told the government used a nudge, some respondents opted out of the savings arrangement. A strategy for overcoming this effect is to be transparent about the aim of the nudge, for example by informing respondents that the default option may encourage higher contributions to charity. Recent evidence shows that transparent nudges are judged as more trustworthy (Osman et al., 2018) and might be equally effective as traditional nudges that conceal their aim (Bruns et al., 2018).

Finally, the exact framing of empirical norm-nudge messages may improve their efficacy. For example, Stoffel et al. (2019) studied the effect of different quantifiers (*'a large number'* and *'nearly half'*) on intentions to participate in cancer screening. They found that both verbal quantifiers increased intentions compared with an exact numerical norms message (*43%*). While most norm-nudge messages have a binary nature (e.g., people pay or do not pay their tax on time, Hallsworth et al., 2017), some contexts allow for a continuous approach (e.g. "*Neighbors used 1,092 kWh on average*", Allcott, 2011). However, many cases of norm-nudges use a binary message, while the exact distribution of this variable is known. Contributing to the literature on the transparency of nudges (Bruns et al., 2018), this paper tests whether transparently showing the full distribution of choices by previous respondents (i.e. giving the exact percentage who chose each option) is more effective than summarizing these choices as a binary message. Furthermore, we measure several individual characteristics that previous research has identified as influencing the effectiveness of social norms messages, such as identification with the reference network (Liu et al., 2019), political identities (Chang et al., 2019) and a concern for social comparison (Buunk and Gibbons, 2006; Garcia et al., 2013). A further possible moderator of norm-nudge messages is culture. One dimension of culture is the extent to which people perceived their relationships to others, which can be measured on a scale ranging from individualist (people conceptualize themselves as individuals) to collectivist (people conceptualize themselves as members of a

group) (Triandis, 1989). With regard to social norms, collectivists may be more motivated to follow the behavior of others (Baldwin and Mussweiler, 2018; Oh, 2013).

Methodology

We used an experimental study to examine the impact of different norm-nudge messages on individual flood preparedness in two European countries. Following Hafner et al. (2019), who argued that the effect of norm-nudge messages on behavioral intentions in real life may only apply to respondents who are in the position to execute the intention, we restricted the sample to homeowners. The design included an incentivized investment game in which respondents were asked to make decisions about investing in cost-effective measures to prevent damage of low-probability floods. Examples of such investments include installing dry flood proofing measures which keep water out of the building during a flood (e.g. flood shields) or wet flood proofing measures that minimize damage when water enters a building (e.g. by applying water-resistant building materials). To mimic the large consequences of real flood investment decisions, we implemented a random lottery incentive mechanism with high monetary stakes (see Camerer and Hogarth, 1999). Specifically, at the end of the experiment, the software randomly selected one respondent who had the chance to earn up to 650 euro, based on his/her decisions and luck in the game. The payment mechanism was explained at the start of the game, to motivate subjects to consider their decisions carefully under high stakes.

Investment game

The investment game was a simplified version of a previous online experiment (Mol et al., 2018). We used identical parameters to facilitate comparison of the results. In this game, respondents were asked to imagine owning a house under flood risk for a period of 25

years. With the hypothetical house comes a savings balance that could be used to make payments in the game, such as purchasing flood damage reduction measures. The currency used in the investment game was ECU (Experimental Currency Units). The game started with the introduction of the parameters: a yearly flood probability of 1%, the maximum damage of 50,000 ECU in case of a flood and the savings balance of 65,000 ECU. The next page offered five discrete investments with accompanying benefits in terms of reduced damage from flooding. The investment decision was made once, at the start of the game, and damage reducing measures were effective for the full 25 year period of the game. This one-shot short set-up of the game was designed to be suitable for the online sample of respondents. Figure 1 provides a screen shot of the investment game at the page where the flood risk was realized. This page showed a grid with 100 houses, with the house of the respondent enclosed in a square. The software randomly selected (based on the 1% flood probability) a number of houses that were flooded in the 25 years of the game and highlighted these in blue. In case the house of the respondent was flooded, the 50,000 ECU damage was subtracted from the savings balance. The optimal investment based on expected value calculations was 1000 ECU.

We started the online experiment with a short set of socio-demographic questions. Subsequently, the investment game was introduced through several pages of instructions, which were supported with graphics to facilitate understanding of respondents with different education levels. As in Mol et al. (2018), the investment game was preceded by a test scenario to familiarize respondents with the decision screens. Before finishing the test scenario stage, respondents were requested to answer a few comprehension questions. The instructions were always accessible to respondents throughout the game. Additionally, the experimental software tracked attempts to answer these comprehension questions and the reopening of instructions. These were included in all regression analyses to control for

understanding of the experimental design.

Figure 1: Screen shot of flood risk page.

Experimental treatments

Each respondent was randomly assigned by the software into the control group or one of three treatment groups. In two treatment groups we displayed an empirical norm-nudge message with information about decisions of previous respondents. We used the percentages of previous investments in the Control treatment[1] of Mol et al. (2018) to construct these messages. Note that these percentages were based on decisions of a sample of Dutch homeowners. To prevent confounding effects of in-group/out-group preferences, we did not mention the nationality of the reference group, but simply characterized them as

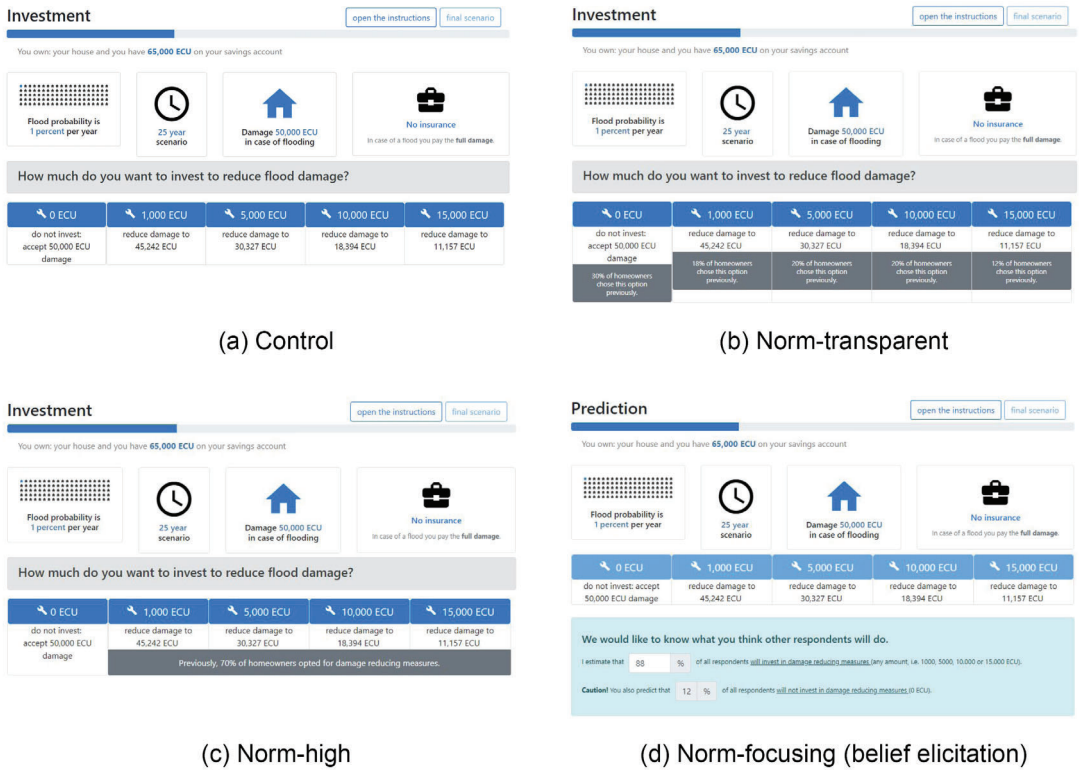
[1]This treatment was called 'Mandatory No Insurance' and had exactly the same parameters as the Control treatment in the current experiment.

homeowners in similar research. A third treatment group faced a focusing norm treatment, by eliciting beliefs about others' investment choices before participating in the investment game (Krupka and Weber, 2009). We did not include an injunctive norm message because results from our previous experiment showed that 90% of Dutch homeowners do not think their peers should invest in flood risk reduction. A message highlighting this information has the potential to backfire such that people are less motivated to invest, particularly if they would otherwise expect that a larger proportion of their peers think they should invest (c.f. Bicchieri and Dimant, 2019). The game was constructed such that individual decisions could not be observed by other respondents, to focus on the effect of the norm-nudge messages in isolation from observability effects. In practice, many flood-preparedness measures are taken inside a house and cannot be observed by neighbors either, except for the most extreme case of elevating a house. Figure 2a shows the investment screen in the Control treatment.

Norm-transparent

This treatment showed the full distribution of previous flood preparedness decisions in terms of the percentage of investments of previous respondents in five small text boxes below the five investment options (see Figure 2b). We expected that respondents would be unfamiliar with the flood preparedness decision environment. In other words, few respondents are confronted with flood preparedness decisions on a daily basis[2], in contrast to other contexts which have been successfully related to social norms, such as energy conservation. Therefore, we expected respondents to have no (strong) beliefs about others' behavior in the investment game. The Norm-transparent treatment provided new informa-

[2]To illustrate, only 9% of our respondents indicated having purchased private flood insurance coverage and even those respondents probably think about flood insurance only when they pay their premium or renew coverage.



(a) Control

(b) Norm-transparent

(c) Norm-high

(d) Norm-focusing (belief elicitation)

Figure 2: Screen shots of the four treatments.

tion on mitigation decisions by others, illustrating the informational effect of a descriptive norm (Krupka and Weber, 2009). All boxes showed flood preparedness decisions by others in percentages. We presented this information as a percentage in the empirical norm-nudge message following Hallsworth et al. (2017), who found in a large natural field experiment that percentage norm messages are more effective than norm messages presented as a fraction (*nine out of ten*) or a general statement (*the majority*) in increasing tax compliance.

Norm-high

In the Norm-high treatment, an empirical norm-nudge message was displayed directly below the positive investment options (see Figure 2c). The message emphasized that a large majority of previous respondents had invested in damage-reducing measures, again by showing a percentage (*"70% of respondents in previous research opted for damage-reducing measures."*). While previous social norms research has mostly focused on binary outcome variables (e.g. whether or not to donate to charity or play a risky lottery), our set-up requires that respondents choose from five discrete investment options. The Norm-high treatment highlights the binary first step of the decision (invest versus not invest) and is an intuitive way to describe the distribution.

Norm-focusing

The final treatment was designed to manipulate the strength of the norm focus (Cialdini et al., 1990; Kallgren et al., 2000). Krupka and Weber (2009) showed in a large lab experiment that the norm focus intervention is effective in increasing pro-social behavior even when respondents believe that others do not behave according to the norm. Recently, Bolton et al. (2019) showed that the mere thought of what other people might do, operationalized with incentivized belief elicitation, leads to the same desired increase of donations compared to a more costly intervention (i.e. with monetary consequences). Note that our dependent variable is individual investment behavior, which cannot be confounded by strategic concerns that might arise in public goods games. We used an incentive-compatible method to elicit beliefs about others' behavior, before requesting that respondents make a decision about their personal investment in the investment game. We asked respondents to estimate the percentage of other respondents investing in damage-reducing measures (1000, 5000, 10.000 or 15.000 ECU). An interactive screen emphasized that the remainder of re-

spondents would not invest (see Figure 2d). We opted for such an explanation to facilitate comparison of answers with the Norm-high treatment, which also showed the percentage of people investing versus not investing. Furthermore, eliciting the full distribution would be a rather complicated task to explain, which could lead to undesirable attrition effects. Belief elicitation was incentivized with a €20 payment on top of the respondent fee for one randomly selected respondent. A large yellow alert marked the transition from the own investment decision to the belief elicitation decision screen. In the control treatment, belief elicitation was conducted after respondents completed the investment game. Figure 3 provides an overview of the experimental treatments.

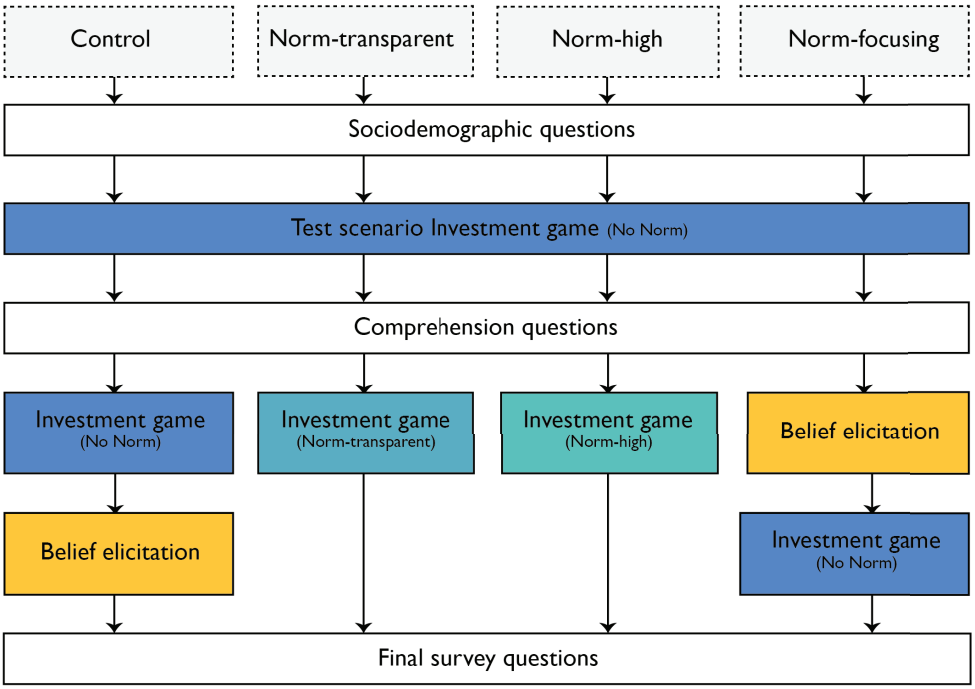


Figure 3: Overview of experiment per treatment.

Procedure

The online experiment was distributed by the survey company Panelinzicht in two rounds: in August 2019 to a sample of Dutch homeowners and in October 2019 to a sample of Spanish homeowners. The instrument was translated into the local language of the respondents (Dutch and Spanish) and administered over the Internet using the experimental software oTree (Chen et al., 2016), which allowed for a similar procedure across countries. The experiment started with a selection question to ensure that only homeowners were eligible to participate. The experimental interface was optimized for the screen size of tablets and desktop computers, which was communicated in the invitation email of the panel company. Nevertheless, it was possible to complete the experiment on smaller screens such as smartphones, but this required more effort through zooming and scrolling. The final data set contains 1200 Dutch responses and 605 Spanish responses.

Survey questions

Variables that were part of our hypotheses included trust in the presented information, susceptibility to peer influence and individualism-collectivism personality scores. These variables were evaluated with survey questions at the end of the investment game. Moreover, we elicited variables that are likely to influence demand for flood damage mitigation investments independent of social norms, such as personal norms, response efficacy of mitigation measures and risk perception. Table 1 provides an overview of all survey questions administered and the order in which they appeared. The full list of survey questions and answer categories can be found in the Online Supplementary Material.

Table 1: Summary overview of the survey questions

Demographics	
Gender (f32)	Dummy variable gender (1 = respondent is female)
Age in years (f33)	Continuous variable, age in years
Master's degree (f35)	Dummy variable education level (1 = holds Master's degree)
High income (f36)	Dummy variable income (1 = monthly household after-tax income > €5,000)
Expensive house (f37)	Dummy variable house value (1 = house value > €400,000)
Hypotheses variables	
Trust in messenger (f12)	Categorical variable (range 1-5), following Hafner et al. (2017), only displayed in Norm-high and Norm-transparent treatments
Independence (f27)	Reverse of susceptibility to peer influence. Scale of three categorical variables (range 1-5), following Eckel et al. (2011).
Self-responsibility (f25)	Categorical variable (range 1-5), following Maidl and Buchecker (2015)
Collectivism (f30)	Short 11-item scale (range 1-7) (Cai and Fink, 2002), revision of INDCOL scale (Hui and Triandis, 1986). Scores averaged: higher numbers indicate more collectivism.
Nationality (from wave)	Dummy nationality (0 = the Netherlands, 1 = Spain)
Control variables	
Awareness (s1)	Dummy sure live in flood-prone area (1 = Yes), adapted from Botzen et al. (2015)
Evacuated (s2)	Dummy ever evacuated due to threat of flooding (1 = Yes)
Damaged (s3)	Dummy property damaged due to floods in the past (1 = Yes)
High damaged amount (s4)	Dummy variable damaged amount (1 = amount > €50,000)
Flood probability (s5)	Categorical variable (*Zero, Very low, Low, Not low/not high, High, Very high, Do not know*), adapted from Mol et al. (2018)
Expected water level (s6)	Expected water level in case of a flood. Categorical variable (*0 cm, 1-10 cm, 11-50 cm, 50-100 cm, 1-2 meters, > 2 meter*), adapted from Mol et al. (2018))
High expected damage (s7)	Dummy high expected damage (1 = respondent expects flood damage > €50,000)
Worry about floods (s8)	Categorical variable (range 1-5), adapted from Botzen et al. (2015)
Threshold of concern (s9)	Categorical variable (range 1-5), adapted from Botzen et al. (2015)
Trust in dikes (s10)	Categorical variable (range 1-5), adapted from Mol et al. (2018)
Flood probability (s11)	Continuous variable, log of estimate, adapted from Mol et al. (2018)
Anticipated regret (f13-15)	Categorical variable (range 1-5), adapted from Kunreuther and Pauly (2018)
Difficult (f16)	Categorical variable (range 1-5) on difficulty of investment game
Strategy (f17)	Open answer to assess strategy in investment game
Measures implemented (f18)	Continuous variable, number of measures, adapted from Mol et al. (2018)
Measures neighbors (f19)	Dummy respondent knows person who has installed measures (1 = Yes), adapted from Mol et al. (2018)
Measures self (f20)	Categorical variable, Person responsible for installing measures in question f3 (*Me, Previous owner, Homeowners association, Other*)
Neighbors relation (f21)	Categorical variable, Relationship to person in f19 (*Partner, Friend, Parent, Aunt/Uncle, Son/Daughter, Cousin, Neighbor, Acquaintance, Other*), adapted from Mol et al. (2018)
Response efficacy (f22)	Categorical variable (range 1-5), adapted from Poussin et al. (2014)
Response cost (f23)	Categorical variable (range 1-5), adapted from Poussin et al. (2014)
Self-efficacy (f24)	Categorical variable (range 1-5), adapted from Poussin et al. (2014)
Personal norm (f26)	Categorical variable (range 1-5), adapted from Doran and Larsen (2016)
Risk aversion (f28)	Categorical variable (range 0-10), adapted from Falk et al. (2018)
Present bias (f29)	Categorical variable (range 0-10), adapted from Falk et al. (2018)
Numeracy (f31)	Short numeracy scale by McNaughton et al. (2015)
House type (s34)	Dummy house includes ground floor (1 = Yes)
House size (f38)	Continuous variable, size of ground floor in m^2, for calculating objective risk

Notes: Order of variable in parentheses: 's' indicates start survey, 'f' indicates final survey.
For example, 's7' indicates it was the seventh question and appeared in the start survey.

Hypotheses

We formulated hypotheses based on results from previous literature. All hypotheses were formally preregistered prior to data collection.[3]

Our main hypothesis concerns the effect of empirical norm-nudge messages on investments in damage-reducing measures in the investment game. Norm-nudges may help individual homeowners to act the way others are acting, as humans are inclined to model behavior on what others do. A large body of literature has shown that norm-nudges may be effective to increase environmental-friendly behavior (Allcott, 2011; Abrahamse and Steg, 2013). Furthermore, survey research indicates that flood preparedness behavior is driven by the risk-reduction behavior of others (Poussin et al., 2014; Grothmann and Reusswig, 2006) and perceived social norms[4] (Lo, 2013). Therefore, we expect that an empirical norm-nudge message will increase individual investments in flood risk protection measures, compared to an investment screen without a norm-nudge message.

Hypothesis 1 *Respondents confronted with an empirical norm-nudge (Norm-high and Norm-transparent) will invest more in damage-reducing measures than respondents in the Control treatment.*

To our knowledge, we are the first to test an empirical norm-nudge showing the percentages of previous decisions for each of the five discrete investment options (Norm-transparent), as compared with an empirical norm-nudge highlighting the percentage of previous respondents who either have or have not invested (Norm-high). Hence, we have no empirical information on the basis of which we can hypothesize whether investment in damage-reducing measures will differ between these two norms. We expect that respon-

[3] https://aspredicted.org/blind.php?x=ik57r5. Preregistered hypothesis 6 was unrelated to the treatments and is suppressed here for brevity.

[4] Measured as the level in which the respondents believed that their family or friends want them to purchase flood insurance.

dents in the Norm-transparent treatment will have greater trust in the norm-nudge message than respondents in the Norm-high treatment, due to the provision of more transparent information in the former condition (see e.g. Osman et al., 2018). Accordingly, we expect that respondents in the Norm-transparent treatment will be more apt to follow the majority of highlighted responses (investing some amount), relative to those in the Norm-high treatment, due to greater levels of trust in the message.

Hypothesis 2 *Respondents in the Norm-transparent treatment have greater trust in the norm-nudge message than respondents in the Norm-high treatment, and are hence more likely to follow the majority of the highlighted responses and invest.*

In the Norm-focusing treatment, respondents are confronted with a belief elicitation page before they are asked to make an investment decision for their own payoff. The question, "What proportion of other respondents would invest in damage-reducing measures?" may encourage respondents to think about the norm (Kallgren et al., 2000), which could increase investments even when respondents do not believe many others will invest (Bolton et al., 2019). Based on previous research on norm-focusing and "norm beliefs" (Krupka and Weber, 2009; Bartke et al., 2017), we expect that the Norm-focusing treatment leads to the highest investments of all treatments.

Hypothesis 3 *Respondents in the Norm-focusing treatment will invest the most in damage-reducing measures, relative to all other treatments.*

Susceptibility to peer influence (Dielman et al., 1987; Bearden et al., 1989) may be another important driver of norm-nudge effects. Susceptibility to peer pressure is commonly studied in adolescents and young adults, where it has been found to drive gambling (Langhinrichsen-Rohling et al., 2004) and delinquent (Prinstein et al., 2011) behavior. Eckel et al. (2011) found that high school students who report being highly independent

are less likely to conform to normative behavior in decisions about sharing funds. Recent empirical evidence among adults shows that individuals are more likely to follow provided peer information if they are susceptible to informational influence, across several domains, including investment decisions (Hoffmann and Broekhuizen, 2009), consumer choice (Orth and Kahle, 2008), vaccination behavior (FitzSimons et al., 2014) and retirement decisions (Verhallen et al., 2018). In a recent paper, Stöckli and Hofer (2020) examined susceptibility to social influence among a large sample of adult online social media users. The authors found that susceptible individuals are more likely to buy what other users post about, and to obtain information about political issues following other uses. Thus, we expect to find the same pattern of results.

Hypothesis 4 *The effect of the empirical norm-nudge messages is greater for respondents who demonstrate higher levels of susceptibility to peer influence.*

The degree to which empirical norm-nudges affect individuals may further be subject to cultural differences (Oreg and Katz-Gerro, 2006). One dimension for characterizing cultural factors is the extent to which people conceptualize themselves in relation to others (Triandis, 1989). The more individualistic the culture, the more people conceptualize themselves as individuals, separate from others; conversely, in collectivistic cultures, people are more apt to conceptualize themselves as members of a group (Hofstede, 2001). These differences in self-concept can influence engagement in protective behaviors. For example, Parboteeah et al. (2012) found that collectivists are more likely to support sustainability initiatives. Recent evidence shows that people from individualistic cultures respond differently to nudges in the context of vaccination behavior (Betsch et al., 2017), such that they are more willing to be vaccinated. Individuals in southern European countries (such as Spain) generally score higher on collectivism than individuals in the Netherlands (Hofstede, 2001; De Raad et al., 2016). Therefore, we expect relevant variation in this variable

within our sample that may explain heterogeneity in responses to the social norms message. To investigate the cultural differences of empirical norm-nudges on flood preparedness, we will examine respondents scores on an 11-item individualism-collectivism scale (Cai and Fink, 2002), a revised version of the original INDCOL scale (Triandis, 1989). We expect that respondents with a more collectivistic worldview are more strongly influenced by an empirical norm-nudge message as they are more inclined to follow group behavior.

Hypothesis 5 *The effect of an empirical norm-nudge is larger for individuals with high collectivism scores on the individualism-collectivism scale, relative to those with high individualism scores.*

Results

In this section we report the experimental results, beginning with descriptive statistics by country. We examine the results for each pre-registered hypothesis. We then turn our attention to a secondary treatment in the Spanish dataset with regard to intention to search for more information about flood risks. Finally, we report a number of observations from an exploratory analysis of the data.

Table 2 presents descriptive statistics of our sample. Demographic variables are very similar across countries, except for income[5] and home value,[6] which are in line with population statistics of each respective country.

[5]Average €2368 per month for Spain (Institute Nacional de Estadística, 2020) and €3042 per month for Netherlands (Netherlands Statistics, 2020b).

[6]Average €151,084 for Spain (Gobierno de España, 2020) and €307,978 for Netherlands (Netherlands Statistics, 2020a).

Table 2: Descriptive statistics by country

	Spain ($n = 605$)	**Netherlands** ($n = 1200$)	**Total** ($n = 1805$)
Gender			
Male	302 (50%)	633 (53%)	935 (52%)
Female	303 (50%)	567 (47%)	870 (48%)
Age (years)			
Mean (SD)	45 (±13)	52 (±17)	49 (±16)
Education level			
Low	99 (16%)	190 (16%)	289 (16%)
Medium	201 (33%)	488 (41%)	689 (38%)
High	305 (50%)	522 (44%)	827 (46%)
Income (per month)			
Mean (SD)	2100 (±1200)	3100 (±1300)	2800 (±1300)
Missing	64 (10.6%)	230 (19.2%)	294 (16.3%)
Home value (× €1,000)			
Mean (SD)	200 (±140)	290 (±130)	260 (±140)
Missing	91 (15.0%)	112 (9.3%)	203 (11.2%)

Results by hypotheses

Our main hypothesis concerned the effect of empirical norm-nudge messages on investments in damage-reducing measures in the investment game. Figure 4 shows the proportions of each investment level chosen by our respondents, split per treatment and country. The shaded areas indicate positive investments (1,000 ECU; 5,000 ECU; 10,000 ECU or 15,000 ECU) and the remaining white area indicates the proportion of respondents who did not invest anything. We observe almost identical investment levels across treatments and countries. This result is unexpected, given the experimental research on the effectiveness of norm-nudges in the environmental domain (Abrahamse and Steg, 2013; Farrow et al., 2017; van Valkengoed and Steg, 2019) and the survey research on importance of perceived social norms in the flood risk domain (Bubeck et al., 2013; Lo, 2013).

We examined this result more formally with chi-squared tests and probit regressions

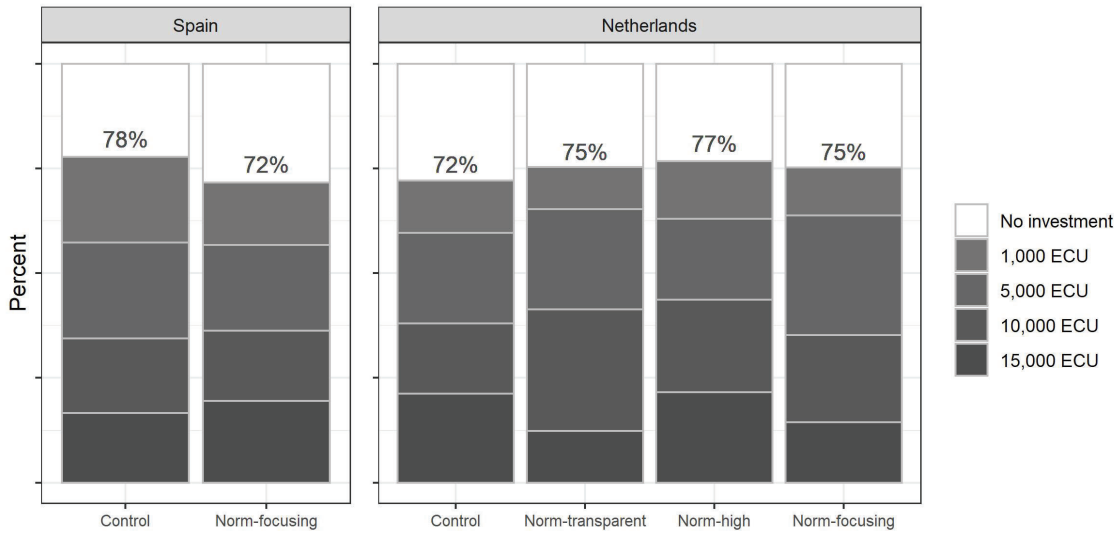


Figure 4: Investments in damage-reducing measures by treatment and country

and discuss the results in detail below. Table 3 provides an overview of all hypotheses and reports two-tailed chi-squared tests to analyze the differences in frequencies of investments with respect to treatments and independent variables of interest. Hypothesis 4 and 5 predicted interaction effects of susceptibility to peer influence and collectivism on the relationship between norm treatments and damage reducing investments. Therefore, Table 3 reports Z-statistics of the interaction term in a probit regression with binary investment as the dependent variable and susceptibility peer influence and collectivism as independent variables.

The first two rows of Table 3 show no support for a main treatment effect as predicted by Hypothesis 1; investments do not differ between respondents in the Control group and the Norm-high group ($\chi^2 = 0.251$, $p = 0.62$), nor between respondents in the Control group and the Norm-transparent group ($\chi^2 = 0.002$, $p = 0.97$). Our Norm-transparent treatment did not lead to higher trust in messenger ($\chi^2 = 1.244$, $p = 0.87$), and investments were identical in the Norm-transparent and the Norm-high treatment ($\chi^2 = 0.093$, $p = 0.76$) (Hypothesis

Table 3: Results by hypotheses

Hypothesis	Prediction	Variable	Test	Support
H1	Norm-high > Control	Investments	$\chi^2 = 0.251$, $p = 0.62$	✗
H1	Norm-transparent > Control	Investments	$\chi^2 = 0.002$, $p = 0.97$	✗
H2	Norm-transparent > Norm-high	Trust in messenger	$\chi^2 = 1.244$, $p = 0.87$	✗
H2	Norm-transparent > Norm-high	Investments	$\chi^2 = 0.093$, $p = 0.76$	✗
H3	Norm-focusing > Control	Investments	$\chi^2 = 0.313$, $p = 0.58$	✗
H3	Norm-focusing > Norm-high	Investments	$\chi^2 = 1.021$, $p = 0.31$	✗
H3	Norm-focusing > Norm-transparent	Investments	$\chi^2 = 0.303$, $p = 0.58$	✗
H4	(Susceptible: Norm-focusing > Control) > (Not susceptible: Norm-focusing > Control)	Investments	z = -0.654, $p = 0.51$	✗
H4	(Susceptible: Norm-transparent > Control) > (Not susceptible: Norm-transparent > Control)	Investments	z = -2.298, $p = 0.02$	✓
H4	(Susceptible: Norm-high > Control) > (Not susceptible: Norm-high > Control)	Investments	z = -0.662, $p = 0.51$	✗
H5	(Collectivist: Norm-focusing > Control) > (Individualist: Norm-focusing > Control)	Investments	z = -0.707, $p = 0.48$	✗
H5	(Collectivist: Norm-transparent > Control) > (Individualist: Norm-transparent > Control)	Investments	z = -1.39, $p = 0.16$	✗
H5	(Collectivist: Norm-high > Control) > (Individualist: Norm-high > Control)	Investments	z = -0.679, $p = 0.5$	✗

Notes: We report χ^2 tests for main effects and z-scores of probit regressions for hypotheses predicting an interaction. Support indicated for $p < 0.05$.

2). With regard to Hypothesis 3, we find no differences in investments between the Norm-focusing group and the Control group ($\chi^2 = 0.313$, $p = 0.658$), the Norm-high group ($\chi^2 = 1.021$, $p = 0.31$), and the Norm-transparent group ($\chi^2 = 0.303$, $p = 0.58$). The difference in investments between the Control group and the Norm-transparent treatment is significantly stronger ($z = -2.298$, $p = 0.02$) for respondents with high levels of susceptibility to peer influence, which is in line with Hypothesis 4. However, this result is not found when comparing the Control group with the Norm-high ($z = -0.662$, $p = 0.51$) and Norm-focusing ($z = 0.707$, $p = 0.48$) treatments. Finally, we find no support for Hypothesis 5; the coefficients of the interaction terms between collectivism and the treatment conditions on investments in damage-reducing measures are not significant (Norm-focusing: $p = 0.48$; Norm-transparent: $p = 0.16$; Norm-high: $p = 0.5$).

Secondary treatment

As soon as the data collection for the Dutch respondents was completed, we conducted a preliminary analysis to determine the most promising treatment condition for the Spanish respondents, as indicated in the preregistration. We hypothesized that the non-significant effects of Norm treatments on investment decisions, as described above, might be attributed to the cost of this investment decision. In other words, changing intentions following the Norm treatments is a first step that many are willing to make, while changing behavior is a substantial next step, in particular when behavioral change is rather costly. In line with previous research (Dur et al., 2019), we speculated that norm-nudge messages are more apt to influence behavioral outcomes for which there is no monetary cost, such as clicking a link to retrieve more information, but less effective at producing changes in behaviors for which there is a tangible cost, such as investing money or increasing savings. To test this alternative explanation, we constructed a button to open a page[7] with more information about flood risk and mitigation possibilities in Spain. We randomly distributed a descriptive social norm-nudge message based on results from a previous survey (Mol et al., 2018) to half of the respondents: *Recent research shows that* ***68% of homeowners*** *have installed at least one measure to protect their home from flood damage* (see Figure 5). We expected more clicks on the link for information from respondents who received the norm-nudge message, compared to respondents in the control group. Results demonstrate that only a very small proportion of our sample clicked the link (63 respondents), and we find no differences information search between these groups ($\chi^2 = 0$, $p = 0.989$).

[7] https://www.miteco.gob.es/es/agua/formacion/guia-reduccion-vulnerabilidad-edificios_tcm30-379148.pdf

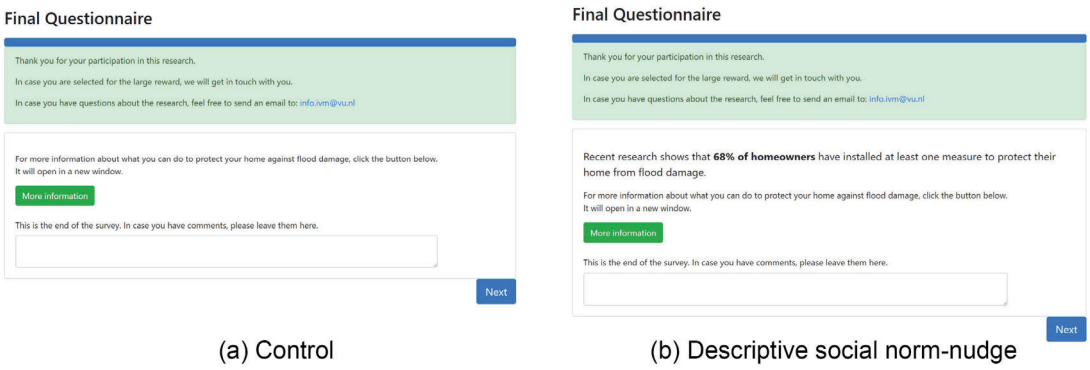


Figure 5: Screen shots of secondary treatment.

Other correlates of investments

Prior to our next set of analyses, we explored which variables have the most predictive power when it comes to investments in damage-reducing measures. We estimated simple binary correlations between all hypothesized predictor variables, control variables and the dependent variable. Figure 6 shows the distribution of the ten variables with the strongest correlations with decisions in the investment game in order of correlation strength.

Type of respondents

An alternative explanation for the absence of norm-nudge message effects is that such messages are not effective for respondents who have already decided they want to invest. In contrast, those respondents with no clear preferences with regard to investing, for example those lacking a strong personal norm to invest, or those without positive experiences with measures already installed at home, could be more sensitive to information about other respondents' behavior. As Sunstein (2017) has noted, though nudges may appear to be ineffective at the aggregate level, they may demonstrate effects in distinct sub-populations.

To test this alternative explanation, we constructed two dummy variables to indicate

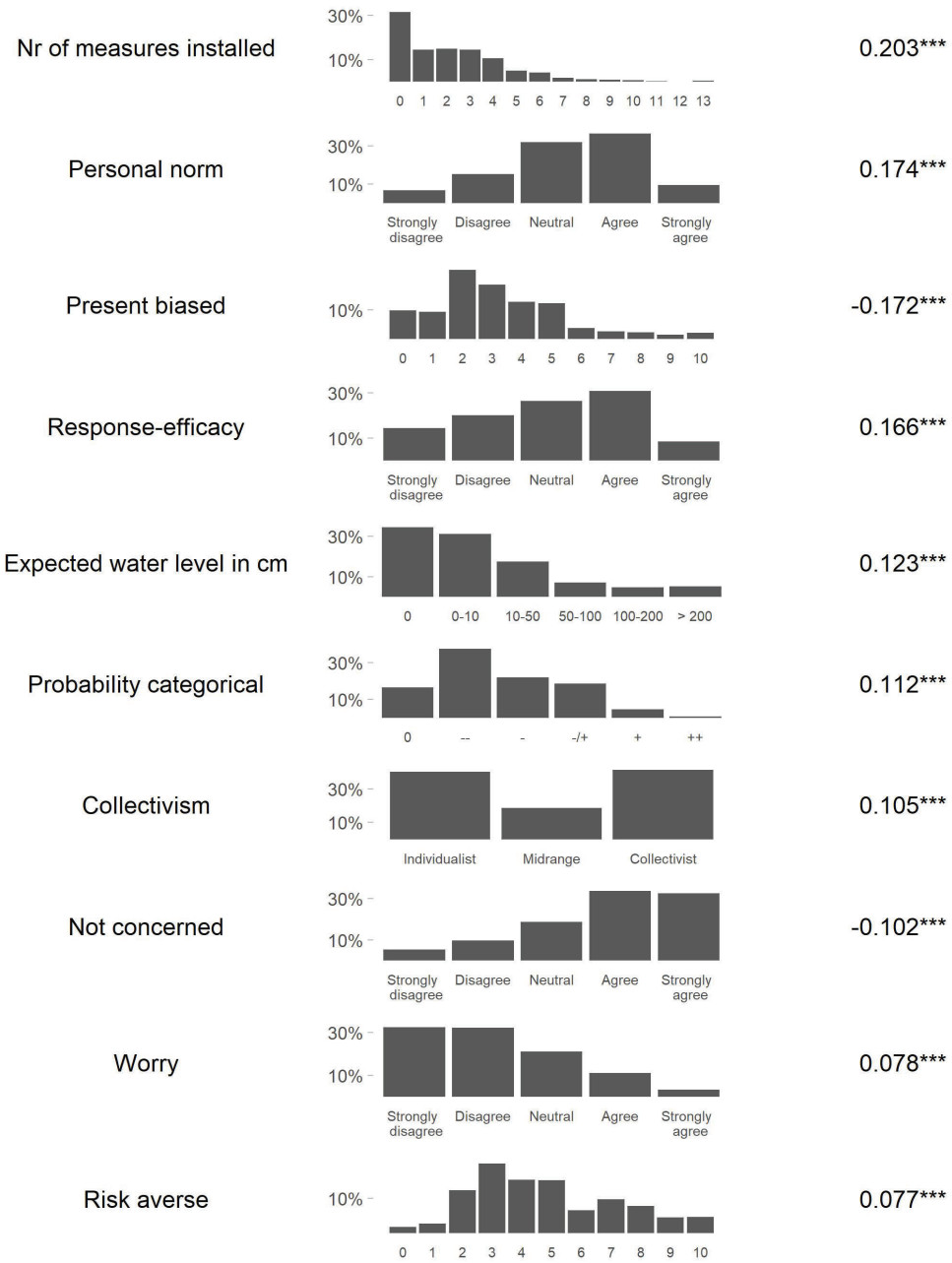


Figure 6: Histograms of flood belief variables and correlations with investment decisions. *Note:* Stars indicate significant Spearman correlations (*** $p < 0.001$).

a type of respondent who may be more susceptible to the treatments based on the most important predictors in Figure 6. The strongest predictor of investment in damage reduction is the number of measures already installed at home (see question $f18$ in Table 1). Therefore, we constructed a dummy of 'No-measures-individuals' (1 = zero measures installed at home, 0 = at least one measure installed at home). Other important predictors included personal norm, present bias, response efficacy and expected water level[8] from Figure 6. We constructed a 'No-investors' dummy ($n = 369$) to indicate individuals who do not expect high water levels (expected water level in cm = 0), have low response efficacy (strongly disagree or disagree) and do not have a strong personal norm (strongly disagree or disagree).[9]

After constructing the two dummies to indicate the 'No-measures-individuals' and the 'Non-investors' type of respondents, we conducted probit regressions to assess whether the norm-nudge treatments worked differently for these sub-samples. The dependent variable in these regressions was binary investment in protection (in the flood risk investment game) and the treatment dummies were included as explanatory variables. The model was estimated separately for each of the different sub-samples ('No-measures-individuals', 'Measures-individuals', 'Non-investors' and 'Investors'). We expected that the treatment is more effective for the non-investors or those respondents who have not yet installed any measures at home than for the opposite samples. We expected that the 'Non-investors' and the 'No-measures-individuals' would not be intrinsically motivated, based on the observation that these people do not have a strong personal norm or have not installed any measures at home. Therefore we expected a larger effect of the treatments for those sub-

[8] We conducted an additional regression analysis (not reported here) on the decision to mitigate (probit and ordered probit) with the top 5 predictors from Figure 6. We find that expected water level, response efficacy and personal norms are robust and significant predictors in either specification.

[9] Although present biased is the third most important predictor, constructing a dummy based on present bias values would require an arbitrary split, which is why we did not use present bias in the construction of the 'No-investors' dummy.

samples, as the treatments are external (they provide information).

Table 4: Probit regressions of treatment by type of respondents

	Dependent variable: investment in protection			
	Investors	Non-investors	Measures	No measures
	(1)	(2)	(3)	(4)
Constant	0.849***	0.364***	0.910***	0.272**
	(0.087)	(0.124)	(0.089)	(0.121)
Treatment (ref = Control)				
Norm-transparent	0.028	−0.055	−0.095	0.159
	(0.138)	(0.194)	(0.138)	(0.193)
Norm-high	0.122	−0.087	0.039	−0.006
	(0.143)	(0.185)	(0.142)	(0.186)
Norm-focusing	0.038	−0.147	−0.023	−0.084
	(0.122)	(0.178)	(0.123)	(0.178)
Log likelihood	-442.9	-245.5	-445.7	-241.2
Pseudo R^2 (McFadden)	0.001	0.001	0.001	0.003
Observations	920	369	927	362

Notes: Robust standard errors in parentheses ($^*p < 0.1$; $^{**}p < 0.05$; *** $p < 0.01$).

Table 4 reports the results of the probit regressions of treatment by type of respondents. Model 1 restricts the sample to 'Investors', where Model 2 restricts the sample to the opposite set ('Non-investors'). Model 3 restricts the sample to respondents who installed at least one measure at home ('Measures'), while Model 4 restricts the sample to respondents who did not install any measure at home ('No measures'). Across all models, we find no effect of treatment on investment in protection for any of the sub-samples. As a robustness check, we ran a probit regression analysis (not reported here) on the full sample with interaction terms, all of which were non-significant. In sum, we find no support for the alternative explanation that norm-nudge treatments are more effective for a sub-sample of the respondents, such as those lacking a strong personal norm to invest, or those without positive experiences with measures already installed at home.

Personal norms

As a next step in our analyses, we explored the differences between personal norms and social norms. Complementary to social norms, personal norms represent what people believe to be appropriate behavior for themselves (Schwartz, 1977), or what they feel morally obliged to do (Harland et al., 1999). Previous research has shown that personal norms can be powerful determinants of pro-environmental behavior (Bamberg and Möser, 2007; Yazdanpanah and Forouzani, 2015; Farrow et al., 2017). For example, Doran et al. (2019) showed that personal norms (moral concerns) are a stronger predictor of policy support to mitigate climate change than consequence evaluations. Huber et al. (2020) examined five years of longitudinal US household data and found that that personal norms are strongly related to recycling behavior. We measured personal norm as a response on a 5-point scale to the statement *"I am morally obligated to take measures to reduce flood risk to my home"*, adapted from Doran and Larsen (2016). We find that personal norm is significantly correlated with investment decisions (Spearman correlation $\rho = 0.174$, $p < 0.001$), such that stronger personal norms correspond to higher investments. Note that the results on personal norms are correlational, thus providing limited information about causality.

Beliefs

Next, we investigate the results of our belief elicitation question. On average, 75% of our respondents (Spanish and Dutch respondents combined) invested at least 1,000 ECU (the minimum amount). The correct answer to the belief elicitation question, which asked respondents to indicate the percentage of other respondents investing a positive amount, was thus 75%. Figure 7 shows the distribution of beliefs about other respondents' investment behavior in our sample, ranging from 0 to 100. The average belief was 46% and the me-

dian belief was 50%. A majority of respondents (71%) underestimated the correct answer. Furthermore, belief responses indicate a preference for round numbers, such as 10, 50 and 80.

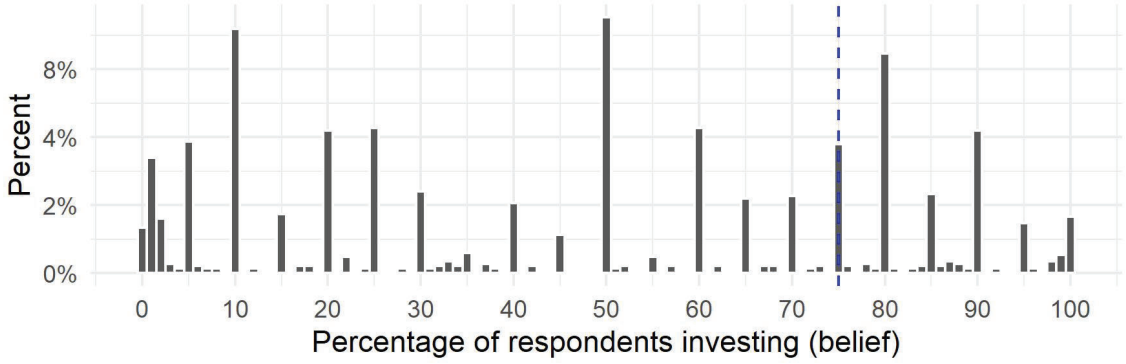


Figure 7: Histogram of beliefs. *Note:* The blue dotted line indicates the correct answer.

The belief elicitation question was asked in two of our four treatments: Control and Norm-focusing. The only difference between these treatments was whether the belief elicitation question was asked before (Norm-focusing) or after (Control) respondents' own investment decisions were taken. We found no difference of belief distributions across treatments (Kolmogorov-Smirnov test, $p = 0.982$). The lack of a treatment effect with regard to elicited beliefs suggests that beliefs about others' behavior and investment decisions are made concurrently - it does not matter which question is posed first. Figure 8 shows the relationship between beliefs and one's own investment decisions.

The figure demonstrates a positive relationship between investments and elicited beliefs, implying that investments increase with the belief that more people are investing

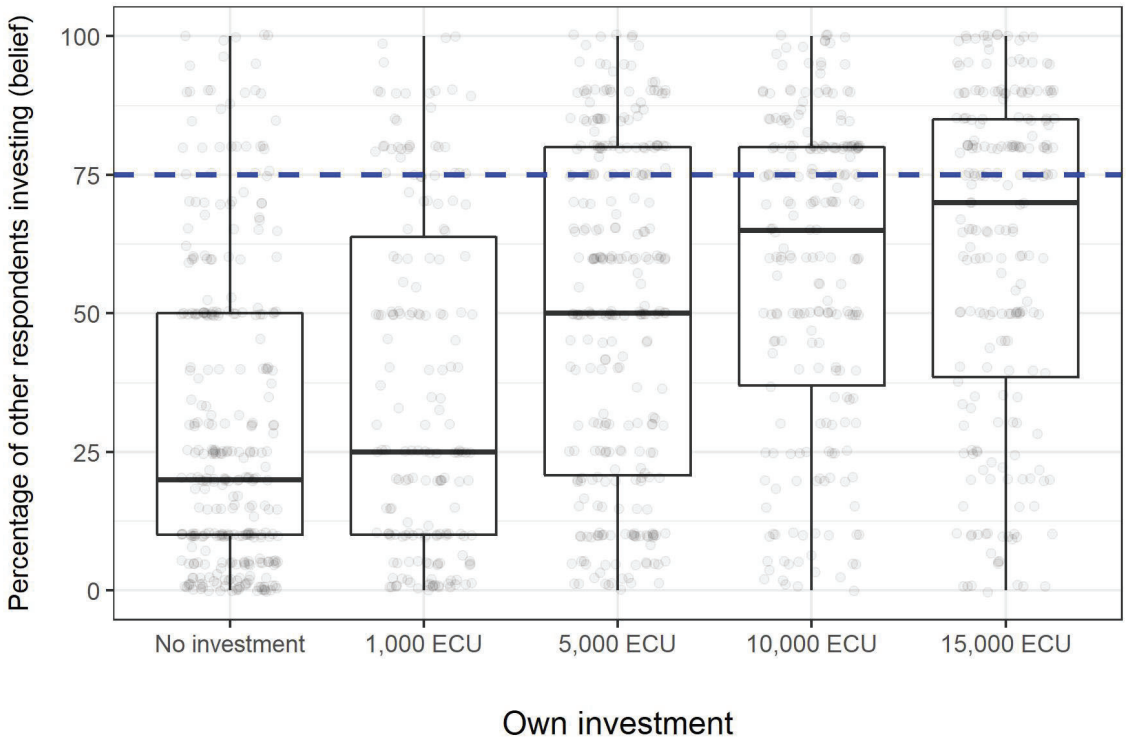


Figure 8: Beliefs of other respondents investing by own investment. *Notes:* The blue dotted line indicates the percentage of respondents who invested in our sample. Each individual observation is indicated with a gray dot, to which a small arbitrary noise has been added to the x coordinate to facilitate readability. Boxplot whiskers indicate the inter-quartile range, middle lines represent medians.

Discussion

We conducted a preregistered experiment with two large, representative samples to assess the effectiveness of norm-nudge frames on flood preparedness across countries. We found no evidence of a treatment effect: investments in damage-reducing measures of respondents in the Norm-transparent, Norm-focusing and Norm-high treatment groups did not differ from investments in the Control group. We examined the alternative hypothesis that social norms affect intentions rather than costly behavioral change with a secondary treatment in

the Spanish sample, but the results show no difference between the two treatment groups. Furthermore, we analyzed a subset of respondents who were not motivated by individual flood beliefs and personal norms and replicated the null effect of our full sample in this subset.[10] Several recent examples of studies that do not identify treatment effects of social norm-nudges are in line with our results: in the environmental domain (Mackay et al., 2019; Chabé-Ferret et al., 2019) and the financial domain (Franklin et al., 2019). Generally, it has been noted for various domains, including corruption (Köbis et al., 2019) and obesity (Oliver and Ubel, 2014), that behavioral approaches such as norm-nudges should not be taken as substitutes but rather as supplements to traditional policies.

A recent paper by one of the founding fathers of nudging, outlined the main reasons for ineffective nudges and three possible responses (Sunstein, 2017). We can rule out one of the two main reasons for failing nudges, namely counternudges, which are nudges aiming to promote the opposite behavior from the original nudge, as they were not at stake in our experiment. The second reason would be that decision-makers have strong antecedent preferences, which would be hard to change regardless of the strength of the nudge. We assumed that most respondents were unfamiliar with the flood damage-reducing investment decision, which would argue against strong preferences. Nevertheless, strong preferences with regard to risk aversion and insurance premiums, for example, could explain our results. If a nudge in the environmental domain proves ineffective, as we show in the current paper, this may warrant the use of stronger measures, such as incentives, regulations and bans, to influence preparedness (Sunstein and Reisch, 2013; Carlsson et al., 2020). In sum, our results suggest that the problem of under-preparedness for natural disasters cannot (even

[10] A possible explanation for the lack of effect of susceptibility to peer influence on our treatments, is that we sampled adults from 18 to 90 years old, while most research on susceptibility to peer influence has been conducted on adolescents (Prinstein et al., 2011; Eckel et al., 2011). To control for this explanation, we reran our analysis (not reported here) for Hypothesis 4 on a subset of respondents younger than 25 years old and we found the same pattern of results as in the full sample.

partly) be solved by social norm-nudges.

One limitation of our study is that we did not elicit beliefs in the Norm-transparent and Norm-high treatments. The reason why we did not do this, is that we did not expect to find independent beliefs about investments in the current sample, right after providing respondents with the percentages of previous investors. Moreover, we argued that investment data from a previous sample gives an indication but no absolute certainty about investment behavior in the current sample. However, in retrospect it could have been interesting to elicit beliefs in the Norm-transparent and Norm-high treatments to allow for checking for attention of respondents. Had we found the same distributions of beliefs in the Norm-transparent and Norm-high treatments as in the Control group, we would have inferred that respondents simply ignored our norm-nudge messages. Furthermore, we could have used the beliefs in the Norm-transparent and Norm-high treatments to test for the 'norm distance effect' (Bergquist and Nilsson, 2018) that suggests that the power of social norms (messages) is larger when behavior is closer to the (perceived) norm. An second limitation is that the cultural differences between Spain and the Netherlands are not extremely large (Pineda et al., 2015). To get a more heterogeneous sample with regard to the collectivism-individualism scale, researchers should consider surveying homeowners in more culturally diverse countries, such as Japan and the U.S. (Hofstede, 2001).

This study suggests three main takeaways for flood risk communication policies. First, communication to raise risk awareness should take risk related emotions into account. This recommendation follows from our finding that worry and concern are significant predictors of investments in damage-reduction (see Figure 6), which is in line with previous literature (Kunreuther, 2018). Second, informing homeowners about the effectiveness of damage mitigation measures may enhance flood preparedness. This recommendation follows from the strong positive correlation between response efficacy and investments in damage-reduction

in our results (see Figure 6), confirming previous findings on this topic (Poussin et al., 2014; Mol et al., 2020). Third, policy makers should pay particular attention to activating personal norms, which were found to be associated with flood risk preparedness (as indicated by the strong correlation of personal norms with investments in flood preparedness in Figure 6). These results are in line with Wenzig and Gruchmann (2018), who showed that personal norms generally have a much larger influence on pro-environmental behavior than social norms, and with Botzen et al. (2019b), who showed that personal norms matter more than social norms in a flood risk context. Schwartz (2012) argued that norms need to be activated to be able to influence intention or behavior by being aware of the consequences of actions and feeling responsible. This explanation complements our results in the context of flood risk preparedness, which was framed on the individual level - respondents who feel responsible for their home (i.e. personal norms) invest more in damage-reducing measures than those who do not feel morally obligated to protect their homes. The actions of neighbors and other fellow homeowners (i.e. social norms) may be of lower importance for mitigation decisions in the context of flood preparedness.

We further found a significant negative correlation between present bias and investments in damage-reducing measures. This finding is in line with previous literature about myopia in the context of preparedness for low-probability/high-impact events, such as floods (Royal and Walls, 2019; Botzen et al., 2019a). Homeowners perceive the high upfront costs of investing in damage-reduction to be much higher than the expected benefits and when they are present biased, they care more about costs now than about benefits later. One way to overcome this bias is through offering low-interest loans that spread the investment costs over time (Meyer and Kunreuther, 2017; Kunreuther and Pauly, 2018), which could stimulate flood preparedness.

Conclusion

Floods are one of the deadliest and costliest natural disasters worldwide. Fortunately, individual homeowners can take several cost-effective measures to prepare their homes for flooding. We attempted to increase investments in flood risk reduction measures in a controlled experiment by subtly nudging respondents (homeowners in the Netherlands and Spain) to consider the social norm of what fellow homeowners are doing. In particular, we showed different norm-nudge messages showing percentages of the population that previously invested in different flood-reduction options (Norm-transparent), or the percentage of previous respondents who invested anything in flood reduction (Norm-high). These treatments were contrasted with a Control treatment and a Norm-focusing treatment, in which respondents' beliefs about normative patterns of flood-reduction investments were elicited. We did not find any evidence of a treatment effect, suggesting that social norm-nudges do not affect flood preparedness of respondents in a flood risk investment game. These results contrast with the existing evidence that social norm-nudge messages can be effective ways to facilitate behavioral change in the environmental domain.

Our exploratory additional results show that there is a strong correlation between beliefs of others' behavior and one's own investments, however our treatments did not influence either. If a nudge in the environmental domain proves ineffective, as we show here, this may warrant the use of stronger measures, such as incentives, regulations and bans, to influence preparedness. To conclude, our results suggest that the problem of under-preparedness for natural disasters cannot (even partly) be solved by social norm-nudges.

Investments in flood risk reduction could be largely explained by the number of measures installed at home, present bias, personal norms and response efficacy. Future research could examine how personal norms with regard to flood risk preparedness can be activated or strengthened. Another promising topic for additional research is how to effectively com-

municate cost-effectiveness of mitigation measures to protect individual homes from flood damage. Finally, we found no differences in flood risk preparedness between homeowners in the Netherlands and Spain. Further studies could extend this work to more culturally diverse countries.

Acknowledgments

We would like to thank conference participants at NoBeC 2019 in Philadelphia, BEEMA5 in Villanova and WINK Nuding and Beyond in Utrecht for valuable comments. This research has received financial support from the Alfred P. Sloan Foundation Grant (No. G-2018-11100) and the Netherlands Organization for Scientific Research (VIDI 452.14.005).

References

Abrahamse, W. and Steg, L. (2013). Social influence approaches to encourage resource conservation: A meta-analysis. *Global Environmental Change*, 23(6):1773–1785.

Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics*, 95(9-10):1082–1095.

Ando, K., Ohnuma, S., Blöbaum, A., Matthies, E., and Sugiura, J. (2010). Determinants of individual and collective pro-environmental behaviors: comparing Germany and Japan. *Journal of Environmental Information Science*, 38(5):21–32.

Arad, A. and Rubinstein, A. (2018). The people's perspective on libertarian-paternalistic policies. *The Journal of Law and Economics*, 61(2):311–333.

Baldwin, M. and Mussweiler, T. (2018). The culture of social comparison. *Proceedings of the National Academy of Sciences of the United States of America*, 115(39):E9067–E9074.

Bamberg, S. and Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, 27(1):14–25.

Bartke, S., Friedl, A., Gelhaar, F., and Reh, L. (2017). Social comparison nudges - Guessing the norm increases charitable giving. *Economics Letters*, 152:73–75.

Bearden, W. O., Netemeyer, R. G., and Teel, J. E. (1989). Measurement of consumer susceptibility to interpersonal influence. *Journal of Consumer Research*, 15(4):473–481.

Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., Tucker-Ray, W., Congdon, W. J., and Galing, S. (2017). Should governments invest more in nudging? *Psychological Science*, 28(8):1041–1055.

Bergquist, M. and Nilsson, A. (2018). Using social norms in smart meters: the norm distance effect. *Energy Efficiency*, 11(8):2101–2109.

Betsch, C., Böhm, R., Korn, L., and Holtmann, C. (2017). On the benefits of explaining herd immunity in vaccine advocacy. *Nature Human Behaviour*, 1(3):56.

Bicchieri, C. (2006). *The grammar of society: The nature and dynamics of social norms.* Cambridge University Press.

Bicchieri, C. (2010). Norms, preferences, and conditional behavior. *Politics, Philosophy and Economics*, 9(3):297–313.

Bicchieri, C. (2016). *Norms in the wild: How to diagnose, measure, and change social norms.* Oxford University Press.

Bicchieri, C. and Dimant, E. (2019). Nudging with care: the risks and benefits of social information. *Public Choice*.

Bicchieri, C., Lindemans, J. W., and Jiang, T. (2014). A structured approach to a diagnostic of collective practices. *Frontiers in Psychology*, 5:1418.

Bolton, G., Dimant, E., and Schmidt, U. (2019). When a Nudge Backfires: Using Observation with Social and Economic Incentives to Promote Pro-Social Behavior. *SSRN Electronic Journal*, May(27).

Botzen, W. J. W., Kunreuther, H., Czajkowski, J., and Moel, H. (2019a). Adoption of individual flood damage mitigation measures in New York City: An extension of Protection Motivation Theory. *Risk Analysis*, page risa.13318.

Botzen, W. J. W., Kunreuther, H. C., and Michel-Kerjan, E. O. (2015). Divergence between individual perceptions and objective indicators of tail risks: Evidence from floodplain residents in New York City. *Judgment and Decision Making*, 10(4):365–385.

Botzen, W. J. W., Kunreuther, H. C., and Michel-Kerjan, E. O. (2019b). Protecting against disaster risks: Why insurance and prevention may be complements. *Journal of Risk and Uncertainty*, pages 151–169.

Bruns, H., Kantorowicz-Reznichenko, E., Klement, K., Luistro Jonsson, M., and Rahali, B. (2018). Can nudges be transparent and yet effective? *Journal of Economic Psychology*, 65:41–59.

Bubeck, P., Botzen, W. J. W., Kreibich, H., and Aerts, J. C. J. H. (2013). Detailed insights into the influence of flood-coping appraisals on mitigation behaviour. *Global Environmental Change*, 23(5):1327–1338.

Buunk, A. P. and Gibbons, F. X. (2006). Social comparison orientation: a new perspective on those who do and those who don't compare with others. In Guimond, S., editor, *Social comparison and social psychology - Understanding cognition, intergroup relations, and culture*, pages 15–32. Cambridge University Press, New York.

Cai, D. A. and Fink, E. L. (2002). Conflict style differences between individualists and collectivists. *Communication Monographs*, 69(1):67–87.

Camerer, C. F. and Hogarth, R. M. (1999). The effects of financial incentives in experiments: A review and capital labor production framework. *Journal of Risk and Uncertainty*, 19:7–42.

Carlsson, F., Gravert, C., Johansson-Stenman, O., and Kurz, V. (2020). Nudging as an environmental policy instrument. *Review of Environmental Economics and Policy*.

Chabé-Ferret, S., Le Coent, P., Reynaud, A., Subervie, J., and Lepercq, D. (2019). Can we nudge farmers into saving water? Evidence from a randomised experiment. *European Review of Agricultural Economics*, 46(3):393–416.

Chang, D., Chen, R., and Krupka, E. L. (2019). Rhetoric matters: A social norms explanation for the anomaly of framing. *Games and Economic Behavior*, 116:158–178.

Chen, D. L., Schonger, M., and Wickens, C. (2016). oTree - An open-source platform for laboratory, online, and field experiments. *Journal of Behavioral and Experimental Finance*, 9:88–97.

Cialdini, R. B., Reno, R. R., and Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58(6):1015–1026.

De Raad, B., Morales-Vives, F., Barelds, D. P., Van Oudenhoven, J. P., Renner, W., and Timmerman, M. E. (2016). Values in a cross-cultural triangle: A comparison of value taxonomies in the Netherlands, Austria, and Spain. *Journal of Cross-Cultural Psychology*, 47(8):1053–1075.

Dielman, T. E., Campanelli, P. C., Shope, J. T., and Butchart, A. T. (1987). Susceptibility to Peer Pressure, Self-Esteem, and Health Locus of Control as Correlates of Adolescent Substance Abuse. *Health Education & Behavior*, 14(2):207–221.

Doran, R., Böhm, G., Pfister, H. R., Steentjes, K., and Pidgeon, N. (2019). Consequence evaluations and moral concerns about climate change: insights from nationally representative surveys across four European countries. *Journal of Risk Research*, 22(5):610–626.

Doran, R. and Larsen, S. (2016). The relative importance of social and personal norms in explaining intentions to choose eco-friendly travel options. *International Journal of Tourism Research*, 18:159–166.

Dur, R. A. J., Fleming, D., van Garderen, M., and van Lent, M. (2019). A social norm nudge to save more: A field experiment at a retail bank.

Eckel, C., Grossman, P. J., Johnson, C. A., de Oliveira, A. C., Rojas, C., and Wilson, R. (2011). Social norms of sharing in high school: Teen giving in the dictator game. *Journal of Economic Behavior and Organization*, 80(3):603–612.

Falk, A., Becker, A., Dohmen, T., Enke, B., Huffman, D., and Sunde, U. (2018). Global evidence on economic preferences. *The Quarterly Journal of Economics*, pages 1–48.

Farrow, K., Grolleau, G., and Ibanez, L. (2017). Social norms and pro-environmental behavior: A review of the evidence. *Ecological Economics*, 140:1–13.

FitzSimons, D., Hendrickx, G., Lernout, T., Badur, S., Vorsters, A., and Van Damme, P. (2014). Incentives and barriers regarding immunization against influenza and hepatitis of health care workers. *Vaccine*, 32(38):4849–4854.

Franklin, M., Folke, T., and Ruggeri, K. (2019). Optimising nudges and boosts for financial decisions under uncertainty. *Palgrave Communications*, 5(1):1–13.

Garcia, S. M., Tor, A., and Schiff, T. M. (2013). The psychology of competition: A social comparison perspective. *Perspectives on Psychological Science*, 8(6):634–650.

Gifford, R., Lacroix, K., and Chen, A. (2018). Understanding responses to climate change. In *Psychology and Climate Change*, chapter 7, pages 161–183. Elsevier.

Gobierno de España, . (2020). Real estate appraisals. Technical report, Ministerio de Transportes, Movilidad

y Agenda Urbana.
Goldstein, N. J., Cialdini, R. B., and Griskevicius, V. (2008). A Room with a Viewpoint: Using Social Norms to Motivate Environmental Conservation in Hotels. *Journal of Consumer Research*, 35(3):472–482.
Grothmann, T. and Reusswig, F. (2006). People at risk of flooding: Why some residents take precautionary action while others do not. *Natural Hazards*, 38(1-2):101–120.
Hafner, R., Elmes, D., and Read, D. (2017). Exploring the Role of Messenger Effects and Feedback Frames in Promoting Uptake of Energy-Efficient Technologies. *Current Psychology*, pages 1–12.
Hafner, R., Elmes, D., Read, D., and White, M. P. (2019). Exploring the role of normative, financial and environmental information in promoting uptake of energy efficient technologies. *Journal of Environmental Psychology*, 63:26–35.
Hallsworth, M., List, J. A., Metcalfe, R. D., and Vlaev, I. (2017). The behavioralist as tax collector: Using natural field experiments to enhance tax compliance. *Journal of Public Economics*, 148:14–31.
Harland, P., Staats, H., and Wilke, H. A. M. (1999). Explaining proenvironmental intention and behavior by personal norms and the Theory of Planned Behavior. *Journal of Applied Social Psychology*, 29(12):2505–2528.
Hauser, O. P., Gino, F., and Norton, M. I. (2018). Budging beliefs, nudging behaviour. *Mind & Society*, 17(1-2):15–26.
Hoffmann, A. O. I. and Broekhuizen, T. L. J. (2009). Susceptibility to and impact of interpersonal influence in an investment context. *Journal of the Academy of Marketing Science*, 37(4):488–503.
Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. SAGE Publications.
Huber, J., Kip Viscusi, W., and Bell, J. (2020). Dynamic relationships between social norms and pro-environmental behavior: evidence from household recycling. *Behavioural Public Policy*, 4(1):1–25.
Hui, C. H. and Triandis, H. C. (1986). Individualism-collectivism: A study of cross-cultural researchers. *Journal of Cross-Cultural Psychology*, 17(2):225–248.
Hummel, D. and Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. *Journal of Behavioral and Experimental Economics*, 80(September 2018):47–58.
Institute Nacional de Estadística, . (2020). Living Conditions Survey. Technical report.
IPCC (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation*. Cambridge University Press.
Kallgren, C. A., Reno, R. R., and Cialdini, R. B. (2000). A focus theory of normative conduct: When norms do and do not affect behavior. *Personality and Social Psychology Bulletin*, 26(8):1002–1012.
Köbis, N. C., Troost, M., Brandt, C. O., and Soraperra, I. (2019). Social norms of corruption in the field: social nudges on posters can help to reduce bribery. *Behavioural Public Policy*, pages 1–28.
Kreibich, H., Bubeck, P., van Vliet, M., and De Moel, H. (2015). A review of damage-reducing measures to manage fluvial flood risks in a changing climate. *Mitigation and Adaptation Strategies for Global Change*, 20(6):967–989.
Krupka, E. L. and Weber, R. A. (2009). The focusing and informational effects of norms on pro-social behavior. *Journal of Economic Psychology*, 30(3):307–320.
Kunreuther, H. C. (2018). Improving the National Flood Insurance Program. *Behavioural Public Policy*, pages 1–15.
Kunreuther, H. C. and Pauly, M. V. (2018). Dynamic insurance decision-making for rare events: The role of emotions. *Geneva Papers on Risk and Insurance: Issues and Practice*, 43(2):335–355.
Langhinrichsen-Rohling, J., Rohde, P., Seeley, J. R., and Rohling, M. L. (2004). Individual, family, and peer correlates of adolescent gambling. *Journal of Gambling Studies*, 20(1):23–46.
Liu, J., Thomas, J. M., and Higgs, S. (2019). The relationship between social identity, descriptive social norms and eating intentions and behaviors. *Journal of Experimental Social Psychology*, 82:217–230.
Lo, A. Y. (2013). The role of social norms in climate adaptation: Mediating risk perception and flood

insurance purchase. *Global Environmental Change*, 23(5):1249–1257.
Mackay, M., Yamazaki, S., Jennings, S., Sibly, H., van Putten, I. E., and Emery, T. J. (2019). The influence of nudges on compliance behaviour in recreational fisheries: a laboratory experiment. *ICES Journal of Marine Science*, Marine rec(fsz020):1–14.
Maidl, E. and Buchecker, M. (2015). Raising risk preparedness by flood risk communication. *Natural Hazards and Earth System Sciences*, 15(7):1577–1595.
McNaughton, C. D., Cavanaugh, K. L., Kripalani, S., Rothman, R. L., and Wallston, K. A. (2015). Validation of a short, 3-item version of the subjective numeracy scale. *Medical Decision Making*, 35(8):932–936.
Meyer, R. J. and Kunreuther, H. C. (2017). *The ostrich paradox: Why we underprepare for disasters.* Wharton School Press.
Mol, J. M., Botzen, W. J. W., and Blasch, J. E. (2018). Behavioral motivations for self-insurance under different disaster risk insurance schemes. *Journal of Economic Behavior & Organization*, pages 1–25.
Mol, J. M., Botzen, W. J. W., and Blasch, J. E. (2020). Risk reduction in compulsory disaster insurance: Experimental evidence on moral hazard and financial incentives. *Journal of Behavioral and Experimental Economics*, 84(February):101500.
Munich RE, . (2018). Hurricanes cause record losses in 2017 - The year in figures.
Netherlands Statistics, . (2020a). Existing own homes. Technical report.
Netherlands Statistics, . (2020b). Inkomen van huishoudens. Technical report.
Oh, S. H. D. (2013). Do collectivists conform more than individualists? Cross-cultural differences in compliance and internalization. *Social Behavior and Personality*, 41(6):981–994.
Oliver, A. and Ubel, P. (2014). Nudging the obese: A UK-US consideration. *Health Economics, Policy and Law*, 9(3):329–342.
Oreg, S. and Katz-Gerro, T. (2006). Predicting proenvironmental behavior cross-nationally: Values, the theory of planned behavior, and value-belief-norm theory. *Environment and Behavior*, 38(4):462–483.
Orth, U. R. and Kahle, L. R. (2008). Intrapersonal variation in consumer susceptibility to normative influence: Toward a better understanding of brand choice decisions. *Journal of Social Psychology*, 148(4):423–448.
Osman, M., Fenton, N., Pilditch, T., Lagnado, D., and Neil, M. (2018). Whom do we trust on social policy interventions? *Basic and Applied Social Psychology*, 40(5):249–268.
Parboteeah, K. P., Addae, H. M., and Cullen, J. B. (2012). Propensity to Support Sustainability Initiatives: A Cross-National Model. *Journal of Business Ethics*, 105(3):403–413.
Pineda, A., Hernández-Santaolalla, V., and del Mar Rubio-Hernández, M. (2015). Individualism in Western advertising: A comparative study of Spanish and US newspaper advertisements. *European Journal of Communication*, 30(4):437–453.
Poussin, J. K., Botzen, W. J. W., and Aerts, J. C. J. H. (2014). Factors of influence on flood damage mitigation behaviour by households. *Environmental Science and Policy*, 40:69–77.
Prinstein, M. J., Brechwald, W. A., and Cohen, G. L. (2011). Susceptibility to Peer Influence: Using a Performance-Based Measure to Identify Adolescent Males at Heightened Risk for Deviant Peer Socialization. *Developmental Psychology*, 47(4):1167–1172.
Richter, I., Thøgersen, J., and Klöckner, C. (2018). A social norms intervention going wrong: Boomerang effects from descriptive norms information. *Sustainability*, 10(8):2848.
Royal, A. and Walls, M. (2019). Flood risk perceptions and insurance choice: Do decisions in the floodplain reflect overoptimism? *Risk Analysis*, 39(5):1088–1104.
Schwartz, S. H. (1977). Normative influences on altruism. *Advances in Experimental Social Psychology*, 10(C):221–279.
Schwartz, S. H. (2012). An Overview of the Schwartz Theory of Basic Values. *Online Readings in Psychology and Culture*, 2(1):1–20.
Stöckli, S. and Hofer, D. (2020). Susceptibility to social influence predicts behavior on Facebook. *PLoS ONE*, 15(3):1–20.
Stoffel, S. T., Goodwin, M., Sieverding, M., Vlaev, I., and von Wagner, C. (2019). Testing verbal quantifiers

for social norms messages in cancer screening: evidence from an online experiment. *BMC Public Health*, 19(1):658.

Sunstein, C. R. (2017). Nudges that fail. *Behavioural Public Policy*, 1(1):4–25.

Sunstein, C. R. and Reisch, L. A. (2013). Green by default. *Kyklos*, 66(3):398–402.

Tajfel, H. (1982). Social psychology of intergroup relations. *Annual Review of Psychology*, 33(1):1–39.

Triandis, H. C. (1989). The self and social behavior in differing cultural contexts. *Psychological Review*, 96(3):506–520.

UNISDR (2015). The human costs of weather related disasters. Technical report, UNISDR.

van Valkengoed, A. M. and Steg, L. (2019). Meta-analyses of factors motivating climate change adaptation behaviour. *Nature Climate Change*, 9(2):158–163.

Verhallen, P., Brüggen, E., Post, T., and Odekerken-Schrrder, G. (2018). Norms in behavioral interventions: Peer or anchoring effects? *SSRN Electronic Journal*.

Wenzig, J. and Gruchmann, T. (2018). Consumer preferences for local food: Testing an extended norm taxonomy. *Sustainability*, 10(5):1–23.

Yazdanpanah, M. and Forouzani, M. (2015). Application of the Theory of Planned Behaviour to predict Iranian students' intention to purchase organic food. *Journal of Cleaner Production*, 107:342–352.