TI 2026-029/IV
Tinbergen Institute Discussion Paper

Floods and homeowners' financial resilience: Survey-based evidence from the Netherlands

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This version: 26 February 2026

Abstract

We study homeowners' awareness and financial resilience in the face of flood risk. Using three surveys among Dutch households, we compare owners of at-risk properties to a control sample of owners living outside a potential flood zone. While the former start exhibiting greater awareness of flood risk, this awareness is not specifically reflected in financial resilience. First, we find no significant differences in terms of net financial wealth or savings. Second, the mortgages that finance the properties have comparable loan-to-value ratios, both at origination and over time. The findings on resilience may reflect a high degree of trust in flood protection. The absence of insurance coverage combined with expected *ex post* government support may also be a factor.

JEL codes: Q54, Q56, D14
Keywords: homeownership, insurance protection gaps, protection motivation theory, financial resilience

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Acknowledgements: With thanks to Cindy Biesenbeek, Maurice Bun, Carin van der Cruijsen, Wolter Hassink, Steven Maijoor, Maarten van Rooij, Marc Roovers, Sweder van Wijnbergen, Lu Zhang. the editor (Robert Dur), two reviewers, as well as participants at a DNB research seminar, the 2025 KVS New Paper Sessions and a VU/ACCREU workshop for constructive feedback. Miquelle Marchand, Natalia Kieruj, and Stein Jongerius (Centerdata) were very helpful in arranging the surveys. Any errors and omissions remain our own responsibility. Views expressed in this paper do not necessarily coincide with those of de Nederlandsche Bank or the Eurosystem.

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1 Introduction

There is increasing attention for the possible transmission of natural disasters, such as storms, floods, or wildfires, to financial stability. Mark Carney (2015) was among the first to argue that property damage caused by extreme weather events could threaten financial stability. Similar arguments have been made by the European Systemic Risk Board (2016) and Bolton et al. (2020). The impact of extreme weather events on financial stability depends on various factors, including households' financial resilience (FSB, 2025). Such resilience is, in particular, material when physical risks coincide with financial vulnerabilities within the household sector. Caloia et al. (2026), for instance, show that floods are more likely to increase credit risk for Dutch lenders when starting point loan-to-value (LTV) ratios for mortgages in their loan book are already elevated. Comparable studies have been conducted by financial authorities in Australia (Bellrose et al., 2021), Canada (Johnston et al., 2023), and Spain (AMCESFI, 2023).[1]

Given their potential role in transmitting climate-related shocks, it is important that households are financially resilient. This presupposes two key factors: first, that households are aware of these risks; and second, that this awareness leads to prudent financial decisions. As a general framework, this paper uses Protection Motivation Theory (Rogers, 1975; Rogers, 1983). Protection Motivation Theory (PMT) indicates that a person's likelihood to act in the face of risk depends on two factors: threat appraisal and coping appraisal. Awareness relates to threat appraisal. If a person is more aware of flood risk, this will be reflected in how the individual perceives this threat. Prudent financial decisions would be the outcome of the process, i.e. the extent to which an individual has acted to mitigate risk. Coping appraisal is related to how an individual sees her ability to deal with the potential risk.

[1] See also Peters (2024) or Reijnders et al. (2025) for discussions of the impacts of climate shocks on the banking system.

Regarding awareness, there is prior evidence that homeowners have difficulty in assessing disaster-related risks. Botzen et al. (2013) report that for a sample of New York residents only a minority have accurate perceptions of their flood probability, damage and risk. Likewise, Mol et al. (2020) find that Dutch residents overestimate the probability of floods and underestimate the maximum expected flood depth.

Regarding household decision-making, much of the literature has taken the perspective of adaptation. A survey by Hornsey et al. (2016) finds that climate change beliefs have only moderate effects on people's willingness to act. Nauges and Wheeler (2017) find that economic incentives can at least partly affect decisions of non-environmentally-motivated households. Noll, Filatova, and Need (2022) find that both prior adaptations and intended future adaptations have a positive effect on the willingness to undertake a specific adaptation measure. In related work, however, Noll et al. (2022) report that perceived flood probability and damage have nearly no effect on motivating households' adaptation actions. Endendijk et al. (2023) do find evidence that timely warnings before flooding can help households in taking emergency actions like placing sandbags.

This paper's key contribution is studying the link between awareness and financial resilience. In general, financial resilience is the capacity to absorb shocks. In the context of household finance, key resilience metrics focus on financial wealth and mortgage debt (see also FSB, 2021). In contrast to the extensive evidence on household adaptation to natural disasters, financial resilience has received comparatively less attention.[2] A particularly relevant factor in the Dutch context is that insurance policies almost always exclude property damages from major floods. Specifically, these would be floods due to breaches in primary flood protection systems, which protect against

[2]Ilhan (2022) finds that U.S. households at risk from sea level rise participate less in the stock market. The interpretation in that paper focuses more on uninsurable background risk rather than financial resilience, however.

floods from the sea, main rivers, and lakes.[3] Hence, as a Dutch homeowner, a direct route to ensuring financial resilience via taking out insurance is not readily available. In terms of PMT, an alternative route to cope with the risk should then be considered. Therefore, this paper focuses on more general notions of financial resilience, namely household wealth, savings, and LTV ratios.[4]

To study awareness as well as resilience, we use three waves of detailed survey data among Dutch households. This survey was conducted via the Centerpanel, which is affiliated to the University of Tilburg. Given our focus on the Dutch context, we focus on flood risk specifically. Nearly a quarter of the Dutch landmass lies below sea level, and about 70% of the population lives in areas at risk of flooding, making flood risk one of the most prominent nature-related threats in the Netherlands.[5] As part of the surveys, we asked respondents to indicate which natural hazard would be the main threat to their property. At the same time, the data set has information on whether the respondent lives in a flood zone or not.

Using this survey data, our first test is whether owners of properties at risk of flooding are more likely to report floods as the number one threat—compared to a control group of owners that do not live in an at-risk area. This question is similar to that studied in Jansen (2024). However, a second series of tests adds further perspective by analyzing the financial resilience of households. We use detailed information available within the Centerpanel, including comprehensive data on households' assets and liabilities. Using this data, we construct a measure of net household wealth. We also use information on savings, as a relatively liquid component of household

[3]Since a few years, damages related to more local floods are often covered by insurance. Such local floods are not the focus of our paper.

[4]See also Wiersma et al. (2025) for a survey-based approach to measuring financial resilience.

[5]See also `https://themasites.pbl.nl/o/flood-risks/` URL last accessed on 28 January 2025.

wealth. Additionally, we combine information on the mortgages that finance a property with property value assessments to calculate LTV ratios. In all this, it is important to emphasize that our analysis is in relative terms. We compare resilience for the at-risk group to that of the control group. That is a different perspective than answering whether resilience is sufficient in absolute terms (see Deelen et al., 2025).

Turning to the results, we do find evidence that at-risk owners are more aware of flood risk. In particular, at-risk homeowners are 9 percentage points more likely to report flood as the main threat to their property. This result is in line with Jansen (2024). However, there are no indications that such awareness is matched by greater financial resilience compared to the control group. First, we find no significant differences in terms of financial wealth between owners of at-risk properties and owners in the control group. There are also no differences in the more liquid components of wealth, such as savings. Second, the mortgages that finance the properties of at-risk owners have comparable LTV ratios to those of the control group, both at origination and over time.

Together, the apparent disconnect between awareness and financial resilience suggests a potential financial vulnerability, in particular if climate change would result in more frequent or more damaging flood events. For the moment, our findings on financial resilience may well reflect a high degree of public trust in flood protection. The unavailability of insurance coverage (regarding damages due to major floods) in combination with expected *ex post* government support in such cases could also be a factor. We discuss these factors in more detail in the concluding Section 5. Before that, Section 2 discusses the research design, while Section 3 presents the results, and Section 4 discusses various sensitivity checks and extensions.

2 Data and methods

We use three survey waves that were collected among the members of the Centerpanel. Centerdata, a research centre affiliated to the University of Tilburg, has been operating the DNB Household Survey on an annual basis since 1993. All panel members aged 16 and above were eligible to complete the questionnaire. The core survey gathers detailed demographic and economic characteristics from a sample of Dutch households. Besides the core survey, we use responses to a set of additional questions that were first asked in the spring of 2021. These additional questions were again submitted to panel participants in the spring of 2023 and 2024. The first two waves were previously analyzed by Jansen (2024), who identified a disconnect between flood awareness and intentions to undertake climate mitigation measures by improving energy efficiency of their property. The appendix lists two relevant questions as they were presented to the panel members.

In general, survey data offers valuable insights by directly capturing individual perceptions, awareness, and other behavioral elements that are often difficult to observe through other means. An alternative to studying financial resilience would be the use of microdata (see, for instance, Deelen et al., 2025). However, such an approach would not enable us to study the link between awareness and resilience. Using microdata also would not allow us to control for prior experience with nature-related shocks. Therefore, for the purposes of our paper, using survey data has distinct advantages. Admittedly, using survey data may also have drawbacks. For instance, households may report certain information less accurately.

To study awareness, we use the same question as in Jansen (2024). Participants could indicate which risk they see as the largest threat to their current place of residence. We provided the survey participants with nine options. Most of these options relate to climate-related physical risks, such as extreme rain, high wind speeds, or floods. Even though there is no link with climate change, we also included earthquakes as an option, as various

earthquakes have occurred in the northern part of the Netherlands in recent decades due to natural gas extraction.

In recent years, the Netherlands experienced two distinct flood events, which could impact the awareness of flood risk among respondents. The first survey wave was collected a few months before the floods in Limburg (and parts of Belgium and Germany) during the summer of 2021. During this event, around 2300 Dutch houses were damaged and the total costs of damage for the Netherlands are estimated to be €433 million.[6] Between the second and third survey wave, the Netherlands experienced high water and local riverine floods around Christmas 2023. Section 3 will discuss the effect of these two events on flood awareness.

To study financial resilience, we use information on household assets and liabilities. In general, financial resilience is the capacity to absorb shocks. In the context of household finance, key resilience metrics focus on financial wealth and mortgage debt (see also FSB, 2021). First, using information from the core Centerpanel dataset, we construct a measure for financial wealth as follows.[7] Total assets are constructed out of all financial assets - such as payment, savings, and investment accounts, shares, and life insurance policies - and other assets such as immovable properties and vehicles. Total debt consists of all loans including mortgages and student debt. Table A.1 in the appendix has further details on the construction of the wealth variable. The savings variable is a subset of the wealth variable. This variable is added to get a better picture of liquid buffers, which can more readily be used in case of flood damage. The savings variable consists of payment, savings and deposit accounts, savings passbooks and savings certificates and notes.[8] Second, we use information from the Centerpanel dataset on mort-

[6] See `https://publications.deltares.nl/11207700_007_0011.pdf`

[7] Other examples using the Centerpanel to study household wealth include Van Rooij et al. (2012) and Christelis et al. (2021).

[8] Regression results are similar when also including stocks and bonds in this measure for liquid wealth.

gages and house prices to compute the loan-to-value ratio. We compute the LTV metric at origination, i.e. when the mortgage was first granted, and the current level. In general, lower levels of the LTV metric indicate a higher degree of financial resilience. Caloia et al. (2026) show how impacts of flood events on credit risk are more material when starting-point LTV ratios for at-risk properties are higher.

To measure the degree to which respondents are at risk, we use a binary dummy variable ($AtRisk$). Here, we use flood maps provided by the Dutch government and define $AtRisk$ based on four-digit postal code areas. These flood maps are based on recent assessments by floods experts. As discussed in Caloia et al. (2025), sea level rise could increase the impact of floods, while adaptation could mitigate potential impacts. When $AtRisk$ takes a value of zero, the respondent's property lies in a postal code that is not at risk from breaches in flood protection systems. A value of 1 indicates that, according to the flood map, the respondent owns a property that is at risk from flooding, in particular those for which no insurance coverage is available. Based on this approach, a majority of the survey respondents are from at-risk areas of the Netherlands.[9] This large share of at-risk owners is in line with priors: these at-risk areas are also the ones that are most densely-populated and where most of the economic activity takes place.[10]

Using the survey responses, we estimate various random effects panel regression models, where $T = 3$. We use an unbalanced panel with 5,142 observations for the awareness variables and between 1,703 and 4,354 observations for the resilience variables.[11] Given that the risk status of the vast majority of respondents (around 95%) did not change between surveys,

[9] As in Jansen (2024), we do not use responses from at-risk owners living outside protected areas. For that sub-sample, we only have a small number of observations available.

[10] Data constraints limit us to an approach based on a binary classification using a list of four-digit postal code areas. Naturally, future work could try to improve in terms of geographic granularity.

[11] The conclusions remain comparable when using a balanced sample.

we use a random effects specification of the individual specific effects. The panel regressions have the following general form:

$$y_{it} = \beta_1 AtRisk_{it} + \boldsymbol{x}'_{it}\boldsymbol{\beta} + \omega_t + \alpha_i + \epsilon_{it} \tag{1}$$

where y_{it} is either flood risk awareness or a measure of financial resilience, i is an index for survey respondents, t indexes the three survey waves, ω_t is a fixed effect for the survey waves, α_i is individual-specific random effect, and ϵ_{it} is an error term. Regarding awareness, the dependent variable is a binary indicator for whether respondents see flood risk as the main threat to their property. Regarding financial resilience, we use four different metrics. First, household wealth (in logs), savings (in logs) or the LTV ratio (either at origination or based on the latest available property value). The variable $AtRisk$ is a binary dummy that indicates whether a respondent's property is located in a flood risk area. The vector x has a range of covariates, which we describe in the next paragraph.

Table 1 gives a description of the covariates. These covariates range from socio-economic indicators, such as income and education, to dummy variables indicating former experience with natural hazards. The table also shows a comparison between the at-risk group and the control group. We find significant differences for the age categories 35–49 and 65+, with the former group more likely to be at risk and the latter less likely. Besides age, the low-income category and having a university degree show significant differences. These significant differences indicate the importance of including a range of socio-economic controls in the regression models. Lastly, we find no significant differences for the variables tracking prior experience. To some extent, this is surprising when it concerns the flood risk experience. Intuitively, one would expect the percentage of not-at-risk owners with prior damages to be lower. This could mean that these variables are measured with some imprecision, perhaps due to recall bias. It may also indicate that, at some point prior to the survey, respondents experiencing a flood event did relocate from an at-risk area to a part of the country that is not at risk

from floods.

Table 1: Descriptives for covariates

	Owns a property that is:		
	Not at risk	*At risk*	
	(1)	(2)	(3)
Male	0.53	0.51	-0.02 [0.02]
Age			
- 16 to 34	0.08	0.08	0.01 [0.01]
- 35 to 49	0.23	0.26	0.04* [0.02]
- 50 to 64	0.31	0.32	0.01 [0.02]
- 65+	0.39	0.33	-0.05* [0.02]
Income			
- low	0.30	0.24	-0.05** [0.02]
- middle	0.20	0.20	0.01 [0.02]
- high	0.16	0.18	0.02 [0.02]
- n.a.	0.34	0.37	0.03 [0.02]
Has university degree	0.13	0.18	0.05** [0.02]
Socio-economic status			
- low	0.15	0.14	-0.01 [0.02]
- high	0.61	0.63	0.02 [0.02]
Prior experience			
- Earthquake	0.06	0.05	-0.01 [0.01]
- Wind damage	0.32	0.31	-0.01 [0.02]
- Flood	0.01	0.01	0.00 [0.00]
- Drought	0.22	0.19	-0.03 [0.02]
Trusts flood protection	0.86	0.85	-0.01 [0.02]
Number of owners	1,112	2,114	

Notes: Descriptives for socio-economic covariates. Column 1 focuses on a control group of owners, while column 2 focuses on owners of at-risk properties. Entries represent fractions of the total sample. Columns 3 indicates significant differences based on two-sided t tests (standard errors in brackets); $^{*}p < 0.05$, $^{**}p < 0.01$.

3 Results

Table 2 presents selected coefficients and standard errors (clustered at the household level, in brackets) for five models based on Equation 1. The dependent variables are: a binary dummy indicating whether the respondent sees flood as main risk to their property (column 1); household financial wealth (in logs, column 2); household savings (in logs, column 3); and, the LTV ratio of the mortgage, either at origination of the loan, i.e. when the mortgage was first granted (column 4) or the most recent level (column 5). The main explanatory variable indicates whether the respondent owns an at-risk property. The covariates include various owner characteristics and prior experience with property damage due to natural hazards.

Regarding awareness, we find that owning a property in a flood zone significantly increases the likelihood of perceiving flooding as the primary threat (Table 2, column 1). The estimated difference between at-risk owners and the control group is 9 percentage points. This estimated difference is comparable, though slightly lower, than that reported in Jansen (2024) for the 2021 and 2023 survey waves. In terms of composition, for the at-risk owners 12.1% report that they perceive flooding as the primary threat to their home. In contrast, only 3.5% of respondents in the control group mention flooding as the main risk to their house. An elevated awareness of flood risk aligns with expectations, as property owners typically bear the financial burden of flood-related damages, reinforcing the importance of risk perception in these areas.

In addition, prior experience with flooding plays a crucial role in shaping homeowners' risk perception. This is in line with the literature on PMT (e.g., Bubeck et al., 2012). Those who have experienced a flood event in the past are 16 percentage points more likely to identify flooding as the main threat to their property. Also, we find that homeowners who have experienced damage due to an earthquake are 8 percentage points less likely to perceive flooding as the main threat to their property.

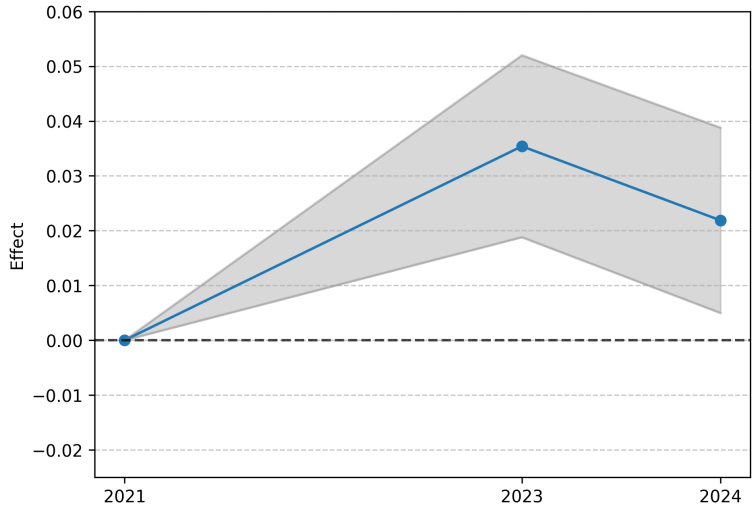
Table 2: Regression results

	(1)	(2)	(3)	(4)	(5)
	Flood threat?	**Wealth**	**Savings**	**LTV ratio**	
				Origination	Current
Owns at-risk property	0.09**	0.04	-0.10	-0.10	-1.43
	[0.01]	[0.04]	[0.07]	[1.51]	[1.48]
Owner characteristics					
Male	0.01	0.07*	0.09	4.00*	-0.17
	[0.01]	[0.03]	[0.05]	[1.75]	[1.71]
Age: 16 - 34	0.00	-0.41**	-0.07	-3.92	0.28
	[0.03]	[0.11]	[0.11]	[2.60]	[3.68]
Age: 50 - 64	-0.02	0.41**	0.30**	-10.26**	-18.67**
	[0.02]	[0.06]	[0.09]	[1.97]	[2.17]
Age: 65+	-0.04**	0.54**	0.40**	-25.35**	-33.67**
	[0.01]	[0.06]	[0.09]	[2.24]	[2.05]
Income: 0 - 30K	-0.00	0.02	-0.03	-0.83	-1.96
	[0.01]	[0.03]	[0.05]	[1.71]	[1.29]
Income: over 50K	0.01	0.09**	0.09	-1.78	-0.52
	[0.01]	[0.03]	[0.05]	[1.52]	[1.37]
Income: NA	-0.01	-0.01	-0.16**	0.98	-0.60
	[0.01]	[0.04]	[0.05]	[1.63]	[1.39]
Has university degree	0.02	0.27**	0.44**	0.32	-1.03
	[0.02]	[0.07]	[0.09]	[2.21]	[2.17]
Prior damages					
- By earthquake	-0.08**	-0.03	0.01	2.30	0.64
	[0.01]	[0.05]	[0.09]	[2.48]	[2.21]
- By flood	0.16*	-0.26*	0.05	4.52	-3.28
	[0.06]	[0.10]	[0.14]	[5.00]	[2.76]
Trusts flood protection	0.01	0.00	0.07	-0.49	-1.20
	[0.01]	[0.03]	[0.05]	[1.50]	[1.34]
Observations	5,142	3,920	4,354	1,597	1,703
R^2	0.05	0.13	0.05	0.16	0.25

Notes: Selected coefficients and standard errors (clustered by household) for random effects panel regressions. Dependent variables are a binary dummy indicating whether a respondent sees flood as main threat to her property (column 1); household financial wealth (in logs, column 2); household savings (in logs, column 3); the LTV ratio, either at origination, i.e. when the mortgage was first granted (column 4) or the most recent level (column 5). The main explanatory variable indicates whether the respondent owns a property that is located in a flood zone. The covariates include owner characteristics (e.g. age) and binary dummies indicating prior types of damages to the property. $^{*}p < 0.05$, $^{**}p < 0.01$.

Given that we have three survey waves, we can also assess variation over time. We find that awareness has increased significantly since the spring of 2021, i.e. the time of the first survey wave. Figure 1 shows year fixed effects that are positive and statistically significant, reinforcing the notion that at-risk owners are increasingly seeing flooding as a threat. A possible explanation for this increased awareness lies in the two recent episodes in which flood risks materialized, i.e. the severe flooding in Limburg in 2021 and the instances of high water during Christmas 2023. These events likely reinforced the urgency of flood risk in the minds of at-risk owners. However, Figure 1 also indicates that the increase since 2021 is not linear. Between 2023 and 2024 there is a small—though not significant—decline in awareness.[12]

Figure 1: Flood awareness over time



Notes: Coefficients and 95% confidence intervals for year fixed effects in column 1 of table 2. The baseline estimate is for the 2021 survey wave.

[12]Looking at averages per year, we can see the pattern in Figure 1 is mainly due to at-risk owners. Results available upon request.

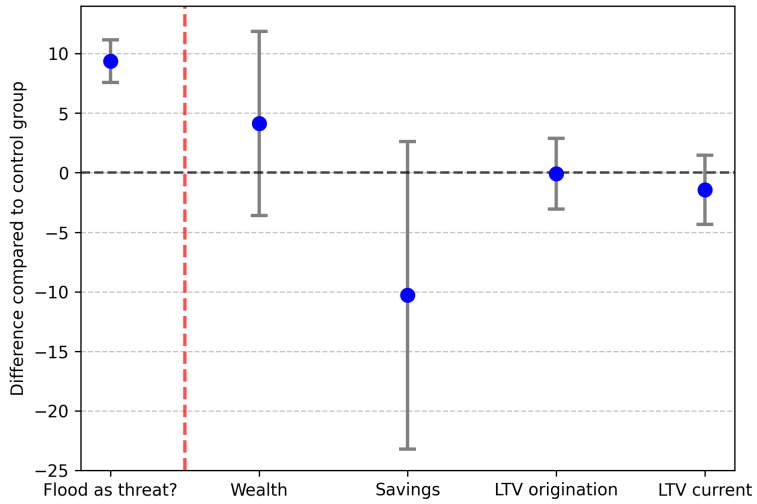
Despite increased awareness, we observe no significant differences in financial resilience between at-risk homeowners and those in the control group. There is no significant difference for owning an at-risk property in wealth (column 2) and savings (column 3).[13] Also, we observe no significant differences in LTV ratios, either at origination (column 4) or the most recent value for the LTV ratio (column 5). Given that the literature has mainly focused on adaptation so far, we think this disconnect between awareness and financial resilience is an important contribution of this paper.

Regarding the socio-economic covariates, there are various significant differences for the wealth variables. We find wealth and savings are higher for older respondents with higher income levels that have a university degree. For the two LTV ratios, we only find significant differences related to age. Older respondents report having lower LTV ratios, both at origination and most recently.

Based on the panel regressions, Figure 2 presents a visualization of the main results. The figure reports coefficients (blue dots) and the associated 95% confidence intervals (gray vertical lines) for flood awareness and financial resilience. The first element of Figure 2 illustrates a difference across the two groups. At-risk homeowners are 9 percentage points more likely to report flood as the main threat to their property. At the same time, as indicated by the other four lines in Figure 2, there are no significant differences for financial wealth, savings, or LTV ratios.

[13] In addition to the marginal effect estimated in the panel regressions, Figure A.1 suggests that the wealth distributions for at-risk owners and the control group are also quite similar.

Figure 2: Owning an at-risk property: effects on awareness and resilience



Notes: Estimated coefficients and 95% confidence intervals for five variables. 'Flood as threat?', 'LTV at origination' and 'current LTV' are presented in percentage point differences. 'Wealth' and 'Savings' is presented as percentage difference. Coefficients represent the difference between at-risk homeowners and a control group living outside a flood zone.

4 Sensitivity checks and extensions

We now consider two sensitivity checks and two extensions.

First, an important point is that our identification is relative, as it relies on the difference between at-risk households and a control group. Respondents in the control group may well face other risks related to their property.[14] This could affect our identification, if owners in the control group are aware of those risks and do prepare financially for those risks. Within the context of our data, we cannot explicitly control for such risks. However, we can do a sensitivity check by leaving out respondents who indicated that earthquakes are the most important threat to their properties. Most likely, this concerns residents of the northern province of Groningen. In addition to floods, this province is at risk from earthquakes related to the decades-long exploitation of gas fields. When doing this sensitivity check, we find that results for awareness and resilience remain very much the same. For instance, the estimated coefficient for 'at-risk' in the awareness regression is now 0.10 ($p < 0.01$) compared to 0.09 in the baseline. And, for wealth and LTV ratios, we still find no significant differences between at-risk households and the control group.

A second sensitivity check focuses on the specification of the regression model. Given that there is limited variation over time for the $AtRisk$ variable, we followed a random effects specification in the baseline model. An alternative approach is simply running a pooled regression. When doing so, we find no material changes to the conclusion.

In a first extension, we incorporate awareness of flood risk by including the variable that captures whether respondents perceive flooding as the primary threat to their property. While the $AtRisk$ variable provides an objective, model-based assessment of flood exposure, individuals' perceptions may be more directly linked to their financial behavior. If a household feels threatened by flooding, this perceived risk could serve as a stronger

[14] We thank one of the reviewers for emphasizing the importance of this point.

motivator for precautionary financial decisions, such as increasing savings. In a second extension, we explore the interaction between perceived flood threat and the objective *AtRisk* measure. This allows us to test whether the behavioral response to perceived risk is amplified when the objective risk is also high.

Table 3 presents the regression results for these two extensions. The results are in line with our baseline regression. There is no direct effect of higher awareness on financial resilience in terms of wealth, savings and LTV ratios. Also, the interaction term between the awareness variable and *AtRisk* does not have a significant coefficient.

Table 3: Regression results for two extensions

Regression		(1) **Wealth**	(2) **Savings**	(3) **LTV ratio**	(4)
				Origin.	Current
(1)	Flood as threat?	0.04	0.00	-42.85	0.58
		[0.03]	[0.05]	[28.66]	[1.64]
(2)	Flood as threat? x AtRisk	0.00	-0.02	134.68	-3.65
		[0.10]	[0.12]	[147.61]	[7.12]

Notes: Selected coefficients and standard errors (clustered by household) for eight panel regressions. Dependent variables are household financial wealth (in logs, column 1); household savings (in logs, column 2); the LTV ratio, either at origination (column 3) or most recent (column 4). In the regressions in row (1), the main explanatory variable indicates whether the respondent sees flood as the primary threat to their property. In the regressions in row (2), the main explanatory variable is the interaction term between the awareness variable and the *AtRisk* variable. The covariates include owner characteristics (e.g. age) and binary dummies indicating prior types of damages to the property. $^{*}p < 0.05$, $^{**}p < 0.01$.

5 Conclusions

This paper examines the relationship between flood risk awareness and financial resilience among Dutch homeowners. Investigating this connection is, to the best of our knowledge, new to the literature. Our findings suggest a degree of disconnect between these two dimensions.

On the one hand, homeowners in at-risk areas are increasingly aware of the risks related to flooding. From the perspective of Protection Motivation Theory (Rogers, 1975; Rogers, 1983), this finding indicates that threat appraisal is growing. However, our analysis indicates that such awareness is most pronounced in the immediate aftermath of flood events, and we also find awareness subsequently declines again. Moreover, the proportion of at-risk homeowners who identify flooding as the primary threat (12.1%) remains low compared to the actual share of at-risk properties.

On the other hand, we find no evidence that changing threat appraisal is matched by greater financial preparedness. In the absence of insurance coverage against major floods, we focus on a range of broad metrics for financial resilience. First, we find no significant differences in terms of wealth between at-risk owners and a control sample. Second, we find no differences in terms of loan-to-value ratios, either at origination or more recent. From the perspective of PMT, this suggest that coping appraisal is not yet growing.

Several factors may explain the degree of disconnect between awareness and financial resilience. First of all, it may reflect that the Dutch general public has a large degree of trust in flood protection measures. Of the survey respondents, more than 80% report that they perceive the strength of Dutch flood protection as strong. Therefore, homeowners may assess the probability of a flood event to be low and, therefore, see less need to financially prepare for such eventualities.

Second, the disconnect may follow from homeowners' expectations regarding government support following major flood events. At present, the

Dutch government can decide to provide financial compensation after natural disasters. This *ex post* approach follows from the 'Wet tegemoetkoming schade bij natuurrampen' (in short: Wts). Currently, this *ex post* approach may be sufficient to mitigate potential financial stability effects of flood events. But, there is also debate on whether this approach will remain effective over the longer run (Engelhard et al., 2024). Likewise, discussions about an *ex ante* private/public insurance approach are on-going (see, e.g., DNB (2022) or ECB/EIOPA (2024)). As risk awareness is growing, an *ex ante* approach might offer at-risk owners a more direct course of action to cope financially with the potential consequences of major flood events. In any case, aligning risk awareness and protection behaviour is important to ensure the financial resilience of households and thus safeguard financial stability in the face of future nature-related physical shocks.

Disclosure statement

The authors have no competing interests to declare that are relevant to the content of this article.

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Appendix

A.1 Survey questions

This appendix gives the wording of two relevant questions on threats to properties. Members of the Centerpanel were invited to answer these questions (alongside a number of other questions) at three points in time, namely spring of 2021, 2023 and 2024.

Q1: Which of these following events is, according to you, the largest threat for your current place of residence?

1. Soil subsidence
2. Extreme precipitation (rain and/or hail)
3. Floods (sea)
4. Floods (rivers)
5. Wind speeds
6. Drought
7. Weakening foundations
8. An earthquake
9. I do not know

Q2: Have you ever experienced that the following events in the Netherlands caused damage to your residence?

- An earthquake
- Wind speeds
- Floods (sea/river)
- Extreme precipitation

A.2 Construction of financial wealth

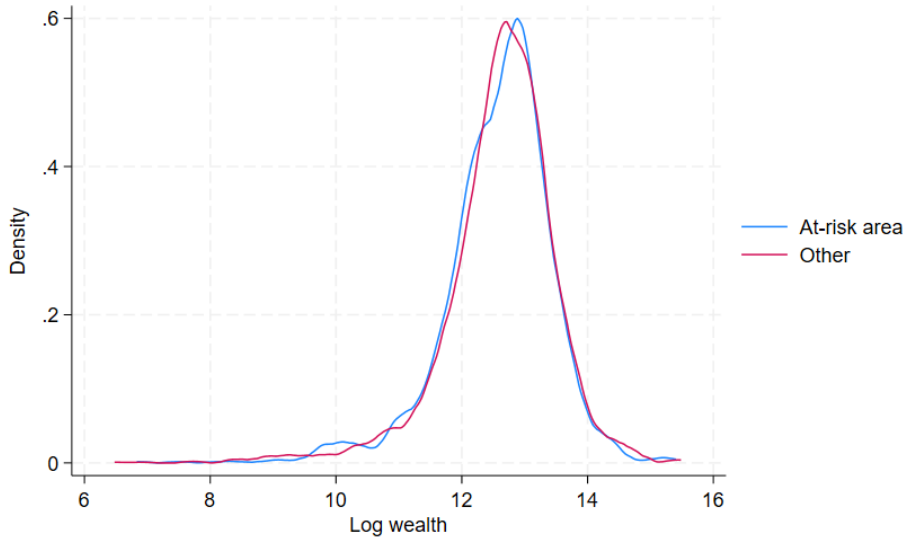
This table gives an overview of the assets and liabilities used to compute household financial wealth.

Assets	**Liabilities**
Payment accounts	Mortgages on immovable property
Savings and deposit accounts	Personal loans
Savings passbooks	Revolving, financing and other credits
Savings certificates and notes	Loans from friends or family
(Covered) bonds	Other loans
Shares and substantial interest	Student loans
Investment funds and accounts	
Single premium life insurance policies and annuity insurance policies	
Savings and capital insurance policies	
Cash value life insurance mortgage for real estate	
Company savings account	
Other assets/savings or investments	
Loans to family or friends	
Immovable property	
Business capital	
Cars, motors, boats, caravans	

Table A.1: Components of financial wealth

A.3 Household wealth and flood risk

Figure A.1: Household wealth and flood risk



Notes: Fitted distribution of household wealth (in logs) for at-risk homeowners (blue line) and a control group of owners living outside a flood zone.