



Policy interventions to overcome individual biases in decision making about flood risk reduction measures

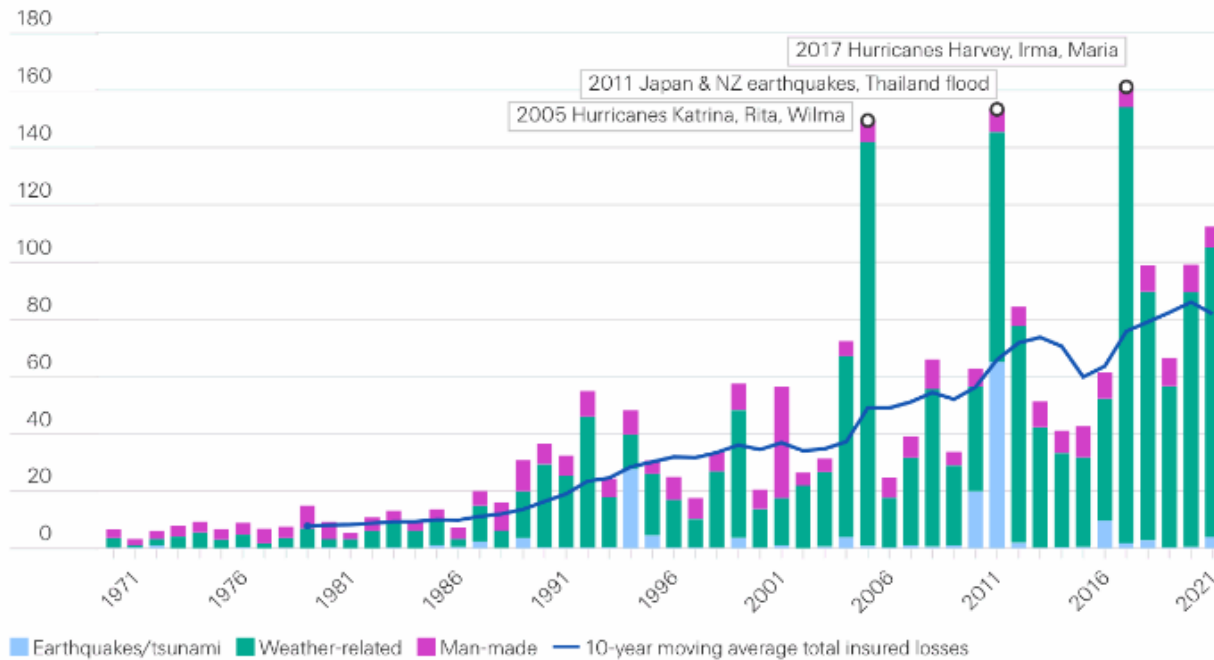
Prof.dr. Wouter Botzen

1. Trends in worldwide natural disaster losses

Insured losses since 1970

USD billion (in 2021 prices)

Rollover/touch chart for details



Source: Swiss Re Institute

Source: Swiss Re (2022)

Trends in global flood risk due to:

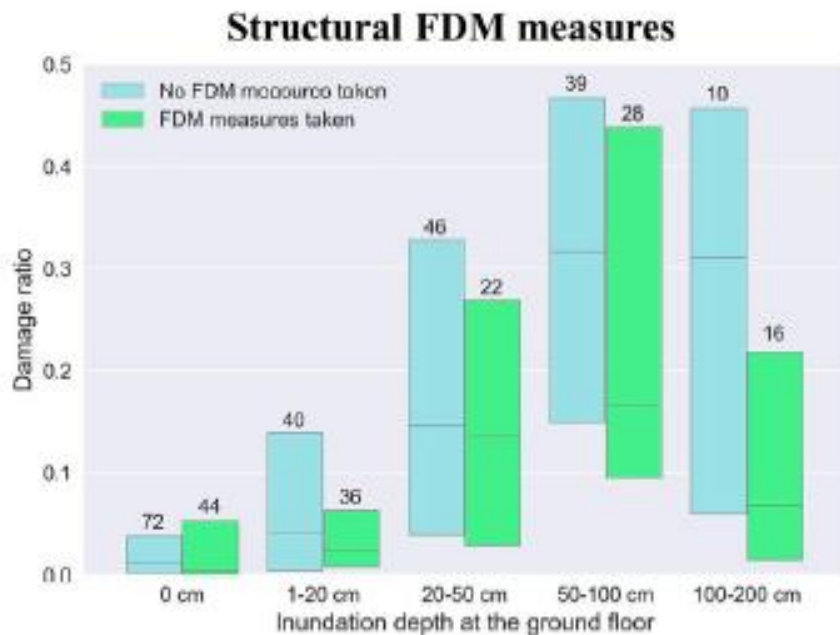
- Population and economic growth
- Climate change impacts: sea level rise, precipitation, storms

Household adaptation actions to reduce flood impacts



Importance damage mitigation actions households

- Often infeasible for flood-prevention to limit risk to zero
- Household level measures can significantly limit flood damage
- Up to 50% of damage savings in Netherlands, Germany and France (e.g. Poussin et al., 2015; Endendijk et al., 2023a)



Empirical estimates of damage ratio for buildings based on 2021 floods in the Netherlands.

Source: Endendijk et al. (2023b)

Boundedly rational behavior w.r.t. flood risk

- Biases imply suboptimal preparedness for floods:
 - Optimism: Underestimation of low-probability risks
 - Simplification: Bounded rationality/costs of information seeking
 - Myopia and discounting of the future
 - Herding behaviour
 - Inertia to stick with the status quo
 - *Moral hazard* of (insurance) compensation
- Or *advantageous selection* if behavioural mechanisms imply both buying insurance and taking other risk reduction measures



Source: Kunreuther & Botzen (2022)

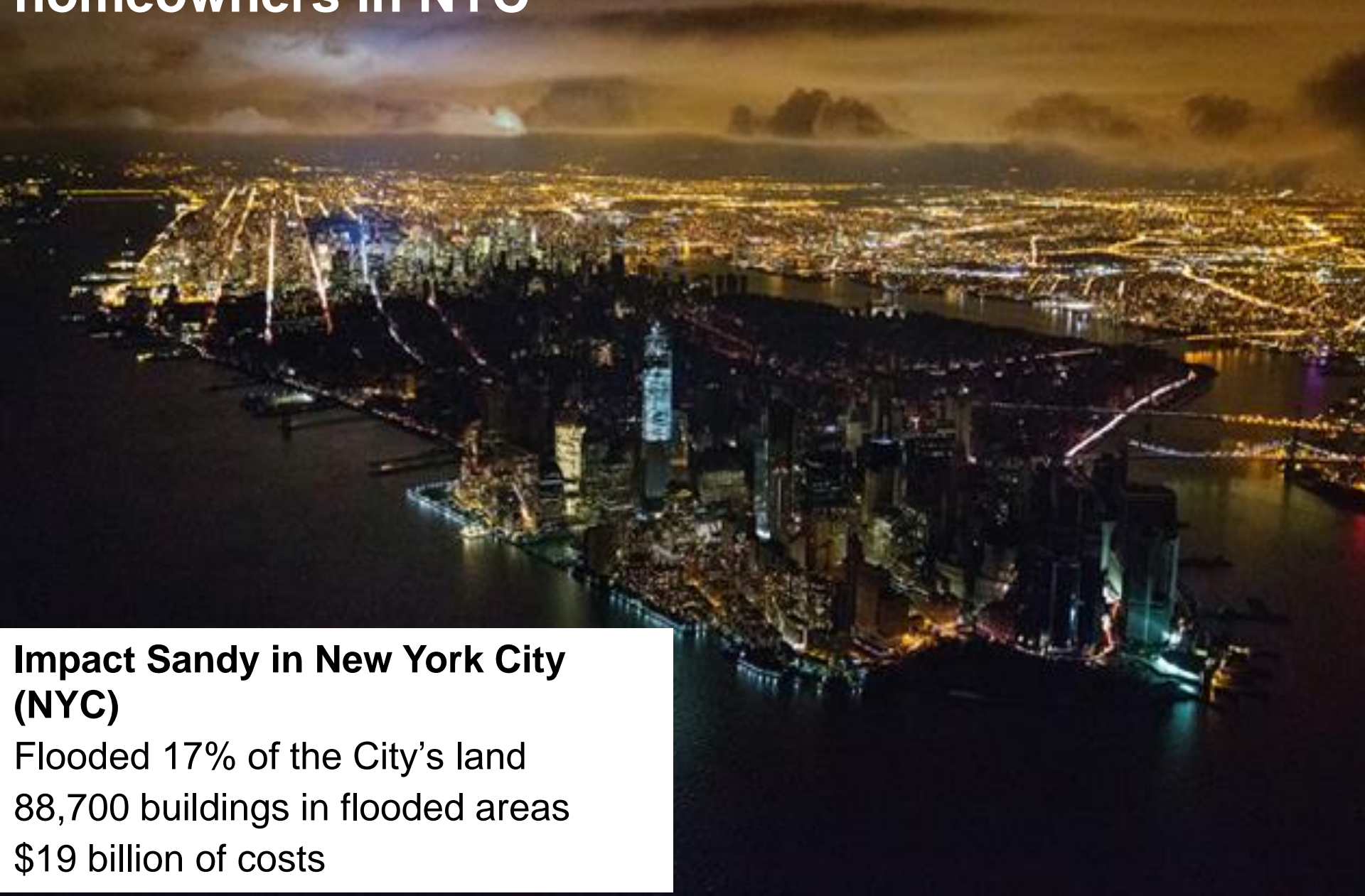
Policy interventions that address behavioural biases

- Communication nudges
 - Express risk information over long time horizons (e.g. 26% flood probability over 30 years instead of 1% per year)
 - Focus on consequences and worst-case scenarios
 - Keep memory of past floods alive
 - Trigger social norms
- Use default options of protection
- Financial incentives from insurance
 - Deductible and insurance premium discounts for policyholders
 - Low-interest mitigation loans
 - Powerful instrument in Europe (e.g. called for by EIOPA), but insurance is less effective if it causes moral hazard

2. Survey flood insurance and risk reduction by homeowners in NYC

Impact Sandy in New York City (NYC)

Flooded 17% of the City's land
88,700 buildings in flooded areas
\$19 billion of costs

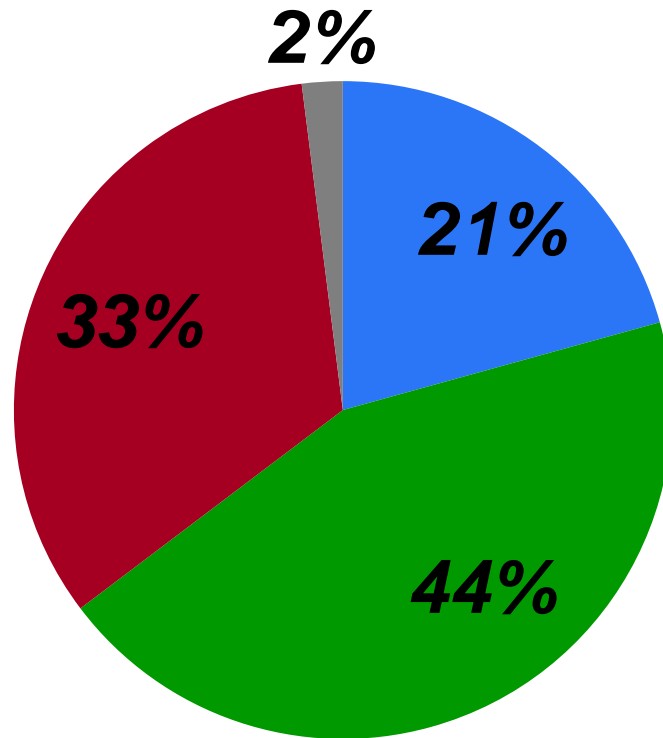


Survey flood preparedness NYC during Sandy

- Conducted by phone March-April 2013
- Random sample ($N=1,035$)
- Location can be linked to objective flood risk
- >100 questions about:
 - Risk perceptions
 - Flood experience and compensation
 - Behavioral motivations for preparedness
 - Insurance purchases
 - Risk mitigation measures
 - Socio-economic characteristics

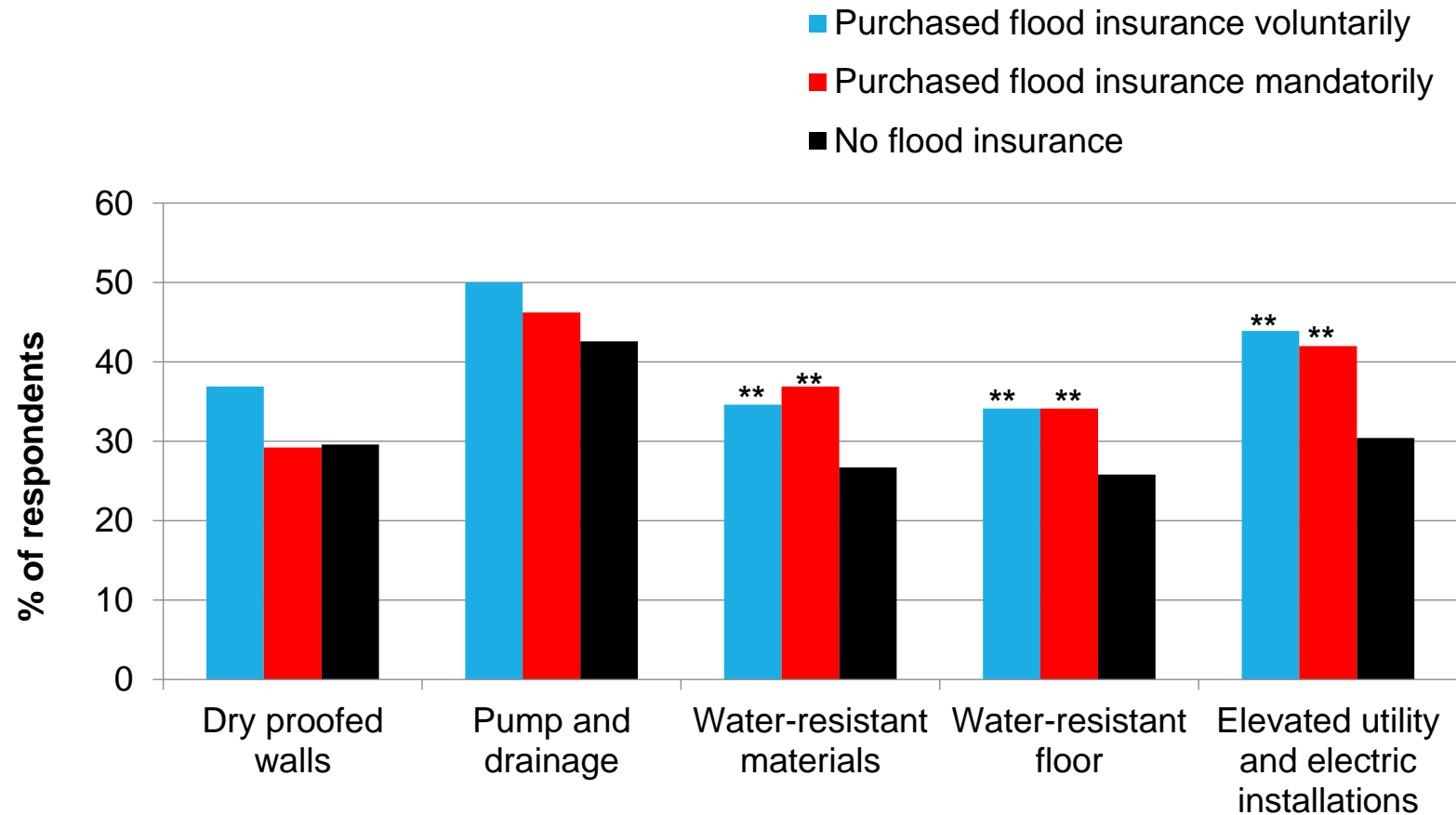
Source: Botzen et al. (2019) *Journal of Risk and Uncertainty*

Survey results flood insurance purchases



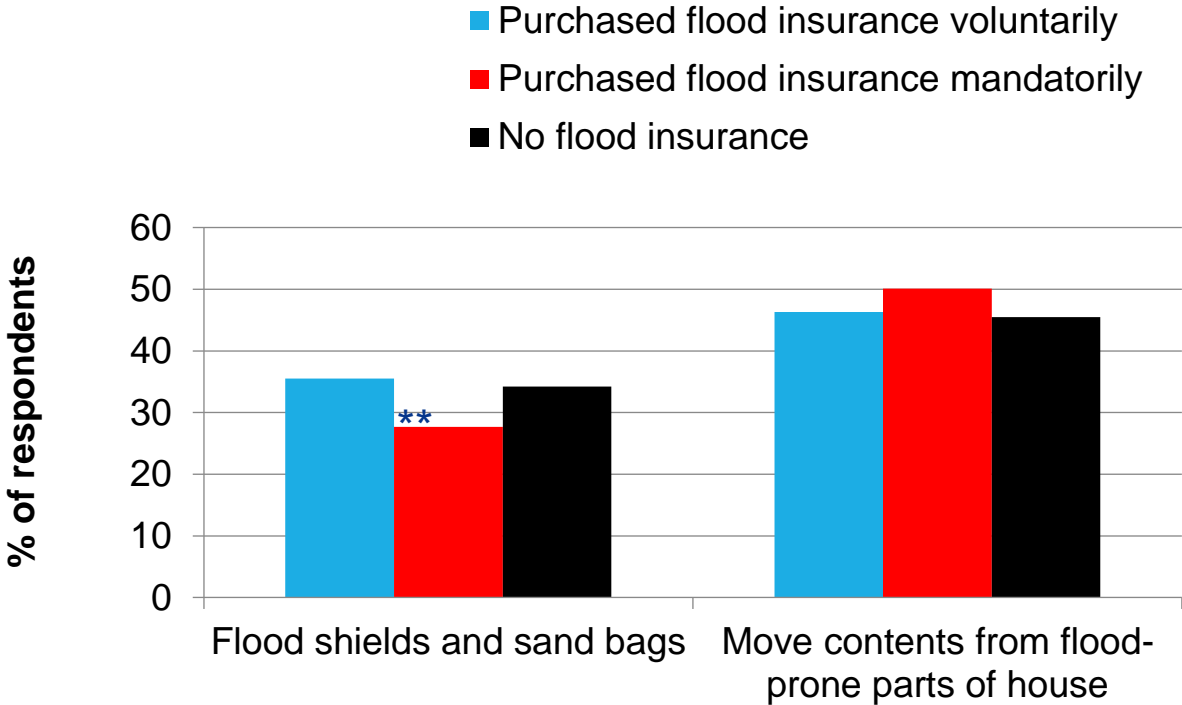
- purchased flood insurance voluntary
- purchased flood insurance mandatory
- no flood insurance
- don't know

Relation insurance and ex ante flood-proofing



Note: ** indicates a significant difference at the 5% level with the no flood insurance group

Relation insurance and emergency preparedness



Note: ** indicates a significant difference at the 5% level with the no flood insurance group

Results model flood insurance (1)

Explanatory variable	mandatory (n=445)	voluntary (n=278)
Emergency flood preparations	-0.09***	-0.11***
Ex ante flood preparations	0.05***	0.05***
Perceived flood probability	0.07	0.09
Perceived flood severity	0.01	0.04*
Federal disaster compensation	-0.21**	-0.12***
Low income (<25,000)	-0.04	-0.25***
High education	0.08	0.17***

Note: ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

Results model flood insurance (2)

Purchases:	Behavioral model voluntary (n=336)
Emergency flood preparations	-0.12***
Ex ante flood preparations	0.08***
Low income (<25,000)	-0.14
High education	0.22***
Flood probability below threshold of concern	-0.11*
Peace of mind	0.16**
Flood proofing measures × Norm of preparing for floods	0.08**
Flood proofing measures × External locus control	-0.04*
Flood proofing measures × Received disaster assistance	-0.11***
Flood proofing measures × Experienced flood damage	0.001***

Note: ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

3. Real-time survey in Florida during Dorian

- Conducted by phone between 29 August and 2 September 2019
- Random sample in Florida flood zones, completion rate 71% ($N=871$)
- Location can be linked to objective flood risk
- 54 questions about:
 - Risk perceptions
 - Expected compensation
 - Behavioral motivations for preparedness
 - Insurance purchases
 - Risk mitigation measures
 - Socio-economic characteristics

Forecast of Dorian on the first day survey



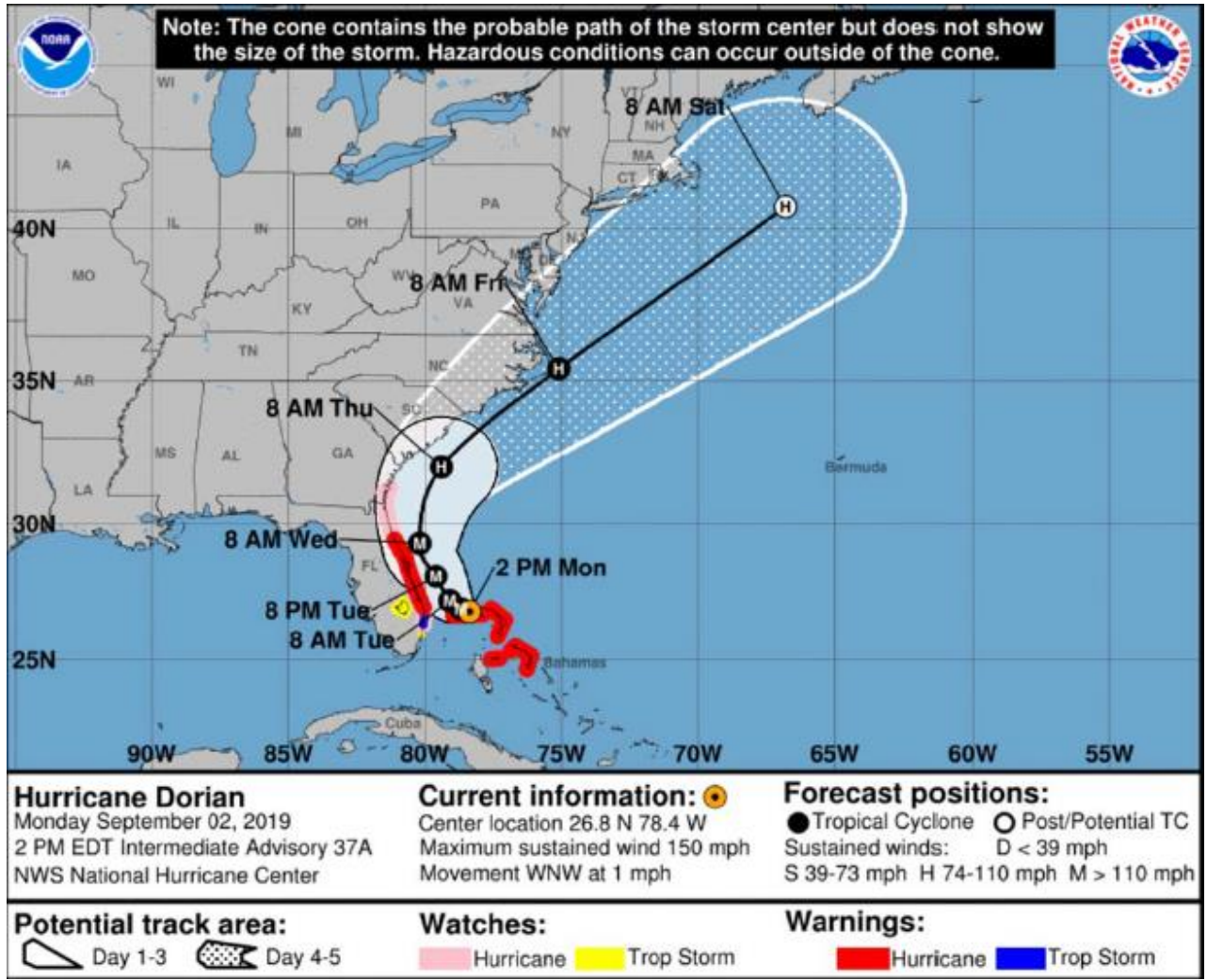
From Cat 1 to Cat 2

Forecast Dorian midway survey



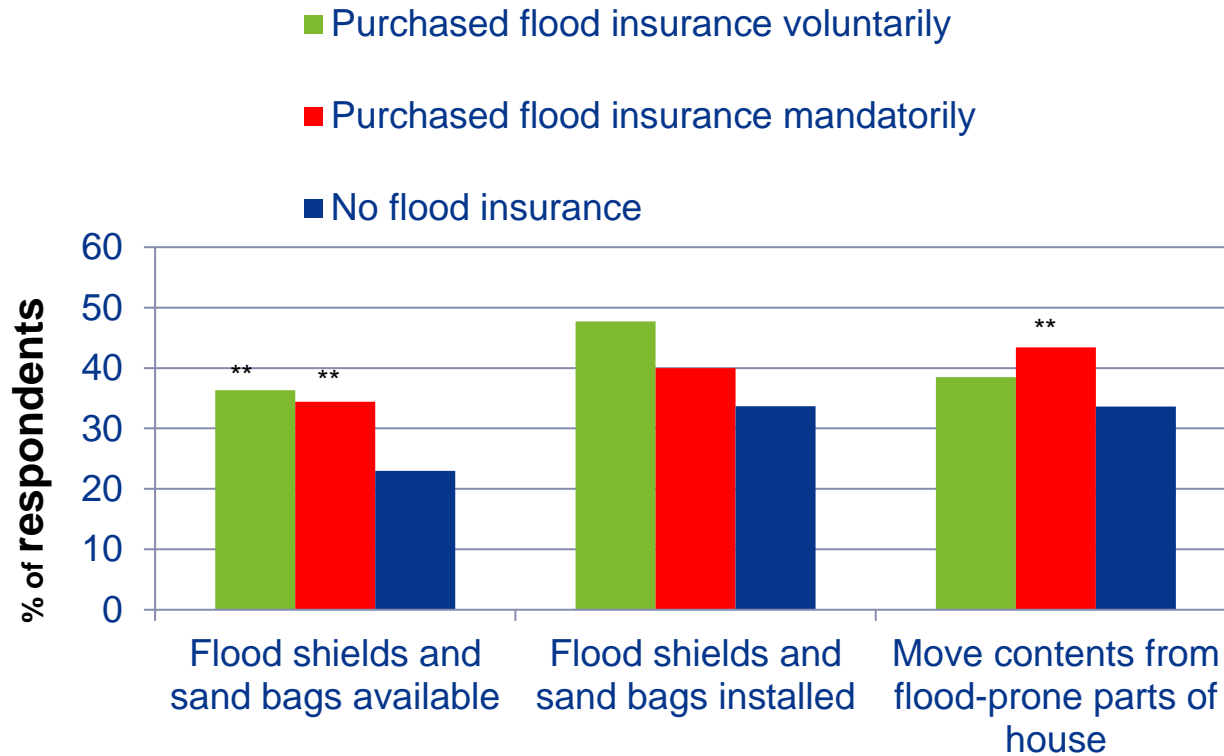
31 August 2019: Cat 4
 1 September 2019: Cat 5

Forecast Dorian final day survey



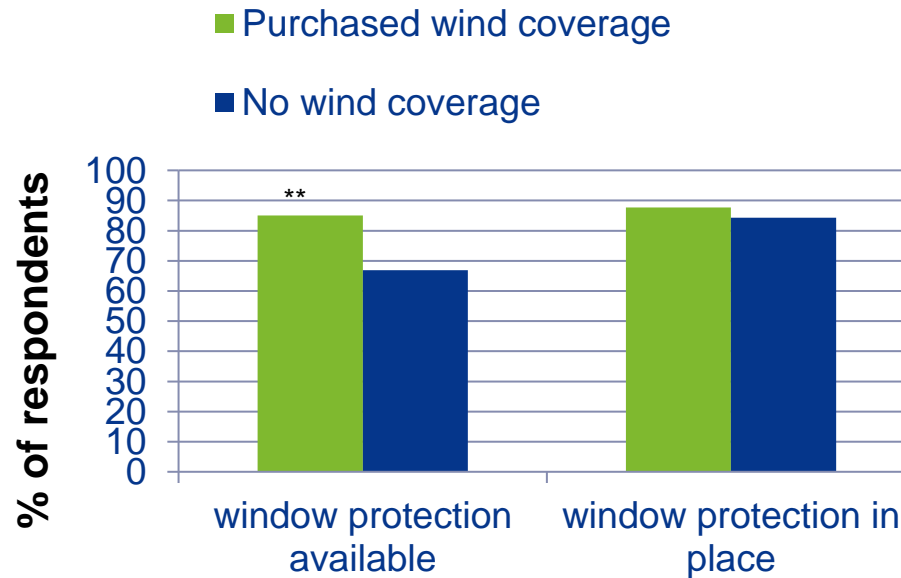
2 September 2019:
Cat 4

Flood insurance and emergency preparedness



Note: ** indicates a significant difference at the 5% level with the no flood insurance group

Wind insurance coverage (purchased by 80%)



Note: ** indicates a significant difference at the 5% level with the no wind coverage group

The overall absence of moral hazard confirms the few other studies on this topic

(Hudson et al., 2017 *Land Economics*, Botzen et al., 2019 *Journal of Risk and Uncertainty*)


4. Lab experiment: incentives for risk reduction by flood insurance

- Experimental setting can offer insights into behavioral responses to policy instruments, which are difficult to test in the field
- Dutch study about the influence on individual investments in flood damage mitigation of:
 - Moral hazard
 - Risk level and deductible
 - Premium discount
 - Risk aversion and time preferences


Source: Mol et al. (2020), *Journal of Behavioral and Experimental Economics*




you own : your house and **75,000 ECU** in savings



Each year there is a flood risk of **15 percent**



Estimated damage in case of a flood **50,000 ECU**



insurer pays 95 percent of damage



you pay 5 percent (deductible)

You have **mandatory insurance** against floods

In exchange for a premium of **7,125 ECU** each year, the insurance company pays part of your damage in case of a flood.

Attention! This is a new scenario and it is independent of the previous scenario. The **deductible** has changed. The **premium** has changed accordingly.

Start the scenario

Flood protection investment decision

[open instructions](#) / scenario 1 / year 1

you own : your house and **79,000 ECU** in savings

(yearly income of 4,000 ECU has been added) ×



Each year there is a flood risk of **15 percent**



Estimated damage in case of a flood **50,000 ECU**



insurer pays **85 percent** of damage




you pay **15 percent** (deductible)

You have **mandatory insurance** against floods


In exchange for a premium of **6,375 ECU** each year, the insurance company pays part of your damage in case of a flood.

How much do you want to invest to reduce the damage of a flood in the coming years of this scenario?

 **0 ECU**


no investment now: accept damage of 50,000 ECU

you pay 7,500 ECU deductible if flooded

 **1,000 ECU**

reduce damage to 46,156 ECU

you pay 6,923 ECU deductible if flooded

 **5,000 ECU**


reduce damage to 33,516 ECU

you pay 5,027 ECU deductible if flooded

 **10,000 ECU**

reduce damage to 22,466 ECU

you pay 3,370 ECU deductible if flooded

 **15,000 ECU**

reduce damage to 15,060 ECU

you pay 2,259 ECU deductible if flooded

Floodrisk

[open instructions](#) / scenario 1 / year 1

you own : your house and **67,625 ECU** in savings

In year 1, your house was not flooded.



Because your house was not flooded, you don't have to pay anything.

[Go to next year](#)

Floodrisk

open instructions / scenario 1 / year 12

you own : your house and **36,473 ECU** in savings

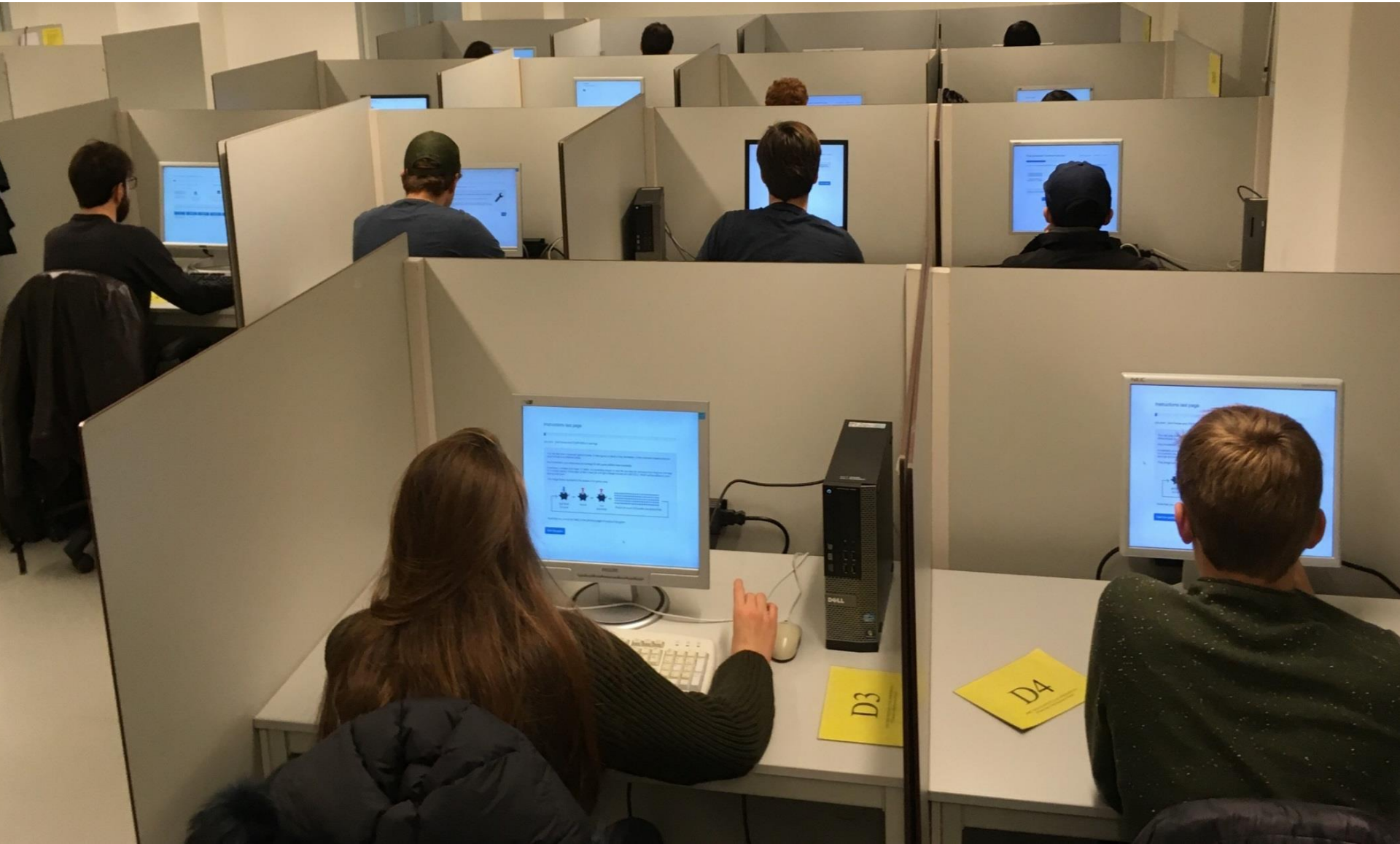
In year 12, your house was flooded.



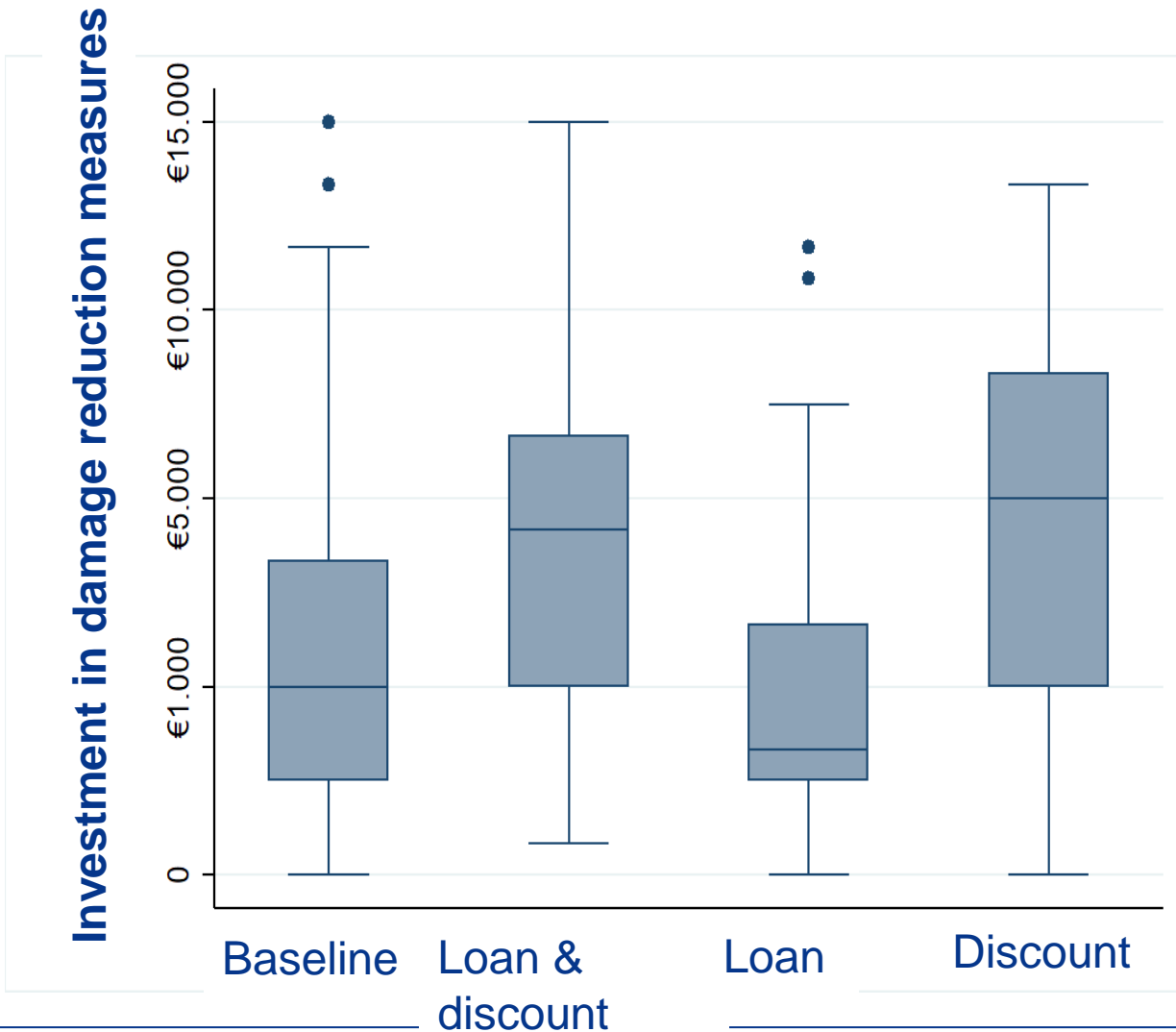
Because you have mandatory insurance and your house was flooded, you should pay your deductible (eigen risico).

Pay 5,027 ECU deductible

Computer lab experiment with 361 participants

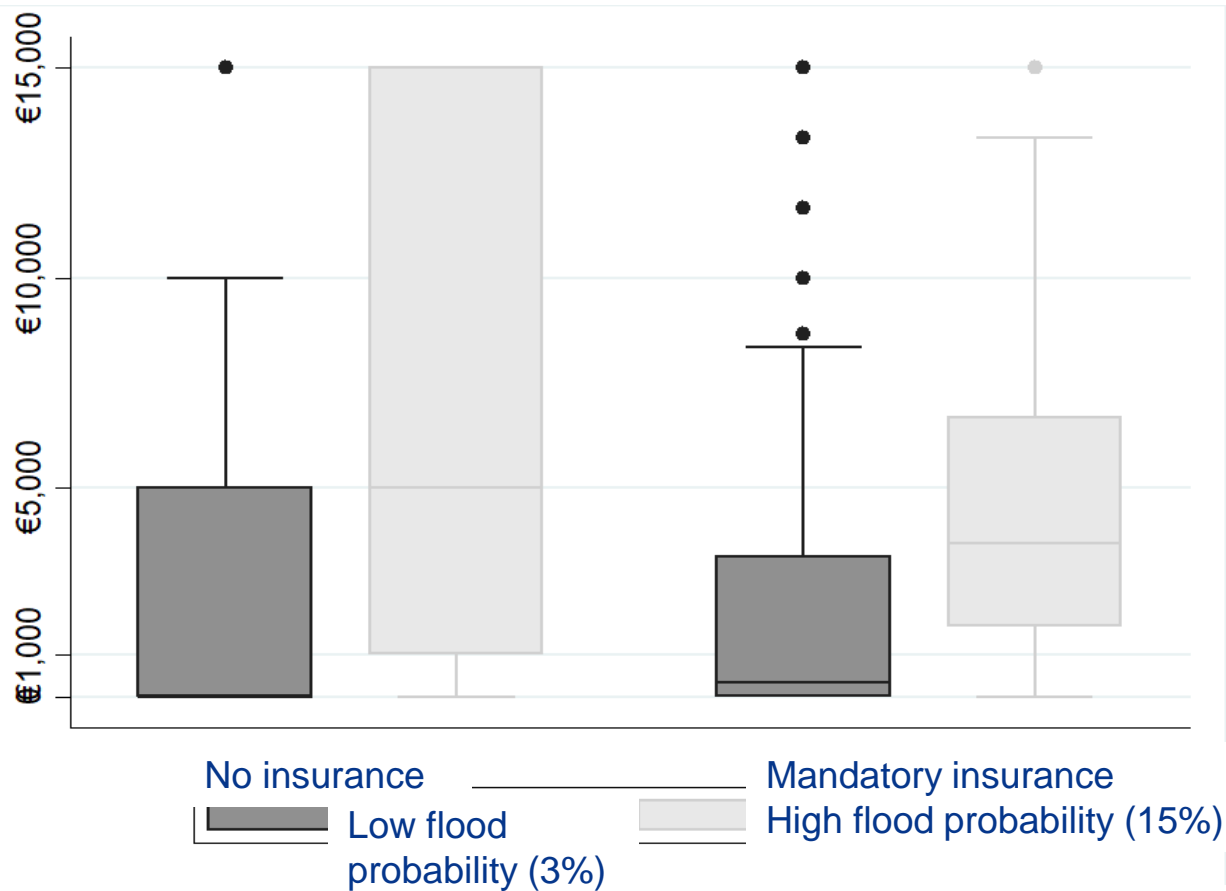


Premium discount is effective, loan not



No moral hazard effect of insurance when flood probability is low

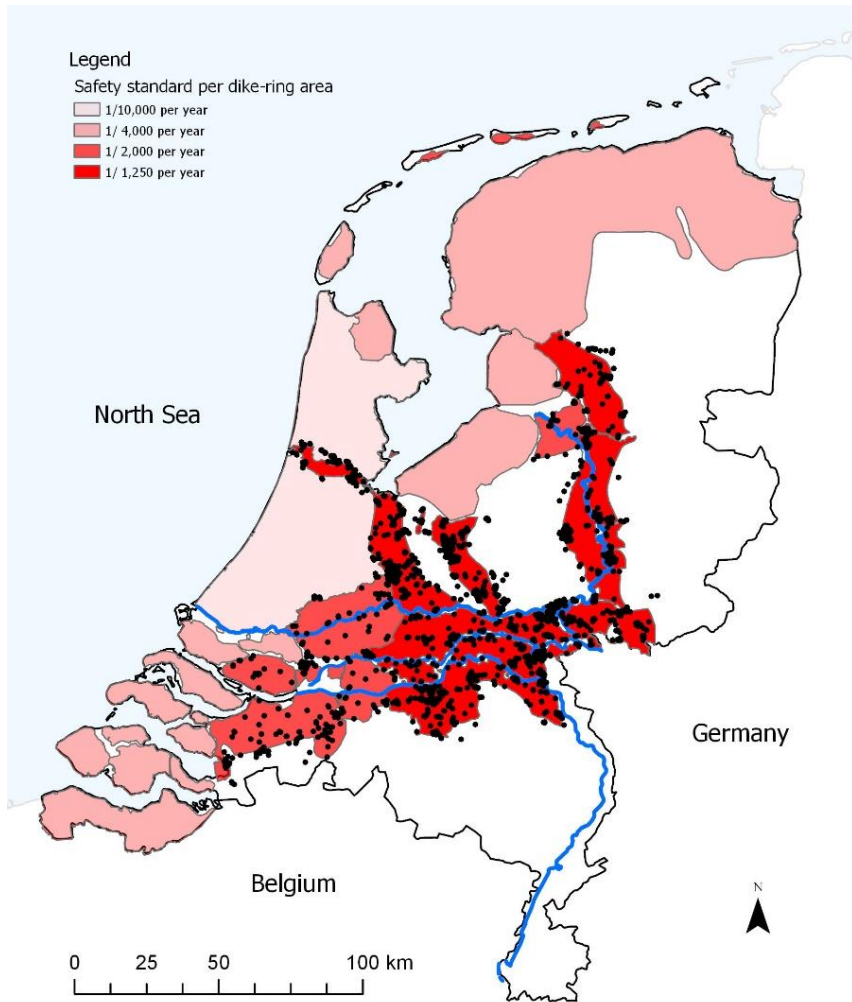
Investment in damage reduction measures



Factors related to risk reduction investments

- Flood probability (+)
- Deductible (+)
- Premium discount (+)
- Experiencing a flood (+)
- Female (+)
- Risk aversion (+)
- Worry about floods (+)
- Perceived effectiveness flood damage mitigation (+)
- Regret about investing, when no flood occurs (-)

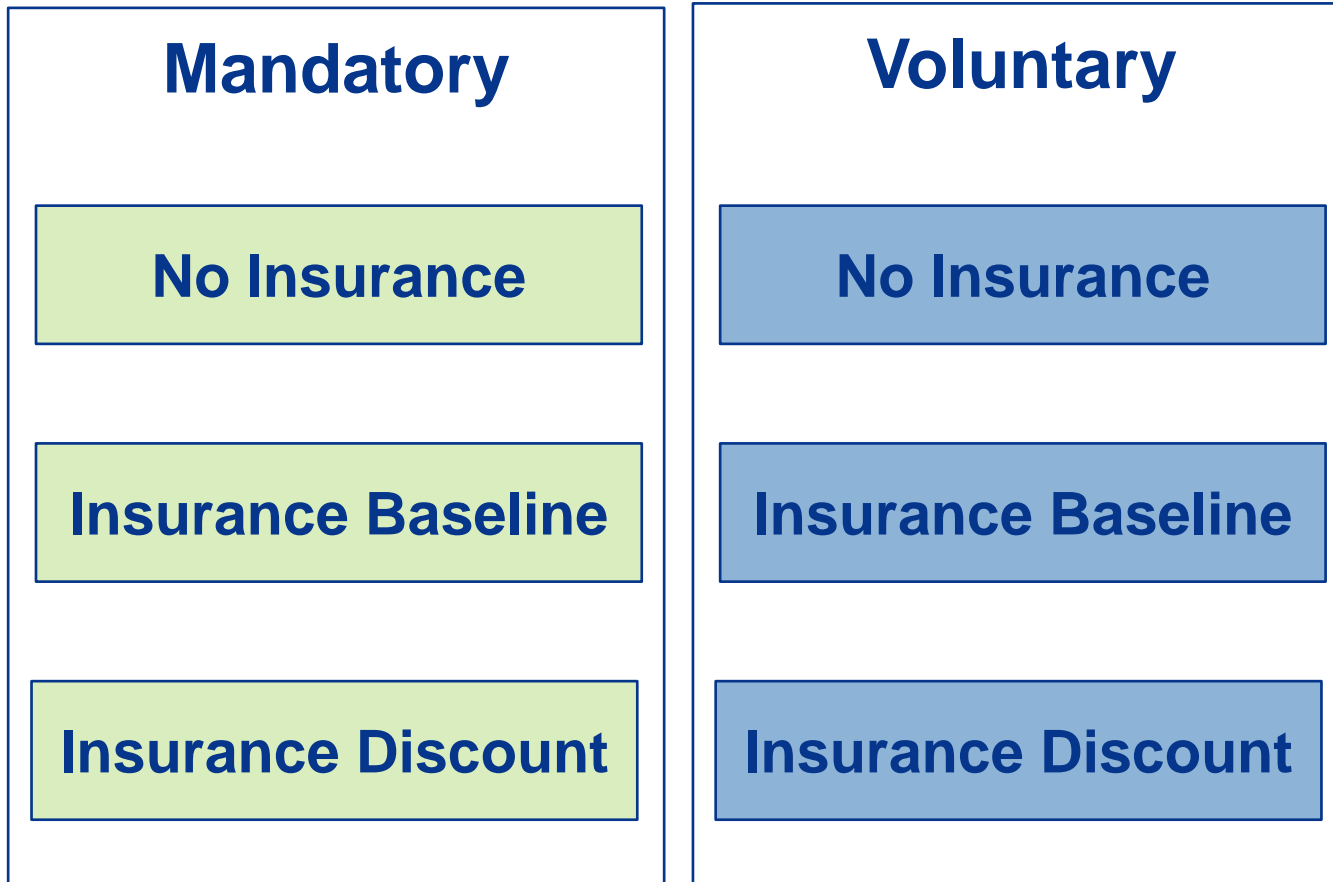
5. Lab in field experiment: incentives for risk reduction in voluntary and compulsory flood insurance



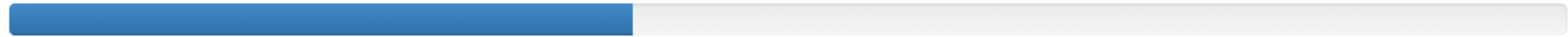
- 2111 homeowners
- Representative sample

Source: Mol et al.(2020), *J. of Economic Behavior and Organization*

Questionnaire versions with treatments



Would you like purchase insurance?



You own: your house and **65.000 ECU** on your savings account

In this scenario your house may be flooded **in the coming 25 years** (the probability is **1 percent per year** so approximately **22 percent in 25 years**).
If you own insurance and your house is flooded, you will pay **2.500 ECU**.



insurer pays
95 percent
of damage



you pay
5 percent
(deductible)

If you are uninsured and your house is flooded, you need to pay the full damage of **50.000 ECU**.

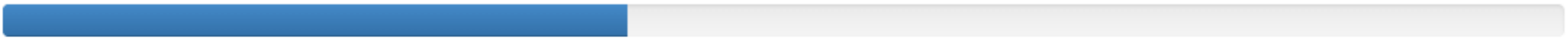
The insurance company offers insurance for 40 ECU ECU per month.

(That is 480 ECU per year. The total costs for 25 years are 12,000 ECU.)

Would you purchase this insurance coverage for the coming 25 years?

Yes, I want to purchase insurance for 40 ECU per month

No, I accept the risk



You own: your house and **65,000 ECU** on your savings account

The probability of a flood is **1 percent** per year

Scenario lasts **25 years**

Damage if flooded **50,000 ECU**

You have flood insurance
In exchange for a yearly premium of **384 ECU**, the insurance company pays 95% of your damage.

How much do you want to invest to reduce flood damage?

0 ECU

do no invest: I accept 50,000 ECU damage

you pay 2,500 ECU deductible if flooded

1,000 ECU

reduce damage to 45,242 ECU

you pay 2,262 ECU deductible if flooded

5,000 ECU

reduce damage to 30,327 ECU

you pay 1,516 ECU deductible if flooded

10,000 ECU

reduce damage to 18,394 ECU

you pay 920 ECU deductible if flooded

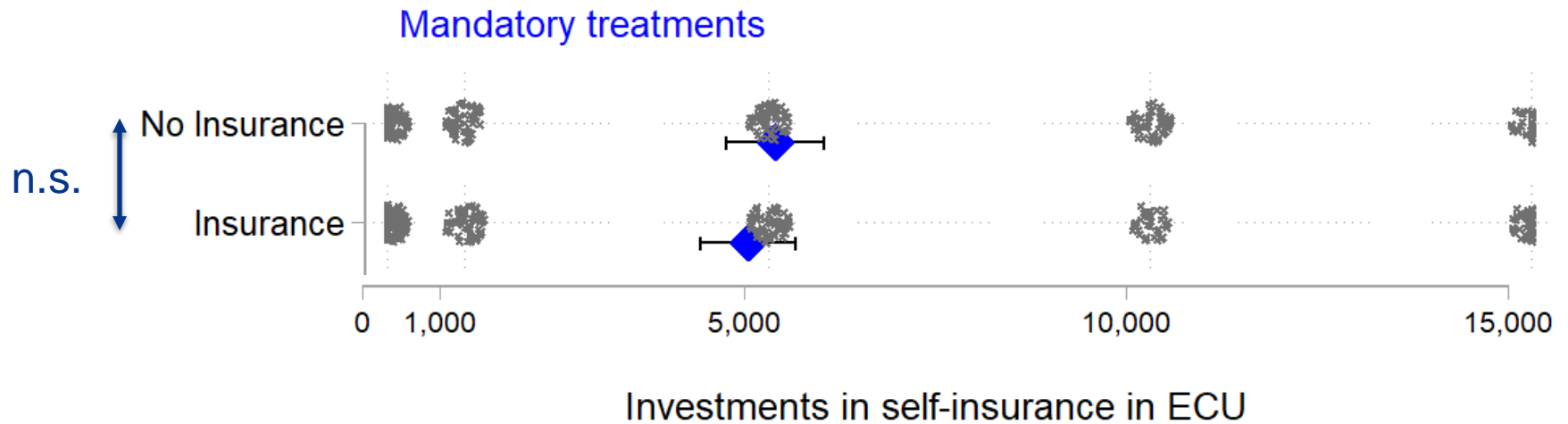
15,000 ECU

reduce damage to 11,157 ECU

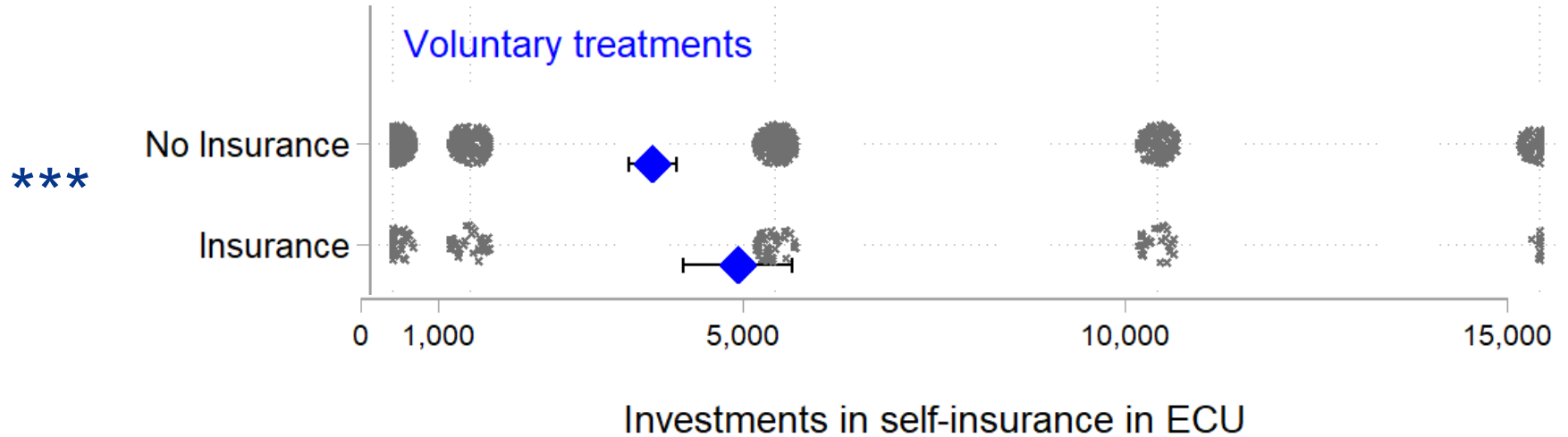
you pay 558 ECU deductible if flooded

Results (1): no moral hazard

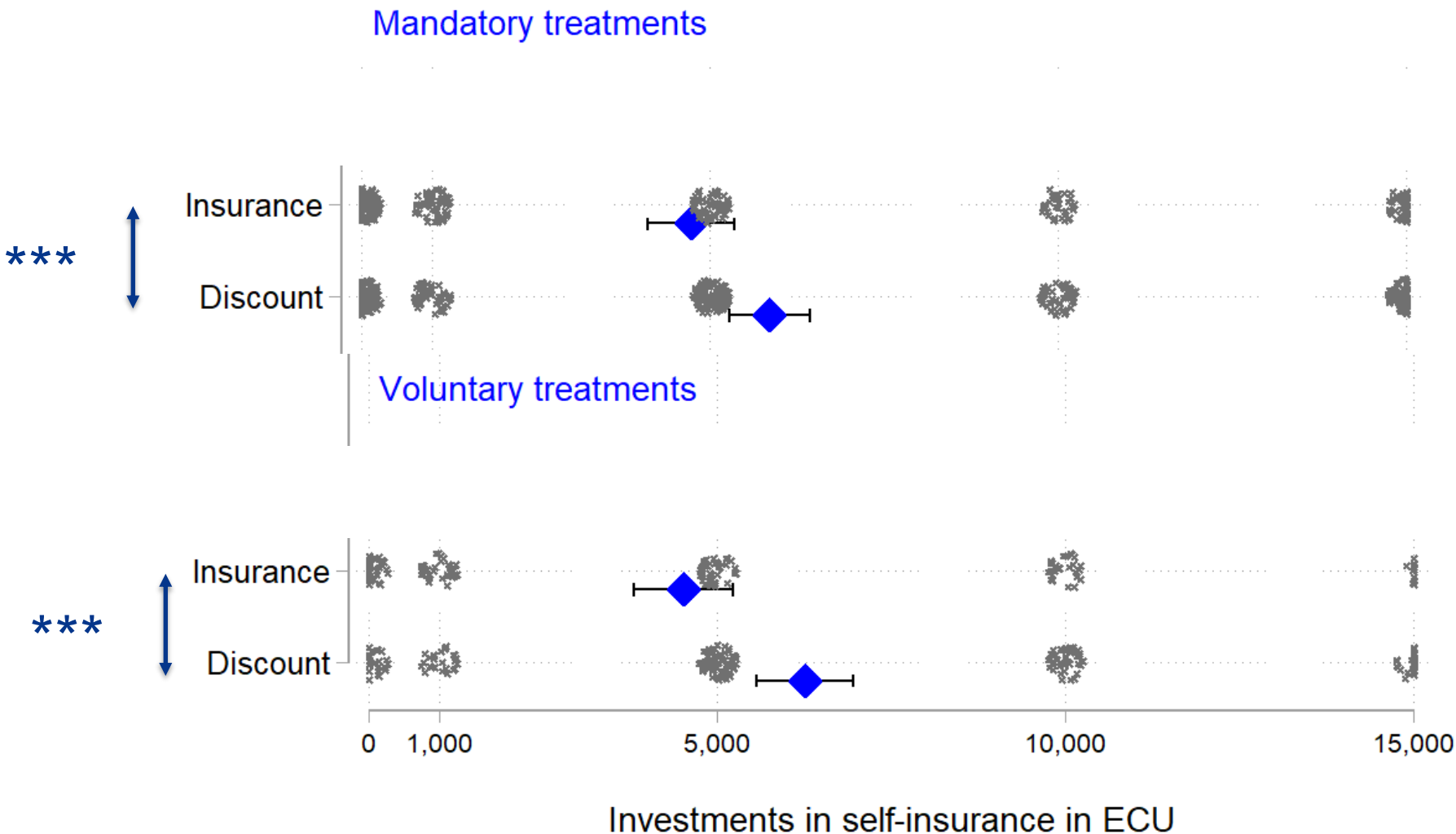
MWW test



Results (2): advantageous selection



Results (3): premium discount incentivizes risk reduction



Results (4): cautious types vs. uncautious types

Cautious types are motivated by:

- Higher risk aversion
- Higher perceived efficacy of mitigation
- Lower trust in dikes
- Social approval of peers

Uncautious types are motivated by:

- Lower locus of control
- Lower risk aversion
- Belief climate risk will not increase

	(3) Probit cautious	(4) Probit uncautious
Gender (1=female)	-0.219*** (0.0548)	0.0271 (0.0906)
Age in years	-0.0169*** (0.00392)	0.0147*** (0.00263)
Home > €500,000	-0.210 (0.193)	0.536** (0.216)
Master's degree	-0.0927 (0.156)	-0.251 (0.162)
Worried about flood	0.130** (0.0546)	-0.0418 (0.0679)
Agree social norm approve	0.310*** (0.118)	-0.240** (0.121)
Perceived efficacy of mitigation n	0.142*** (0.0422)	-0.360*** (0.0421)
Nr of mitigation measures implem	0.0356* (0.0205)	-0.0622*** (0.0208)
Risk averse self reported	0.170*** (0.0237)	-0.133*** (0.0247)
Present biased self reported	-0.104*** (0.0112)	0.0620** (0.0283)
Strong trust in dikes	0.118 (0.112)	-0.312*** (0.0960)
Locus of control	0.0326 (0.0201)	-0.0950*** (0.0266)
Climate risk will increase	-0.0481 (0.0777)	-0.174** (0.0831)
Expected damage > €50,000	0.206 (0.127)	-0.159 (0.124)
Sure live in flood plain	-0.374** (0.156)	0.123 (0.114)
Calculating strategy	0.238*** (0.0873)	-0.468*** (0.0848)

6. Concluding remarks

- Various behavioural biases imply suboptimal flood preparedness to be addressed by policy interventions
- Given increases in natural disaster losses the link between insurance and risk reduction should be strengthened
- Insurance can play this role since empirical studies find little evidence for moral hazard
- Premium discounts could be promising for stimulating risk reduction
- Insurance incentives should be part of a more comprehensive strategy (e.g. communication), as will be analysed in a new ERC project INSUREADAPT

References

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Questions?



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