Flood Insurance and Adaptation

Flood insurance in the Netherlands

- No general coverage available
- Ex-post public compensation (WTS)

Insurance as an instrument to increase economic resilience

- Risk spreading
- Financial security
- Incentives to reduce losses via price signal (Botzen et al., 2009 *Ecol. Econ.*)
- Mitigation via insurance limits variance of risk (Aerts & Botzen et al., 2008 *Ecol. Soc.*)
- Prevents government relief paid by tax money

Public-Private Partnership for Insuring Flood Damage

Extreme damage	Government
Medium damage	Capital markets Reinsurance companies Primary insurance companies
Low damage	Households and companies

Source: Botzen and van den Bergh (2008) *Risk Analysis*

Is WTP for flood insurance sufficient to make a private market viable?

Valuing Demand for Flood Insurance

Internet survey of 1200 homeowners in the river delta to examine

- WTP for flood insurance in the current situation

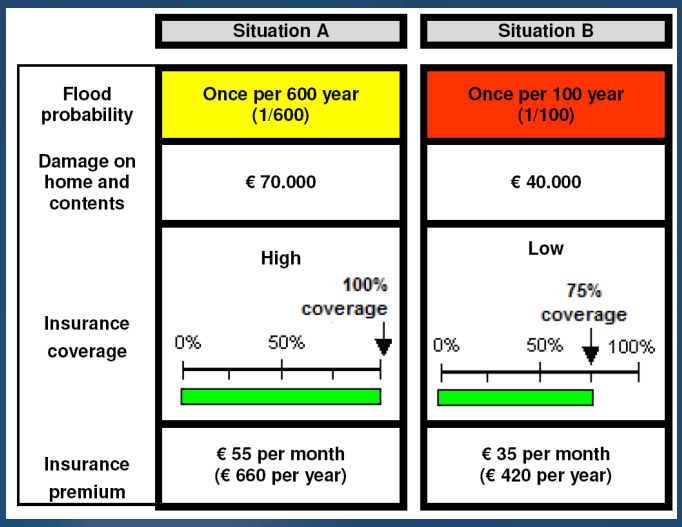
- Effects of climate and socio-economic change on WTP

- Influence of government compensation on WTP

-Possible problems with adverse selection

- Heterogeneity of WTP

Example of a Choice Card



Attributes and Levels used in the Choice Experiment

Attributes	Levels
Flood probability	Once per 1250 years
	Once per 600 years
	Once per 400 years
	Once per 100 years
Damage on home contents and house	€ 40,000
	€ 70,000
	€ 120,000
Insurance coverage	High (100%)
	Low (75%)
Insurance premium	€ 10 per month
	€ 20 per month
	€ 35 per month
	€ 55 per month
	€ 80 per month

Insights from Economic Decision Theories

Prospect theory (Kahneman and Tversky, 1992)

- Non-linear probability processing

Prospective reference theory (Viscusi, 1989)

- Individual risk perceptions

Availability heuristic (Kahneman *et al*., 1982)

- Experience of flooding

Samaritan syndrome (Kunreuther *et al*., 2009)

- Government relief

Model with Observed Heterogeneity

$$U_{\text{Insurance}} = \beta_1 * SQRT(probability) + \beta_2 * damage + \beta_3 * coverage + \beta_4 * (coverage * close\ to\ river) + \beta_5 * price + \beta_6 * (price * high\ income)$$

$$U_{\text{No insurance}} = constant + \beta_k * x_n$$

Where x contains variables on (n=25)

- Availability of government relief
- Perceptions of flood probability, flood damage, climate change
- Experience with flooding
- Geographical characteristics (GIS)
- Risk aversion and actual insurance purchases
- Socio-economic characteristics

Unobserved Heterogeneity

Mixed Logit Model

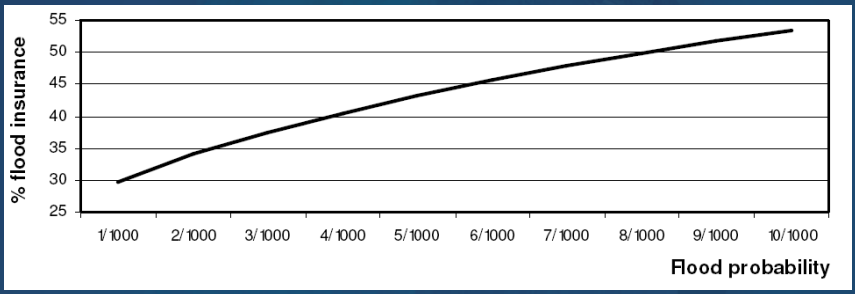
- Behavioral literature indicates heterogeneity in probability processing
- Random parameter of probability attribute

$$p_{ni} = \int \prod_{t=1}^{T} \left(\frac{e^{\beta x_{nit}}}{\sum_j e^{\beta x_{njt}}} \right) f(\beta) d\beta$$

Results of the Model with Heterogeneity

	Logit model		Mixed logit	
Variable	Coefficient	Wald-statistic	Coefficient	Wald-statistic
Attributes and interactions *(U Insurance)*:				
Flood probability	10.0541***	7.67	18.7052***	11.99
Flood damage	0.0041***	3.70	0.0044***	3.72
Insurance coverage	0.0072**	2.33	0.0077**	2.36
Insurance coverage * Close to main river	0.0032***	2.58	0.0035***	2.59
Insurance premium	-0.0447***	-20.48	-0.0486***	-20.12
Insurance premium * High income	0.0117***	3.44	0.0131***	3.60
Standard deviation flood probability	*n.a.*	*n.a.*	18.7052***	12.00
Constant	0.6173*	1.68	1.0616***	2.70
Number of observations	2751		2751	
Log likelihood	-2061		-2027	
Pseudo R^2	0.32		0.33	

Effects of Climate Change on % of Choices for Insurance



Estimates of Heterogeneity in Demand

Scenarios of the experiment:
- Flood damage and probability (+)
- Insurance coverage (+)
- Insurance premium (-)
- Availability government relief (-)

Indicators of objective risk:
- Distance to river (-)
- Elevation of the house (-)
- Rural area (+)
- Dike protection (*n.s.*)

WTP Flood Insurance

Socio-economic variables:
- Income (+)
- Risk aversion (+)
- Education (+)
- Children (+)
- Female (-)
- Values of assets (-)

Experience and risk perceptions:
- Experience with flooding and evacuation (+)
- Climate change causes higher flood risk (+)
- Risk of suffering flood damage (+)
- Expected flood damage (+)
- Lower flood risk than average resident (-)
- Flooding is exogenous to human control (-)
- Expected return period flood (-)

Market Penetration Insurance under a Range of Scenarios

Insurance premiums

- Risk based: *probability * damage*
- Loading factor similar as in NFIP

Socio-economic scenarios		Climate change scenarios			
Government relief available:	Expected Flood damage:	Current climate 1 in 1250	Small change 1 in 600	Middle large change 1 in 400	Extreme change 1 in 100
No	€ 40,000	58%	59%	59%	46%
No	€ 70,000	58%	56%	53%	21%
No	€ 120,000	58%	52%	44%	4%
Yes	€ 40,000	49%	50%	47%	38%
Yes	€ 70,000	49%	47%	45%	16%
Yes	€ 120,000	49%	43%	36%	3%

WTP, Conditional WTP, and Risk Premiums for Insurance

$$\Delta E(CS_n) = \frac{1}{\alpha_n}\left[\ln\left(\sum_{j=1}^{J1} e^{V_{nj}^1}\right) - \ln\left(\sum_{j=1}^{J0} e^{V_{nj}^0}\right)\right]$$

Insurance coverage and socio-economic scenarios			Flood probabilities under climate change scenarios							
			Current climate 1 in 1250		Small change 1 in 600		Middle large change 1 in 400		Extreme change 1 in 100	
Insurance coverage	Government relief	Expected flood damage:	WTP	CWTP	WTP	CWTP	WTP	CWTP	WTP	CWTP
100%	No	€ 40,000	180	220	209	259	233	290	388	491
			{148}	{188}	{142}	{192}	{133}	{190}	{-12}	{91}
100%	No	€ 70,000	196	240	227	280	252	312	414	520
			{140}	{184}	{111}	{164}	{77}	{137}	{-286}	{-180}
100%	No	€ 120,000	225	274	260	317	286	352	458	569
			{129}	{178}	{60}	{117}	{-14}	{52}	{-742}	{-631}
100%	Yes	€ 40,000	134	167	159	199	178	226	314	405
			{102}	{135}	{92}	{133}	{78}	{126}	{-86}	{5}
100%	Yes	€ 70,000	148	183	174	217	195	245	337	432
			{92}	{127}	{57}	{101}	{20}	{70}	{-363}	{-268}
100%	Yes	€ 120,000	172	212	201	250	224	280	377	478
			{76}	{116}	{1}	{50}	{-76}	{-20}	{-823}	{-722}

Conclusions

Demand side of flood insurance in the Netherlands

- Opportunities for (partly) private flood insurance
- Problems with adverse selection may be minor
- Damage mitigation limits impacts of climate change
- Samaritan syndrome

Behavioural findings

- Concave relation between WTP and the flood probability
- Perceptions play an important role in choice
- Intense experience with flooding drives demand
- Heterogeneity exists in processing of probabilities

Comparison of results

- Similar to results of a CV study and prospect theory
- Price elasticity and market penetration are similar to RP studies in USA