

### 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?

3

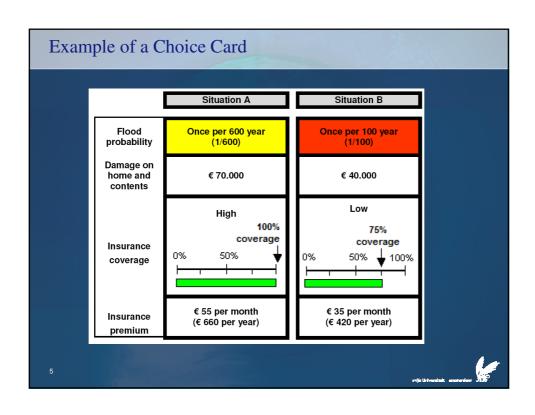
## Valuing Demand for Flood Insurance

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



4



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

7



## 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

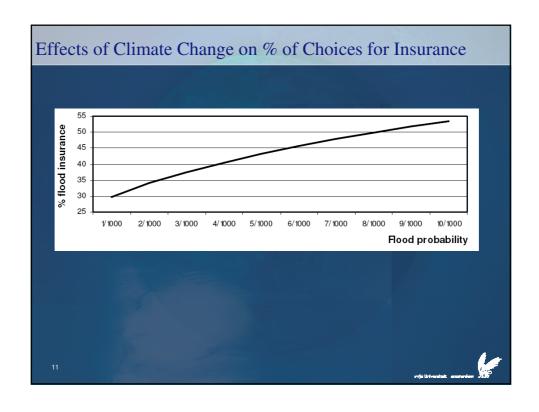
$$p_{ni} = \int \prod_{t=1}^{T} \left( \frac{e^{\beta x_{nit}}}{\sum_{j} e^{\beta x_{njt}}} \right) f(\beta) d\beta$$

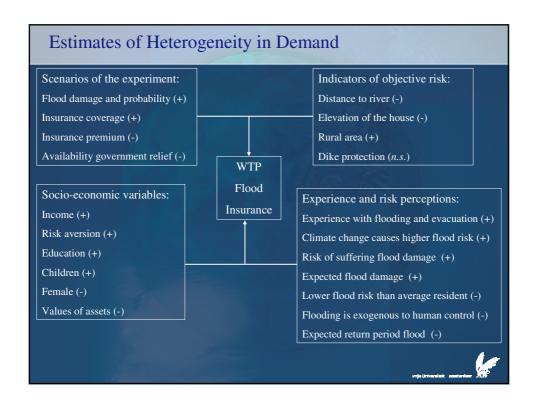
9

6

# Results of the Model with Heterogeneity

	Logi	t 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 <sup>2</sup>	0.32		0.33		





# 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	Expected	Current climate Small change		Middle large change	Extreme change		
available:	Flood damage:	1 in 1250	1 in 600	1 in 400	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

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

						-17/	102575 (87.7)			
Insurance coverage and		Flood probabilities under climate change scenarios								
socio-economic scenarios		Current climate		Small change		Middle large change		Extreme change		
Insurance	Government	Expected	1 in 1250		1 in 600		1 in 400		1 in 100	
coverage	relief	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

15

rije Universiteit: excetendem :